GL Noble Denton

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Review and Comparison of Petroleum Safety Regulatory Regimes for the Commission for Energy Regulation

Written to support the design of the Petroleum Safety Framework under the Petroleum (Exploration and Extraction) Safety Act 2010

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Executive Summary

The Petroleum (Exploration and Extraction) Safety Act 2010 (PEES) passed in April 2010 empowers the Commission for Energy Regulation (CER) to set up a petroleum safety framework for petroleum activities that is risk-based and is permissioning in that a Safety Case produced by the Operator needs to be accepted by the CER before petroleum activities/operations can commence.

In summary, the PEES Act requires that the CER:

- Define the designated petroleum activities to which the PEES Act applies (by further regulation);
- Set up a petroleum safety framework;
- Write Safety Case guidelines for Operators and a Safety Case assessment manual for the CER;
- Define a risk-based framework that includes guidance on how to assess if a risk is as low as reasonably practicable (ALARP);
- Determine a fees structure; and
- Define petroleum incidents that must be reported (by further regulation).

The CER has established a project team, to manage the full implementation of the PEES Act and has commissioned GL Noble Denton to provide a review and comparison of five different regulatory regimes to identify good practice for Ireland, and to provide information that may be considered by the CER in meeting their responsibilities under the PEES Act.

This review by GL Noble Denton has covered five regulators who regulate onshore and offshore petroleum activities in various ways depending on: historical factors, size of industry and size of regulator. The regulators that have been reviewed are: UK, Denmark, Norway, Australia (Western) and Canada – Nova Scotia and cover a range of industry size from large (UK and Norway) to small (Nova Scotia) where the number of offshore installations is similar to Ireland.

The legislation in each country is summarised in the body of the report and this is followed by a comparison of key aspects of them in order to provide information on the options for development of the petroleum safety framework:

- Differences in scope between offshore, pipelines and onshore and the regulators that cover these areas;
- The legislative structure including scope and documentation submission requirements;
- The status of guidance and standards within the legislative framework (in some cases, there may be many standards referred to in the legislation);
- Incident reporting;
- The regulators' approach to compliance assurance;
- The risk framework that underpins each regulatory approach;
- Interaction with other regulatory authorities e.g. marine and aviation; and
- Safety Case guidelines and comparison of Safety Case content.

From a comparison of the above, it is apparent that there is a significant degree of similarity between each regulatory regime. All are risk-based, although some refer more directly to standards in the legislation and all have safety cases, or almost equivalent documents. All counties reviewed operate a permissioning regime whereby permission to operate is only given if documentation is received and approved by the regulator. However, three differences are apparent, the inclusion of occupational hazards, the use of third parties for compliance assurance activities and the level of detail in the legislation.

- Occupational hazards are included in the same legislation as major hazards for all countries reviewed apart form the UK. Thus inclusion could be considered best practice. To achieve this in Ireland, the CER will have to liaise with the HSA, who are responsible for occupational matters offshore.
- In all areas some compliance assurance is undertaken through third parties. This is most often concerned with design and is termed, validation, verification or similar, though in the UK it extends to operations as well.
- Different regulators have significantly different amounts of guidance and detail in their legislation. Larger and more established regulators in the UK, Norway and Australia have either produced detailed legislation (Norway), or significant guidance (UK and Australia). Denmark has little guidance, but refers to the UK HSE. Canada and Norway refer to standards which, by definition do not need guidance, but for the goal setting elements in Canada, there is little guidance. Denmark and Canada, with little guidance, spend more time on inspection per installation than UK, Norway, or Australia.

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Glossary

ACOP	Approved Code of Practice. An approved code of practice gives guidance as to how a regulation may be complied with and (in the UK) has the standing in law that if complied with, the Operator is assumed to have generally discharged their duties effectively. It is also recognised that there will be other means of complying with the regulation that may not follow the approved code of practice.
ALARP	As Low As Reasonably Practicable". At the core of this is the concept of "reasonably practicable" and this involves weighing a risk against the trouble, time and money needed to potentially reduce the level of risk and thus assess the acceptability of the risk. Using "reasonably practicable" allows regulators to set goals for Duty Holders, rather than being prescriptive.
Duty Holder	A Duty Holder is the Operator of a production installation or Owner of non-production installation.
Goal-Setting	Instead of a prescribed checklist of things to do, which may not be right for all circumstances, goal-setting law sets out the objectives to be achieved. Duty Holders must systematically identify hazards, assess the risks and the consequences of those hazards being realised; and put in place suitable procedures and measures to control the risks.
Permissioning	A regime is permissioning if the start or continuation of a particular work activity is conditional upon a consent, licence or acceptance of a safety case or safety report by the regulator.
Risk-Based	Legislation is risk-based if it sets a framework for an Operator to manage the risk of their operations as they see fit as long as the risk from these operations meets a certain criteria (e.g. the risk is as low as reasonably practicable, ALARP).
Operator	An Operator is the person appointed by the licensee to manage and control directly the execution of the main functions of an installation.

Abbreviations

Generic Abbreviations

ALARP	As Low As Reasonably Practicable
EIA	Environmental Impact Assessment
ESDV	Emergency Shutdown Valve
EU	European Union
FPSO	Floating Production Storage and Offloading vessels
HLV	Heavy Lift Vessel
IADC	International Association of Drilling Contractors
IACS	International Association of Classification Societies
IMO	International Marine Organisation
IRF	International Regulators Forum
MODU	Mobile Offshore Drilling Unit
NSOAF	North Sea Offshore Authorities Forum
OIM	Offshore Installation Manager
PTW	Permit to Work
SMS	Safety Management System
SOLAS	Safety Of Life At Sea

Irish Abbreviations

CER	Commission for Energy Regulation
HAS	Health and Safety Authority
PEES	Petroleum (Exploration and Extraction) Safety Act 2010

UK Abbreviations

AAIB	Air Accident Investigation Board
ACOP	Approved Code of Practice
CAA	Civil Aviation Authority
COMAH	Control of Major Accident Hazard Regulations
COMOPS	Combined Operations
DCR	Design and Construction Regulations
ED	Environmental Impact Directive
EPWR	Electricity and Pipelines Works Regulations 1990
HID	Hazardous Installations Directorate (UK HSE)
HSC	Health and Safety Commission (UK)
HSE	Health and Safety Executive (UK)
HASAW	Health and Safety at Work Act
ICP	Independent Competent Person

KP3/4	Key Programme Reports (UK HSE)
LOLER	Lifting Operations and Lifting Equipment Regulations 1998
MAPD	Major Accident Prevention Document (MAPD)
MAR	Offshore Installation and Pipeline Works (Management and Administration) Regulations
MHSWR	Management of the Health and Safety at Work Regulations
OSD	Offshore Safety Division (UK HSE)
PFEER	Prevention, Fire & Emergency Response Regulations
PLL	Potential Loss of Life
PPE	Personal Protective Equipment
PSR	Pipeline Safety Regulations
R2P2	Reducing Risk – Protecting People (UK HSE)
RIDDOR	Reportable Incident and Dangerous Occurrences Regulations
SCE	Safety Critical Elements
SCR	Safety Case Regulations
SEPA	Scottish Environmental Protection Agency
SIL	Safety Integrity Level
SMS	Safety Management System
SR&SCR	Safety Representatives and Safety Committees Regulations
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
WSE	Written Scheme of Examination

Danish Abbreviations

CAA-DK	Danish Civil Aviation Authority
CRPO	Conditions Regarding Pre-Investigations Offshore
DEA	Danish Energy Agency
DEMA	Danish Emergency Management Authority
DEPA	Danish Environmental Protection Agency
DMA	Danish Maritime Authority
DWEA	Danish Working Environment Authority
EIA	Environmental Impact Assessment
EO	Executive Order
GFD	Guidelines for Drilling 1988
GDFOS	Guidelines for the Design of Fixed Offshore Installations 2009
OSA	Offshore Safety Act 2006
WEA	Working Environment Authority
WPA	Work Place Assessment

Western Australian Abbreviations

AMSA	Australian Maritime Safety Authority
APPEA	Australian Petroleum Production and Exploration Association
ATSB	Australian Transport Safety Bureau
CASA	Civil Aviation Safety Authority
DMP	Western Australian Department of Mines and Petroleum
DPP	Diving Project Plan
DSMP	Diving Safety Management Plan
EPA	Environmental Protection Agency
IADC	International Association of Drilling Contractors
IRF	International Regulators Forum
IRT	Independent Review Team
MCMPR	Ministerial Council on Mineral and Petroleum Resources
NOPSA	National Offshore Petroleum Safety Authority
OGP	International Association of Oil and Gas Producers
OPGGSA	Offshore Petroleum and Greenhouse Gas Storage Act 2006
OSH	Occupational Safety and Health
PAGERA	Petroleum and Geothermal Energy Resources Act 1967
PAGOSR	PAGERA Occupational Safety and Health Regulations 2010
PAGMSR	PAGERA Management of Safety of Pipeline Operations Regulations 2010
PLARA	Petroleum Legislation Amendment and Repeal Act 2005
PMP	Pipeline Management Plan
PPA	Petroleum Pipelines Act 1969
PPAMSR	PPA Management of Safety of Pipeline Operations Regulations 2010
PPAOSR	PPA Occupational Safety and Health Regulations 2010
PSLA	Petroleum Submerged Lands Act 1982
PSLDSR	PSL Diving Safety Regulations 2007
PSLMSR	PSL Management of Safety on Offshore Facilities Regulations 2007
PSLMWR	PSL Management of Well Operations Regulations 2006
PSLOSR	PSL Occupational Safety and Health Regulations 2007
PSLPR	PSL Pipelines Regulations 2007
PSMP	Pipeline Safety Management Plan

Norwegian Abbreviations

AoC	Acknowledgment of Compliance
IRF	International Regulators Forum
NAR	The Norwegian Activities Regulations
NFR	The Norwegian Facilities Regulations

NHSER	The Norwegian Framework HSE Regulations
NIDR	The Norwegian Information Duty Regulations
NMR	The Norwegian Management Regulations
NPD	Norwegian Petroleum Directorate
NSHD	Norwegian Social and Health Directorate
NSOAF	North Sea Offshore Authorities Forum
PSA	Petroleum Safety Authority
SFT	Norwegian Pollution Control Authority

Canadian – Nova Scotia Abbreviations

CEAA	Canadian Environmental Assessment Act 1992
CNLOPB	Canada Newfoundland & Labrador Offshore Petroleum Board
CNSOPB	Canadian Nova Scotia Offshore Petroleum Board
COGOA	Canada Oil & Gas Operations Act 1985
COGOSHR	COGO Safety and Health Regulations
CPRA	Canada Petroleum Resources Act 1985
CSA	Canadian Standards Association
GOR	Goal-Oriented Regulation
IMO	International Maritime Organisation
NEB	National Energy Board
NEBA	National Energy Board Act 1959
NSODPR	Nova Scotia Offshore Drilling and Production Regulations
OPR	Onshore Pipeline Regulations 1999
OPPR	Onshore Process Plant Regulations 2003
PPR	Processing Plant Regulations 2003
TLS	Target Level of Safety

1 INTRODUCTION

1.1 PETROLEUM (EXPLORATION AND EXTRACTION) SAFETY ACT AND CER

The Petroleum (Exploration and Extraction) Safety Act 2010 (PEES) passed in April 2010 empowers the Commission for Energy Regulation (CER) to set up a petroleum safety framework for petroleum activities that is risk-based and is permissioning in that a Safety Case produced by the Operator needs to be accepted by the CER before petroleum activities/operations can commence.

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The CER has established a project team, to manage the full implementation of the PEES Act and has commissioned GL Noble Denton to provide a review and comparison of five different regulatory regimes to identify good practice for Ireland, and to provide information that may be considered by the CER in meeting their responsibilities under the PEES Act.

1.2 REVIEW STRUCTURE

Following a very brief overview of typical oil and gas activities below, the scope of the review is defined in Section 2. An overview of the current situation in Ireland and the five countries reviewed is given in Section 3 and Section 4 gives the methodology used to do this. Sections 5, 6, 7, 8 and 9 give details of the review for the five countries. Finally, Section 10 gives a comparison of the different regimes and identifies some of the pros and cons of their application to Ireland. Covering five different countries, the scope of the review is large and so approaches most issues from a high level that will be sufficient to inform the structure and approach for the Petroleum Safety Framework. In order to show some of the detail that will need to be considered as the framework is developed, Appendix A contains a comparison of legislation across the five countries for a single safety system in an offshore situation.

Within Section 10, there is a summary table for each country that describes the main features of the legislative framework for onshore, offshore and pipelines.

1.3 OIL AND GAS ACTIVITIES

The process of producing oil and gas involves many parties and complex facilities, but is in essence a simple process of drilling a well into an oil, or gas-bearing rock (reservoir), separating the gas and oil from water that is also produced from the well and piping it back onshore for further treatment to sales quality gas, or oil for further refining.

Prior to drilling operations, seismic surveys are undertaken from vessels to identify where oil-bearing rock is located. If such rock is found, an exploration well is drilled from a vessel, or a rig that stands on the sea bed (a jack-up) and, if hydrocarbons are found, the well is tested to determine the type of oil and gas that is in the reservoir and the likely quantities and its pressure and temperature. Once this information has been gathered, a facility to produce the hydrocarbons is designed. Such a facility may be a subsea well with a

pipeline directly to the beach, or a platform where some processing of the hydrocarbon is undertaken prior to export to the beach. The design must also take into account the expected environmental conditions, life of the field and, for a platform, or floating production unit, the number of people that will be required to work on it. At the same time, if export is not by tanker alone, the pipeline from the offshore location to an onshore terminal needs to be designed along with any onshore facilities that are required.

If the hydrocarbon cannot be processed sufficiently offshore, the pipeline will terminate at an onshore terminal. The terminal will perform further processing to separate gas from oil and potentially different types of gas (methane, ethane etc). Other contaminants ranging from gasses to metals may also be removed onshore and specialist treatment facilities are designed for this.

During the operation of a platform, a significant proportion of the overall workload is routine maintenance of production and safety systems. Other work includes logging of production parameters, testing of oil and gas samples and engineering changes associated with repairs and process modifications to improve production rates. Personnel travel offshore in helicopters, but most equipment is transported by supply vessel. As a standard safety measure, a standby vessel is permanently stationed close to the platform and is ready to assist in an emergency. Other support services are required from time to time. For example, if the pipeline or jacket structure needs to be inspected a dive support vessel is used to support diving activities. Further wells may be drilled, which may involve a drill rig coming alongside the platform for a number of months.

2 SCOPE OF THE REVIEW

The scope of the review is directed by the magnitude of the oil and gas industry in Ireland and, to a lesser extent, by the legislation that already exists. There is currently one producing offshore asset in Irish waters (Kinsale) and one potential development (Corrib Gas Field) both with associated pipelines and onshore facilities and so, even considering future developments, the oil and gas industry in Ireland is relatively small. The CER is in the advantageous position of developing the petroleum safety framework anew and therefore has the opportunity to identify and review processes to ensure that international best practice is applied. Therefore, a review was undertaken of similarly sized oil and gas provinces and those that are thought to embody best practice. The following five countries were selected for this review:

- The United Kingdom;
- Denmark;
- Western Australia;
- Norway; and
- Canada – Nova Scotia.

These were selected by CER and GL Noble Denton on the basis that they all have well-established onshore and offshore oil and gas industries and they reflect the extent to which different approaches to safety regulation are recognised internationally as both appropriate and effective for the petroleum industries.

Canada Nova Scotia is especially relevant due to the small number of offshore installations (one), which is the same as currently exists in Ireland. Denmark has 21 installations (although some of these are unmanned and connected to larger facilities), and therefore provides an example of a medium-sized oil and gas industry in a Western European location. Norway and the UK both have sizable oil and gas industries with several hundred installations between them and both have relatively mature, yet different, safety legislative and regulatory systems. Due to their size, they are at the forefront of legislative development, but the legislation differs between them in being more prescriptive in Norway, while the UK was the first country to introduce permissioning and then goal-setting legislation offshore. Australia has a large oil and gas industry, but has recently updated its onshore and offshore oil and gas legislation and it thus gives a good example of how other countries are developing their legislation in today's environment.

Analysis of the PEES Act identifies the three most significant requirements that will have to be met by the CER in meeting its responsibilities with respect to petroleum activities in Ireland. These are given below together with how each requirement is covered within the scope of this report:

1. *To develop a list of petroleum activities that will be designated to fall within the scope of the PEES Act.*

   The scope of this report includes analysis of activities that are included within the five regulatory regimes in different countries.

2. *To establish a safety regulatory framework.*

   The safety regulatory framework for each country is analysed in terms of:

   - The legislative structure including scope, documentation requirements and size
   - Incident reporting
   - The regulator and their internal processes and size
   - The risk framework that underpins the legislation
   - Interaction with other regulatory authorities e.g. marine and aviation

3. *To prepare safety case guidelines.*

   Within this report, an overview of the contents of a Safety Case, or equivalent document is given.

3 Overview of Countries Reviewed

The growth of civilised industrial societies, particularly those involving potentially major hazard related industries, has engendered the development of legislated safety regulation. This is particularly the case in the petroleum exploration and extraction industry.

In the UK, health and safety legislation is built on the Health and Safety at Work Act (1974), which addressed aspects of both public and worker safety associated with general employment. However, it was in response to the Piper Alpha Disaster in the UK North Sea, with 167 fatalities, that in 1992 the UK Government enacted specific legislation directed at the oil and gas exploration and production industry. This development also separated the specific regulation of safety from economic regulation. The UK adopted permissioning and then goal-setting oil and gas safety regulation and is recognised as having one of the most mature of the current safety regulatory systems. Currently for the UK there is separate legislation governing offshore, onshore and pipeline safety, but all are administered by the same regulatory authority. This same authority is also responsible for non oil and gas specific safety regulations that also apply to oil and gas facilities. The UK approach is predominantly risk-based and requires the operator of an installation or facility to demonstrate compliance through the preparation and implementation of a formal safety case and safety management system; although there are some elements of the regulations that are clearly prescriptive. It is particularly relevant that the concept of reducing risk to As Low As Reasonably Practicable (ALARP), which is recognised in some form or other in most international risk-based regulatory processes, originated in the UK. The UK Health and Safety Executive (HSE) have carried out much work in assessing the public tolerability of risk and have thus derived suggested values that can be applied as risk acceptance criteria.

Australia has historically employed the UK processes for safety regulation, but in recent years has undergone a significant internal review and update of its legislative processes and is therefore considered to present a modern approach to risk-based regulation. The Australian system also requires the development of a safety case and a safety management system, although it is notable that more emphasis is placed upon occupational health and safety management than is the case within the UK regulations. The outcome of the review and update is a commonality of approach for offshore, onshore and pipeline installations. Although this process was driven by the National Government of Australia, the actual day-to-day application of safety regulation is handled by the individual states, albeit following the common model defined by the central government. The state of Western Australia was chosen as the specific area for review as it has more extensive offshore and onshore facilities than other states. Nevertheless, it is important to note that the regulatory authority covering offshore petroleum activities operates nationally whereas the onshore regulatory processes are administered by a state specific mineral and geothermal energy authority.

Norway is also recognised as having a well-established and mature safety regulation system. The Norwegian approach is significantly prescriptive and it utilises risk assessment and represents an alternative approach to that employed in the UK. The same safety regulations apply across all aspects of the petroleum industry and these regulations are administered by a single authority although there are many other sets of occupational and environmental regulations administered by their own authorities. For major hazards, a single petroleum industry authority has been given the responsibility to apply all the different regulations as they apply to the petroleum industry. Another pertinent aspect of the Norwegian approach is the raised emphasis placed upon occupational health, safety and environmental controls.

in Denmark, there are separate regulators for offshore and onshore facilities and again for marine matters and vessel regulation. The Danish regime employs some goal-setting processes in its requirements for risk management, although elements of prescription still remain. There are also a number of regulators for onshore sites in Denmark, which is analogous to Ireland. Denmark differs from the other regimes reviewed in that a large amount of subsidiary legislation exists, covering very specific aspect of operations, or design.

Within Canada, regulation of pipelines is by a national body, whereas onshore terminals and offshore are regulated by the relevant province. In this review, Nova Scotia is chosen as the provincial regulator due to its relatively small size. The primary importance of including the Canadian regulatory approach in this review is that it employs recognised certifying authorities to assess compliance with the regulations and then to issue a Certificate of Fitness to provide the necessary compliance assurance evidence to the regulator. The regulatory systems are mostly prescriptive with minimum standards imposed by referencing existing Canadian and American standards. However it is notable that goal orientated regulations are now being introduced into the process. A key part of the Canadian offshore goal orientated approach is the use of the Concept Safety Analysis and Safety Plan and these can be equated to safety cases and safety management systems as required in the other countries. With respect to risk assessment and specifically the assessment of risk to life and to the environment, the operator is required to set his own target levels of risk.

The underlying objective of all the five safety regulatory regimes is to address major accident hazard concerns and therefore they focus on the integrity of engineered systems and the reliability of defined barriers to potential hazard impacts. However the various occupational safety and environmental philosophies in each country lead to varying degrees of emphasis placed upon occupational health and safety matters and environmental impact and pollution issues. These differences are addressed within the review process, as are variations in the extents of the requirements relating the demonstration of safety compliance to the issue of licences, leases or permits for various petroleum activities.

4 METHODOLOGY

The first part of the methodology was to identify the primary and secondary legislation in each country and to present a summary of the resulting applicable regulatory structures. The detailed requirements defined within the legislation are then summarised to provide an insight into safety philosophies being followed by each country. The two primary aspects of regulation being addressed are;

i) The emphasis being placed upon either risk-based concepts where the operator is responsible for demonstrating safety, or a prescriptive approach where the regulator sets out specific requirements that have to be met by the operator;

ii) The extent to which occupational health, safety and environmental considerations are being addressed in addition to the core issue of major accident hazards. Recognising that even under the more prescriptive regimes there is a need to assess hazards and risks, specific consideration is given to indicating how each regime defines appropriate criteria for risk acceptance.

The physical scope is given for each set of legislation relating to installations, facilities, pipelines, and for the offshore environment, the types of vessels that could be involved in petroleum exploration or extraction activities. The range of submissions that are required to be made by operators to demonstrate their compliance with the applicable regulations is listed to provide indications as to what types of documentation can be reviewed or audited by regulators to achieve compliance assurance. Note that for each country this data are from various sources and may not be exhaustive in some areas.

The scope of the PEES Act includes offshore and onshore installations and their associated pipelines. Potentially this covers all facilities and installations from wells through to the terminals and processing facilities from which sales or distribution quality products will be exported. Typically different sets of regulations are applied to offshore or onshore facilities and pipelines and therefore, unless it is clear that common legislation applies the review separately addresses each of these aspects of petroleum activity.

In addition to addressing the technical details of the statutory regulatory processes for each of the selected countries, the review also provides information relating to the organisation of the authorities within each country that are responsible for administering and enforcing compliance with their regulations. Due to the inevitable cross-over with other areas such as marine, the review identifies other national authorities that hold responsibilities associated with petroleum activities. Where appropriate it also defines the statutory relationships between safety and economic regulation.

Following the summaries for each country, the report discusses a number of comparative aspects of regulation with a specific intent to provide an insight into what is considered to be best regulatory practice, to demonstrate how the various different approaches may be put to work within the context and practicable constraints applicable to the CER and Ireland and to highlight any identifiable strengths and weaknesses that are apparent in each regime. The subjects of the comparative discussions include:

- Comparison of differences in scope between offshore, pipelines and onshore and the regulators that cover these areas.
- For the safety regulatory framework, comparison of:
  - The legislative structure including scope and documentation submission requirements;
  - The status of guidance and standards within the legislative framework (in some cases, there may be many standards referred to in the legislation);
  - Incident reporting;
  - The regulators' approach to compliance assurance;
  - The risk framework that underpins each regulatory approach; and
  - Interaction with other regulatory authorities e.g. marine and aviation.
- Safety Case guidelines and comparison of Safety Case content.

Note that where a definition from a regulation or Act is used and its meaning is not immediately clear, it is marked in italic.

5 REVIEW OF THE UK REGULATORY SYSTEM

5.1 OVERVIEW

5.1.1 OIL AND GAS ACTIVITY IN THE UK

The extent of the UK oil and gas activity is shown on Figure 1 on the following page. Gas fields (shown in green) and oil fields (shown in red) are exploited by fixed production platforms, floating production vessels and a small number of subsea wells tied directly back to onshore terminals. The pipelines to the onshore terminals are shown in red and green for oil and gas respectively.

There are approximately 286 offshore production installations, of which approximately 147 are permanently manned and the rest normally unmanned, with regular visits for maintenance. In 2009 there were approximately 40 drilling rigs of which half were semi-submersibles and half were jackups. Most major pipelines in the UK are used to transport oil and gas products and the total length of all major pipelines is over 8,000km. There are fourteen major terminal sites in the UK where offshore pipelines come ashore and from which connections are made either to refineries or to the onshore distribution grid.

5.1.2 LEGISLATIVE OVERVIEW

The safety regulator for almost all industries in the UK is the Health and Safety Executive (HSE) which was established in 1974 as the executive arm of the Health and Safety Commission (HSC). Separate legislation covers offshore, onshore and pipelines facilities and the legislation is mainly goal-setting and permissioning, meaning that Safety Cases are required to be submitted to allow operations. The concept of reducing risk to As Low As Reasonably Practicable (ALARP), which is recognised in some form or other in most international risk-based regulatory processes, originated in the UK in 1949. The UK Health and Safety Executive (HSE) have carried out much work in assessing the public tolerability of risk and have derived suggested values that can be applied as risk acceptance criteria.

5.1.3 REGULATOR

The regulator for all oil and gas safety matters (occupational and major hazard) for onshore, pipelines and offshore is the HSE. Prior to 1992 the Department of Energy, had responsibility for offshore safety, however following the Cullen Report in 1992, this government department was relieved of this responsibility due to a perceived conflict of interest between economic and safety interests.

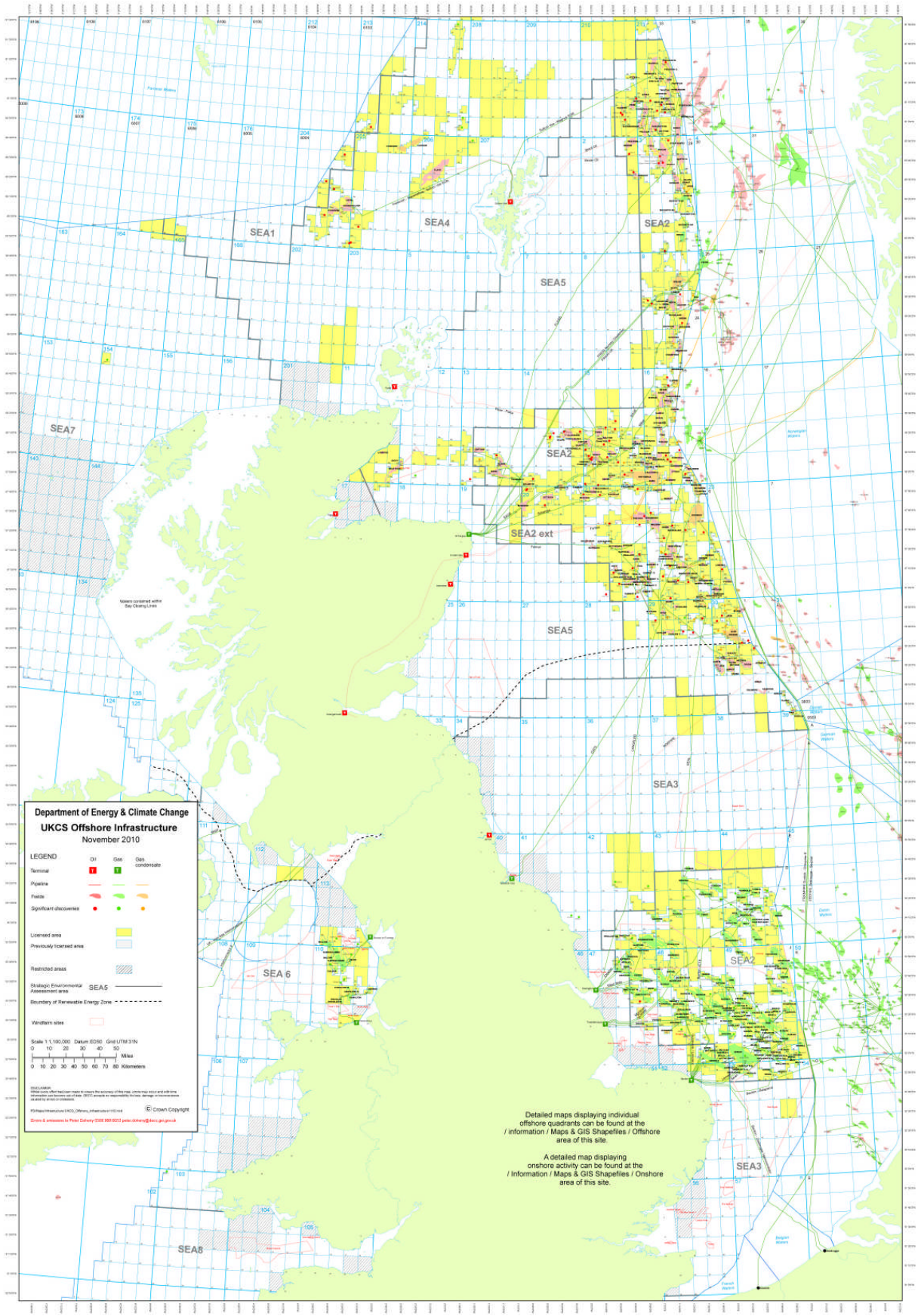

Figure 1: UKCS Oil and Gas (courtesy of the Department of Energy and Climate Change)

5.2 UK LEGISLATIVE STRUCTURE

5.2.1 PETROLEM ACTS AND LEGISLATIVE REGULATIONS

In the UK, Acts are passed that allow for further regulations (termed Statutory Instruments - SIs) that contain detailed requirements relating to a specific industry, plant, operation, or equipment. The Primary Acts in the UK that relate to health and safety for onshore sites, pipelines and offshore installations are:

- The Health and Safety at Work etc Act 1974 (HSWA); and
- The Offshore Safety Act 1992.

The HSWA sets up the general framework for safety legislation in the UK, which is, broadly speaking, risk-based, with the requirement for safety cases in certain instances. It is known as risk-based because it requires the employer to identify, assess and manage the risks of their operations. This is contrasted to the prescriptive approach where legislation defines the safety measures that must be taken without the need for the employer to assess risk. In the UK, the employer must demonstrate that risk is 'as low as reasonably practicable' (ALARP).

The two acts include provision for:

- General requirements for the employer and employee to manage and work in a safe manner taking account of the hazards that may be found in the workplace;
- The creation of the Health and Safety Commission and Executive (HSE) to monitor compliance with the HSWA and regulations (also known as Statutory Instruments) associated with it;
- The HSE to issue approved codes of practice (ACOP) and guidance, with the consent of the Secretary of State;
- The HSE to investigate an accident, occurrence, situation or other matter;
- The concept of Inspectors;
- Improvement Notices, where a specific improvement is required; and
- Prohibition Notices, where an operation has to be stopped until an improvement is made.

The regulation of major accident hazards is generally separate for offshore installations, onshore sites and pipelines and the primary regulations are shown in Table 1, with further explanation given in Sections 5.2.2, 5.2.3 and 5.2.4. The regulations are risk-based and require Safety Cases to be submitted to the regulator.

Occupational safety is regulated in all three areas by the Management of Health & Safety at Work regulations (MHSWR).

Note that the Gas Safety Management Regulations are included for completeness, but given that they do not apply to a pipeline from an oil / gas facility to a terminal or similar, they are not considered further in this review.

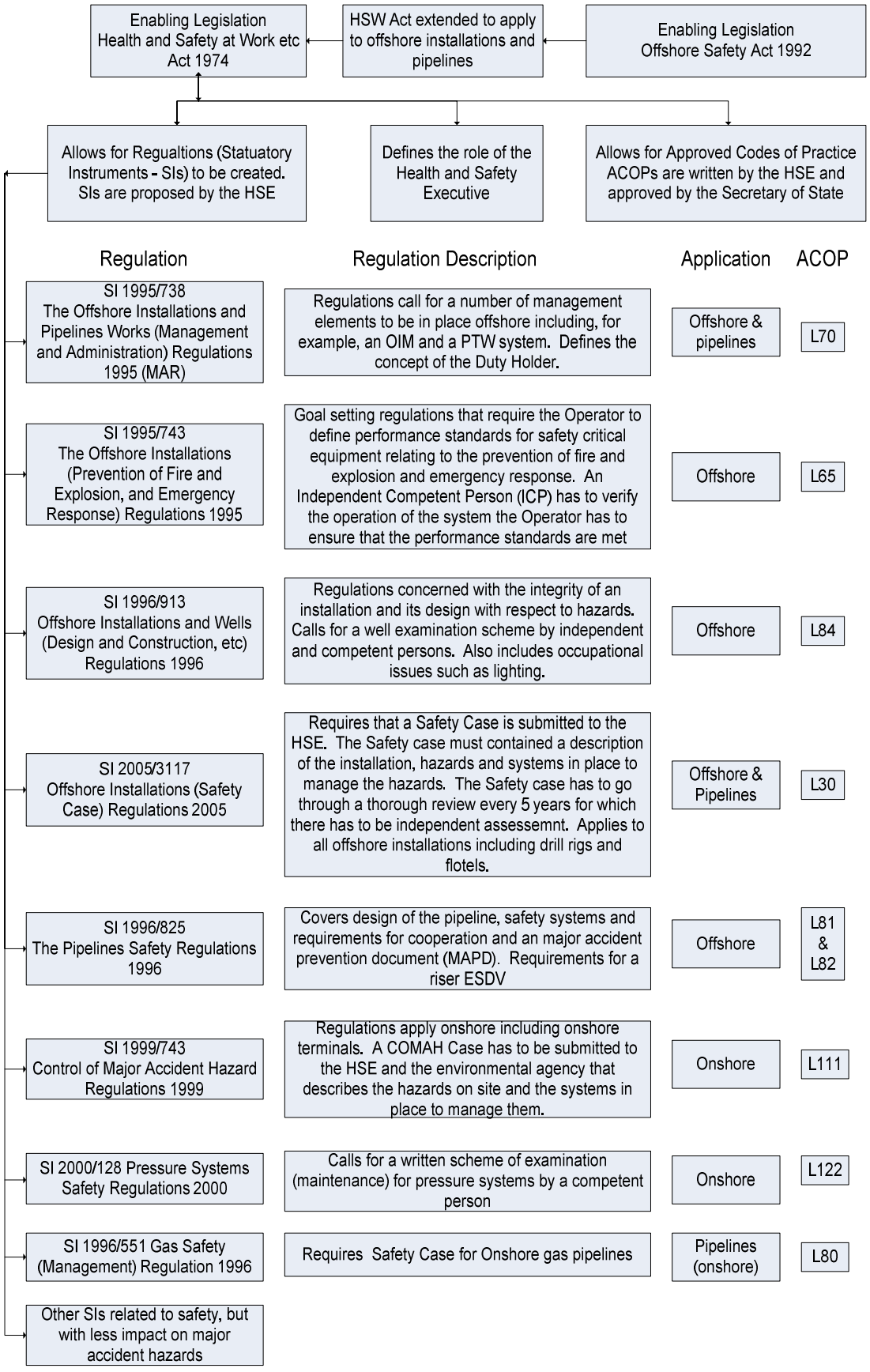

Figure 2: Primary UK Acts and Regulations

5.2.2 OFFSHORE

5.2.2.1 Overview

The UK offshore regime is a permissioning regime with a goal-setting, risk-based framework, where Duty Holders are required to manage the risks arising from their operations and describe this in a Safety Case for the operational phase of an installation and Notifications for other activities throughout the lifecycle of the installation. The regulations are not totally separate for major hazards and occupational safety, but the Safety Case Regulations (SCR), which form the cornerstone of the regime in the UK, do not deal directly with occupational matters. The SCR require a Safety Case to be prepared and submitted to the HSE prior to operation, on the HSE's direction and for a major modification to the installation. The Safety Case must be thoroughly reviewed at least every 5 years and a summary of the review submitted to the HSE.

The Safety Case describes how the Duty Holder has identified the major accident hazards that can affect the installation and how the consequential risk to personnel has been assessed and is being managed. The key parts of the Safety Case are therefore:

1. Description of the installation and its safety systems;
2. Management systems to manage the hazards and risks;
3. Hazard identification and risk assessment; and
4. Summary of the 5-yearly thorough review of the Safety Case.

Additional regulations which are relevant to major accident hazards are the PFEER and DCR regulations, which require the Duty Holder to have certain measures to prevent, detect, control and mitigate against these. For most safety measures, they are goal-setting and require the Duty Holder to define the performance of Safety Critical Elements (SCEs) and undertake maintenance so that this performance is maintained throughout the installation's lifecycle. The regulations then require an Independent Competent Person (ICP), which is normally a number of persons from one company, to independently verify whether this is being done.

The key part of these regulations is the requirement for the Duty Holder to establish performance standards for SCEs that define the minimum performance that the equipment needs to effectively manage the hazards and risks defined in the Safety Case. For a new design, the Duty Holder must show that the Performance Standards are suitable and sufficient, which is done through the application of industry standards or alternatively more detailed assessment, to show that the residual risk not removed by the safety system is as low as reasonably practicable (ALARP). In terms of safety related decisions, a framework for consideration of these approaches is illustrated in the UKOOA document 'A Framework for Risk Related Decision Support 1999'.

For an operational asset the Duty Holder must show that that the Performance Standards continue to be met. This is achieved by regular inspection, testing, maintenance and repair, (termed assurance) by the Duty Holder. In addition to the assurance work, the Duty Holder must establish a suitable Verification Scheme (or Written Scheme of Examination) that defines the scope of work for an ICP when verifying that the assurance activities are being undertaken and that the performance standards are being met. The HSE also has authority to investigate the ICP's findings and take appropriate action (see Section 5.4.3).

Wells are also safety critical, but are covered by a separate Well Examination Scheme under DCR.

5.2.2.2 Scope

Occupational and major hazards are managed largely by separate legislation offshore. The MHSWR regulate occupational matters and the DCR also contain some occupational health & safety requirements. Major accidents are regulated by SCR, DCR and PFEER and for these a major accident is defined as:

- Fire, explosion or release of dangerous substances that will cause death or serious injury;
- Major damage to the structure or plant;
- Loss of stability;
- Collision of a helicopter;
- Failure of life support system for diving operations; and
- Any other event involving death or serious injury to 5 or more people.

The SCR apply to installations and guidance provides a summary of what is an installation and what is not and this is repeated below:

Offshore installations (or parts of installation)	**Not offshore installations (or parts of installation)**
• Fixed production platforms • Floating production platforms • Floating storage units • Mobile offshore drilling units (MODUs) • Flotels • Subsea wells inside or outside the 500 metre zone and connected to an installation	• Heavy lift vessels* • Diving support vessels* • Shuttle tankers • Well service vessels* • Stacked MODUs • Subsea wells not connected to an offshore installation • Dredgers • Wells not connected to an installation • Survey vessels • Pipelaying barges • Pipelines which are more than 500 metres away from the main structure to which they are attached • Structures which are permanently attached to dry land by bridges or walkways * Under certain circumstances these may become offshore installations

Table 1: Installations defined within the scope of UK Regulations

5.2.2.3 Documentation

The table below shows the information that must be supplied to the HSE at different stages in the lifecycle of an installation:

Activity	Document Required	Legislation Reference	Comments
Seismic	No requirements		
Exploration Drilling	Notification before commencing any Well operations	SCR 17-1	Duty Holder shall ensure no well operation is commenced unless a notification has been sent to the Executive containing details in schedule 6 of SCR at least 21 days (or such a shorter period as the executive may specify) before commencing that operation.
Concept & FEED	Design Notification	SCR 6	Notification to be sent at such time before the submission of a field development programme to the Department of Trade and Industry as this will enable them to take account in the design of any matters relating to health and safety raised by the Executive within 3 months (or such shorter period as the Executive may specify) of that time.
Operations	Notification	MAR 5-1	The duty holder shall notify the Executive in writing no later than the date on which the offshore installation is due to enter or leave the relevant waters of its intended entry or departures from such waters.
	Safety Case for production installation	SCR 7,	Safety Case shall be prepared and forwarded to the executive at least 6 months before commencing operations.
	Safety Case for non-production installation	SCR 8b	Safety Case for a non-production installation shall be prepared and forwarded to the executive at least 3 months before it is moved into relevant waters with a view to operating there.
	Safety Case for non-production installation to be converted	SCR 9-1a&b	Design notification in respect of proposed conversion is required to be sent to the executive with enough time to incorporate any concerns of the executive made within 3 months of such notification.
	Reporting of danger to installation	DCR 9	Duty Holder shall ensure that within 10 days after the appearance of evidence of a significant threat to the integrity of the installation, a report is made to the executive in writing identifying such threat and specifying any actions taken or to be taken to avert it.
	Summary of the Thorough review	SCR 13	Safety Case thorough review done within 5 yrs, or when there is a major change to the installation, or when directed by the HSE.
Well Operations	Notification before commencing any Well operations	SCR 17-1	Duty Holder shall ensure no well operation is commenced unless a notification has been sent to the Executive containing details in schedule 6 of SCR at least 21 days (or such a shorter period as the executive may specify) before commencing that operation.
Well Operations - On Production Installation	Notification	SCR 17-2a	Duty Holder shall ensure no well operations involving (i) insertion of a hollow pipe in the well or (ii) altering the construction of the well, is commenced unless a notification has been sent to the Executive containing details in schedule 6 of SCR at least 10 days (or such a shorter period as the executive may specify) before commencing that operation.
	Notification	SCR 17-2b	Duty Holder shall ensure no well operations involving drilling are commenced unless a notification has been sent to the Executive containing details in schedule 6 of SCR at least 21 days (or such a shorter period as the executive may specify) before commencing that operation.
COMOPS	COMOPS Notification	SCR 10	21 days minimum notice required to be sent to executive before commencing any COMOPS.

Activity	Document Required	Legislation Reference	Comments
Abandonment	Notification	SCR 11-1b	Minimum of 3 months before commencing dismantling.
All	Notification and reporting of injuries & dangerous occurrences, death of an employee and reporting of cases of diseases and reporting of gas incidents	RIDDOR 3,4,5	Reports relating to the offshore industry should be reported using the OIR9/B and F2508A forms and wherever possible the guidance in Operations Notice 30 should be followed. OIR/12 reports relating to hydrocarbon releases should be sent to the local HID-Offshore Division contact.

Table 2: Documentation required by UK Offshore Regulations

5.2.3 PIPELINES

5.2.3.1 Overview

The main UK regulation for pipelines is the Pipelines Safety Regulations 1996 (PSR), which replaced earlier prescriptive legislation on the management of pipeline safety with a more integrated, goal-setting, risk-based approach encompassing both onshore and offshore pipelines. Offshore they complement the regime surrounding the Safety Case regulations, (the risk from pipelines within an offshore installation's 500m zone is covered by SCR 2005) and onshore they complement the Gas Safety (Management) regulations 1996.

Regulation of the pipeline design is risk-based although there is some reference to British and Institution of Gas Engineers Standards. The construction and installation of a pipeline is required to be 'so far as is reasonably practicable' sound and fit for purpose. The measures required to comply with PSR are not prescriptive and while the scope of the risk evaluation is defined, the methodology and extent are not hence there is not a specific requirement to carry out a quantified risk assessment although this may be required if the design does not wholly conform to the above recognised standards. The guidance referred to above provides pipeline operators with generic advice for controlling the risks from the hazards of high pressure gas transmission. Individual and societal risk concerns are 'built-in' to these standards i.e. the standards requirements are a form of generic risk assessment. For example the standards consider pipeline routeing, population density, proximity to occupied buildings, area classifications and increased design safety factors where pipelines run close to populations or cross roads.

Emergency Response for onshore gas pipelines is defined by the Gas Safety (Management) Regulations 1996 and for other pipelines this is covered by the PSR requirements for Emergency Procedures and Plans.

For all pipelines, the Operator must produce a Major Accident Prevention Document (MAPD), which defines how the Operator has dealt with: hazard identification, risk evaluation, safety management systems and auditing arrangements.

The regulator's role is to receive Notifications for pipeline construction and use and review the safety arrangements for the pipeline with the Operator. Authorisation for construction and use is only granted when the regulator is satisfied that all regulations have been satisfied. There is no requirement to submit an MAPD to the regulator, though the regulator may ask to see the MAPD at any time.

Safety Cases are required for Onshore Gas Pipelines as defined in the Gas Safety (Management) Regulations 1996. The Pressure Systems Safety Regulations 2000, which cover the stored energy due to pressures in a system, apply to pipelines and require that a written scheme of examination for the system is prepared by a Competent Person. The Competent Person is similar to the Independent and Competent Person referred to in the offshore legislation, but can be an employee of the operating organisation if there is sufficient independence from the operating functions of the Operator whereas for offshore, this option is not included in the guidance and has been discouraged by the HSE.

5.2.3.2 Scope

Pipelines are fundamentally different to offshore and onshore production or processing installations in that their day-to-day operation is relatively low risk. Therefore, for pipeline operations, the PSR do not specifically cover occupational issues, which come under the MHSWR, but do require safety systems to protect persons from risk to their health and safety.

5.2.3.3 Documentation

The documentation required to be sent to the regulatory authority for a pipeline is:

Activity	Document Required	Reference	Comments
Before MAH pipeline construction	Notification	PSR 20	Notification 6 months prior to construction.
Before onshore pipeline construction	Environmental Statement	EPWR 1990	Accompanies application for construction.
	Environmental Impact Assessment	ED	
Use or bringing back into use of a MAH pipeline	Notification	PSR 21	Notification 14 days before use or bringing back into use.
Change of Duty Holder	Notification	PSR 22	Notification within 14 days thereafter.
Changes to operating regime, route, fluid etc.	Notification	PSR 22	Notification 3 months prior to change.
Design completion	MAPD	PSR 23	Includes: Hazard identification, risk evaluation, safety management system and auditing arrangements.
Operation	Emergency Procedures and Plans	PSR 24 & 25	Consultation with Local Authority or HSE as appropriate and preparation of procedures and plan. To be completed before the pipeline is brought into use.

Table 3: Documentation required by UK Pipeline Regulations

5.2.4 ONSHORE

5.2.4.1 Overview

The regulation of the major accident hazards from onshore petroleum facilities in the UK is predominantly defined within the scope of the Control of Major Accident Hazard (COMAH) Regulations 1999 as amended in 2005. The COMAH regulations include the submission of a Safety Report that has similarities to a Safety Case. Occupational safety is regulated by MHSWR, as for any industrial site.

The COMAH regulations apply to onshore establishments where dangerous substances are present in quantities exceeding specific limits. The regulations list a wide range of substances defined as hazardous and define threshold quantities relating to two tiers of compliance. Most petroleum sites would be top-tier sites meaning that the COMAH safety report is more extensive. In this case, the COMAH report includes:

- Descriptive information;
- Major accident hazard information;
- Safety management system;
- Measures to prevent or limit the consequences of a major accident;
- Description of measures and organisation to control emergencies; and
- Justification for continued operations.

The Pressure Systems Safety Regulations 2000 also apply to onshore plant and require that a written scheme of examination for the system is prepared by a Competent Person (see above).

In addition to these two primary legislative instruments there is a significant number of other Statutory Instruments that also apply to onshore establishments in the UK. These include the LOLER, RIDDOR and MHSWR regulations

5.2.4.2 Scope

The COMAH regulations apply to onshore establishments where dangerous substances are present in quantities equal to or exceeding specific quantities defined within the COMAH regulation. The definitions of dangerous substances includes all the various types of hydrocarbons and associated products that would be involved in onshore terminal sites and the stated thresholds are such that in practice all onshore terminals fall within the requirements for top-tier sites.

5.2.4.3 Documentation

Documentation required to be submitted to the regulator for onshore sites is:

Activity	Document Required	Reference	Comments
Prior to construction	Notification	COMAH Part 2 Clause 6 (1) and (2)	Within a reasonable period of time prior to construction. Preliminary information to identify the location, the operator, the dangerous substances exceeding the defined thresholds, the intended activities at the location and other relevant environmental issues.
	Partial Safety report	COMAH Part 3 Clause 1	Within a reasonable period of time prior to construction. Requires information that safety & reliability have been incorporated in the design & construction. Required a 'reasonable time' prior to construction.
Prior to operation	Major Accident Prevention Policy Document	COMAH Part 2 Clause 5	Include particulars to demonstrate the establishment of a safety management system.
	Notification of change in quantities of the prevailing dangerous substances present	COMAH	This is not required if covered by a relevant safety report.
	Safety Report	COMAH Part 3 Clause 5	Full Safety Report.
	Emergency plan	COMAH Part 4 Clause 9,10	Onsite and Offsite.
	Provision of information to the competent authority	COMAH	Sufficient information to demonstrate compliance with these regulations and enable the authority to assess the possibility of a major accident part 5 Clause 15.
	Provision of information to the public	COMAH	This is as important as information to the authority as it is a specified requirement Part 5 Clause 14.
	Provision of information to other establishments	COMAH	This is as important as information to the authority as it is a specified requirement. Appropriate information to enable other operators to take account of hazard and major accidents. Part 5 Clause 16.

Activity	Document Required	Reference	Comments
In the event of a major accident	Notification of a major accident	COMAH Part 5 Clause 15(3)	
At any time	Reporting an accident or dangerous occurrence	RIDDOR	If an operator has reported an accident in compliance with RIDDOR he is deemed to have complied with the relevant duty under COMAH.
During operation	Review and revision of safety report	COMAH Part 3 Clause 8	At least every five years or when circumstances have changed or when the safety management system has been changed.
	Review and revise Major Accident Prevention Policy Document	COMAH	In the event of modification of the facility or a change in the quantities of the relevant dangerous substances present

Table 4: Documentation required by UK Onshore Regulations

5.3 RISK FRAMEWORK

In the UK, the HSE's document R2P2 outlines their approach to risk assessment and the tolerability of risk. Key elements from the document are used in the explanations below.

5.3.1 ALARP

Under much of the UK legislation covered by this review, a requirement is placed upon the Duty Holder to demonstrate that hazards have been fully and properly identified, that the resulting risks have been assessed and managed such that the remaining residual risks have been reduced to a level As Low As Reasonably Practicable (ALARP).

This is a fundamental principle of safety management, as practiced in the UK where it has been understood in law since a judgement by Lord Justice Asquith in 1949. The concept of ALARP formed a key element in the regulatory requirements of the HSWA and then also became the principle risk acceptance criteria applied within onshore legislation and also offshore legislation following the Lord Cullen report on the Piper Alpha accident.

5.3.2 RISK CRITERIA

5.3.2.1 Individual Risk

The ALARP concept uses individual risk in its risk criteria. Within the ALARP framework, there are two risk levels; a lower boundary below which the risk is broadly acceptable and a higher boundary above which the risk is unacceptable. Any hazards with a risk between these two levels are 'tolerable' but must be reduced unless the effort to achieve this objective is deemed to be grossly disproportionate to any benefit gained. This concept is shown below.

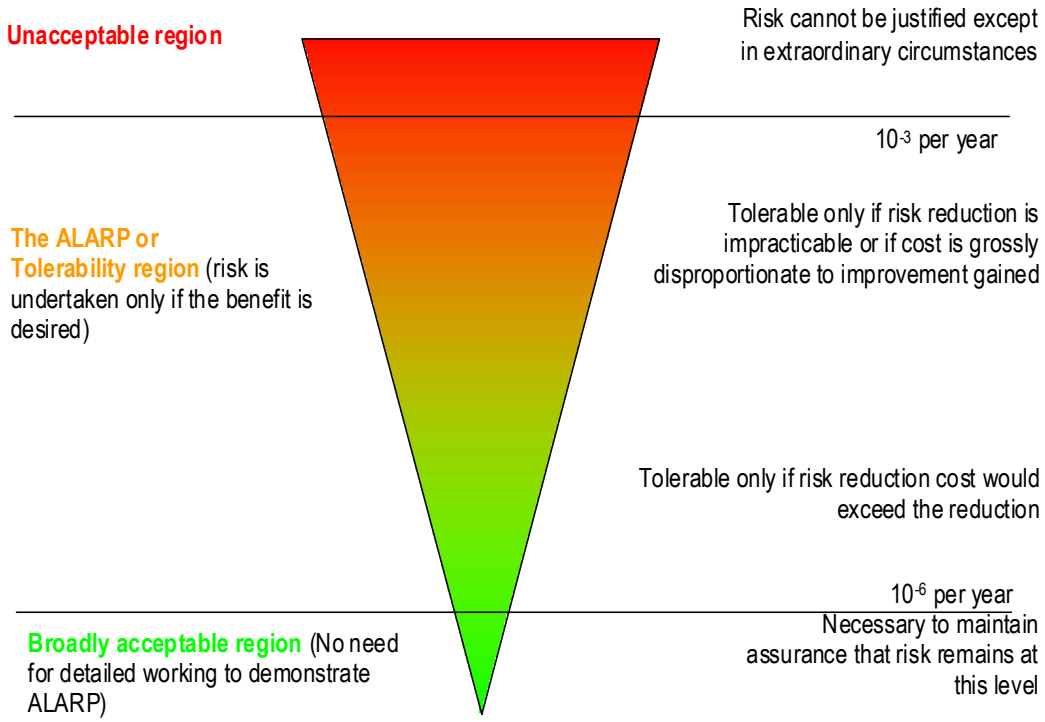

Figure 3: ALARP Triangle

The legislation does not directly define risk limits and in theory these can be set by the Operator. However, they are contained in the important guidance document, R2P2, which is derived from research on the public perception of risk in the nuclear industry and the tolerability of risk.

The guidance suggests the lower boundary for individual risk as being of the order of one in a million per year for both workers and the public following the premise that this represents a very small level of risk that is typically less than most people accept in their daily lives. It is recognised that the upper boundary is more open to variation depending upon prevailing circumstances, but, following the work carried out in the nuclear industry an upper limit for workers of one in a thousand per year and an equivalent level of risk of one in ten thousand per year for members of the public is suggested.

5.3.2.2 F-N Curves

Although individual risk is a good representation of the risk to an individual, society has an aversion to large numbers of fatalities in single events; especially from events that may be outside the control of the persons exposed to the risk. Therefore, F-N curves are used, which show the relationship between the cumulative frequency (F) of hazardous events and number of fatalities (N) that could occur. These are not used offshore due to the fact the population at risk is limited to those working on site, but are used in pipeline risk assessments and in some cases for onshore sites. While the HSE do not publish F-N curves, interpretation of pre-existing pipelines codes has led to an agreed F-N curve being used in the UK for the gas transmission system, which is published in BS PD 8010 Part 3.

Also, in its publication R2P2, the HSE give a frequency of 50 fatalities that would be deemed unacceptable at a greater frequency than once every 5,000 years.

A further complicating factor for F-N curves is the issue of aversion. Risk is defined as the product of event frequency and consequence. Therefore, the risk of 10 fatalities every 100,000 years is the same as one fatality every 10,000 years or 100 fatalities every million years. However, society has an aversion to events that involve a large number of people and so this simple assessment of risk is not sufficient in some cases. This is especially true if the persons at risk are members of the public and have no part to play in the control

of the hazard. This situation is analogous to the unfortunate high number of fatalities that occur in car accidents in many countries compared to the lower number of fatalities in trains. The latter is undoubtedly safer, but the train passengers play no part in the management of the hazard (as oppose to a car driver, who has control of brakes and steering) and train incidents often involve more fatalities than a car accident.

Therefore, to account for aversion, F-N curves are used, which define a line of acceptability for the frequency (F) or having N or more fatalities – the societal risk. The criteria is then relatively more stringent for larger N. A sample F-N curve is given below.

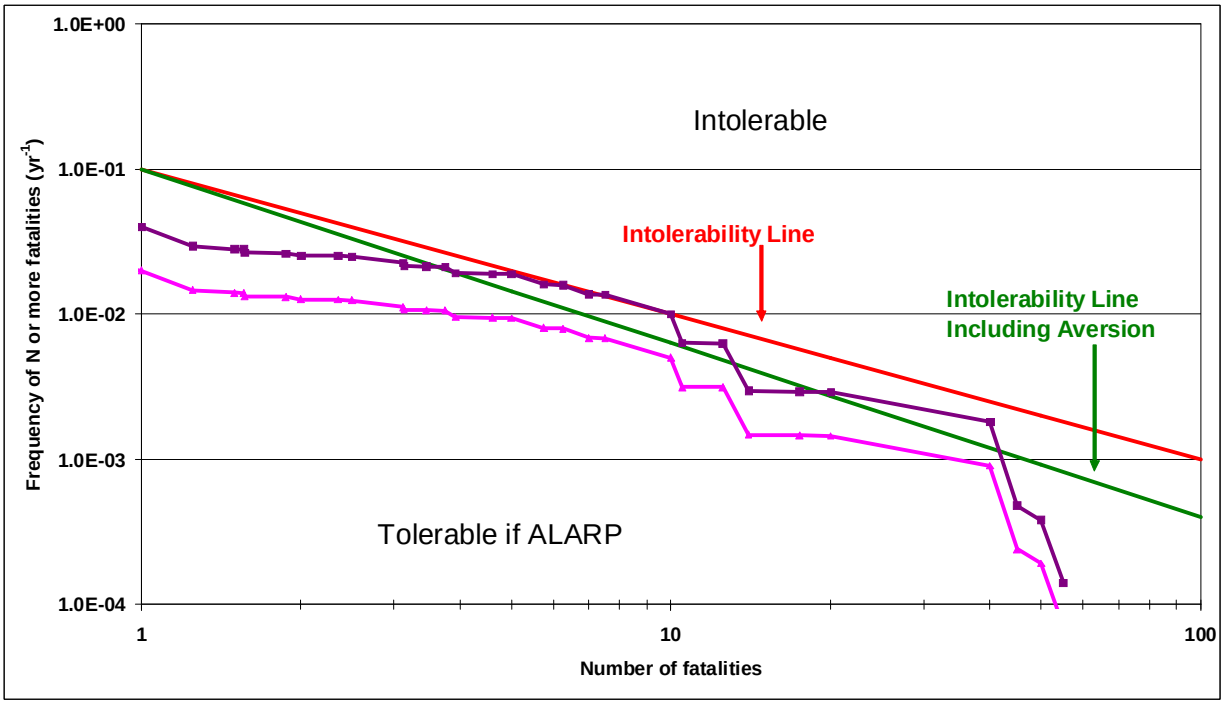

Figure 4: Example F-N Curves

Aversion is included in the F-N curve that is implied by BS PD 8010 Part 3.

5.3.2.3 Potential Loss of Life and Cost Benefit Analysis

The potential loss of life (PLL) is the cumulative risk to a population and rises as the number of persons exposed to the hazard rises. Thus, for large offshore platforms, its value may be three orders of magnitude higher than a normally unmanned gas-gathering platform. The PLL is used to compare the total risk between installations and as input to cost benefit calculations used in ALARP assessments that compare the risk benefit of a safety measure to its cost. This calculation requires that the risk is equated to a cost and for this, a cost of life value is needed. This value is given in R2P2 and was £1m in 2001, though a higher figure is used by most offshore Operators.

The potential loss of life metric is also used in safety integrity level (SIL) assessments, where, as defined in IEC61511, the Operator defines a maximum acceptable PLL from failure of a safety system and thus calculates the required reliability of the system to achieve this.

5.4 THE REGULATOR

5.4.1 FORMAL ARRANGEMENT

The Health and Safety at Work Act 1974 set up the Health and Safety Commission (HSC) to act on behalf of the Crown with respect to the legislation outlined above. The HSC was originally supported by the Health and Safety Executive (HSE) with the remit to enforce UK safety legislation. Recent organisational changes have resulted in the HSC being subsumed into the working structure of the HSE and identifying it as the HSE Board.

The role of the Board includes ensuring that relevant legislation is appropriate and understood, by conducting and sponsoring research; providing training; providing an information and advisory service; and submitting proposals for new or revised regulations and approved codes of practice. The Board is made up of nine commissioners appointed following consultation with representative groups to create a tripartite system that represents trade unions, employers and Government. The HSE advises and assists the Board in its functions and has specific responsibility, shared with local authorities, for enforcing health and safety law.

The HSE is the safety regulator across almost all industries in the UK. Thus, the HSE is a large organisation (about 3,500 employees), and can call on significant resources. The current structure of the HSE consists of a Board made up of a Chair Person and 9 Directors. Reporting to the Board are a Senior Management Team currently consisting of a Chief Executive, 3 Deputy Chief Executives and 11 Departmental Directors. The Department within the HSE that is concerned with both the offshore and onshore oil and gas industry is the Hazardous Installations Directorate (HID). Within HID, the Offshore Safety Division (OSD) consists of five operating units identified as follows:

- Inspection Management;
- Inspection Management of Well Equipment and Operations;
- Process Integrity;
- Materials; and
- Occupational Health.

HID is one of the recognised Competent Authorities given the remit to regulate COMAH. The other Competent Authorities are the Environment Agency and the Scottish Environmental Protection Agency (SEPA).

5.4.2 COMPLIANCE ASSESSMENT

In the UK, the role of HSE Inspector is specified in the HSWA and Inspectors are allocated to specific Duty Holders. HSE Inspectors are responsible for legislative compliance assessment. This is achieved through a combination of workplace (onshore and offshore) inspections and meetings at the Duty Holder's offices. Third parties are not used for these inspections. The frequency of inspections is not defined in legislation, but is controlled by:

- Investigation of an incident (where the HSE may also liaise with the Police);
- A specific HSE initiative, such as KP3 for asset integrity, or the KP4 aging installations initiative;
- Follow-on from a Safety Case thorough review (every 5 years), or a major modification to the platform; and
- Follow up from an issue raised by an interested party e.g. MP.

The HSE's business plan has internal targets for Inspector visits to both onshore and offshore installations, however the level set and the level of achievement are kept internal to the HSE.

In addition, there are compliance assessment activities which take place onshore, offshore and for pipelines. These range from being undertaken by totally, independent person (offshore under DCR and PFEER), through to being undertaken by a person with a degree of independence (onshore under PSSR), where it may be undertaken by a different part of the same operating organisation. The HSE are entitled to review and assess these compliance activities at any time.

5.4.3 ENFORCEMENT

The HSWA allows for Improvement and Prohibition Notices. An Improvement Notice gives a Duty Holder a certain timescale to make a defined improvement. They are normally be raised by an Inspector as a result of an incident, visit to the workplace or some other failing that has come to the attention of the HSE, such as a failure to comply with the regulations by, for example, failure of a safety system, or part of the management system.

A Prohibition Notice will prohibit the Duty Holder from undertaking defined operations until a specified improvement is made. They will normally result from the same causes as an Improvement Notice. The prohibited operations may be a subset of all the operations that can be undertaken on the installation, and may lead to it being shutdown for an extended period. Table 6 below shows the numbers of offshore notices issued between January 2010 and September 2010.

Improvement Notice	Prohibition Notice
12	3

Table 5: HSE Notices 2010

A Duty Holder can be prosecuted for non-compliance with the regulations. However in many cases, the HSW Act itself is quoted as the legislation that has been violated since there is a body of case law associated with it. Prosecution may also follow an injury, or fatality, or for failure of a system that has not necessarily led to injury or fatality, but had the potential to do so had the circumstances been slightly different, e.g. Buncefield, which was the biggest peacetime explosion in Europe, but miraculously led to no fatalities. For UKCS offshore installations, the HSE have carried out nine prosecutions since 2003, all of which were successful.

5.4.4 INTERACTION WITH OTHER BODIES

5.4.4.1 International Interaction

The international interaction that occurs is described for the UK, but is mostly all applicable for other countries reviewed and is not repeated.

International Regulators Forum

The International Regulators Forum comprises nine states that produce offshore oil and gas – USA, Canada, Brazil, Netherlands, Norway, Australia, New Zealand, India and the UK. The IRF shares knowledge and information on safety issues and global company performance. The group meets annually and corresponds throughout the year sharing issues of concern and raising awareness of best practice.

Bilateral Talks

The HSE have regular bilateral talks with major producing neighbours. They have links with the Norwegian Petroleum Safety Authority through the UK/Norwegian Special Working Group. They also hold annual

meetings with the Danish Energy Authority and the Dutch State Supervision of Mines, to facilitate agreement on cross-border issues.

North Sea Offshore Authorities Forum (NSOAF)

The NSOAF has representatives from Denmark, the Faroe Islands, Germany, Ireland, the Netherlands, Norway, Sweden and the UK. It meets annually to exchange information and develop common positions and joint initiatives. NSOAF is working to reduce difficulties arising from differences in regulatory regimes; for example to make it easier to move rigs between North Sea countries, and to harmonise safety training standards.

European Union

In recent years most health and safety legislation has been introduced to implement European directives; mainly to promote minimum standards for health and safety of workers, but also to maintain the single market or protect the environment. There is now a body of EU health and safety law, the basis of which is the Framework Directive [*Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work*], which established broad obligations for employers to avoid and reduce risks in the workplace. The HSE work with other member states to ensure standards are appropriate for the UK and offshore. Also of particular note are the COMAH regulations, which have to be implemented for each member state for onshore sites that contain hazardous material above a certain quantity.

International Committee On Regulatory Authority Research And Development

The above committee is dedicated to disseminating knowledge in the area of health, safety and environment in the petroleum sector. Australia, Brazil, Canada, Mexico, New Zealand, Norway, The Netherlands, UK, and the USA are members.

International Bodies

Regulators have links with international industry organisations including the International Association of Drilling Contractors (IADC) and the International Association of Oil and gas Producers (OPG).

5.4.4.2 UK Government

The remit of the HSE includes advising and co-operating with all other governmental authorities. Some specific examples of this cross boundary co-operation are given below:

Air Transport Offshore – Civil Aviation Authority / Air Accident Investigation Board

Marine Transport Offshore – Department of Transport

Incident Response – Police

Emergency Planning – Local Authorities and Coastguard

Environmental Incident – Environment Agency or Scottish Environment Protection Agency (SEPA)

Aviation

In the UK, the HSE reports to the Department of Work and Pensions, whereas the Civil Aviation Authority (CAA) reports to the Department of Transport. The main area for liaison between the CAA and HSE is over the use of helicopters for offshore transport. The management of the helicopter transport system including: Airports, Helidecks, Helicopter Certification, Pilot Training etc is governed by CAA regulations. Incident investigation is carried out by the Air Accident Investigation Board (AAIB) under the auspices of the CAA, but with HSE involvement as required.

Marine

Marine transport used offshore is regulated by the Department of Transport, which has its own regulations covering the health and safety of workers on ships. International regulations are also issued by the International Maritime Organisation (IMO), which has a worldwide remit for the regulation of the maritime industry. Vessels that are being used as production installations potentially come under three different regimes as shown in Table 7 below.

Area	Oil & Gas	Marine Transport	Vessel Seaworthiness
Regulator	HSE	Department of Transport / IMO	Classification Society
Regulatory Regime	Goal-Setting, Risk-Based	Prescriptive although Formal Safety Assessment may be introduced in the future	Prescriptive – Surveys carried out to Society Rules

Table 6: Floating Production Vessel Regimes

The HSE has a MoU with the Marine and Coast Guard Agency.

The HSE also has regular contacts with the International Association of Classification Societies (IACS) who are almost invariably selected as Independent Competent Person for the verification of floating installations. Other contacts are maintained with the various trade associations who represent Duty Holders for floating and jack-up drilling rigs, and semi-submersible production installations.

Incident Response

Liaison between the HSE and the emergency services is required to ensure a coordinated response to emergencies. After a serious or fatal incident both the Police and HSE will wish to gather evidence for a potential prosecution, therefore there is a need for this phase to be organised. Liaison between the HSE and Police is via the local HSE office and local Police Authority. Liaison with the Crown Office and Procurator Fiscal is also undertaken to facilitate prosecution following an incident.

Emergency Planning

Emergency Planning is the responsibility of the Local Authority and the Duty Holder, with the HSE reviewing the plans though the COMAH case for onshore.

Environmental Bodies

The UK offshore safety regulations do not encompass environmental issues although within the regulations it is claimed that compliance with the regulations should by default reduce the risks of an environmental incident.

The onshore regulations, namely COMAH, address environmental issues by stating that the HSE and the Environment Agency or the SEPA form the Competent Authority for regulation thus providing a framework for collaboration.

For example, for the regulation of the Grangemouth onshore refinery in Scotland a Memorandum of Understanding defines the responsibilities of the two bodies. Under the terms of the agreement SEPA are involved in the Competent Authority investigations that take place following incidents, but the HSE will take the lead if safety issues are predominant.

Economic Regulation

The onshore and offshore health and safety related regulations do not address economic issues and, within the UK, these are covered by other government departments. The separation of safety regulation from economic regulation is especially important in the UK since the Piper Alpha disaster. Prior to this, the economic regulator and the safety regulator was the Department of Energy. The Cullen Enquiry made a recommendation to divide the responsibilities for safety and economics to avoid any conflict of interest and,

as a result of this, responsibility for offshore safety was transferred to the HSE in 1992. Economic regulation is still the responsibility of the Department of Energy and Climate Change.

5.4.5 HSE GOVERNANCE

5.4.5.1 Methods for ensuring inspector competence

On top of basic entry qualifications, the HSE has in-house training (via Warwick University - a simplified post-Graduate Diploma course) for undertaking the role of inspectors. They have a CPD process to identify gaps in professional knowledge, depending on the specialism involved.

5.4.5.2 Internal review

Internal review is undertaken by peer review of a sample of enforcement decisions.

5.4.5.3 How the regulatory body measures and reports on its performance

The Offshore Division of HSE have published their Business Plan for year 2010/11. The plan contains details of how the Offshore Division plan and measure their deployment of effort throughout the year. An example of their reporting is shown below (intervention means compliance assurance, or inspection in this context):

The work we will undertake to achieve this outcome are:	Key milestones for delivery	Measures to monitor our progress
Assessment of safety cases and safety reports submitted to HSE by duty holders to time and quality standards	Milestones are set within the Safety Case Plan which is reviewed on a weekly basis	Performance standards are set within the OSD Safety Case Handling and Assessment Manual
Maintain and deliver intervention plans for all offshore installations	Set out in OSDs intervention guide Improved Intervention Planning Processes to be in place for the development of 2011/12 intervention plans	A report is issued to the DMM monthly and highlights issues which may impact on delivery of planned interventions Delivery of planned front line Duty Holder resource, monitored monthly
OSD will work to ensure that there is continued reduction in the number of major and significant hydrocarbon releases (HCRs) in the offshore oil and gas sector. OSD will investigate major and significant hydrocarbon releases and other significant loss of containment incidents in compliance with OSD procedures (SPC/Tech/OSD/38, awaiting revision May 2010). OSD will continue to analyse all hydrocarbon release to identify emerging trends and underlying causes	Hydrocarbon statistics produced on a quarterly basis. Revised OSD HCR investigation and analysis procedures to be launched May 2010	Progress reports on Industry KPI on HCRs produced and monitored quarterly OPM D – no less than 95% of all mandatory investigations (which include certain HCRs) to be carried out

Table 7: An example of UK HSE Reporting [3]

5.4.6 EFFORT REQUIRED PER PLATFORM

The HSE undertake around 2-3 offshore visits per "complex" installation, and once a year for mobile drilling units and other manned installations. For the first six months of 2010, the staff out-turns (in days) for font-line activities has been (in days):

Assessment	591
Inspection	3228
Investigation	851
Enforcement	199
Inspection Generic	626
Developing Policy/Standards	206
Advice education & promotion	355
Stakeholder engagement	378
TOTAL	**6434**

Expanded to a calendar year, this equates to 57 man years. Each inspection is generally undertaken by three inspectors with one or two nights offshore.

6 REVIEW OF THE DANISH REGULATORY SYSTEM

6.1 OVERVIEW

6.1.1 OIL AND GAS ACTIVITY IN DENMARK

Figure 4 on the following page shows the extent of the Danish oil and gas activity. Gas fields (shown in red) and oil fields (shown in green) are exploited by offshore platforms, floating productions systems. The pipelines to the onshore terminals are shown in green and red for oil and gas respectively.

In Denmark, there are approximately 25 offshore production installations on the continental shelf. Some are bridge-linked complexes in shallow water, which have been counted as one installation. In 2009 there were approximately 18 new wells drilled out of a total of about 290 production wells and 112 injection wells.

In Denmark there are three pipelines that run from offshore fields to land, as follows.

Offshore	Onshore	Fluid	Length (km)
Lulita Field	Nybro Terminal	Gas	260
Tyra Field	Nybro Terminal	Gas	235
Tyra SE Field	Frederica Terminal	Oil	330

Table 8: Danish Offshore Pipelines

There are also five onshore pipelines used to export gas from Denmark to Sweden running from the west coast, via storage facilities to the east coast, then under the sea to Sweden. In addition there is a gas distribution grid within Denmark.

Two natural gas storage facilities have been established in Denmark with a total capacity of around 921 million m³ of working gas. The storage facilities are primarily used to even out seasonal fluctuations, as the demand for natural gas is greatest during the winter, but are also used as emergency storage facilities in case of interruptions to gas deliveries. There are three terminals in Denmark where offshore pipelines come ashore, two in the west (Nybro and Frederica) and one in the east (Dragor) which supplies Sweden with gas.

These facilities are shown on the following page (from [8]).

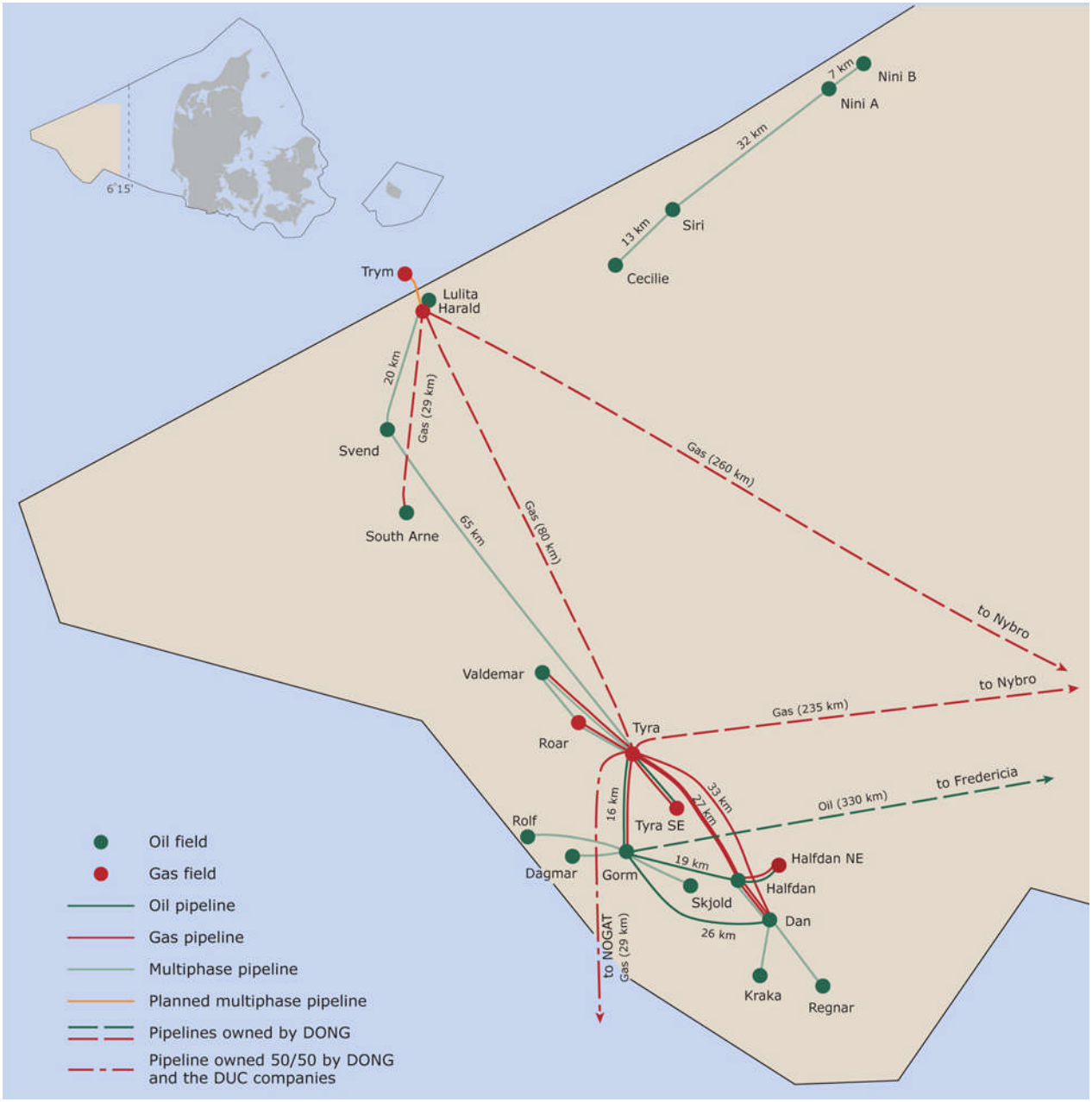

Figure 5: Danish Oil and Gas Activity [8]

6.1.2 LEGISLATIVE OVERVIEW

Safety legislation in Denmark is divided between onshore and offshore, with the Denmark Energy Agency responsible for major accident and occupational health issues offshore. Onshore, legislation is divided between emergency management, the working environment and environmental protection. Dedicated agencies are responsible for all three areas.

Separate legislation covers offshore, onshore and some pipeline facilities and the legislation is mainly goal-setting and permissioning, meaning that Safety Reports (onshore major accident sites) and Health & Safety Reports (offshore installations) are required to be submitted to allow operations. Therefore both onshore and offshore regimes for major accidents are intrinsically goal-setting, risk-based regimes.

Structurally, there are regulations (termed Executive Orders in Denmark) below the Acts and these are often short and cover very specific points in contrast to Australia and the UK, where there are few regulations.

Note that the Acts and associated Regulations are published in both the Danish and English languages. It should be noted that in the event of any ambiguities between the two versions, it is the Danish language version that takes precedence.

6.1.3 REGULATOR

The regulator for all offshore safety matters (occupational and major hazard) since 2005 is the Danish Energy Agency (DEA). The Danish Maritime Authority also has responsibility for marine matters and vessel regulation.

Onshore the regulation is administered by the Danish Environmental Protection Agency (DEPA) and the Danish Working Environment Authority (DWEA).

6.2 DANISH LEGISLATIVE STRUCTURE

6.2.1 PETROLEM ACTS AND LEGISLATIVE REGULATIONS

In Denmark, Acts are passed that allow for further regulations (termed Executive Orders) that contain more detailed requirements. The Primary Acts in Denmark that relate to health and safety for onshore sites, pipelines and offshore installations are:

- The Working Environment Act 1975;
- The Danish Subsoil Act 2007;
- The Environmental Protection Act 1998;
- The Emergency Management Act 2004; and
- The Offshore Safety Act 2005.

The Working Environment Act 1975 sets up the general framework for employee safety legislation in Denmark, which is, broadly speaking, prescriptive. There is a requirement for Safety Reports for onshore Major Accident sites under the European Seveso Directive.

The regulations are generally separate for offshore installations, onshore sites and pipelines and the primary regulations for offshore are shown below, with further explanation given in following sections. Note that there are a large number of regulations (executive orders) and only some of the most important are listed here.

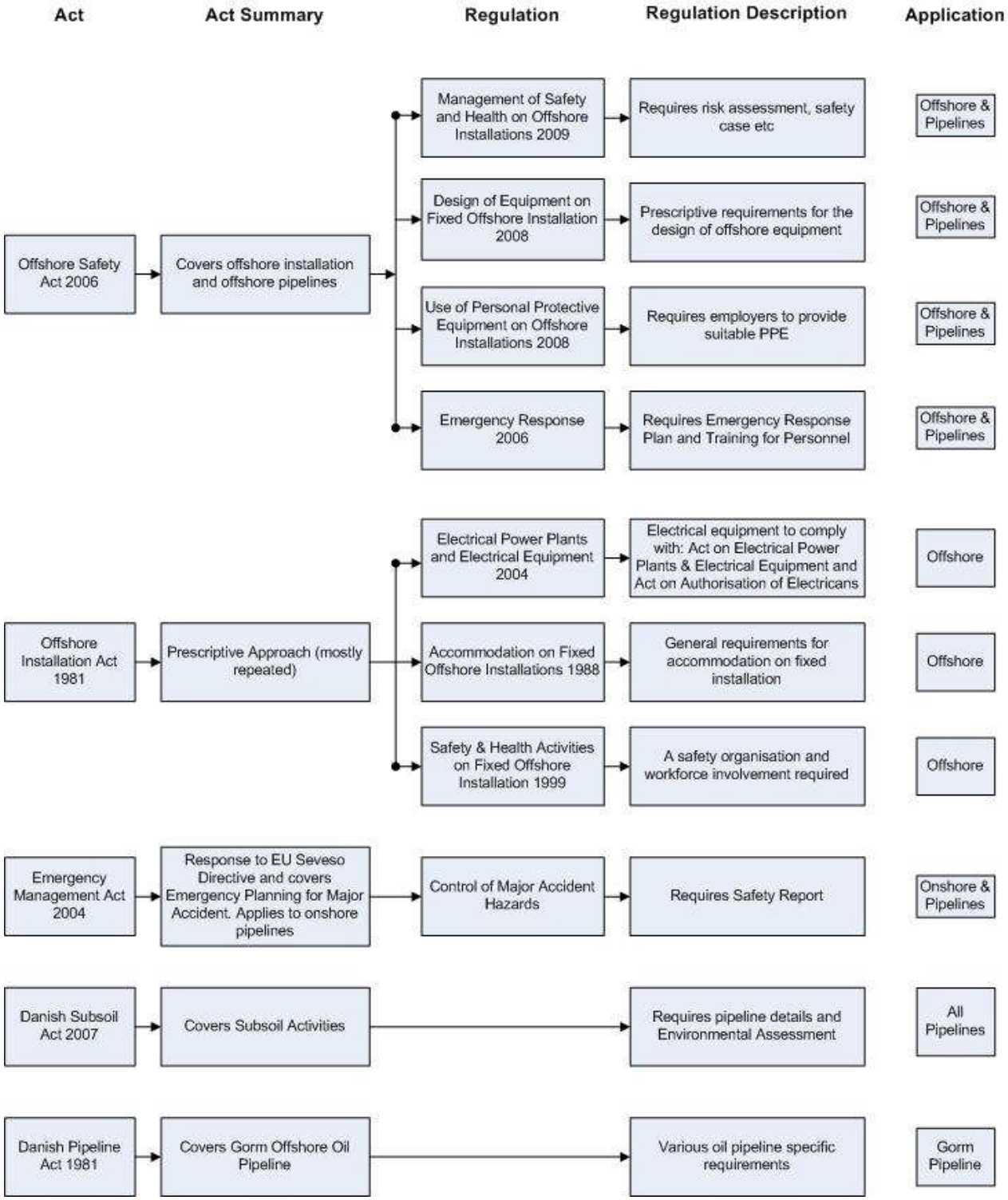

Figure 6: Primary Danish legislation

6.2.2 OFFSHORE

6.2.2.1 Overview

The Danish offshore regime is a permissioning regime with some goal-setting aspects. An element of prescription still remains as a result of numerous Executive Orders from the previous Offshore Installations Act 1981 that remain in place. Although the Offshore Installations Act 1981 has been replaced by the Offshore Safety Act 2006, an Executive Order under the latter Act has extended these prescriptive requirements made under the previous Act. There are also prescriptive Guidelines for the design of offshore installations, but these do not cover all aspects pertinent to the design of an installation.

The leading principle in the Offshore Safety Act is that health and safety risks for persons staying and working on an offshore installation are to be identified, assessed and minimised as much as reasonably practical. In general terms, the responsibilities placed upon offshore Duty Holders are to ensure that health and safety is addressed in all working contexts which includes identifying the health and safety responsibilities of contractors and equipment suppliers. Responsibility for ensuring health and safety at work also applies to individual workers and to supervisors and managers in a similar way to that ordained within the UK Health and Safety and Work Act.

The specific rules defined within the regime encompass the following:

- A Health and Safety Management System must be established for all fixed and mobile offshore installations. This must comply with recognised standards and independent verification by a classification or certifying authority is employed to demonstrate compliance. The relevant Government Minister is given powers to apply additional and specific rules to this requirement;
- Health and safety risks must be reduced to ALARP;
- A Health and Safety Case must be prepared for both fixed and mobile installations and the required format is recognisable as that generally accepted by other regulatory regimes worldwide. The Health and Safety Case is required to be initially prepared at the design stage of a fixed offshore installation or prior to the operation of a mobile unit and it must address all identifiable risks and it is required to be updated regularly although the time between updates is not specified. For mobile units the safety case must define the length of time of the operation covered by the case. It must also substantiate that the Operator has adopted the ALARP principle in accordance with their management systems;
- Permissions are required before the fabrication of a new installation is started, prior to operation of a facility, prior to making risk-related changes to an offshore installation, and before dismantling an installation and in all cases the submissions must include an up-to-date Health and Safety Case. Such permissions are granted for a period of five years. Movement of a mobile unit also requires permission, but safety cases accepted or approved by other international agencies may be employed subject to the approval of the supervisory authority; and
- A condition for putting an offshore installation into use is that an emergency response plan has been prepared and that appropriate co-ordination with the rescue services has been arranged.

The management of Health and Safety Executive Order 2009 (729) includes the provision for verification:

> *Independent verification of the fact that an offshore installation, parts thereof or its equipment fulfil requirements laid down in or pursuant to the Offshore Safety Act can partially replace the management system.*

The same order requires safety critical equipment to be identified by risk assessment, though there is no mention of performance standards for the safety critical equipment.

Offshore installations operating in Denmark must also have a Work Place Assessment (WPA) System. When developing and using the WPA system, there must be co-operation between management and safety representatives, amongst others in the Safety Committee. The WPA system must ensure that all workplaces and all work functions are evaluated with regard to potential improvements of the safety and health conditions and that these are prioritised and implemented as planned.

6.2.2.2 Scope

Occupational and major hazards are managed together under the Offshore Safety Act, but major accidents are not defined. The Offshore Safety Act applies to installations and defines an installation to be:

i) Platforms or other facilities,

a) from where exploration or extraction of hydrocarbons is carried out from the subsoil below the seabed,

b) used for accommodation of persons employed on or at the facilities mentioned in a) above, or

c) used in connection with transport of hydrocarbons and other substances and materials through pipelines between the platforms and facilities mentioned in a) above or between these and onshore installations.

ii) Facilities used for storage and offloading of hydrocarbons produced by a facility mentioned in i)

a) and which is permanently attached to such a facility.

(2) Vessels are not covered by the definition in subsection (1) except for drill ships and floating production, storage and offloading units, ….(abridged)

6.2.2.3 Documentation

The table below shows the information that must be supplied to the DEA at different stages of a project:

Activity	Document Required	Reference	Comments
Seismic	Notification	CRPO II A	Twenty days before commencement.
	Weekly Report	CRPO II B	Starting no more than 8 days after commencement.
After Seismic	Report on Data Acquired	CRPO II C & D	Seismic data freely issued to DEA plus data on kilometres covered.
Exploration Drilling	Drilling Application	GFD 1	Drilling programme, rig details, contingency plan, well site details and economic details required 3 weeks before start date.
Well Testing	Well Logs and Test Programme	GFD 8	Approval to be granted by DEA.
Concept Design	Development Plan	DEA	Approval of project description.
Detailed Design	Design Docs	GDFOS	Compliance with Guidelines for the Design of Fixed Offshore Installations 2009.
Fabrication	Health & Safety Case	OSA	Health & Safety Case to be approved before fabrication. Permit for construction.
Installation	Health & Safety Case	DEA	Health & Safety Case to be approved before installation. Permit for installation.

Activity	Document Required	Reference	Comments
Operations	Health & Safety Case	DEA	Health & Safety Case Review. Review of Health and Safety certificates. Permit to operate installation.
	Manning and Organisation Plan Approval,	DEA	Offshore installations operating in Denmark must have a Safety Organisation, Safety Representatives and Safety Committee.
	Emergency Response Plan Approval	EO668/2006	Review of the Contingency Plan prepared by the Duty Holder with input from various Danish organisations.
	Work Place Assessment System	DEA	WPA system must ensure that all workplaces and all work functions are mapped and evaluated with regard to potential improvements of the safety and health.
	Incident Reports	DEA	Serious incidents such as work-related accidents and major hydrocarbon gas releases must also be reported to the DEA in accordance with the Executive Order on the Registration and Reporting of Work-Related Injuries, etc.
	Revised Health & Safety Cases	OSA	Significant Changes to Installation, Dismantling etc. Permit to change or extend installation.
Well Activities	Notification	GFD 5	Sequence of operations prescribed by DEA.
Abandonment	Notification	GFD 11	Abandonment parameters prescribed by DEA.

[Note: Abbreviations used above: Conditions Regarding Pre-Investigations Offshore – CRPO, Guidelines for Drilling 1988 – GFD, Guidelines for the Design of Fixed Offshore Installations 2009 – GDFOS, Offshore Safety Act 2006 – OSA, Emergency Response - EO668/2006]

Table 9: Documentation required by Danish Offshore Regulations

6.2.3 PIPELINES

6.2.3.1 Overview

The Danish Subsoil Act 2007 (DSA 2007) regulates the establishment and use of the all onshore and offshore pipelines apart from the oil pipeline from the Gorm Field in the North Sea to the terminal at Fredericia which is regulated by a special purpose act (the Danish Pipeline Act). This Act has been amended in 2010 to include onshore separation plants.

The DEA regulates all pipelines and also works with other governmental environmental (e.g. Danish Forest and Nature Agency) and planning (e.g. Agency for Spatial and Environmental planning) agencies to ensure safety and environmental protection.

The Offshore Safety Act 2006 can also cover offshore pipelines in the same way as installations, however the Minister for Transport and Energy has some choice as to which parts of DSA 2007 will apply to a specific pipeline.

However Safety Reports are required for the major accident installations associated with the onshore pipelines. These are overseen by the Environmental Protection Agency.

6.2.3.2 Scope

Major accidents and occupational hazards are covered by different regulations and many provisions of the Offshore Safety Act 2006 can be applied to offshore pipelines if the Minister wishes to do so.

Offshore Pipelines are also partially covered by the Offshore Safety Act 2006 at the installation.

6.2.3.3 Documentation

The table below shows the documentation requirements for pipelines.

Activity	Document Required	Reference	Comments
Before MAH pipeline construction	Notification	DSA 2007	Required by DEA
Before onshore pipeline construction	Environmental Impact Assessment	DSA 2007	Accompanies application for construction
Before offshore pipeline construction	Environmental Impact Assessment	DSA 2007	Accompanies application for construction
Use or bringing back into use of a MAH pipeline	Notification	DSA 2007	Routine notification
Change of Duty Holder	Notification	DSA 2007	Routine notification
Operation	Emergency Procedures and Plans	EMA 2004	Requires approval by DEMA before operation

Table 10: Documentation required by Danish Pipeline Regulations

6.2.4 ONSHORE

6.2.4.1 Overview

Safety Reports are required for onshore major accident installations in compliance with the European Seveso Directive 1996. These are regulated by the Environmental Protection Agency (EPA). The Statutory Order No. 1156, on the control of major-accident hazards involving dangerous substances, dated November 18 2005 is the relevant legislation. The Order is made under the Environmental Protection Act, the Working Environment Act and the Emergency Management Act. In addition the Working Environment Authority (WEA) has issued Order No.20 on the control of major-accident hazards involving dangerous substances, in January 2006 which supplements Order No. 1156/2005 and provides an additional legal basis, for major hazards within the workplace.

The main enforcement Authorities are the local EPA, one of the Working Environment Authorities Regional Offices, the local Emergency Management Authority and the local Police District. The Environmental Authority coordinates the activities of the abovementioned authorities.

Safety Reports require the following subjects to be covered:

- Safety Management System;
- Major Accident Prevention Policy;
- Major Accident Hazard Identification and Evaluation;
- Measures to prevent accidents and limit consequences; and
- Emergency Plan.

The Safety Report system is essentially a goal setting regime allowing the Duty Holder to evaluate the risks and determine appropriate measures to manage the risks.

6.2.4.2 Scope

Major hazards are covered by the implementation of the Seveso Directive under Statutory Order No. 1156, on the control of major-accident hazards involving dangerous substances, requiring a Safety Report for all 'top-tier' sites.

Occupational health and safety is covered by the Working Environment Act 1975 administered by the Working Environment Agency. There may also be input from the Danish Ministry of Labour.

6.2.4.3 Documentation

The table below shows the documentation requirements for onshore sites.

Activity	Document Required	Reference	Comments
MAH installation development	Notification	EPA 1998	Required by Planning Authorities
Before onshore installation construction	Environmental Impact Assessment	EPA 1998	Accompanies application for construction
Operation	Safety Report	SO 1156	As required by Seveso Directive. The assessment by the Environment Authority may take up to 2 years
	Emergency Procedures and Plans	SO 1156	Consultation with Local Authority and Police as appropriate
	Major Accident Prevention Plan	SO 1156	Reviewed by Emergency Management Agency
Change of Duty Holder	Notification	EPA 1998	Notification to Environmental Protection Agency

Table 11: Documentation required by Danish Onshore Regulations

6.3 RISK FRAMEWORK

6.3.1 ALARP

Under the Offshore Safety Act 2006, a requirement is placed upon the Duty Holder to demonstrate in a Health & Safety Case that the identified risks have been fully and properly identified, that suitable and sufficient effort has been employed in assessing and identifying such risks and in the management of those risks and that the remaining residual risk have been reduced 'as much as reasonably practicable'.

Similarly the requirements of a Safety Report, which is required for onshore major accident installations, include for a risk assessment and a demonstration that risks have been reduced 'as much as reasonably practicable'.

6.3.2 RISK TARGETS

There is no information in the legislation on formal risk targets in Denmark. The requirement in the legislation is for risk to be reduced 'as much as reasonably practicable'.

However the Danish Ministry of the Environment have published *Acceptance criteria in Denmark and the EU 2009* which suggests that the maximum level for individual risk of fatality in a non-major risk establishment should be 10^{-5} per year. The equivalent value for the general population is 10^{-6} per year.

6.4 THE REGULATOR

6.4.1 FORMAL ARRANGEMENT

The Danish Energy Agency (DEA) is an institution under the Ministry of Environment and Energy. The DEA administers all technical matters, administrative and political issues in the energy area, advises the Minister, and handles relations and coordination with external parties.

The Offshore Installations Division of the DEA is the supervising authority of health and safety matters in relation to offshore installations. Issues concerning emissions to the environment are handled by the Danish Environmental Protection Agency, while other environmental issues lie with the DEA. Environmental issues in relation to offshore installations also lie with in the DEA's Oil and Gas Division.

At the turn of the year 1999/2000, the Agency employed the equivalent of about 275 full-time employees, about 40 of whom were involved in the administration of oil and gas activities.

6.4.2 COMPLIANCE ASSESSMENT

The Offshore Safety Act entered into force in July 2006, and the DEA supervises compliance with it. The three main types of supervision are **Immediate Inspections**, **Project Supervision** and **Operations Supervision**.

Immediate inspections

Immediate inspections are carried out in connection with work-related accidents and major near-miss occurrences. The DEA will assist in investigating the sequence of events in cases where the police are involved; the DEA will be solely responsible for investigations if the police are not involved. The police authority itself will assess whether or not it will become involved in investigating a work-related accident. If the DEA believes that significant provisions in the Offshore Safety Act have been contravened in connection with a work-related accident, the DEA will recommend to the police that those responsible should be prosecuted.

Project Supervision

Project supervision consists of supervising new facilities and major modifications to existing offshore installations.

Operations Supervision

The DEA undertakes announced Regular Inspections and Unannounced Inspections, in addition to supervision of special topics.

The core element of the DEA's health and safety inspections is an annual, regular inspection of the operating conditions on all manned fixed installations and mobile units. A predetermined programme is carried out during this inspection, see below. Among other things, the programme covers three fixed inspection items: a review of work-related accidents, hydrocarbon gas releases and the maintenance of safety-critical equipment.

Offshore inspections are targeted mainly at the individual company's health and safety management system. The DEA usually gives the operating company about a fortnight's notice of inspections, but may also make unannounced inspections. An offshore inspection typically comprises:

- An initial meeting with the safety organisation;
- A meeting with the health and safety representatives;
- A meeting with the health and safety groups;

- An interview of the management on board (Offshore Installation Manager, technical managers, medic, catering staff, etc.);
- A tour of the installation with a supervisor and a safety representative; and
- A final meeting with the safety organisation.

After the inspection, the DEA prepares a Supervision Report for submission to the company. The report is to be made available to everyone on the relevant offshore installation.

Unannounced inspections are carried out if announcing the inspection would compromise its purpose, e.g. when checking compliance with the regulations regarding rest periods, accommodation facilities and emergency procedures for the increased manning of installations, painting projects, etc. Moreover, unannounced inspections are carried out if unlawful circumstances are reported, or if otherwise warranted by employee health and safety considerations. An unannounced inspection differs from an annual inspection in the sense that the programme normally only focuses on two or three relevant issues.

The offshore regulations also include verification. However, it is an option and if not undertaken, the operator must include procedures in their management system which give the same level of safety.

6.4.3 ENFORCEMENT

The Working Environment Act allows for the issue of Consultation Notices.

Three types of consultation notices are issued in case of violations of the health and safety legislation for complex and serious violations, multiple violations and repeated violations

The DEA can also issue an Improvement Notice, which will give a Duty Holder a certain timescale to make a defined improvement. It will normally be raised by an Inspector as a result of an incident, visit to the workplace or some other failing that has come to the attention of the DEA, such as a failure to comply with the regulation (termed executive order in Denmark), for example, failure of a safety system, or an aspect of a management system that is not sufficient.

A Prohibition Notice will prohibit the Duty Holder from undertaking defined operations until a specified improvement is made. They will normally result from the same causes as an Improvement Notice but are more serious and normally required immediate cessation of the defined operations. The operations may be a subset of all the operations that can be undertaken on the installation, and may lead to it being shutdown for an extended period.

A Duty Holder can also be prosecuted by the Police following a recommendation from the DEA for non-compliance with the regulations.

6.4.4 INTERACTION WITH OTHER BODIES

See Section 5.4.4.1 for international regulator interaction.

6.4.4.1 Danish Government

The remit of the DEA includes generally advising and co-operating with all other governmental authorities. Some specific examples of this inter-departmental co-operation are given below:

- Air Transport Offshore – Danish Civil Aviation Authority / Air Accident Investigation Board;
- Marine Transport Offshore – Danish Maritime Authority;
- Post Incident Response – Jutland Police;
- Emergency Planning – Local Authorities and Police; and
- Environmental Incident – Danish Environment Protection Agency.

Liaison with other government departments and regulators is typically organised by informal contacts which are normally followed by a yearly meeting.

Aviation

In Denmark the DEA reports to the Ministry of Energy and Climate Change, whereas the Danish Civil Aviation Authority (CAA-DK) reports to the Ministry of Transport. The main area for liaison is the use of helicopters for offshore transport. The management of the helicopter transport system including: Airports, Helidecks, Helicopter Certification, Pilot Training etc is governed by CAA-DK regulations.

Marine

Marine transport used offshore is regulated by the Danish Maritime Authority (DMA), which has its own regulations covering the health and safety of workers on ships. International regulations are also issued by the International Maritime Organisation (IMO), which has a worldwide remit for the regulation of the maritime industry. Vessels that are being used as production installations potentially come under three different regimes as shown in Table 12 below.

Area	Oil & Gas	Marine Transport	Vessel Seaworthiness
Regulator	DEA	Danish Maritime Authority	Classification Society
Regulatory Regime	Goal-Setting, Risk-Based	Prescriptive	Prescriptive – Surveys carried out to Society Rules

Table 12: Floating Production Vessel Regimes

The DMA also has regular contacts with the International Association of Classification Societies (IACS) who are 'Recognised Organisations' and are authorised to undertake statutory certification services for vessels registered in Denmark. The Division for Investigation of Maritime Accident is an "Accident Investigation Board" that investigates accidents at sea.

Incident Response

Liaison between the DEA and the emergency services is required to ensure a coordinated response to emergencies. After a serious or fatal incident both the Police and DEA will wish to gather evidence for a potential prosecution, therefore there is a need for this phase to be organised. Liaison between the DEA and Police is via the DEA main office and local Police Authority (Jutland Police).

Emergency Planning

Emergency Planning offshore is the responsibility of the Duty Holder with input from the DEA, Danish Maritime Authority and Emergency Management Authority.

Emergency Planning onshore is the responsibility of the Local Authority and the Emergency Management Authority with input from the Duty Holder. In the case of an incident onshore, the main enforcement Authorities are the local Environmental Protection Authority, one of the Working Environment Authorities Regional Offices, the local Emergency Management Authority and the local Police District. The Environmental Authority co-ordinates the activities of the abovementioned authorities related to the individual establishments.

Environmental Bodies

Offshore, the DEA, in partnership with many other authorities and organisations is responsible for protecting the marine environment.

Marine discharges are regulated by the Marine Environment Protection Act and the Minister for the Environment's Offshore Action Plan, which sets targets for the discharge of oil in produced water and chemicals as well as atmospheric pollution.

Major oil and gas development projects both onshore and offshore require an Environmental Impact Assessment (EIA) at an early stage. The EIA report must be subjected to public consultation before the DEA can approve the project. The DEA, the Danish Environmental Protection Agency and the Agency for Spatial and Environmental Planning cooperate with regard to the processing of EIAs.

Economic Regulation

The DEA is responsible for both economic and safety regulation of the oil and gas sector in Denmark. This arrangement clearly runs the risk of a conflict of interest between safety and the desire to maximise production. The DEA has made different divisions responsible for: Exploration & Production, Gas Supply and Safety, which may go some way to mitigating the conflict of interest.

6.4.5 DEA GOVERNANCE

6.4.5.1 Methods for ensuring inspector competence

Inspectors are giving a side by side training combined with an Occupational Health & Safety Management Systems Auditor/Lead Auditor Training Course. Inspectors are typically expected to cover 3-4 disciplines. The ongoing competence of an inspector is assessed every year, where the inspector and the head of the department agree any competences to be improved / developed in the forthcoming year.

6.4.5.2 Internal review

There is no formal internal process that reviews performance of the inspectors.

6.4.5.3 How the regulatory body measures and reports on its performance

There is no internal process that reviews the successful achievement of regulation enforcement.

6.4.6 EFFORT REQUIRED PER PLATFORM

An annual inspection of each manned fixed installation and mobile unit is carried out. An onshore inspection/assessment is normally done the day before or the day after an annual inspection.

Each installation is estimated to take up to 150 hours for a lead inspector and about 100 hours for an accompanying inspector annually.

7 REVIEW OF THE WESTERN AUSTRALIAN REGULATORY SYSTEM

7.1 OVERVIEW

7.1.1 OIL AND GAS ACTIVITY IN WESTERN AUSTRALIA

There are approximately 112 identified oil and gas fields located in 4 geological zones within the offshore area falling within the jurisdiction of Western Australia.

Within the jurisdiction of Western Australia there are 4 major onshore distribution pipelines and three major offshore pipeline systems that come ashore in the North West running from platforms in the Carnavon Basin into onshore facilities between Dampier and Onslow and a longer pipeline from the Scarborough field to the coast. There are also a number of connections to small fields in the area of Geraldton, which is about 300km north of Perth. It is estimated that this amounts to approximately 7000 kilometres of pipeline, excluding pipelines from the Bonaparte Basin that flow into the Northern territories.

Details of these facilities are shown on the maps on the following pages (by kind courtesy of Department of Mines and Petroleum, Government of Western Australia).

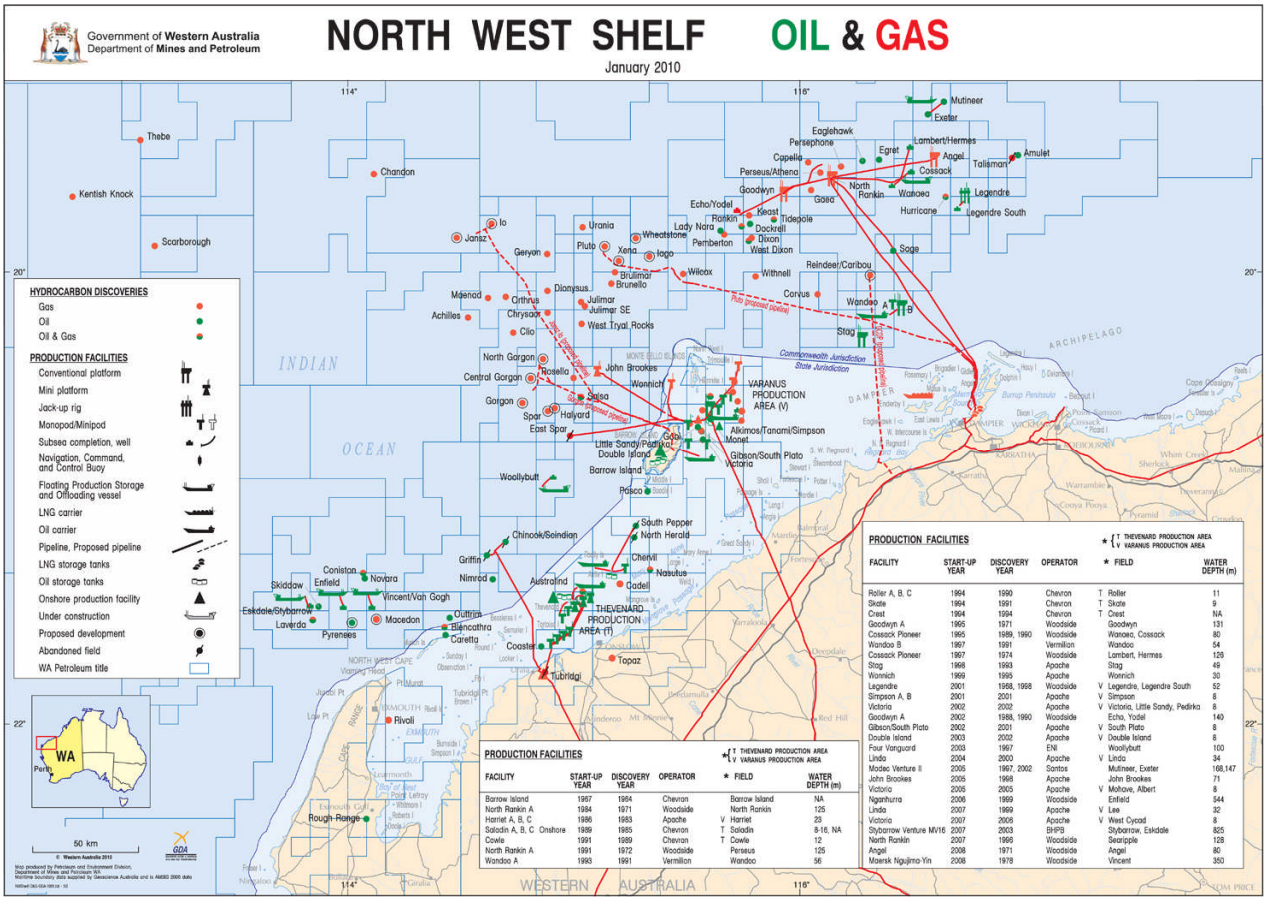

Figure 7: Western Australia – Northwest Shelf Oil and Gas Activity

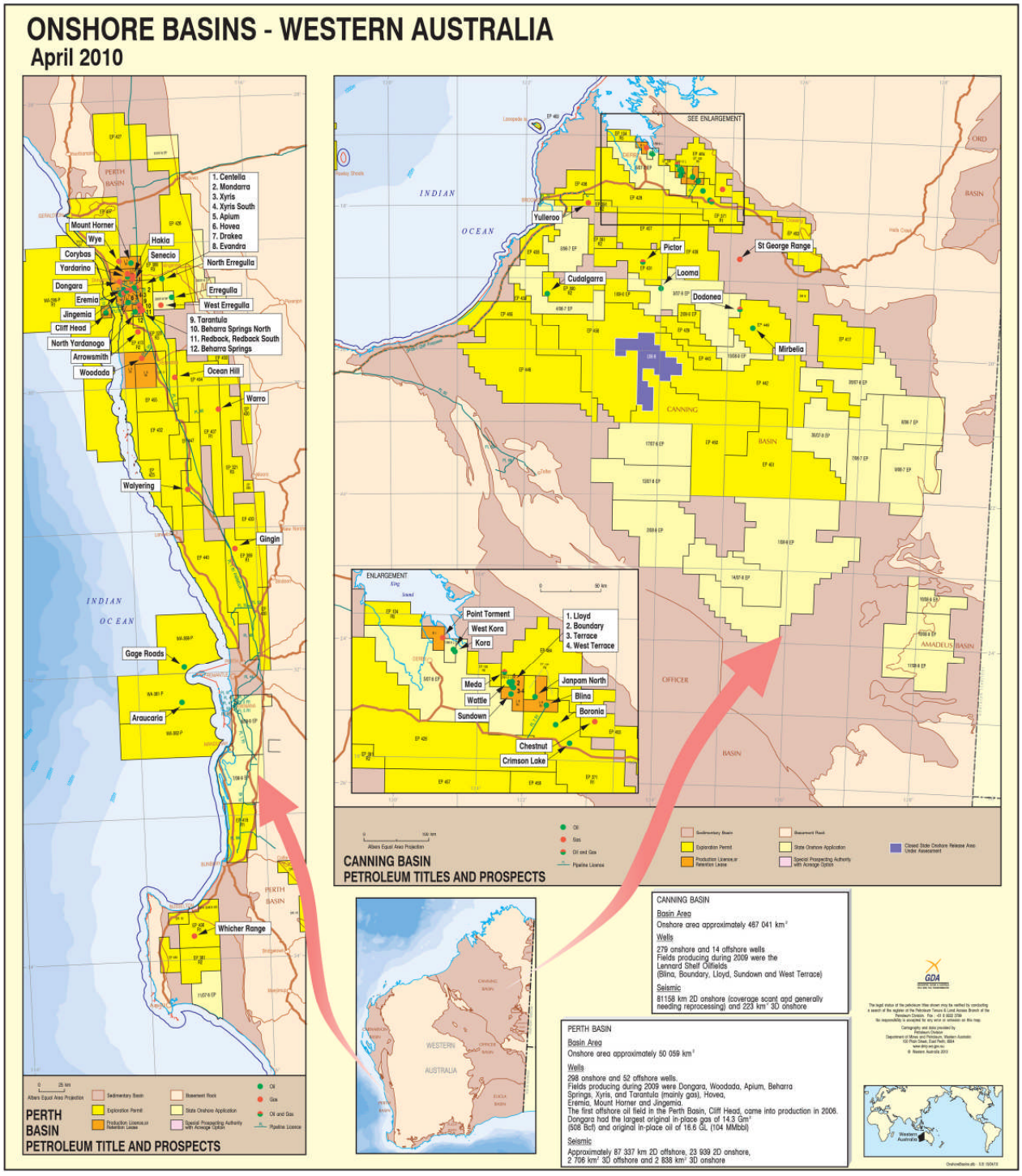

Figure 8: Western Australia – Onshore Oil and Gas Activity

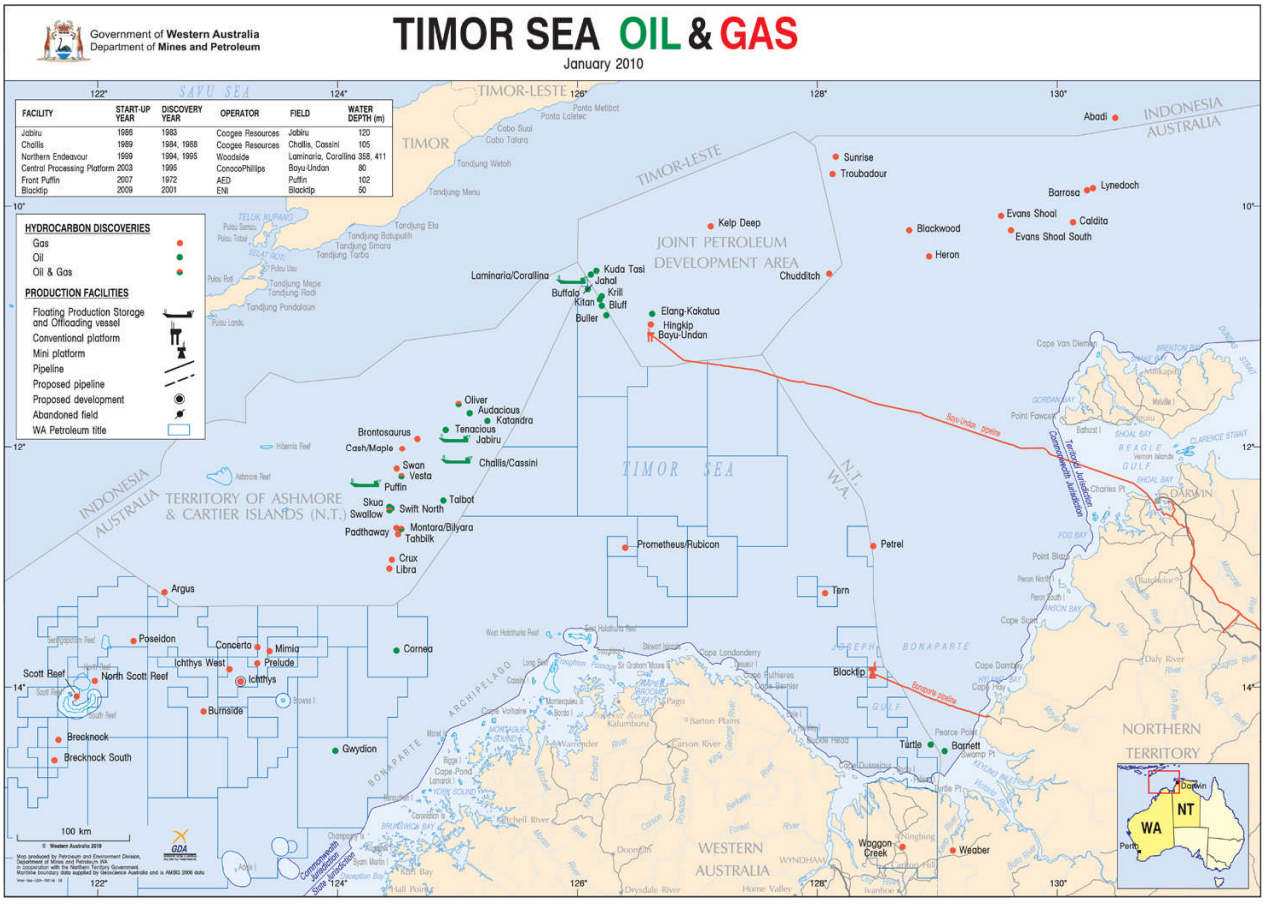

Figure 9: Western Australia – Timor Sea Oil and Gas Activity

7.1.2 LEGISLATIVE OVERVIEW

Health and safety legislation in Australia has recently undergone a significant programme of review and update and the result is that a high degree of harmonisation of regulation of all hazardous industries and activities gas been achieved. This has been led by the central Australian Government, but, in practice, the majority of regulation is applied through individual state authorities. The result is that there are a clearly defined and specific set of regulations that apply both offshore and onshore to oil and gas exploration and production. These regulations are predominantly goal setting and require the preparation of safety cases. Australia has risk-based regulation, which requires that the potential for major accident events must be comprehensively addressed and managed. The primary purpose of the safety case is to cover major accident hazards, but it must also cover occupational issues.

The Australian legislation has therefore established a safety regime concentrating upon the responsibility of providing a duty of care on the part of the operators of installations, vessels and facilities, employers of personnel working on installations or vessels and the manufacturers and providers of plant and equipment that are involved in petroleum activities. The legislation is goal setting with operators having to define performance standards, which are then subject to validation at the design stage by an independent and competent person. Being risk-based, the aim of the legislation is to ensure that all reasonable practicable steps are taken to protect the safety and health of all facility workers and any other persons who may be affected.

7.1.3 REGULATOR

The regulator for all offshore petroleum activities including offshore pipelines is The National Offshore Petroleum Safety Authority (NOPSA). Onshore facilities and onshore pipelines are regulated by the Resources Safety department of the Western Australian Department of Mines and Petroleum (DMP).

7.2 WESTERN AUSTRALIAN LEGISLATIVE STRUCTURE

7.2.1 PETROLEUM ACTS AND LEGISLATIVE REGULATIONS

This review addresses Western Australia, as the legislative structure applied in this state is representative of that applicable in other states and also the majority of offshore activity in Australia is contained within the jurisdiction of this state.

Recent developments in the Australian legislative structure have resulted in there being very little difference between the approaches employed offshore and onshore, which has the benefit of more expedient administration and more clarity for the industry. The primary variations are concerned with aspects of land tenure that exist onshore. Economic aspects of regulation are jointly administered by state and national government authorities and the specifics concerning operational and occupational safety are addressed by specific regulations.

The general model for safety regulation applied within Western Australia is taken from the National Government's Offshore Petroleum and Greenhouse Gas Storage Act 2006 (OPGGSA 2006). Prior to the recent and comprehensive reviews of Australian safety legislation, the basic approach was heavily predicated on UK historic HSE practice providing a rather prescriptive based regulatory process. The primary outcome of the OSH review was a change to a goal setting approach making a specific point of requiring a high level of workforce involvement.

Due to these recent developments, there are now complete and comprehensive sets of Regulations specifically applicable to the petroleum exploration and production sector. The upstream oil and gas industries in Western Australia (either offshore or onshore) are regulated under the following Acts, administered by the DMP:

- Petroleum (Submerged Lands) Act 1982 (PSLA);
- Petroleum Pipelines Act 1969 (PPA); and
- Petroleum and Geothermal Energy Resources Act 1967 (PAGERA).

The PPA and PAGERA apply onshore to the mean low-water mark, while the PSLA applies to state waters and waters inside state waters, collectively termed the "adjacent areas".

The Australian legislation clearly relates its risk management and occupational safety and health regulations to its permit and licence requirements and so is a permissioning regime. Each of the primary Acts deliver a series of detailed regulations, which apply a common safety related regulatory philosophy to all petroleum activities, both offshore and onshore, albeit allowing for the different physical and environmental factors associated with these different areas. The authorities publish guidance notes to assist operators in achieving compliance with the regulations. The safety case itself must contain detail of the standards to which the facility is built and whatever set is used, operator should justify the applicability and limitations of them.

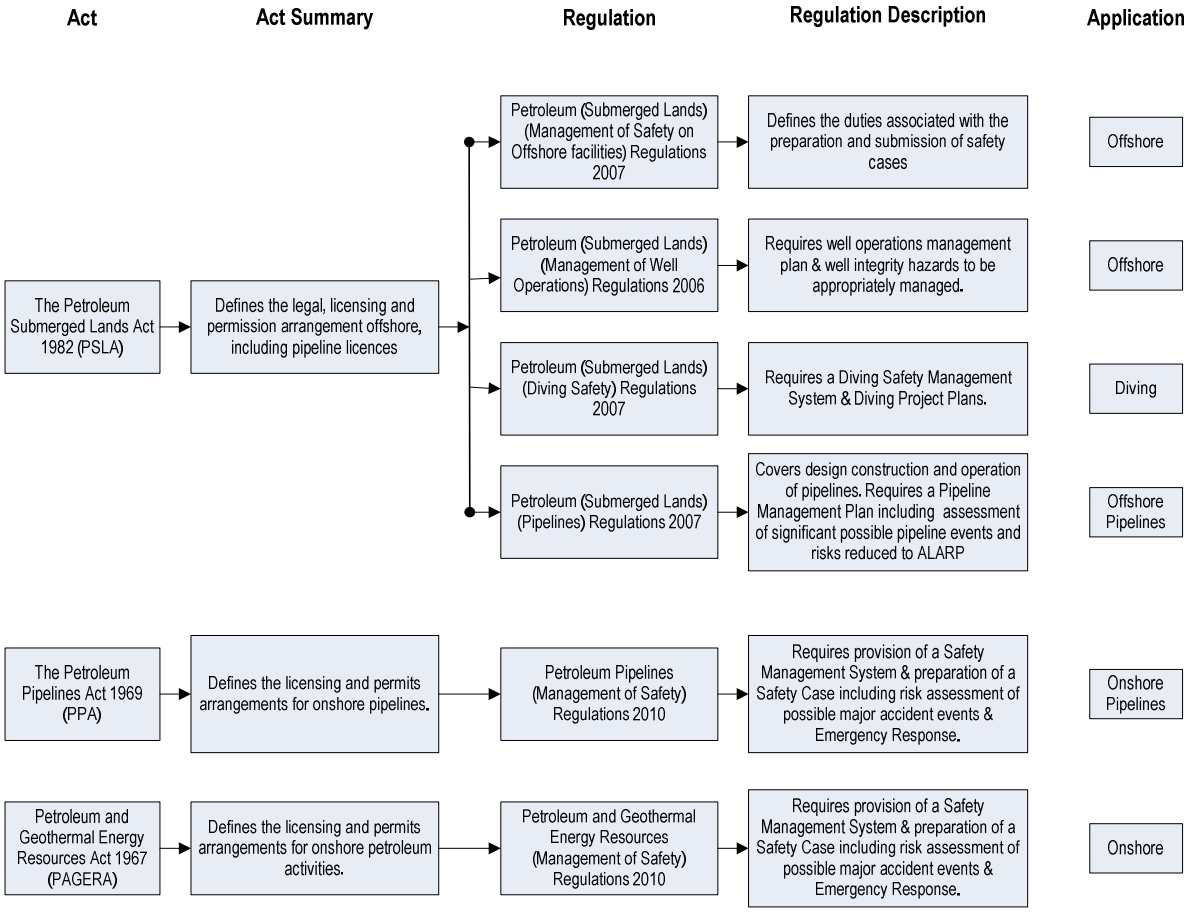

Figure 10: Western Australian Primary Acts and Regulations

7.2.2 OFFSHORE

7.2.2.1 Overview

The safety regulation of offshore and offshore pipelines falls within the Petroleum Submerged Lands Act 1982 (PSLA) with various amendments up to the current version in 2010. This Act details requirements concerning permits, leases and licences for offshore exploration and production of petroleum and pipeline licences. It also introduces the requirements for occupational health and safety and defines the functions and powers of the safety authority (NOPSA). Detailed requirements are defined within the associated regulations, which are as follows:

- Petroleum (Submerged Lands) (Occupational safety and Health) Regulations PSLOSR 2007;
- Petroleum (Submerged Lands) (Management of Safety on Offshore facilities) Regulations PSLMSR 2007;
- Petroleum (Submerged Lands) (Management of Well Operations) Regulations PSLMWR 2006;
- Petroleum (Submerged Lands) (Pipelines) Regulations PSLPR 2007; and
- Petroleum (Submerged Lands) (Diving Safety) Regulations PSLDSR 2007.

The regulations incorporate requirements to develop safety cases and to apply detailed risk assessments to identify potential major accident hazards and to provide suitable justification for the applied control arrangements. The relative rarity of events with catastrophic consequences may give rise to the situation where potential MAEs receive little attention, as compared with operational issues: this was one conclusion

from the Longford incident in Australia. The safety case regime therefore is a regulatory initiative focused on addressing potential for MAEs, while continuing to address occupational health and safety. In addition, there is a requirement for the election and involvement of workforce health and safety representatives in the overall safety management process.

Similar to the UK, the operator's safety management system for a facility must specify the performance standards that apply. The performance standards are the parameters against which control measures for MAEs are assessed to ensure they reduce the risks to ALARP on an ongoing basis. The operator's safety management system must be comprehensive and integrated, including consideration of all aspects of the control measures. As such, as part of the description provided in the safety case, the safety management system needs to be shown to fully support and maintain the performance standards of the control measures within an integrated management framework.

The PSLMSR introduces the option for validation of a design by an independent body. In this context validation is a review process by which compliance with relevant regulations is assessed. It is NOPSA's policy to undertake validation wherever the option exists. The scope of the validation must be agreed with NOPSA and it also must be agreed prior to any safety case submission and subsequent evaluation by NOPSA. The operator is responsible for demonstrating the independence and competence of the appointed validator and then the validator is required to compile a validation report.

7.2.2.2 Scope

The PSLA regulations cover:

Included in the scope of the regulations	Excluded from the regulations
• The recovery, processing, storage and offloading of petroleum • Providing accommodation whether or not bridge connected to a platform • Drilling or servicing of wells • Laying or working on pipelines • The erection, dismantling and/or decommissioning of structures • Any other purposes related to offshore petroleum operations	• Off-take tankers • Tugs and anchor handlers • Supply vessels • A vessel or structure that is declared by the regulations not to be a facility

Table 13: Installations defined within the scope of Western Australian Regulations

The relevant facilities include wells, associated process plant, storage systems and inter-field pipelines. Licensed pipelines and any connected wells and associated plant not specifically associated with another facility are also included within the defined scope of this Act.

7.2.2.3 Documentation

The table below shows the documentation required by the offshore regulations. Note that the regulations also stipulate that additional information should be held and made available as and when requested by the authority.

Activity	Document Required	Reference	Comments
Prior to exploration	Application for Permit	PSLA Clause 21	Applications generally include technical data that would typically be found in a safety case.
	Notification of discovery of petroleum	PSLA Clause 34 and 38J	Within 3 days.
Prior to operation	Safety Case	PSLMSR Clause 10 Clause 35	Safety Case to include: a safety management system; details of safety measures and emergency preparedness arrangements; an evacuation, escape and rescue analysis; a fire and explosion risk analysis; pipelines and vessel and aircraft controls.
	Application for lease or production licence	PSLA Clause 38A	Applications generally include technical data that would typically be found in a safety case and fiscal data associated with taxation and fees.
Prior to pipeline construction	Safety Case	PSLA Clause 64	Requires pipeline licence.
	Application for consent to construct	PSLPR Clause 11	The regulations include the provision for the Minister to specify that particular details to be included in the application are subject to independent
Pipeline operations	Pipeline management plan	PSLPR Clause 17	Also requires a consent to operate and an independent validation.
	Pipeline safety management plan	PSLPR Clause 26	Plan to include a safety policy, a description of pipeline, details of management system and statement of applicable standards.
	Revised pipeline safety management plan	PSLPR Clause 31 Clause 33-35	Due to changes in operational circumstances or after five years.
	Revised safety case	PSLMSR Clause 40 Clause 42	Safety Case to be reviewed in the event of significant change to pipeline or operation, at the request of the authorities or at least after five years from initial acceptance.
	Health and safety representatives and OSH matters	PSLOSR All clauses	Details of health and safety representatives, election details and election failures etc, and other OSH data.
Pipeline decommissioning	Pipeline safety management plan	PSLPR Clause 21	Plan in force to contain details of decommissioning.
Adverse incident	Notification of accident or dangerous occurrence	PSLMSR Clause 52 PSLPR Clause 55	As soon as possible after the incident. Same process for pipelines.
	Reports of all accident and dangerous occurrences	PSLMSR Clause 53 PSLPR Clause 56	Report to be submitted within 3 days. Same for pipelines.
Well operations	Well operations management plan	PSLMWR Clause 4	To be submitted at least 30 days prior to the start of well activities.
Diving activities	Diving safety management plan	PSLDSR Clause 6	To be submitted at least 60 days prior to commencement of the diving project.
	A revised diving safety management plan	PSLDSR Clause 6	After five years or following issue of a revision notice by the safety authority.
	Diving project plan	PSLDSR Clause 15	To provide a detailed description of the proposed diving operations including applicable standards, risk assessments and emergency response plans.
	Written notice of start of diving operations	PSLDSR Clause 30	To be submitted at least 14 days prior to the start of diving activities.

Table 14: Documentation required by Western Australian Offshore Regulations

7.2.3 PIPELINES

7.2.3.1 Overview

The safety regulation of onshore and offshore pipelines not specifically covered by the PSLA falls within the requirements of schedule 1 of:

- The Petroleum Pipelines Act 1969 (PPA) (Plus amendments to 2006).

The PPA lays down the licensing requirements for pipelines and enables a number of specific regulations addressing health and safety issues. The current versions of these regulations are:

- Petroleum Pipelines (Management of Safety of Pipeline Operations) Regulations PPAMSR 2010; and
- Petroleum Pipelines (Occupational Safety and Health) Regulations PPAOSR 2010.

The PPAMSR require that an approved safety case should be in force prior to the commencement of any pipeline operations.

These regulations adopt a similar philosophy to that laid down under the PSLA in that major accident hazards and events are addressed through the requirement to include formal risk-based safety assessments as well as describing a detailed safety management system. The approach is goal setting although a number of the requirements concerning occupational safety and health are in practice prescriptive.

The regulations define a pipeline operation as encompassing construction, operation, periodic inspection, maintenance or repair and modification.

The PPA and its subsidiary regulations also include for independent and competent validation to be requested to support the information being submitted in safety cases and their associated safety management systems.

7.2.3.2 Scope

A pipeline, either onshore or offshore, is defined as a pipe or system of pipes used or intended to be used for the conveyance of petroleum. As defined in the PPA, the system includes *all structures for protecting and supporting the pipeline and all loading terminals, works and buildings and all fittings, pumps, tanks, storage tanks, appurtenances and appliances and any facility declared as being used in connection with the pipeline*.

The PPA applies to all pipelines, both onshore and offshore, except those offshore pipelines such as inter-field connections that specifically fall within the scope of the PSLA. Separate legislation applies to distribution systems within Australia and these are not addressed in this report.

7.2.3.3 Documentation

The documentation and submissions required under the PPA are as follows:

Activity	Document Required	Reference	Comments
Prior to pipeline construction	Licence application	PPA Clause 8	The information required in support of the application for a licence. Includes a range of technical information that would typically be included in a safety case but excludes the requirement for a safety management system.

Activity	Document Required	Reference	Comments
Prior to pipeline operation	Safety Case	PPAMSR Clause 10	To include description of the pipeline and its operation, a safety management system, a formal safety assessment in the form of a risk assessment covering all risks including major hazard accident events. Use of standards to justify safety case and risk assessment. Includes a fire and explosion risk analysis. Safety Case to include and emergency response plan.
Ongoing operation	Revised safety case	PPAMSR Clause 32 Clause 34	Safety Case to be reviewed in the event of significant change to pipeline or operation, at the request if the authorities or at least after five years from initial acceptance.
	Health and safety representatives and OSH matters	PPAOSR All clauses	Details of health and safety representatives, election details and election failures etc, and other OSH data.
Adverse incident	Notification of accident or dangerous occurrence	PPAMSR Clause 44	Notification ASAP.
	Reports of all accident and dangerous occurrences	PPAMSR Clause 45	To be retained by the operator for inspection. Submitted in 3 days.

Note: The regulations also stipulate that additional information should be held and made available as and when requested by the authority.

Table 15: Documentation required by Western Australian Pipeline Regulations

7.2.4 ONSHORE

The safety regulation of onshore sites falls within the requirements of:

- Petroleum and Geothermal Energy Resources Act 1967 with various amendments up to the current version in 2010.

This Act details requirements concerning permits, leases and licences for onshore exploration and production of petroleum. It also introduces the requirements for occupational health and safety and defines the functions and powers of the DMP. The detailed requirements for risk and safety related aspects of the above Act are defined within the latest amendments of the following associated regulations:

- Petroleum and Geothermal Energy Resources (Occupational Safety and Health) Regulations 2010; and
- Petroleum and Geothermal Energy Resources (Management of Safety) Regulations 2010.

These regulations have the same requirements as the offshore regulations. The onshore Acts apply to all onshore petroleum operations in addition to geothermal energy related activities. This scope also includes onshore drilling.

7.3 RISK FRAMEWORK

This is a performance based regime, the underlying principle being that the primary responsibility for ensuring health and safety should lie with those who create risks and those who work with resulting prevailing risks. An onus is therefore placed upon the operator of a petroleum facility to demonstrate that all relevant hazards and risks have been identified and recognised and that suitable controls are in place to avoid, manage or mitigate such risks and this is demonstrated in a safety case. Within the published guidance the operators are encouraged to broaden the scope of their risk assessments to address both major hazard events and occupational and workplace risks. The guidance also indicates that either quantitative or qualitative risk assessment methods can be used as the primary objective should be to identify levels of risk that can be used to develop and then justify appropriate controls or preventative measures.

7.3.1 ALARP

The concept of risk being demonstrated as low as reasonably practicable that is used by the Australian Authorities is based upon the judgement made by Lord Justice Asquith in the UK in 1949 and subsequently confirmed in the Australian High Court. In this the term 'reasonably practicable' is interpreted as meaning that the cost, in terms of either time or money, to further reduce an identified level of risk is disproportionate. The published guidance makes reference to the UK HSE definition of ALARP including providing the example of the risk band thresholds suggested by the HSE but then stresses that it is the concept and principle of ALARP that is considered important and the operator is required to justify the acceptance criteria he has decided to use but then to demonstrate an ongoing process of continuous improvement.

7.3.2 RISK CRITERIA

The risk framework in Australia is similar to the UK in that guidance is given in how to assess ALARP with example upper and lower limits (10^{-3} and 10^{-6} as in the UK) of individual risk given in guidance [4]. The UKOOA risk-based decision making framework is also referenced [5].

7.4 THE REGULATOR

7.4.1 FORMAL ARRANGEMENT

Oil and gas exploration and production takes place in all of Australia's political states and the applicable safety and health legislation is primarily enacted separately within each state, although a common regulatory approach, encouraged by Federal initiatives, is now typically employed. Western Australia has the largest offshore industry of all the states and therefore this review focuses on the legislative regulations published and applied by this state's government.

Although the focus is state based, the regulation of offshore petroleum activities is common to all the states and as a result a single national authority is defined within the PSLA. This is the National Offshore Petroleum Safety Authority (NOPSA) and it is responsible for the safety regulation of all offshore petroleum activity in waters up to the mean low-water mark.

The Western Australian Department of Mines and Petroleum (DMP) regulates all onshore activities.

7.4.2 COMPLIANCE ASSESSMENT

7.4.2.1 Regulator

The compliance assessment and inspection regime for offshore installations and pipelines is provided by inspectors appointed by NOPSA. The compliance assessment and inspection regime for onshore installations and pipelines is provided by the Resources Safety Department staff of the DMP who are appointed as inspectors under the petroleum legislation. In both cases, the inspectors are provided with powers to enter an installation, facility or premises to make physical inspections, to interview personnel with a view to assessing compliance with the regulations.

The role of the regulator in this performance based regime is to provide independent assurance that health and safety risks are properly identified and addressed by challenging the operator's risk assessment and resulting management arrangements by inspection and review of the submitted safety cases. Planned inspections are then conducted to monitor compliance and to verify that the risk management controls are being implemented as per the accepted safety cases.

7.4.2.2 Validation

The Western Australian Regulations include a process entitled 'Validation' that can be interpreted as a similar process to verification by an Independent Competent Person (ICP) as defined within UK legislation. The Safety Authority may impose on an operator a requirement to provide a validation of a proposed facility or in respect of proposed significant changes to an existing facility. The required validation is a statement in writing by an independent person in respect of the design, construction and installation of those parts of a facility specified in an agreed scope of validation. The operator of the facility is responsible for liaising with NOPSA such that the Scope of Validation may be agreed, for submitting the completed Validation, providing information regarding the competence of the Validator, and finally for submitting the relevant Safety Case to NOPSA.

Validation must therefore establish to a level of assurance reasonably required by the Safety Authority that the matters agreed in the scope have been reviewed and assessed to ensure that the item has been designed and where appropriate manufactured to comply with relevant parts of a relevant standard. In cases where standards are not available, the risk-based framework can be used. The operator is responsible for satisfying the Safety Authority that persons undertaking validation have the necessary competence and access to appropriate data to be able to deliver an independent opinion on the scope of the validation. The Validator may be an individual or an organisation.

7.4.3 ENFORCEMENT

The Australian legislation clearly relates its risk management and occupational safety and health regulations to its permit and licence requirements and so is a permissioning regime. The regulations stipulate financial penalties in relation to non-compliance with each of the specified requirements. The powers given to the NOPSA and the DMP Inspectors include:

- The right of inspection to ascertain compliance or contravention of applicable OSH law;
- The right of entry and search into places other than where the operation is being carried out;
- The power to require assistance, services and information necessary to address their duties;
- The power to require their questions to be answered;
- The right to take possession of plant, substances or other items; and
- The right to issue improvement and prohibition notices, and in the event that further investigations may be required, what are called 'do not disturb' notices.

7.4.3.1 Incident Reporting

Investigations are conducted when information obtained or received by NOPSA justifies seeking evidence of non-compliance with relevant OHS legislation. All reports of accidents and dangerous occurrences are reviewed. Investigations can either result in prosecution, or an administrative outcome, which is any outcome not involving prosecution such as a written warning or issuing an Improvement Notice.

An investigation will generally be conducted when:

- There is an accident that causes death or serious injury;
- There is an abandonment of a facility due to an emergency;
- There is an accident or dangerous occurrence which could *easily* have led directly to death or serious injury;
- There is an accident, dangerous occurrence or complaint which creates suspicion of a significant lack of compliance with relevant legislation;
- There is an accident, dangerous occurrence or complaint which creates suspicion of an immediate threat to health or safety; and
- The operator has a history of similar incidents or relevant enforcement.

7.4.4 INTERACTION WITH OTHER BODIES

See Section 5.4.4.1 for international regulator interaction.

Aviation and Marine

Within the national context three other authorities with specific involvement in the offshore and onshore environment are the Australian Maritime Authority (AMSA), the Australian Transport Safety Bureau (ATSB) and the Civil Aviation Safety Authority (CASA). The safety regulatory framework employed in Australia stipulates a close working liaison between all appropriate authorities and agencies.

The AMSA is responsible for maritime safety, maritime environmental protection and the provision of maritime and aviation search and rescue. The authority is responsible for the national plan for an effective response to marine pollution incidents including those emanating from petroleum operations.

The ATSB is an independent National Governmental Agency with a specific function to improve safety and public confidence in all forms of transport. Its primary function with regard to petroleum activities is to investigate accidents and to foster safety awareness.

The CASA is responsible for all regulations and legislative instruments forming the aviation regulatory framework for Australia and with regards to petroleum activities this encompasses the rules for helidecks, flight operations and crewing and operational safety.

Economic Regulation

Economic regulation of all petroleum activities in Western Australia, through the administration of approvals and registration of permits, leases, production and drilling licences is handled within the overall scope of the DMP.

Environmental Bodies

Environmental regulation with respect to the petroleum industry is handled by the Environmental Services Department of the DMP. There is a published memorandum of understanding between the DMP and the Environmental Protection Authority (EPA) that enables the DMP to get appropriate support from the EPA as and where considered appropriate.

OSH Regulators

The policy of harmonisation of petroleum industry regulation has brought about a close relationship between the DMP and NOSPA. The Western Australian Government has a stated commitment to achieving a close working arrangements between all its responsible authorities and a common approach to health and safety regulation, which the result that NOPSA can effectively administer all regulatory processes offshore and DMP can achieve the same ends onshore.

NOPSA is a member of the International Regulators Forum (IRF), which represents OSH regulators in many of the major oil and gas producing countries. This organisation encourages the improvement in health and safety in the petroleum sector through collaboration and the sharing of relevant information.

7.4.5 NOPSA AND DMP GOVERNANCE

7.4.5.1 Methods for ensuring inspector competence

NOPSA has an in-house competency programme to ensure its inspectors achieve a uniform standard in a core set of competencies. NOPSA assists its employees to attain a competency based academically recognised qualification and this is administered through an agreement with the University of Ballarat.

7.4.5.2 Internal review

NOPSA publishes Offshore Health and Safety Performance Reports, the first two being dated 2008 and 2010. These reports summarised what are considered to be the key performance indicators for both the industries safety performance and NOPSA's regulatory performance, and their most significant factors are listed as:

- Accident rate;
- Dangerous occurrence rate;
- Hydrocarbon release rate; and
- International benchmarks.

The recent process of legislative revision and update was brought about by the National Governments commitment to review the safety of the petroleum industry.

7.4.5.3 How the regulatory body measures and reports on its performance

NOPSA continuously collects and reviews data on the safety performance of the industry and uses this information to publicly report on its own regulatory performance and monitors the outcomes against a number of key performance indicators including accident rates per million hours worked, dangerous occurrence rate per million hours worked, hydrocarbon release rates per 100 facilities per year (Production and Drilling) and related international bench marks.

7.4.6 EFFORT REQUIRED PER PLATFORM

Planned inspection will be done in general by a team consisting of two persons, one of whom is designated as the Lead Inspector. Where possible the Leader Inspector will be the OSH inspector designated to that facility. The regulatory activities undertaken are as follows:

Assessments – Approximately 200 assessments are performed each year. These vary in complexity, the time typically taken for completion, and the inspector resources required. Assessments are office-based reviews of safety cases. The rate of assessments per facility has ranged between 1.0 - 1.7 (2005-2009).

Inspections – Approximately 100 inspections of offshore facilities and 10 inspection/audits of onshore facilities are conducted each year. The onshore inspection/audits are undertaken either via agreements with onshore regulators or as part of the management system inspection of an offshore facility. Each fixed, normally attended facility and MODU is inspected twice per year (NOPSA has recently increased this target from once per year). Not normally attended facilities such as monopods and pipelines are typically inspected annually and other mobile facilities (vessels) are inspected within six weeks of entering our regime. The rate of inspections per facility has ranged between 0.5 - 0.8 (2005-2009)

Investigations – Approximately 400 incidents and complaints are investigated annually. The level of these investigations varies in time taken to complete, complexity and resource-cost. There have been up to 11 high level investigations per year. The rate of investigations per facility has ranged between 1.8 - 2.8 (2005-2009)

Enforcements – Approximately 60 enforcement actions are issued per year. Four enforcement types are utilised, increasing in severity from a written warning, improvement notice, prohibition notice, through to prosecution. The rate of enforcements per facility has ranged between 0.2 – 0.4 (2005-2009).

Data on the number of hours required for the above work is given below:

- Inspector time spent on Assessments 25-30%
- Inspector time spent on Inspections 40-50%
- Inspector time spent on Investigations 15-20%
- Inspector time spent on Enforcements 1-2%
- Total number of Inspectors 28-32
- Total Inspector Hours 45,000–50,000 per year

8 REVIEW OF THE NORWEGIAN REGULATORY SYSTEM

8.1 OVERVIEW

8.1.1 OIL AND GAS ACTIVITY IN NORWAY

The oil and gas sector of Norwegian industry is recognised as one of the major petroleum regions in the world. There are 73 offshore installations and 23 mobile drill rigs within the Norwegian sector of the North Sea. Oil and gas is recovered from these fields using a wide variety of installation designs including entirely subsea completions and manifolds, steel jacket and concrete gravity platforms, tethered floating installations and floating production storage and offloading (FPSO) vessels. There are ~13,400 kilometres of pipeline originating in the Norwegian sector of the North Sea. The Norwegian onshore regulations specifically identify petroleum facilities at eight locations. The overall extent of this activity is shown on Figure 11 on the following page.

8.1.2 LEGISLATIVE OVERVIEW

The regulation of health, safety and environmental issues across Norwegian industry is administered by three primary authorities. The Petroleum Safety Authority (PSA) is one of these three authorities and is responsible for all safety aspects of petroleum activities either offshore or onshore. Primary legislative regulation covering petroleum activities is administered by the Norwegian Petroleum Directorate (NPD) but this is specifically a fiscal authority and all requirements concerning health and safety have been transferred to the PSA. The regulations administered by the PSA are a mixture of goal setting and perspective regulations that heavily refer to NORSOK standards, which themselves are a mixture of goal setting and prescriptive requirements. There is also a significant emphasis on occupational health and safety.

The Norwegians have changed from an *approvals* regime, which had the effect of turning the enforcing agency into a virtual guarantor that company activities were acceptable, to a *consent* regime. The latter allows the PSA to express confidence that the operator concerned will pursue its activities in compliance with the regulations and with the information in its consent application.

The concept of a specific safety case is not defined within the Norwegian legislation, but the extent of information needing to be provided to the regulator is similar and for mobile units (e.g. drilling, flotel), an acknowledgement of compliance is needed for which almost the same information as a safety case is needed. As a whole, the regulations cover all the hardware, procedural and personnel issues that affect safety offshore. For example, there are specific paragraphs in the regulations covering gas detection, maintenance and competence. There is some element of prescription in most of these paragraphs meaning that most safety systems are in some way prescribed by the regulations.

Note that the Acts and associated Regulations are published in both the Norwegian and English languages. It should be noted that in the event of any ambiguities between the two versions, it is the Norwegian language version that takes precedence.

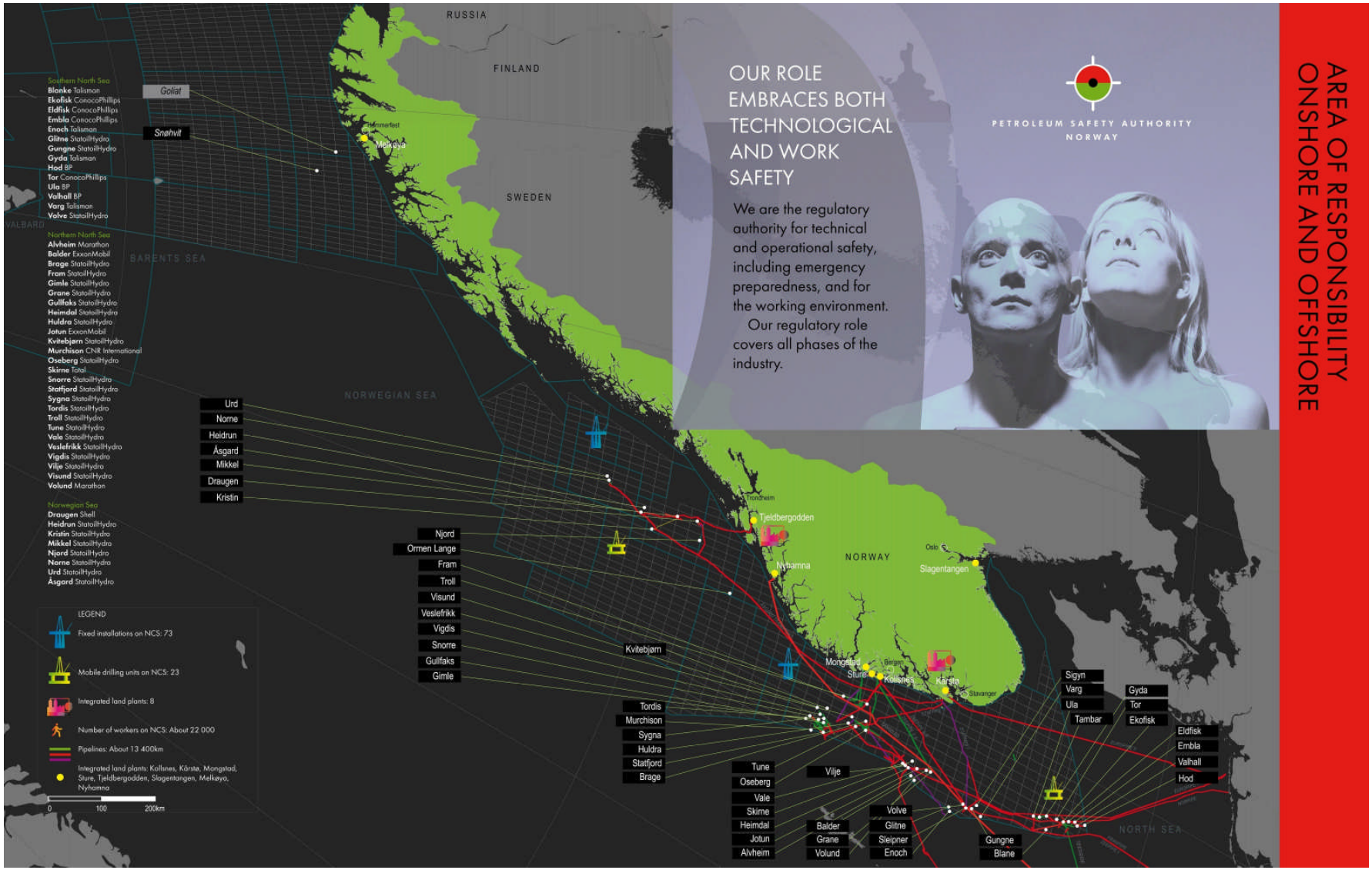

Figure 11: Oil and Gas Activity in Norway

8.1.3 REGULATOR

The day-to-day safety regulation of the petroleum industry is undertaken by the PSA. Occupational Health and Safety issues are in practice additionally delegated to the PSA, which also provides supervision in respect of the complete range of other more generic applicable regulations both offshore and onshore. In this context supervision is defined as a combination of audits, verifications, investigations, consents, meetings with industry and surveys etc that are carried out by the PSA.

8.2 NORWEGIAN LEGISLATIVE STRUCTURE

8.2.1 PETROLEUM ACTS AND LEGISLATIVE REGULATIONS

In Norway the responsibility for petroleum activities is vested in the NPD and the primary remit for this authority is to promote the value of the industry for the benefit of society as a whole. Its role is therefore principally fiscal. There are three offshore related Acts that fall within the jurisdiction of the NPD:

- The Petroleum Activities Act 1998 No 104 amended to 2009 is principally concerned with the fiscal arrangements associated with licenses although it also includes the premise that petroleum activities should only be carried out with pragmatic regard for operational safety and the environment;
- The CO_2 discharge Act, which is also a fiscal measure to limit the discharge of natural gas and the flaring of petroleum products offshore through the imposition of a tax on quantities discharged; and
- The Scientific Research Act, which applies to scientific research of the seabed and the exploration for subsea natural resources

Safety regulation under the Petroleum Activities Act is delegated to the PSA, which provides supervision in respect of the complete range of both petroleum specific and non-specific general industry regulations that are applicable both offshore and onshore. The regulation of onshore terminal facilities and associated pipelines utilises the same processes as employed offshore, but with reference to other Acts under which the regulations address, for example, the prevention of fire and explosions, the supervision of electrical installations and relating to the working environment.

The regulation of the Norwegian petroleum industry is defined within the following regulations:

- The Activities Regulations (NAR) amended to 2010, which address how the different activities associated with a petroleum installation are to be conducted;
- The Facilities Regulations (NFR) amended to 2009, which stipulate requirements relating to the design and outfitting of facilities;
- The Framework HSE Regulations (NHSER) amended to 2009, which are concerned with health, the environment and personal safety;
- The Information Duty Regulations (NIDR) amended to 2010, which identify the information requirements that have to be met by the managers of a petroleum installation and by the managers of services and suppliers of equipment being provided to such an installation; and
- The Management Regulations (NMR) amended to 2004, which describe the requirement for the management of petroleum activities.

The regulations prescribe specific requirements regarding a wide range of technical design factors and management processes and require a significant number of strategies, records of activities and management plans to be prepared and submitted and audited by the PSA.

The regulations also require that specific quantitative risk analysis is carried out to provide evidence and justifications of the management of hazards. It is stipulated that such analyses address major accident risk, emergency preparedness and environmental risk and specifically address the intended working environments and thus contribute to improving the health, well being and security of the employees, and preventing personal injury, deaths and work related disease.

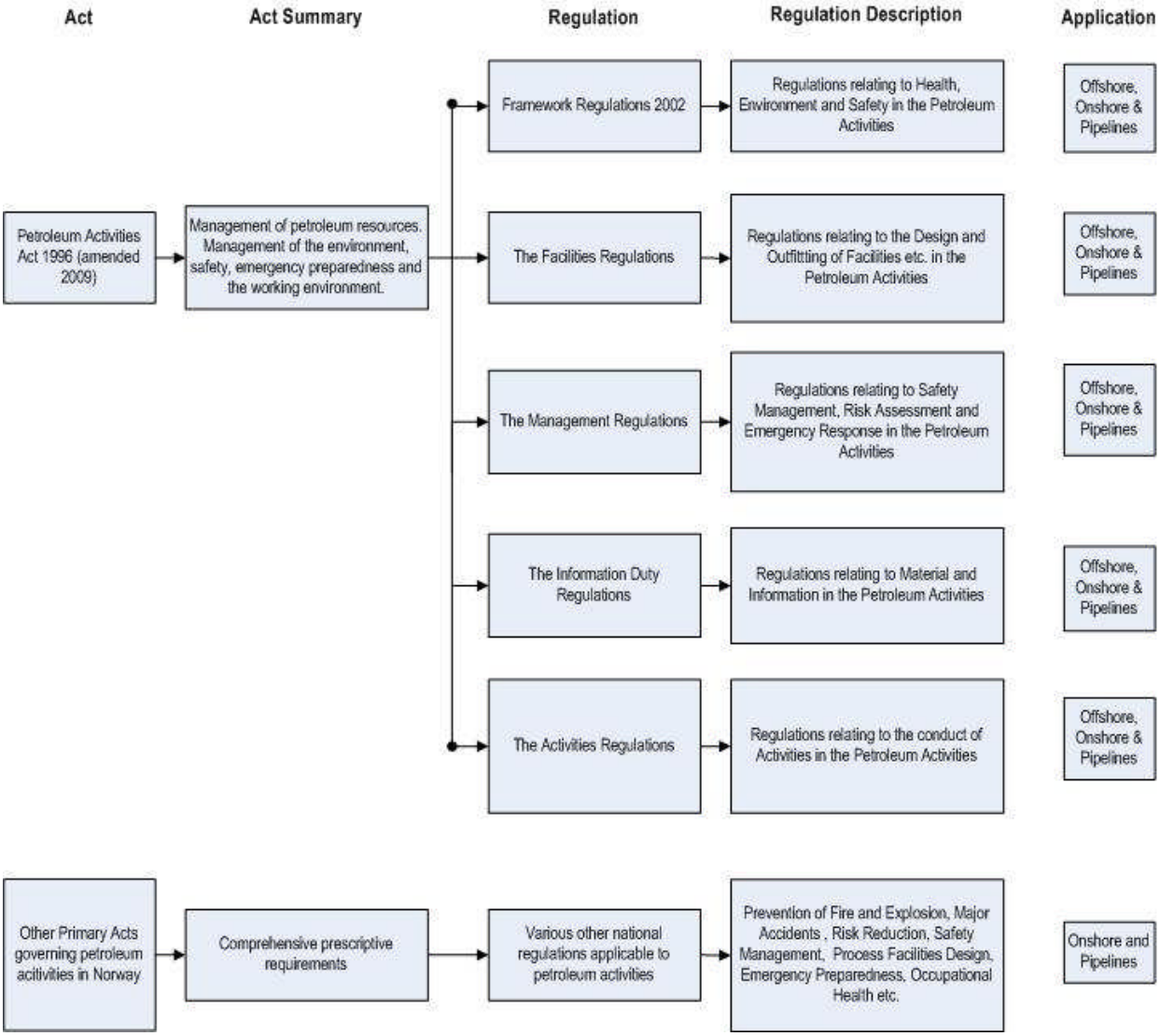

Figure 12: Primary Norwegian Acts and Regulations

Although the terminology of safety critical elements (SCE) is not used, the Activities Regulations ask the Operator to define equipment for which *functional failures that may entail serious consequences* can occur.

8.2.2 SPECIFICS FOR ONSHORE, OFFSHORE AND PIPELINES

8.2.2.1 Offshore

Offshore jurisdiction covers Norwegian territorial waters and the continental shelf but do not apply to the waters around Svalbard (Spitzbergen) where separate discrete, albeit similar, regulations are applied.

The framework regulations stipulate that supply vessels, anchor handling tugs, seismic and geological survey/exploration vessels are exempt from these regulations but are covered within Norwegian shipping regulations. All other aspects of the offshore petroleum industry are covered by these regulations.

The Information Duty Regulations require mobile units to have an Acknowledgment of Compliance (AoC), which is approval of a document akin to a safety case. An AoC is a decision made by the PSA to the effect that the technical condition of a mobile facility and the applicant's organisation and management system are considered to be in compliance with relevant requirements in Norwegian shelf legislation.

The application for an AoC encompasses two parts; the location and activity specific matters, and one part which encompasses the facility specific matters, i.e. technical condition and the applicant's organisation and management system, analyses carried out, maintenance programme and plans for upgrading.

8.2.2.2 Onshore

The regulation of onshore terminal facilities and associated pipelines utilises the same processes and legislative instruments as employed offshore, but with reference to other Acts addressing the prevention of fire and explosions, the supervision of electrical installations and relating to the working environment. Other primary Norwegian Acts that are identified as having an impact on onshore petroleum installations include:

- The Fire and Explosion Prevention Act (Accidents involving hazardous substances and the fire service) of June 2002 No 20;
- The Supervision Act (Electrical Installations and Equipment) of May 1929 No 4;
- The Working Environment Act (Working environment, working hours and employment protection) of June 2005 N0 62;
- The Petroleum Activities Act of November 1996 N0 72;
- (parts of) The Product Control Act (control of products and consumer services) of June 1976 No 79; and
- Temporary regulations relating to safety and working environment for certain petroleum facilities on land and associated pipeline systems. FOR 2003-12-19 No 1595. (With amendments to January 2008).

These regulations formally incorporate elements of their primary Acts into this specific area of regulation.

The onshore aspects of these regulations relate to safety and working environments at specifically named petroleum facilities and include their associated pipelines but do not apply to Svalbard (Spitzbergen) where separate discrete, albeit similar, regulations are applied.

8.2.2.3 Pipeline

Offshore pipelines are directly incorporated in the offshore facility regulations whereas onshore pipelines are addressed within what are currently entitled, the Temporary Onshore Regulations. In each case the pipelines are addressed as elements of the facilities or installations being regulated.

The scope of the Norwegian Petroleum Activities Act encompasses all pipelines associated both with offshore facilities and onshore installations and therefore the same regulations detailed above are considered applied.

8.2.3 DOCUMENTATION

Given that the same regulatory requirements apply onshore and offshore the documentation requirements are similar and the analysis below is for offshore. However, the need to additionally comply with other more generic onshore regulations inevitably results in further documentation requirements but these are not addressed in this review.

The Norwegian Information Duty Regulations (NIDR) defines the information that must be supplied to the regulators. The NIDR cross reference other Norwegian regulations. The documentation requirements are

given below. Note that this excludes information that has to be held by the Operator but not necessarily supplied to the regulator.

Activity	Document Required	Reference	Comments
Prior to detailed design	Plans of early phase work management and process	NHSER Ch 5 Sec 19	To be submitted to the Ministry of Labour and Social Inclusion as part of the process to obtain a production licence.
Prior to operation	Various technical documents	NAR Ch VI Sec 18	Includes Risk Assessment according to NORSOK Z-001. The PSA specifically supervise the SMS albeit in co-operation with the Norwegian Pollution Control Authority and the Norwegian Board of Health.
	Application for Compliance	NIDR	Required for mobile units. Documentation required is akin to a safety case.
	Application for Consent	NIDR Sec 6	Must be kept up to date and is akin to a safety case. Needs to be submitted if a substantial change is made.
	Management System	NHSER Ch IV Sec 13	Management system must show how the workforce has been involved.
	Maintenance Programme	NAR	Ch IX Sec 44.
	Plans for environmental monitoring		Ch X-I Sec 52b. And Ch X-I Sec 52° For the Norwegian pollution control agency.
	Prepare environmental evaluations		Ch X-II Sec 56c.
	Plan for treatment of waste		Ch X-III Sec 63.
	Emergency preparedness strategy and plans		Ch XI-I Sec 64 and Ch XI-I Sec 67.
	Plans covering health, environment and safety for the development of a petroleum deposit	NHSER Ch V Sec 20	To be submitted to the Ministry of Petroleum and Energy and the Ministry of labour and Social Inclusion with copies to the NPD and the PSA.
	Analysis of risk	NMR Ch IV All Sections	The general requirement is to conduct risk analyses in order to provide the necessary decision basis in order to give due consideration to health, environment and safety. Quantitative risk analyses are required for major accident risks, emergency preparedness, environmentally orientated risk and the working environment.
	Decommissioning Plan	NHSER Ch V Sec 22	To be submitted to the Ministry of Petroleum and Energy and the Ministry of labour and Social Inclusion with copies to the NPD and the PSA.
Prior to starting well activities	Programme for drilling and well activities	NAR	Ch XIII Sec 72.
	Action plan for lost well control		Ch XIII Sec 77.
Prior to operation	Plans covering matters relating to health, environment and safety	NHSER Ch V Sec 20	To be submitted to the Ministry of Petroleum and Energy and the Ministry of labour and Social Inclusion with copies to the NPD and the PSA. Applies to the development of a petroleum deposit.

Activity	Document Required	Reference	Comments
	Analysis of risk	NMR Ch IV All Sections	The general requirement is to conduct risk analyses in order to provide the necessary decision basis in order to give due consideration to health, environment and safety. Quantitative risk analyses are required for major accident risks, emergency preparedness, environmentally orientated risk and the working environment.
	Decommissioning Plan	NHSER Ch V Sec 22	To be submitted to the Ministry of Petroleum and Energy and the Ministry of labour and Social Inclusion with copies to the NPD and the PSA.
Incident of violation	Notification of violation of a safety zone	NHSER Ch VII Sec 39	To the Police, the PSA and the Ministry of labour and Social Inclusion.
Prior to drilling operations	Drilling and well activities	NIDR Ch III Sec 7	Time limits are not set in the regulations but advised by the PSA.
	Well programme	NIDR Ch III Sec 8	
Ongoing operations	Annual report of the safety committee	NHSER Ch VIII Sec 45	To be held available but submitted to the PSA upon request.
	Plan for working hours	NHSER Ch VIII Sec 48	Also included within the Working Environment Act.
	All relevant documentation	NIDR Ch 1 Sec 1	All documentation associated with the preparation of submissions and other required records to be held and made available to the PSA upon request.
	Reporting of drilling and well activities	NIDR Ch IV Sec 17	Submitted to PSA on a daily basis.
	Ongoing monitoring of risk analysis, reanalysis of risk and development of corrective actions	NMR Ch V All Sections	These processes are identified as employing the same concept of continuous improvement and response to identified short comings as defined within typical international quality management standards.
	Planning of activities and work processes	NMR Ch III All sections	Plans to give due consideration to health, environment and safety.
	Monitoring and discharge and risk of pollution	NIDR Ch III Sec 9	
	Survey, marine and seismic data	NIDR Ch III Sec 10	To be provided to various other institutions as indicated in the regulations within time limits advised by the PSA.
	Plan of implementation of response to pollution	Various	To be provided to other relevant agencies. (NIDR Ch III Sec 9, NAR Ch XI Sec 70).
Adverse incident	Alert notification regarding hazard and accidents	NIDR Ch IV Sec 11	Immediate telephonic alert followed by confirmation in writing. To include incidents resulting in death or personal injury and work related disease.
	Follow up reports concerning notified hazards and accidents	NIDR Ch IV Sec 12	The authorities to be continuously informed about the development of measures that are planned to be implemented.
	Reporting of damage to structures and pipeline s	NIDR Ch IV Sec 17	Submitted to PSA for inclusion in their database Corrosion and Damage (CODAM).

Table 15: Documentation required by Norwegian Offshore, Pipeline and Onshore Regulations

Note that a fuller (though not complete) list is available in [2], though it includes some requirements that are not relevant to safety. In addition to the documentation requirements listed above in Table 17, the Information Duty Regulations identify a number of activities for which technical information must be submitted as part of a process to obtain formal consents to commence such activities. These activities include:

- Exploration Drilling;
- Manned underwater operations;
- Putting into service of new or changed facilities;
- Major rebuilds of facilities;
- Use of a facility that will exceed initial design lifespan;
- Disposal of facilities, plant or equipment;
- Change of function of a facility; and
- Change of use of safety related vessel.

8.3 RISK FRAMEWORK

8.3.1 ALARP

The concept of ALARP is not formally recognised in the Norwegian regulations although in the HSE Framework Regulations (Sec 9), there is an equivalent concept:

In effectuating risk reduction the party responsible shall choose the technical, operational or organisational solutions which according to an individual as well as an overall evaluation of the potential harm and present and future use offer the best results, provided the associated costs are not significantly disproportionate to the risk reduction achieved.

Other parts of the regulations require the risk assessment itself to be undertaken.

Within the Norwegian National Standard Z-013 (Risk and Emergency Preparedness Analysis), the concept of ALARP as a tool for decision making is outlined. No values are given for the upper or lower level of tolerability, but values are suggested for the cost of life for costs benefit analyses that may form part of an ALARP assessment.

8.3.2 RISK CRITERIA

The NMR regulations require the operator to derive their own risk acceptance criteria for major accident risk and environmental risk.

The Management Regulations Guidance defines the need for the operator to determine whether risk criteria are met. The terminology of Risk Acceptance Criteria (RAC) is used in NORSOK Z-013, but a value is not given and the standard just gives further guidance. Values are given for the maximum tolerable impairment frequency of critical safety equipment (NORSOK Z-013, Appendix A.1.2).

The regulations specify that the risk analyses and therefore the derived risk acceptance criteria shall cover:

- Risk to personnel as a whole and to specific exposed groups of personnel;
- The loss of main safety functions;
- Pollution from the facility; and
- Damage to a third party.

8.4 THE REGULATOR

8.4.1 FORMAL ARRANGEMENT

The regulation of the Norwegian petroleum arrangements both onshore and offshore is vested in a number of organisations, including, the Norwegian Petroleum Directorate (NPD), The Petroleum Safety Authority Norway (PSA), the Norwegian Pollution Control Authority (SFT) and the Norwegian social and Health Directorate (NSHD). For health and safety regulation, the primary authorities are the NPD and the PSA.

The NPD is responsible for petroleum activities within Norwegian jurisdiction including licensing. Some licensing conditions include reference to health and safety issues, but following the setting up of the PSA the responsibilities in this area were taken over by the PSA. The paramount objective of the NPD is to contribute to creating the greatest possible values for society from the oil and gas activities by means of prudent resource management based upon safety, emergency preparedness and safeguarding of the external environment. The NPD thus administers the fiscal and permissioning aspects of petroleum activities in Norway and stipulate some high level requirements regarding the safety related management of the installations and facilities that they administer. Nonetheless the detailed regulation of health and safety is conducted by the PSA.

The PSA was created as an independent and petroleum specific legislative regulator in 2004 and, although subordinate to the Ministry of Labour, the PSA has total regulatory responsibility for safety, emergency preparedness and the working environment in the petroleum industry. The published remit of the PSA includes its co-ordinating role in relation to other regulators with independent authority in the HSE area. With respect to offshore activities these include the Climate and Pollution Agency (the former SFT), The Norwegian Board of Health and the Norwegian Radiation Protection Authority and, for onshore facilities, the Norwegian Coastal Directorate and the Norwegian Industrial Safety Organisation.

8.4.2 COMPLIANCE ASSESSMENT

Compliance assessment is achieved through a process of supervision, which is defined as a combination of audits, verifications, investigations, consents, meetings with industry and surveys etc that are carried out by the PSA. The audits are defined as a systematic examination of the management and control systems that the operator has in place. These are supported as considered necessary with the aid of verifications based upon measurements, tests and inspections, checks which are made to ensure that the actual circumstances conform with the regulatory and management system requirements.

The party responsible shall decide on the extent of verifications, the method to be used in and the degree of independence of the verification in order to document that the requirements of the legislation relating to health, environment and safety have been met. When it has been decided that verifications are to be carried out, such verifications shall be carried out according to an overall and unambiguous verification programme and verification basis.

The operator shall establish the verification basis for the total petroleum activities after having determined the scope, method and the degree of independence of the verification. The operator shall also carry out an overall evaluation of the results of verifications that have been carried out.

The Petroleum Safety Authority may order the operator to have verifications carried out, or alternatively carry out verifications itself.

The PSA has been set up as an independent authority and the relevant government ministry has provided guidance to the PSA on discharging its duties as follows:

- Audits should be system orientated 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 a high risk / technology regulator and a labour inspection authority; and
- Contributing and collaborating with companies and unions represent a crucial requirement for and principle in the PSA's operation.

8.4.3 ENFORCEMENT

The supervision teams have formally been given the authority to make enforcement decisions during the conduct of their audits and inspections. Enforcement is achieved through the issuing of Orders specifically relating to non-conformances with regulatory requirements identified during the supervisory audits or inspections. Orders typically do not order the implementation of a specific change or technical solution, but a requirement to achieve compliance except in circumstances where the regulations stipulate specific solutions. Under more serious circumstances stronger sanctions are available including stopping operations, compulsory fines, penalties and other measures.

8.4.4 INTERACTION WITH OTHER BODIES

See Section 5.4.4.1 for international regulator interaction.

The PSA is defined by the Norwegian Government as one of three co-ordinators of HSE regulation covering all national industry and society. The co-ordination role encompasses the development of regulations and supervision and monitoring to confirm compliance with the regulatory requirements.

A number of other Regulatory Agencies retain their individual authority regarding petroleum industry activities although falling within the co-ordination umbrella operated by the PSA. With respect to offshore activities these include the Climate and Pollution Agency (the former SFT), the Norwegian Board of Health and the Norwegian Radiation Protection Authority and, for onshore facilities, the Norwegian Coastal Directorate and the Norwegian Industrial Safety Organisation.

The prescriptive nature of Norwegian HSE regulations has resulted in the development of a wide range of industrial and safety related legislation, aspects of which inevitably relate to the petroleum industry. Some of the other specific regulations that are also imposed on the petroleum industry include:

- PPE regulations for pressure vessels;
- ATEX regulations for explosives;
- Pressure equipment regulations; and
- The machinery regulations.

The co-ordinating role given to the PSA provides it with the responsibility of ensuring that the requirements of both the petroleum specific and the other more industry generic applicable legislative regulations are addressed within its own administration and regulatory process.

Collaboration between employers, unions and government as well as worker participation are considered as essential parts of the Norwegian regulatory process and nationally this includes participation by the PSA in the Norwegian Safety and Regulatory Forums. Collaboration internationally is also undertaken including membership of the North Sea Offshore Authorities Forum (NSOAF) and the International Regulators Forum (IRF).

Aviation

The Facilities Regulations require that installations shall be equipped with instrumentation for aviation weather services in accordance with the requirements of the Civil Aviation Authorities Regulations No 1181 concerned with commercial air transport to and from helidecks and regulation No 81 concerning meteorological services for aviation.

Marine

The regulation of shipping and marine activities falls within the responsibilities of the Norwegian maritime Directorate. Additional maritime regulations that are relevant offshore include, but are not limited to:

- Regulation No 278 concerning stability and watertight subdivisions of mobile offshore units;
- Regulation No 998 (the anchoring regulations) of mobile offshore units; and
- Regulation No 123 mooring and turrets.

Economic Regulation

Economic Regulation is provided through the administration of consents and licenses etc, which is handled by the NPD. The NPD is a permissioning regime but all safety related requirements that were originally included within the NPD regulations have now been transferred to the PSA.

Environmental Bodies

Environmental regulation is a specific component of the primary offshore legislation and is based on the Norwegian Pollution Control Act. The co-ordination role that has been given to the PSA means that it must maintain close working relationships with the Norwegian Social and Health Directorate (NSHD) and with the Norwegian Pollution Control Authority (SFT), now identified as the Norwegian Climate and Pollution Agency. Environmental issues are therefore addressed through the close co-operation of these bodies.

8.4.5 PSA GOVERNANCE

8.4.5.1 Methods for ensuring inspector competence

PSA personnel are trained in accordance with individually assessed training plans. Some training is obligatory, such as for risk analysis/assessment, auditing and accident investigation. There is then a yearly appraisal/performance interview between each employee and their manager.

8.4.5.2 Internal and regulator performance review

This is undertaken by yearly review with management.

8.4.6 EFFORT REQUIRED PER PLATFORM

Each year the PSA prepare a supervision plan defining required audits and compliance assurance activities, but this plan it not openly available to the operators or the general public. This plan is based upon a variety of drivers including known incidents, general historical performance and inputs from the SFT and the Ministry.

The regulatory compliance is carried out by supervisors attached to six separate teams. The teams are allocated to different operators, fields or activities with specific operators as follows:

- Statoil (shelf-based activities);
- Shell, Exxon Mobil, Eni, Marathon GDF Suez;
- BP, Conoco Phillips, Talisman, Total, operating companies that are in the exploration phase only, other licensees;
- Statoil (processing facilities onshore), Esso (processing facilities onshore), Naturkraft. Gassco, Gassnova;
- Mobile facilities and drilling contractors; and
- Other contractors, Petoro.

Offshore supervisory activities are risk based – not calendar based. This means that some installations might be visited more frequently than other ones. However, most installations are visited at least once every three years.

For a supervisory activity, the teams may include as many as 6-8 persons and last for typically 3 weeks (planning, meetings with the company being audited, and possible verification activities). If the audit includes an offshore verification, this will typically employ 2-3 persons for approximately two days.

9 REVIEW OF THE CANADIAN (NOVA SCOTIA) REGULATORY SYSTEM

9.1 OVERVIEW

9.1.1 OIL AND GAS ACTIVITY IN NOVA SCOTIA

In the Canada, there are 4 offshore production platforms:

Offshore – Nova Scotia	Offshore – Newfoundland & Labrador
Sable Island – Fixed Platforms	White Rose - FPSO
	Terra Nova - FPSO
	Hibernia – Gravity Based Structure

Table 17: Canadian Offshore Fields

The Sable Offshore Energy Project lies near Sable Island, 10km to 40km north of the edge of the Scotian Shelf, offshore Nova Scotia, in water depths ranging between 20 and 80m. The Sable Offshore Energy Project consists of the six gas fields Venture, South Venture, Thebaud, North Triumph, Glenelg and Alma. These contain about 85 billion m^3 of recoverable gas reserves. The Sable Project is projected to last until the year 2025.

The first phase of the Sable Island project saw the development of the Thebaud, Venture and North Triumph fields in November 1999. The development consists of four fixed steel jackets. Thebaud has two bridge linked jackets and Venture and North Triumph have a jacket each, linked by subsea pipelines to the Thebaud installation, which acts as a hub for gathering production and exporting fluids to onshore.

The Deep Panuke development called Deep Panuke using a jack-up platform to extract and export gas via a pipeline to mainland Canada, is planned for installation approximately 45 km West of Sable Island in 44 m water depth in the future.

NEB regulates approximately 104 oil, gas and product pipeline companies operating approximately 47000 kilometres of pipeline. This figure includes large and small diameter, high-pressure natural gas, crude oil and product pipelines as well as a number of non-hydrocarbon commodity pipelines.

Nova Scotia has a small but growing onshore oil & gas industry but at present there are only two onshore installations that fall within the scope of the Processing Plant Regulations 2003, both associated with the Sable Island offshore development.

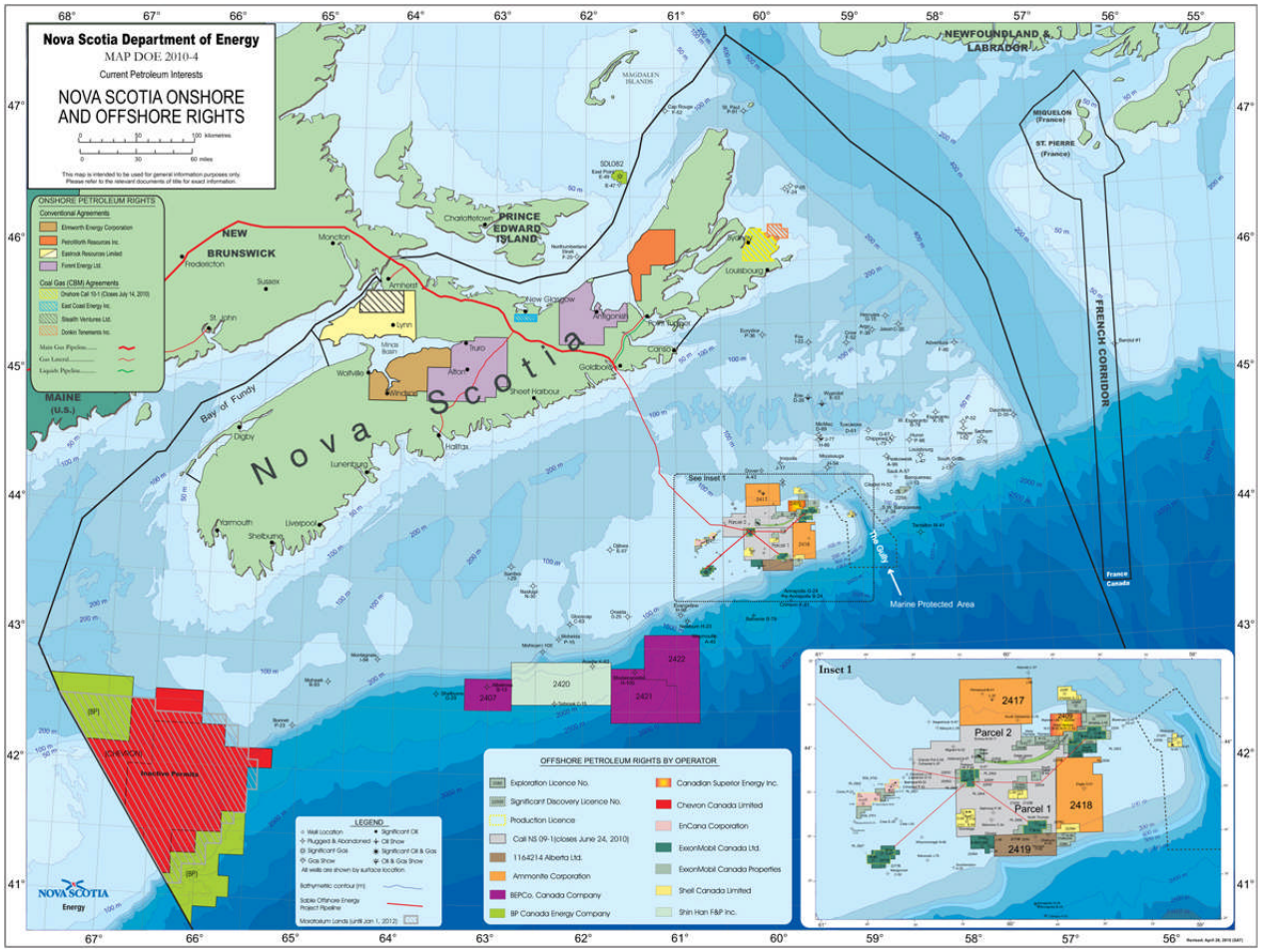

Figure 13: Nova Scotia oil and gas activity

9.1.2 LEGISLATIVE OVERVIEW

Safety legislation in Canada is divided between the mainland and the provinces. The mainland is regulated by the National Energy Board (NEB), which has been responsible for the numerous onshore developments around Calgary and other areas since 1959. The NEB are therefore experienced and well resourced. The provinces of Newfoundland and Nova Scotia are regulated by provincial regulators the Canada Newfoundland Offshore Petroleum Board (CNLOPB) and the Canada Nova Scotia Offshore Petroleum Board (CNSOPB). These two boards were set up in 1990 to promote local input to the regulation process.

All three bodies work closely together and have recently jointly published guidelines for the preparation of Safety Plans.

Historically the regulation for onshore installations by the NEB has been prescriptive, however a move has been made to goal setting regulation onshore and this has been further amplified by developments for offshore installations, where use of the Concept Safety Analysis and Safety Plans are now the norm.

9.1.3 REGULATOR

The regulators for all safety matters in Nova Scotia (occupational and major hazard) are:

- Onshore and pipelines - National Energy Board NEB; and
- Offshore Installations - Canada Nova Scotia Offshore Petroleum Board CNSOPB.

9.2 LEGISLATION OVERVIEW

9.2.1 PETROLEUM ACTS AND LEGISLATIVE REGULATIONS

In Canada the regulation for oil and gas is divided between mainland Canada and the provinces of Newfoundland and Nova Scotia. The NEB legislates for onshore installations and pipelines and the CNSOPB legislation for offshore installations. These are elements are included in this review.

In Canada, Acts are passed that allow for further regulations on specific industries. The Primary Acts in Canada and Nova Scotia that relate to health and safety for onshore sites, pipelines and offshore installations are:

- National Energy Board Act 1959 – NEBA;
- Canada Oil & Gas Operations Act 1985 – COGOA;
- Canada Petroleum Resources Act 1985 – CPRA; and
- Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act (NS Accord Act).

The above Acts set up the general framework for safety legislation, which is, generally prescriptive with goal-orientated additions. They include provision for:

- The creation of the National Energy Board (NEB) and Canada Nova Scotia Offshore Petroleum Board (CNSOPB) to monitor compliance with the Acts and Regulations associated with it;
- The NEB and CNSOPB to issue Regulations, with the consent of the Secretary of State;
- The NEB and CNSOPB to investigate an accident, occurrence, situation or other matter;
- The concept of Operating Licence, Works Authorisation, Certificate of Fitness, Certifying Authorities, Installation Managers; and
- Withdrawal of Operating Licence or Works Authorisation where an operation has to be stopped until an improvement is made.

The Acts listed above were passed as mirror legislation by the Parliament of Canada (1988) and the Legislature of Nova Scotia (1987). The Accord Acts implement the 1986 Canada-Nova Scotia Offshore Petroleum Resources Accord.

The oil and gas industry has been long established in the Canada in the Calgary area and hence the national regulator, the NEB, is well established and has extensive experience compared to the CNSOPB. Historically the regulations have been prescriptive, but the NEB is taking the lead with developing elements of the regulations to be risk-based; termed in this case “Goal-Oriented Regulation” (GOR). The intention of GOR is to reinforce the fact that the primary responsibility for safety and environmental protection rests with Operators, not the regulator.

The extent of the perspective and risk-based approaches are outlined under the offshore, pipeline and onshore headings below. Note that the regulations are generally not completely separate for onshore and offshore installations, however there are additional requirements for offshore installations.

The regulations are partially risk-based and offshore require Safety Cases to be submitted to the regulator.

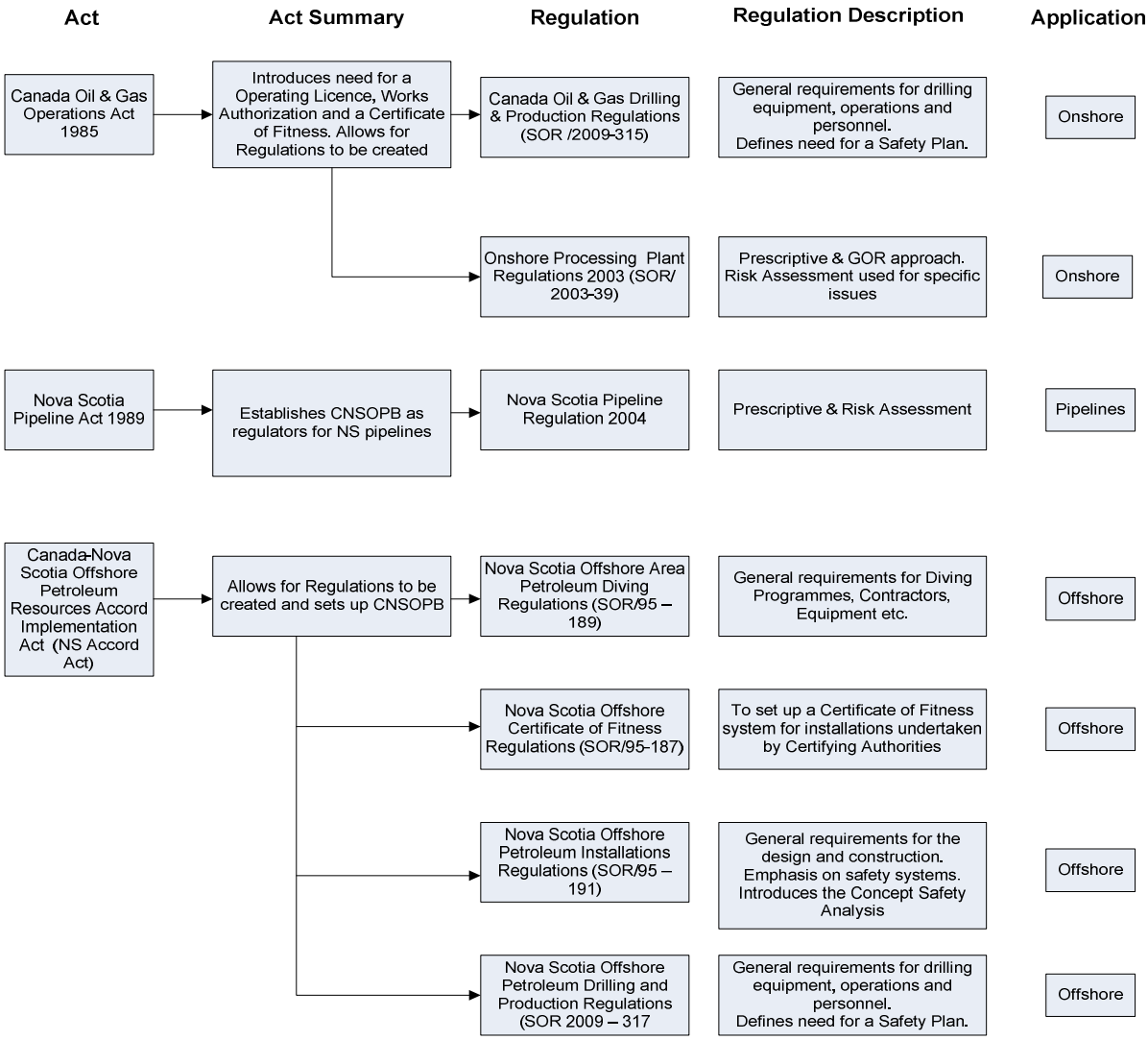

Figure 14: Primary Canadian (Nova Scotia) Acts and Regulations

9.2.2 OFFSHORE

9.2.2.1 Overview

The Canadian implementation Act sets up a number of regulations as in the diagram in figure 10. The offshore regulatory system is mostly prescriptive with minimum standards imposed by referencing existing Canadian and American standards.

Certifying Authorities then assesses compliance with the regulations and issue a Certificate of Fitness. Regular surveys are undertaken by the Certifying Authority, according to a schedule agreed between the Operator and the Certifying Authority. By regulation, a Certifying Authority has to submit a scope of work for the approval of the Board's Chief Safety Officer prior to commencing work. Board staff then assess certifying authority performance by reviewing reports, through regularly scheduled meetings to address issues, and by performing audits of their execution of the work. Additionally, findings from CNSOPB offshore audits and inspections are cycled back to the Certifying Authority, and explanations / corrective actions sought in cases where it is believed the work of the Certifying Authority should have prevented such findings.

Goal orientated regulations have recently been introduced for some aspects both onshore and offshore. For instance for offshore installations, Target Levels of Safety for the risk to life and the risk of damage to the environment are defined at the time the Operator applies for a development plan approval.

A key part of the Canadian offshore goal orientated approach is the use of the Concept Safety Analysis and Safety Plan. The Concept Safety Analysis considers all activities associated with each phase in the life of the production installation, including the construction, installation, operation and removal phases. The Concept Safety Analysis will include for each potential accident, a determination of the probability of its occurrence and its potential consequences.

The regulations require that Personnel Safety Measures designed to protect, from risk to life, all personnel outside the immediate vicinity of the accident site and provide for the safe and organised evacuation of all personnel from the production installation, when the accident could lead to an uncontrollable situation.

The Safety Plan is a component of the Operator's management system, which should assure that the Operator manages safety appropriately when conducting a specific work or activity. The Safety Plan shall summarize and reference the management system that will be applied to the planned work to protect workers and to fulfil the duties set forth in the legislation and regulations for a specific authorized activity.

The Safety Plan Guidelines 2009 state that – 'While the concept 'as low as reasonably practicable' (ALARP) is not discussed in the Regulations, this will be a factor when considering a Safety Plan under the regulations.' – and also – 'Industry may demonstrate incorporation of ALARP into their risk reduction and associated mitigating measures through a number of means, including by a combination of qualitative analysis, quantitative analysis and good industry practice.' This is similar to the ALARP guidance published by UKOOA in the UK.

The Safety Plans shall include a listing of all structures, facilities, equipment and systems critical to safety, and a summary of the system in place for their inspection, testing and maintenance. The methodology used to develop this list of Safety Critical Items should be summarised and then referenced, including links to the overall risk assessment and design processes. These risk assessments may include ALARP studies and they are reviewed by the CNSOPB before granting of an authorization allowing planned work or activities to be conducted.

9.2.2.2 Scope

Occupational and major hazards are managed jointly in the regulations in as much as there are regulations specifically for occupational hazards and regulations that cover major accident and occupational hazards.

9.2.2.3 Documentation

The table below shows the information that must be supplied to the NEB or CNSOPB at different stages of a project:

Activity	Document Required	Legislative Reference	Comments
Activity Requiring a Licence	Environmental Assessment	CEAA 1992	Environmental Assessment required before the Government can grant a Licence or Permit.
Exploration Drilling	Declaration of Equipment fit for purpose. Certificate of Fitness for prescribed equipment.	COGOA 5. (1) & COGOR 3. (1) & 5.	Operating Licence granted for one year maximum. Authorisation granted for indefinite period

Activity	Document Required	Legislative Reference	Comments
Development	Development Plan	COGOA 5.1 (1)	CNSPOB will approve the Development Plan, which includes General Description, Technical Information, Canadian Benefits Plan, Installation Manager.
Offshore Production Installation Design & Construction	Concept Safety Analysis	NSOPIR 43.(1)	Akin to a Safety Case
Operations	Safety Plan (including Concept Safety Analysis); Certificate of Fitness by Certifying Authority; Environmental Protection Plan; Decommissioning & Abandonment Plan	NS Offshore Drilling & Production Regulations SOR/2009-317	Authorization to Operate. Approval of Flow System.
Drilling	Drilling Programme Well Data Acquisition Programme		Well Approval (also required for workover, completion and suspension). Requires description of well operation, Fluids, Engineering Data.
	Well Environment Report		Environmental Conditions & Environmental Protection.
	Well History Report		Operational, engineering, petrophysical and geological information.
Incidents or Near Miss	Notification of Incident or Near Miss Investigation Report	As above, Para 76	Notification Form with details of incident.
Operations	Daily Reports	NSODPR Para 84.	Drilling / Production Records.
	Monthly/Annual Production Report	NSODPR Para 85. /86.	Monthly / Annual Production & Reservoir Management plus Cost Estimates.
	Annual Environment Report	NSODPR Para 87. (1)	Environmental Conditions & Environmental Protection.
	Annual Safety Report	NSODPR Para 88.	Injury & Incident Data.

Table 18: Documentation required by Canadian Offshore Regulations

9.2.3 PIPELINES

9.2.3.1 Overview

The Canadian Onshore Pipeline Regulations (OPR99) apply to all oil and gas pipelines which are not covered by the National Energy Board Processing Plant Regulations or fall within the scope of the Nova Scotia Offshore Regulations. The regulations set down prescriptive requirements that the design and operation of pipelines must be with comparable Canadian National Standards (CNS) or be considered adequate for the prevailing circumstances of the pipeline.

Unless specifically required by the NEB to do so, the only definitive requirement to submit a risk assessment is associated with pipelines to be located in a Class 1 location (as defined within CNS Z662) and within 500metres of a railway or a paved road with the intention of determining a need for increased wall thickness. The requirement indicates a need to take account of factors relating to aspects of design and use of the adjacent right of way but does not specify specific criteria in respect of risk acceptability.

The regulations indicate a need to address safety and environmental issues associated with construction, operation and maintenance and to define procedures for responding to emergencies etc and include specific requirements to prepare and submit the following:

- A Construction Safety Manual;
- Operation and Maintenance Manuals (including information on safety and environmental protection);
- A Maintenance safety Manual;
- An Emergency Procedures Manual;
- A training program (to include safety regulations, procedures and working practices);
- A Safety Program; and
- An Environmental Protection Program.

9.2.3.2 Scope

The regulation of pipelines within Canada is carried out by the single federal body (NEB) and (in Nova Scotia), the Nova Scotia regulator via very similar regulations (see above). The scope of the regulations encompass all the technical design and operational aspects, including activity related to the safety of hazardous hydrocarbon pipelines.

Both sets of regulations contain prescriptive and goal setting elements, requiring compliance with Canadian National Standards and also risk assessments in certain high risk situations.

The NEB deals with the following Provincial Regulators in Nova Scotia:

- Department of Natural Resources;
- Nova Scotia Department of Energy; and
- Nova Scotia Utility and Review Board.

9.2.3.3 Documentation

The table below shows the information that must be supplied to the NEB at different stages of a project.

Activity	Document Required	Reference	Comments
Activity Requiring a Licence	Environmental Assessment	CEAA 1992	Environmental Assessment required before the Government can grant a Licence or Permit.
Pipeline Development	Application. Development Plan	COGOA 5. (1), COGOR 3. (1) & 5. Labour Code, COGOSHR	Operating Licence granted for one year maximum. Authorization granted for indefinite period.
Pipeline Design	Design Documents Risk Assessment (HVP only)	OPR	Issue Permit.
Pipeline Construction	Construction Safety Manual	OPR 20.Labour Code, COGOSHR	Regular Inspections.
Pipeline Operation	Annual operator reports on health & safety performance	Labour Code, COGOSHR	Regular Inspections.

Table 16: Documentation required by Canadian Pipeline Regulations

9.2.4 ONSHORE INSTALLATIONS

9.2.4.1 Overview

The onshore regime is a prescriptive regime with some goal setting additions, with regulations as shown in Figure 14. Goal setting was introduced in the Onshore Processing Plant Regulations 2003 for some aspects, see Section 9.3 below. There are some requirements to provide specific risk assessments in OPPR 2003 and safety related measures as far as reasonably practicable in COGOSHR, which are the only goal setting parts in a prescriptive regime. The regulations require risk assessments to be carried out for hydrocarbon installations, but there is no definition of the type of hazards that are to be risk assessed.

The Processing Plant Regulations (PPR 2003) and Onshore Pipelines Regulations (OPR 1999) have elements of both prescriptive (e.g. adherence to the Canadian Standards Association – CSA) and goal-based (performance-based) requirements. This combination of prescriptive and performance-based approaches requires that the regulations be supplemented by non-mandatory guidance.

9.2.4.2 Scope

The scope of the regulations encompasses all the technical design and operational aspects, including activity related to the safety of hazardous onshore process plants. Some regulations cover major hazards and occupational risks.

9.2.4.3 Documentation

The table below shows the information that must be supplied to the NEB at different stages of a project:

Activity	Document Required	Reference	Comments
Activity Requiring a Licence	Environmental Assessment	CEAA 1992	Environmental Assessment required before the Government can grant a Licence or Permit.
Installation Construction	Application. Development Plan	COGOA 5. (1), COGOR 3. (1) & 5. Labour Code, COGOSHR	Operating Licence granted for one year maximum. Authorization granted for indefinite period. Regular Inspections.
Installation Design	Design Documents & Risk Assessments	OPPR 2003	Issue Permit.
Installation Operation	Annual operator reports on health & safety performance	Labour Code, COGOSHR	Regular Inspections.

Table 17: Documentation required by Canadian Onshore Regulations

9.3 RISK FRAMEWORK

9.3.1 RISK-BASED APPROACHES

Offshore, the Concept Safety Analysis requires Target Levels of Safety to be defined. The Target Levels of Safety are based on assessments that are quantitative, where it can be demonstrated that input data are available in the quantity and of the quality necessary to demonstrate the reliability of the results and qualitative, where quantitative assessment methods are inappropriate or not suitable. There is no guidance on suitable TLS metrics.

The following text is taken from the NEB / CNSOPB Draft Safety Plan Guidelines 2009:

While the concept 'as low as reasonably practicable' (ALARP) is not discussed in the Regulations, this concept has been used for a number of years by industry and regulatory boards in considering safety matters and reduction of risk The Board expects that this concept will continue to be a factor when considering a Safety Plan under these Regulations. Industry may demonstrate incorporation of ALARP into their risk reduction and associated mitigating measures through a number of means, including by a combination of qualitative analysis, quantitative analysis and good industry practice.

There is no guidance on the procedures to be used in a risk assessment, for instance when a qualitative or a quantitative approach might be applicable. In addition there is no guidance on tolerable risk levels.

9.3.2 RISK CRITERIA

There are some risk criteria related to onshore sites in Alberta, but these do not apply in Nova Scotia.

9.4 THE REGULATOR

9.4.1 FORMAL ARRANGEMENT

The Board is the independent joint agency of the Governments of Canada and Nova Scotia responsible for the regulation of petroleum activities in the Nova Scotia Offshore Area. It was established in 1990 pursuant to the Canada-Nova Scotia Offshore Petroleum Accord Implementation Acts (Accord Acts). The CNSOPB's economic role is limited to the management of offshore oil and gas reservoirs.

The Board's responsibilities include:

- Health and safety of offshore workers;
- Protection of the environment;
- Management and conservation of offshore petroleum resources;
- Compliance with the provisions of the Accord Acts that deal with Canada-Nova Scotia employment, industrial benefits;
- Issuance of licences for offshore exploration and development; and
- Resource evaluation, data collection, duration and distribution.

The Board reports to the federal Minister of Natural Resources Canada in Ottawa, Ontario, and the provincial Minister of Energy in Halifax, Nova Scotia.

The Board's staff is led by a Chief Executive Officer who reports to the Board. The CEO is responsible for the day-to-day operations of the Board and a staff of 35 professional and support personnel.

9.4.2 INSPECTION REGIME

The NEB and CNSOPB conduct safety, security and environmental inspections and audits, investigate incidents and monitor emergency response procedures. In addition, for an offshore installation, regular surveys would be undertaken by the relevant Certifying Authority, according to a schedule agreed between the Operator and the Certifying Authority.

For offshore installations, the CNSOPB audit the Operator against claims made in the Safety Plan or Concept Safety Analysis.

CNSOPB staff may also investigate health and safety incidents that occur at offshore worksites, depending upon their nature and severity. This includes investigations into worker complaints and work refusals.

9.4.3 ENFORCEMENT

The CNSOPB has an established compliance and enforcement policy to address situations of regulatory non-compliance. Enforcement actions may include:

- Voluntary compliance – responding to a verbal notice of non-compliance;
- Issuance of orders, directives or notices;
- Suspension or revocation of approvals and authorisations; and
- Prosecution in the courts.

9.4.4 INTERACTION WITH OTHER BODIES

See Section 5.4.4.1 for international regulator interaction.

The Boards have regular contact with the Certifying Authorities, especially those certifying installations offshore Canada. Other interactions are dictated by the regulations, as follows:

Aviation

Offshore installations must adhere to aviation legislation and the Transport Canada TP 4414 guidance for helidecks.

Marine

Floating installations complying with the Nova Scotia Offshore Petroleum Installations Regulations (SOR/95 – 191) will need to use DNV and IMO standards.

Economic Regulation

Onshore and offshore health and safety related regulations have been prepared by the National Energy Board who also address economic issues. The CNSOPB economic role is limited to the management of offshore oil and gas reservoirs.

Environmental Bodies

The onshore and offshore regulations do not encompass environmental issues although the responsibilities of the NEB and CNSOPB encompass some aspects of environmental protection via the CEAA 1992 requiring interaction with the Canadian Environmental Protection Agency (CEPA).

9.4.5 CNSOPB/NEB GOVERNANCE

9.4.5.1 Methods for ensuring inspector competence

This is achieved by on the job-training and attendance at training courses.

9.4.5.2 Internal and regulator review

An annual performance review is conducted of all HSE staff by the responsible manager. CNOSPB also operate an Officer Review Committee that performs an annual review of safety officers (inspectors) and their successful achievement of regulation enforcement.

9.4.6 EFFORT REQUIRED PER PLATFORM

Onshore assessments are conducted as part of the review of applications for authorization to conduct work or activities in the offshore area (e.g. for drilling, production, seismic, etc.), and as part ongoing regulatory oversight activities whilst work or activities are ongoing. The number of assessments is driven by the type of work or activity, issues identified, confidence in operator management oversight, etc. For offshore

drilling, the norm is at least once during a single well drilling program, and once or twice per year in the event that the drilling program involves multiple wells. A visit usually lasts 2 days and is either one or two persons.

For the Sable Offshore Energy Project (five offshore platforms - 4 unmanned, 1 manned), CNSOPB would visit one of the platforms 3-4 times per annum, with an emphasis on the manned platform.

The CNSOPB Health, Safety and Environment group consists of one Director, and six subject specialist advisors (e.g. drilling, marine, production, environment, OHS) plus one technical administrator. Collectively, they are currently investing approx. 2.2 person-years in oversight of the Sable Offshore Energy Project, which includes offshore visits, onshore assessments and in-house activities related to the regulatory oversight of this project. Additionally, this fiscal year (April 1st to March 31st), they are investing approx. 3.1 person-years in the oversight of the new Deep Panuke project which includes onshore assessments of the design for a new build MOPU (to be installed next fiscal year), for the regulatory oversight (in-house and offshore visits) of certain construction related activities (i.e. installation of sub-sea flow lines, and completion of previously drilled exploration wells for production purposes) that are being done in advance of project start-up, and for CNSOPB's preliminary review of the Operator's readiness for operations.

10 COMPARATIVE ASSESSMENT

10.1 INTRODUCTION

The Petroleum (Exploration and Extraction) Safety Act 2010 (PEES) stipulates that the CER will undertake the safety related regulation of petroleum activities and also lays down a number of specific requirements that will need to be addressed by the CER. It is considered that the following are the most significant key elements that will have to be addressed by the CER:

- The CER is to define which petroleum activities are covered by these regulations;
- The CER is to establish a safety framework;
- The PEES Act defines the responsibilities of the operator to ensure that petroleum activities are carried out in such a manner as to reduce any risk to safety to a level that is ALARP, and sets out the Safety Case as the means by which this must be demonstrated to the CER;
- The PEES Act requires the development of a Safety Case and the CER are responsible for preparing guidelines for an appropriate format;
- The CER are responsible for assessing the submitted Safety Cases, for determining their acceptability and for ensuring that the risk assessments supporting the Safety Case are suitable for purpose;
- The PEES Act requires that Notifications of reportable incidents are submitted to the CER and then that the CER are to investigate such incidents and report accordingly to the minister;
- The CER are responsible for monitoring and enforcing the provisions of the Act; and
- The CER are required to publish relevant information regarding these regulations.

This section of the report provides a comparison of the five regulatory regimes that have been reviewed to identify the significant aspects of each approach and to discuss the potential benefits or disadvantages that are represented in the different approaches, in relation to meeting the above requirements. Key within these requirements are the following comparisons, which reflect the significant tasks to be addressed by the CER:

1. Petroleum activities that are to be designated to fall within the scope of the PEES Act
    - Comparison of differences in scope between offshore, pipelines and onshore and the regulators that cover these area
2. To establish a safety regulatory framework

Comparison of:

- The legislative structure including permissioning, scope and documentation submission requirements
- Incident reporting
- The regulators' approach to compliance assurance
- Interaction with other regulatory authorities e.g. marine and aviation
- The risk framework that underpins each regulatory approach

3. To prepare Safety Case guidelines
    - Comparison of Safety Case content

All of the above are reviewed in the context that the size of the petroleum exploration and extraction industry in Ireland, although likely to grow, is small by international standards. The size of the oil and gas industry has a direct impact on the regulatory regime that can be supported and thus impacts some of the factors above when considered for Ireland.

10.2 SUMMARY TABLES

In these summary tables, a Standard Safety Case is assumed to contain: Introduction, Description of facility including safety systems, safety management system, control of major hazards analysis and justification for continued operations. Deviations from this are noted in the tables.

UK				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
Size	Number of installations	14 Major terminals	>8000km	286 platforms plus 40 drilling rigs
Legislation	Type of Legislation	Mainly goal-setting driven by the Health & Safety at Work Act 1974		
	Major Hazards Legislation	PSSR, COMAH	PSSR, PSR	SCR, PFEER, DCR
	Scope	COMAH applies to all sites with a threshold of hazardous material. PSSR applies to pressure systems	PSR applies to all hazardous pipelines including offshore. PSSR applies to pipelines above 2 barg operating pressure	All assets that have the possibility of experiencing production fluids (ex tankers) or may be connected to such an asset
	Occupational safety included in this legislation?	No	No	No
	Approved Code of Practice or Guidance Available?	Approved Codes of Practice (ACoP) give clarification of particular aspects of duties and regulations and define a compliant. approach. Guidance gives advice on measures available and good practice. Compliance with legislation can be by other means than that described in the ACoP		
	Status of common international, or national standards within legislation	Standards are referred to in Guidance, but not in legislation	British Standards referred to in PSR ACoP (Reg 5, clause 32)	Standards are referred to in Guidance, but not in legislation
Safety Cases	Safety Cases Required to operate?	Yes	Yes	Yes
	Safety Case differences to standard Safety Case (*)	Yes. COMAH Safety Cases include environmental impact	Yes. PSR (MAPD) which has no description	No. Defined by SCR (Note: Five yearly update via a Thorough Review Process)
	Project phases for which a Safety Document or Case is required	Before Construction and before Introduction of a dangerous substance	MAPD before completion of design	Notification during Design, Conversion or before Relocation. Safety Case before Production or Move into UK waters (non-production Installation) or Dismantling

UK				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
Regulator	Safety regulator(s) (excluding marine and aviation)	HSE	HSE	HSE
	How does the regulator assess compliance?	Supervision and Detailed Inspections	Supervision and Detailed Inspections	Supervision and High Level Inspections. Detailed Inspections (Verification) by a third party
	Economic regulation links?	None. Economics part of different ministry		
	Regulator Organisation Size	Large – total size of HSE organisation is some 3,500 people with over 60 in the offshore division		
Assurance	Assurance processes required to be in place by legislation?	The operator must set up an assurance scheme for pressure equipment that is reviewed by someone who is not connected with operation of the plant in question	Assurance seen as part of operator's SMS	The operator must define performance standards for safety critical equipment and have a process in place for assuring their continued operation
	Who defines what is an SCE?	No SCE concept	No SCE concept	Duty Holder - with some prescriptive elements
Risk Framework	What frame work exists to assess risk?	ALARP, with suggested upper and lower limits and a cost of life defined in paper from the regulator.		

Denmark				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
Size	Number of installations	3 Terminals	925km	25 platforms
Legislation	Type of Legislation	Mainly goal setting regime and permissioning driven by the Offshore Safety Act 2005, Danish Subsoil Act 2007, Emergency Management Act 2004. However the Offshore Installation Act 1991 (partially repealed) is prescriptive		
	Major Hazards Legislation	Emergency Management Act 2004, Environmental Protection Act 1998	Danish Subsoil Act 2007	Offshore Safety Act 2005. Regulations for: Management of Safety and Health, Emergency Response, Personal Protective Equipment Design for equipment on offshore installation, Electrical power plant and electrical equipment, Safety and health for activities on fixed offshore installations
	Scope	All Top Tier sites as defined in the Seveso Directive	All Pipelines	All offshore assets
	Occupational safety included in this legislation?	Working Environment Act 1975	Working Environment Act 1975 (construction)	Yes, Occupational Hazards managed with Offshore Safety Act
	Approved Code of Practice or Guidance Available?	Guidelines for the Design of Fixed Offshore Installations 2009 exist, but most regulations, of which there are many, do not have guidance		
	Status of common international, or national standards within legislation	Standards not referred to	Standards not referred to	Standards are referred to in Guidance, but not in legislation
Safety Cases	Safety Cases Required to operate?	Yes - is required for an onshore major accident installation (Safety Report)	Not under Danish Subsoil Act.	Yes (Health & Safety Case)
	Safety Case differences to standard Safety Case (*)	Yes – includes environmental impact		No
Regulator	Safety regulator(s) (excluding marine and aviation)	DEPA DWEA	DEA	DEA
	How does the regulator assess compliance?	Supervision and Detailed Inspections	Supervision and Detailed Inspections	Regulator undertakes inspection, though verification can be undertaken for some elements instead
	Economic regulation links?	None. Economics part of different ministry		Economics by a different department of DEA

Denmark				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
Size	Number of installations	3 Terminals	925km	25 platforms
	Regulator Organisation Size	The DEA in total has 295 staff (data in December 2010) with 44 in the Energy Resources division who are responsible for health and safety regulation and other aspects of underground resources		
Assurance	Assurance processes required to be in place by legislation?	Yes - Statutory Order No. 1156 requires maintenance, testing and inspection	Yes – Danish Subsoil Act - Implied by requirement for means to prevent pollution	Yes – Offshore Safety Act - maintenance required
	Who defines what is an SCE?	Not applicable	Not applicable	Operator. Defined in Executive Order 729, though performance standard are not mentioned
Risk Framework	What frame work exists to assess risk?	ALARP is required to be demonstrated. A risk framework exists – see Offshore safety Act. A similar framework is described in [1] for Denmark as a whole		

Western Australia				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
Size	Number of installations	3 plus onshore wells	~ 7000 km	41
Legislation	Type of Legislation	Mainly goal-setting and a risk-based regulation requiring a high level of workforce involvement and with operators defining performance standards which are subject to validation by an independent and competent person		
	Major Hazards Legislation	Petroleum and Geothermal Energy Resources (Occupational Safety and Health) Regulations 2010 Petroleum and Geothermal Energy Resources (Management of Safety) Regulations 2010	Some are covered under PSLA (Pipelines such as interfield connections) Others are under PPA, PPAMSR 2010, PPAOSR 2010	PSLA (applies to state waters and waters inside state waters) and provides support for the PSLOSR 2007, PSLMSR 2007, PSLMWR 2006, PSLPR 2007, PSLDSR 2007
	Scope	Onshore acts apply to all onshore petroleum operations in addition to geothermal energy and drilling related activities	The pipeline and all associated equipment	Most offshore activities excluding supply vessels, off-loading vessels and similar
	Occupational safety included in this legislation?	Yes, part of safety case and permissioning regime		
	Approved Code of Practice or Guidance Available?	The authorities publish guidance notes to assist operators in achieving compliance with the regulations. Also risk framework provides guidance on how to assess ALARP with example upper and lower limits of individual risk given in guidance		
	Status of common international, or national standards within legislation	Safety Case guidelines define that standards must be used, but Operator free to determine (with justification) which standards are used		
Safety Cases	Safety Cases Required to operate?	Yes	Yes	Yes
	Safety Case differences to standard Safety Case (*)	Yes. Covers major accident hazards, but must also cover occupational issues including competence and define the standards to which facility is built		
	Project phases for which a Safety Case is required	Prior to Operation	Prior to Operation	Design, Construction and Operation
Regulator	Safety regulator(s) (excluding marine and aviation)	DMP	NOPSA	NOPSA

Western Australia				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
	How does the regulator assess compliance?	Supervision and Detailed Inspections provided by the Resources Safety Department staff of the DMP who appoint inspectors with powers to enter an installation, facility or premises to make physical inspections, to interview personnel		Inspection by NOPSA staff and validation of a design by an independent body
	Economic regulation links?	No. Jointly administered by state and national government authorities		
	Regulator Organisation Size	Large, 53 persons in NOPSA (2009 annual report)		
Assurance	Assurance processes required to be in place by legislation?	The operator must define performance standards for safety critical equipment and operator is responsible for demonstrating the independence and competence of the appointed validator.		
	Who defines what is an SCE?	Operator	Operator	Operator
Risk Framework	What frame work exists to assess risk?	The risk framework in Australia is similar to the UK in that guidance is given in how to assess ALARP with example upper and lower limits of individual risk given in guidance		

Norway				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
Size	Number of installations	8	~13,400km	73 installations 23 drilling rigs
Legislation	Type of Legislation	Regulation of health, safety and environmental issues across Norwegian industry is administered by three primary authorities. Regulations administered by the PSA are combination of goal setting and prescriptive referring to NORSOK standards		
	Major Hazards Legislation	The Activities Regulations (NAR) 2010, Facilities Regulations (NFR) 2009, Framework HSE Regulations (NHSER) 2009, Information Duty Regulations (NIDR) 2010, Management Regulations (NMR) 2004 Offshore pipelines are directly incorporated in the offshore facility regulations whereas onshore pipelines are addressed within what are currently entitled, the Temporary Onshore Regulations		
	Scope	Onshore terminals that are covered by the regulations are specifically listed by the PSA	All pipelines associated both with offshore facilities and onshore installations	Offshore installations except that supply vessels, anchor handling tugs, seismic and geological survey/exploration vessels are exempt from these regulations but are covered within Norwegian shipping regulations
	Occupational safety included in this legislation?	Yes, Regulation administered by PSA includes occupational health and safety		
	Approved Code of Practice or Guidance Available?	Regulations administered by the PSA include guidance		
	Status of common international, or national standards within legislation	Significant reference to NORSOK and other standards from the legislation		
Safety Cases	Safety Cases Required to operate?	No, although the documents that re required are almost akin to a safety case, especially for mobile offshore units		
	Safety Case differences to standard Safety Case (*)	n/a	n/a	n/a
	Project phases for which a Safety Case is required	None, though the Norwegian legislation uses permissioning significantly for all stages of development		
Regulator	Safety regulator(s) (excluding marine and aviation)	Petroleum Safety Authority (PSA)		

Norway				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
	How does the regulator assess compliance?	PSA carries out supervision i.e. audits, verifications, investigations, consents, meetings with industry and surveys Verification is also undertaken by a third party		
	Economic regulation links?	No, managed by NPD through administrative consent and licenses etc		
	Regulator Organisation Size	Large, 160 staff		
Assurance	Assurance processes required to be in place by legislation?	Operators management and control systems which is assessed for compliance by the PSA		
	Who defines what is an SCE?	Operator. Although the terminology SCE is not used, the Activities regulations ask the Operator to define equipment for which functional failures that may entail serious consequences		
Risk Framework	What frame work exists to assess risk?	The concept of ALARP is not formally recognised in the Norwegian regulations however an equivalent concept for assessing the acceptability of risk is employed as the regulations state that risk has to be as low as practically possible		

Canada – Nova Scotia				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
Size	Number of installations	2 (Nova Scotia) within the scope of Processing Plant Regulations 2003	47000km	1 (Nova Scotia)
Legislation	Type of Legislation	Regulation for onshore installations by the NEB has been prescriptive, however a move has been made to a goal setting approach for pipelines and offshore installations		
	Major Hazards Legislation	Processing Plant Regulations 2003 Drilling & Production Regulations 2009	Nova Scotia Pipeline Reg 2004 OPR99 (for pipelines under NEB)	SOR/95-189, SOR/95-187, SOR/95-191, SOR 2009-317
	Scope	Onshore processing plants and terminals	All pipelines	Offshore installations
	Occupational safety included in this legislation?	Managed jointly with major hazards in the regulation	Managed jointly with major hazard in the regulation	Managed jointly with major hazard in the regulation
	Approved Code of Practice or Guidance Available?	Limited guidance available, with no technical guidance beyond Canadian standards		
	Status of common international, or national standards within legislation	Minimum standards imposed by referencing existing Canadian and American standards directly from the legislation		
Safety Cases	Safety Cases Required to operate?	Safety Plan – Emphasis on Management Systems	No – only risk assessment for HVP pipelines	Concept Safety Analysis and Safety Plan is required
	Safety Case differences to standard Safety Case (*)	Not applicable	Not applicable	Yes
	Project phases for which a Safety Case is required	Not applicable	Not applicable	Construction, installation, operation and removal
Regulator	Safety regulator(s) (excluding marine and aviation)	NEB	NEB	CNSOPB
	How does the regulator assess compliance?	Regulator Inspection	Regulator Inspection	Certifying Authorities (against concept of safety analysis)
	Economic regulation links?	Economic issues are also addressed by NEB and CNSOPB has responsibility for reservoir licensing		

Canada – Nova Scotia				
Area	**Parameter**	**Onshore**	**Pipelines**	**Offshore**
	Regulator Organisation Size	–The total CNSOPB organisation comprises 48 people, but only seven of these have safety related regulatory responsibilities		
Assurance	Assurance processes required to be in place by legislation?	Safety Plan defines assurance process	Yes – Integrity Management Plan	Safety Plan defines assurance process
	Who defines what is an SCE?	Not applicable	Not applicable	Yes , listed in safety plan and should state methodology for developing list of SCE
Risk Framework	What frame work exists to assess risk?	Concept Safety Analysis and Safety Plan, target Levels of Safety for the risk to life and the risk of damage to the environment are defined at the time the Operator applies for a development plan approval. This is similar to UK ALARP guidance. Also some risk criteria related to onshore sites in Alberta, but this does not apply to Nova Scotia.		

10.3 SCOPE OF THE REGULATIONS

Of the regimes reviewed, only the Canadian and Danish legislators also have an economic role, although economics are handled by a different department to safety matters. Within the scope of regulations and guidance, good practice would indicate that there should be boundaries in place between safety and economic regulatory responsibilities.

Table 18 shows the regulator for each country reviewed for major hazards and occupational risks offshore, onshore and for pipelines.

Country	Hazard Area	Offshore	Pipeline	Onshore
UK	Major Hazard	HSE		
	Occupational			
Denmark	Major Hazard	DEA	DEA with Emergency Management Agency, Working Environment Agency	
	Occupational			
Western Australia	Major Hazard	NOPSA	DMP	
	Occupational			
Norway	Major Hazard	PSA		
	Occupational			
Canada	Major Hazard	CNSOPB(*)	NEB	NEB
	Occupational			

Table 18: Summary of Legislators (* - CNSOPB have a role in reservoir licensing)

This would indicate that good practice is to have a single regulator and at least the same regulator for major hazard and occupational issues. It is noted that post the full implementation of the PEES, this will not be the case given that the Health and Safety Authority will have both occupational health and safety and major hazard safety regulatory roles alongside the CER's new role (see table below). This area will have to be carefully managed in the design and implementation of the petroleum safety framework .

Country	Hazard Area	Offshore	Pipeline	Onshore
Ireland	Major Hazard	CER+	CER+	CER+, HSA
	Occupational	HSA	HSA	HSA

Table 19: Summary of Legislators in Ireland (+ when PEES is enacted)

In terms of physical scope, there are differences in the regulations for pipelines. For example in the UK, the offshore installation regulations and pipeline regulations would apply to any pipeline within 500m of an installation whereas in Australia interfield pipelines are not subject to the pipeline legislation. There is no clear best practice identified in the boundary of the physical scope.

10.4 LEGISLATIVE STRUCTURES

10.4.1 PERMISSIONING

All of the countries reviewed operate a permissioning regime in that documentation must be submitted and approved (the exact wording varies from country to country) to the regulator before an operation, or design can commence. Therefore, permissioning can be seen as best international practice and the PEES Act is also in line with this in its requirements for safety permits and Safety Cases.

There is a significant difference between the level of permissioning in each regime. Norway is probably the most detailed with some specific operations requiring their own permissioning. Denmark, UK and Australia all require less documentation to be issued to the regulator.

In developing the petroleum safety framework, the CER will have to decide the stages of the petroleum lifecycle where permission is required before continuing to the next stage and the documentation which needs to be submitted with such an application.

10.4.2 PRESCRIPTION AND GOAL-SETTING

10.4.2.1 Overview

The fundamental difference between goal-setting and prescriptive legislation is that in the former, the Operator determines how to design and operate an installation to meet a safety goal as defined, or guided by the regulator, whereas in a prescriptive process, the regulator defines the way in which an Operator designs and operates an installation and thereby takes on at least some responsibility for safety standards on the installation.

The difference between the two can be tragically demonstrated by one aspect of the Piper Alpha disaster. At the time, the legislation was prescriptive in the UK. Prescription included the provision of deluge, but at the time of the incident, the deluge pumps were set to manual initiation because there were divers in the water, who could be affected by the deluge intake. The pumps were never started during the incident. Thus, the letter of the legislation had been met in that the pumps were there, but with the legislation being quiet on risk assessment, the Operator did not put enough thought into the consequences of turning them off. Today, the legislation is goal setting, where the pumps would be identified as safety critical by the operator with a robust system in place to risk assess whenever they were turned off. The change in legislation also firmly gave the responsibility for safety related decisions to the operator.

However, within a goal-setting regime, there is still significant benefit from prescription. For example, it is clearly advantageous for all helidecks to achieve a certain minimum standard of lighting, helideck size etc so that pilots can operate safely and consistently. Therefore, there is a balance to be made between prescription and goal setting and this balance differs for each of the regulatory authorities reviewed. For example, Canada refers to standards in their regulations, which generally contain significant prescription. Australia require design standards to be identified, while the UK legislation contains minimal standards.

It is apparent that different regulators give different amounts of guidance in relation to goal-setting. In the UK, there is extensive guidance on many topics that affectively aid the Operator in deciding whether a risk is ALARP. However, in smaller provinces such as Denmark and Canada, there is less guidance (often referring to the UK), but more inspection per platform. This difference is also explored in Section 10.7.

To facilitate this balance in Ireland reasons for and against goal-setting and prescription are given below.

10.4.2.2 For Prescription

Prescription has the role of acting as a depository of expert knowledge on a particular subject and sets a level playing field for the duty holders. The role of knowledge depository also educates Duty Holders as to the basics of the requirements for safety systems and management. Prescription can be kept reasonably current by referring to Industry and National Standards which are updated by the relevant learned societies when industry demands change. However there is no guarantee that this will happen on a regular basis.

Therefore prescriptive regulation has its place in situations where:

- The regulator is new and wishes to take a firm hand on a previously unregulated situation;
- The inspectors may be inexperienced and be unable to apply professional judgement to an intervention or audit;

- The regulator does not have the technical resources to support the preparation of documentation and review the safety cases etc. required by a goal setting regime;
- The duty holders are unsophisticated and do not have technical resources – e.g. small contractors in the underdeveloped world; and
- A high degree of uncertainty exists as to the risk, which may cause societal concern.

The enforcement of prescriptive regulation is also simple in that a simple pass / fail criteria can be applied so that the inspector requires little training for the role and has relatively little need to apply judgement to a situation.

10.4.2.3 Against Prescription

There is an underlying problem with prescription in that the regulator decides what is appropriate to minimise risk which means that the regulator is effectively taking on the role of risk minimisation, rather than leaving this responsibility with the duty holder. This is magnified when conditions change: the prescription may have been perfectly reasonable on day one, but as the production profile changes, it may no longer be appropriate and may lead to an unsafe, or an over managed situation.

A similar situation can exist when conflicting prescriptive regulation is applied by either one regulator or different regulators.

Should specific requirements be spelt out in a regulation then any changes incur the process of amending statute or regulation which is time-consuming in any jurisdiction.

10.4.2.4 For Goal Setting

Goal setting regulation has the advantage of placing the responsibility for safety on the operator (duty holder) of the business concerned rather than the regulator. The duty holder has to demonstrate to the regulator (and society) that the risk is 'as low as reasonably practicable' by various means, which can include risk assessment as well as compliance with applicable standards. Goal setting also allows flexibility in the achievement of safety which allows new technology to be used when it becomes available. However this flexibility also allows some judgements to be made either by the duty holder or regulator, which may be questioned, leading to a debate on the judgements. This debate can be fruitful, when carried out by competent personnel on both sides, but can be a source of frustration when one side is not fully understanding of the goal setting approach. Goal setting thus requires training of personnel to understand the basic principles of the approach.

The approach encourages the duty holder to understand and analyse his operation and review the safety management system which is being used, as this will have to be explained in the Safety Case, which is a necessary part of the demonstration of safe operation.

Reviews of goal setting regulation have found that generally the persons involved, on both sides of the regulatory fence, favour the goal setting approach after a few years of operation, however the burden of technical expertise can be challenging for small businesses, who tend to favour the prescriptive approach for this reason.

Goal-oriented regulation is more adaptable to changes in technology than is prescriptive regulation. It has the ability to accommodate changes more quickly and efficiently because those changes can be handled administratively, without the need to modify the regulation as would be the case for prescriptive requirements.

10.4.2.5 Against Goal Setting

Problems with goal setting seem to arise when understanding of the basic principles is lacking either in the regulator or duty holders. This education can take the form of guidance in the format of Safety Cases, safety systems, analysis etc. and may also involve organising industry forums and joint industry projects. This will take considerable technical resource within the regulator and the question can be asked whether this amount of effort is appropriate if the number of installations to be regulated is small. This is because there is a certain fixed base load of effort that is the same regardless of the number of regulated installations.

Once the guidance has been prepared, the acceptance of Safety Cases can also create a considerable burden, which may detract from the physical inspection of installations. The use of outside resources to review Safety Cases may have dangers in that the reviewers may be closer to the duty holders than the regulator, thus producing a conflict of interest.

The use of guidance can be problematical in that some parties may take them to be prescriptive rather than suggesting one possible approach. The interpretation of guidance then becomes an issue and guidance needs to be carefully written so that it is clear.

Another potential problem with goal setting is that no common standards are imposed by a pure goal setting approach. This can create difficulties when auditing the duty holder and inspecting the installation, as equipment that is generally accepted (such as TEMPSC on an offshore installation), could be removed as being not justified by risk and cost/benefit calculations.

The effectiveness of the goal setting approach may be reduced where other regulatory agencies continue to follow a prescriptive or different approach. In this case the duty holder has the task of satisfying multiple and possibly conflicting requirements. In practice the prescriptive regulator may dominate as its inspectors will easily detect non-compliances and insist on their rectification in spite of a risk based approach showing that they are not justified. Thus a regulator introducing the goal setting approach needs to educate other regulators to accommodate any novel or different safety approaches that may result from goal setting.

The concept of ‘as low as reasonably practicable’ (ALARP) can create problems with interpretation. Although the concept of ‘justifiable cost’ has been used to screen out safety measures, this has led to some unacceptable outcomes and the trend has been to use other multiple criteria to show that risk is ALARP. The regulator needs to define how the concept of ALARP is to be demonstrated.

10.4.3 INCIDENTS

One of the requirements of PEES is to define incidents that need to be reported to the CER. Given that many of the regulators are the same for occupational and major hazard issues, there is no need to define the difference between major hazard and occupational incidents and with general legislation, such as the Health and Safety Act in the UK giving the HSE powers to investigate dangerous occurrences.

Suitable thresholds for reporting and possible prosecution should be defined based on harm to persons or the environment, however it is expected that all responsible operators will maintain an incident investigation process that will record all accidental events, including near misses, to ensure that the bottom of the incident pyramid is covered. The regulator should actively review the record of these low level events and their root causes with the duty holder.

Suitable thresholds have been defined by various regulators depending on the societal attitude to incidents. For pollution these may vary quite widely, but for injuries and fatalities the thresholds are uniform in that all injuries above ‘first aid’ are usually reportable.

For hydrocarbon releases, often differentiation is made between different sizes of release. For example, in Denmark:

Major releases	*A quantity of more than 300 kg or a release rate of more than 1 kg/sec. for more than 5 minutes*
Significant releases	*A quantity of 1-300 kg or a release rate of 0.1-1 kg/sec. for 2-5 minutes*

Such an approach allows differing responses from the regulator and is seen as good practice.

10.4.4 COMPLIANCE ASSURANCE

Having developed a set of regulations, the primary purpose of the regulator is to determine whether compliance with the regulations is being maintained. Given the complexity of offshore and onshore operations and the even greater complexity of design issues associated with onshore, offshore and pipelines, a significant body of experience and skill needs to be available to the regulator to cover all the areas that need to be assessed. For a province with a large number of oil and gas installations such as Norway, UK, or Australia, it is possible for the regulator to employ a significant number of people and have expertise in all areas required. This is more efficient if the regulator also covers industries that experience similar hazards. However, for smaller provinces, there is the potential need for more external expertise to be needed.

However, even in Norway, UK and Australia, there is a role for 3rd parties in the overall process of compliance assurance. In the UK, this is through verification as defined in DCR and PFEER, where a competent and independent person (different meaning for offshore and onshore), is required to assess the assurance processes that the operator has in place. Unlike the HSE, the verifier has no powers to limit, or stop operations, but is able to raise anomalies that the Operator is obliged to resolve and which the HSE is able to see. Offshore, this system applies to safety critical elements, which are, in theory, defined by the Operator, but, in reality, are a relatively standard set of systems (listed below) and onshore it applies through PSSR to pressure systems. Verification applies to the design and operational stages.

Prevention	Control and Mitigation	Emergency Response
Collision avoidance	Certified electrical equipment	Temporary refuge / muster areas
Emergency preparedness (*)	Fire and gas detection	Personal protective equipment
Hydrocarbon containment systems	Emergency shutdown system	Escape routes
Riser and pipeline integrity system	ESD and BD valves	Emergency lighting
Structures	Active fire protection	Helideck
Temporary and portable equipment (*)	Portable and trolley mounted fire extinguishers (*)	TEMPSC
Drilling operations	HVAC	Liferafts
Cranes and lifting operations	Passive fire protection	Means of escape to sea
	Explosion protection	Rescue and recovery
	Alarms and intra complex comms	
	External communications	

Table 20: Typical List of Safety Critical Elements (Items marked * are not included by some Operators)

In Australia, there is a similar system of validation defined in the Management of Safety on Offshore Facilities, which is essentially design verification.

In Norway, there is a system of verification defined in the Framework Regulations, whereby the Operator must have independent verification of certain health and safety aspects undertaken. These aspects are defined in the various regulations, and include those elements defined by the Operator through the requirements of the Management Regulations. There is scope within the regulations for the PSA to order a verification to be carried out, or for the PSA to undertake a verification process itself.

In Canada, design review is undertaken by a third party, usually a Certifying Authority, employed by the regulator (CNSOPB).

In Denmark, the regulator has the possibility to require third party verification.

Therefore, in all countries analysed, an element of compliance assurance is undertaken by parties other than the regulator. This type of approach is worthy of review for applying in Ireland, where it is unlikely that the size of the oil and gas industry will be able to support all the technical elements required from a regulator. In terms of compliance assurance, the following elements need to be assessed:

- Projects at the design and construction stage;
- On-off short-term activities such as construction, or diving;
- Normal and Combined Operations (including decommissioning); and
- Incident follow-up.

International practice is that 3rd parties are almost always involved at the design and construction stage as a 3rd party can be significantly sized, will often be an international organisation and have experts in all areas. For the other operations, there is less involvement by 3rd parties, ranging from none in Norway to operational verification in the UK.

Compliance Assurance may also vary between different types of safety system:

- Plant;
- Procedures; and
- Personnel (competence).

All regimes cover these three areas to a lesser, or greater degree. Compliance assurance of the latter is usually restricted to particular key positions e.g. OIM, and there is rarely assessment of others. Procedures may be assessed, but usually by their impact on plant, which is the main focus of much of the legisaltion.

Overall, good practice appears to be that a number of different agencies are used for compliance assurance – always the regulator at a high level and often one or more competent third parties.

10.4.5 INTERACTIONS BETWEEN REGULATORY AGENCIES

For all the regimes studied, there are essential interactions with marine and aviation safety bodies. There are also interfaces for floating production vessels where they have to follow regulations relating to major hazards and also marine legislation.

Multiple regulators regulating the same infrastructure has the potential to cause confusion, particularly where there is more than one safety regulator involved. It is imperative therefore that there is agreed interfaces and arrangements in place to ensure that both the industry and the regulators understand the roles of each. For example, for helicopter travel in the UK, there is a MOU between the HSE and the CAA and guidance [9] from which the following quote is taken:

CAA regulates aviation legislation. HSE regulates health and safety law. They work together, with industry and others, to make sure that provisions for safety are as compatible and complete as possible. A Memorandum of Understanding (MOU) exists between HSE and CAA to ensure they work together effectively.

10.5 RISK FRAMEWORKS

10.5.1 BACKGROUND

A risk framework consists of two elements:

- The definition of how a risk is measured; and
- A definition or methodology as to how it can be assessed whether the risk is acceptable.

In terms of the first element, there are relatively few ways in which risk can be measured:

- The risk to a group of people that are exposed to a hazard – for example the frequency of an event that can cause a number of fatalities – known as the societal risk;
- The potential loss of life is the number of fatalities over a population over a period of time e.g. persons working offshore;
- The risk to an individual – for example individual risk, or fatal accident rate; and
- The frequency with which a safety function is impaired e.g. escape route impairment frequency.

The final measure given is not a direct measure of the risk since risk is the product of the frequency of an event and its consequence. In this case, there is an implicit assumption that the consequence of safety system failure is undesirable, with the exact consequences not being assessed and the limit being placed on the frequency.

10.5.2 EXISTING RISK FRAMEWORKS

A summary of existing risk frameworks and the use of ALARP is given below:

Country	Safety systems	Individual Risk	PLL	F-N	ALARP
UK	None directly in legislation, but the Operator is obliged to define reliability targets within performance standards for SCEs	Used to define upper and lower limits in ALARP triangle	Used for large events for onshore sites (frequency of 50 fatalities)	Used for onshore pipelines	Fully integrated into legislative system with suggested cost of life and reference to UKOOA Risk-Based Decision Making Framework(*)
Norway	Maximum impairment frequency suggested in guidance for critical systems	Limits suggested in guidance			ALARP outlined in guidance, but no values given for risk limits
Canada	Target levels of safety are required to be set offshore. These may cover risk values, or impairment frequencies for safety systems				Included in Safety Plan Guidelines
Australia	None identified	Limits suggested in guidance			Integrated into legislation and also covers procedures
Denmark	None identified	Proposed limits given in [1]		Proposed limits given in [1]	Included in Offshore Safety Act

Table 21: Summary of Risk Frameworks

Note that in addition to the above, the use of IEC61511 for instrumented systems includes use of a PLL limit by default. This limit is normally determined by the Operator.

All countries use the concept of ALARP and this is seen as good practice. Individual risk values for use in ALARP assessments are also seen as good practice as it gives a degree of consistency between different

scenarios where, otherwise, comparison may be difficult. However the actual values used may vary from one regulator and situation to another.

10.5.3 RISK DECISION

In most cases, risk limits for an installation are given in guidance documents. The limits are not set in the legislation, but the guidance defines how the regulator would assess whether a risk was tolerable or not. An Operator would have to have a very strong case to be able to operate outside these limits and in practice, this would never be the case due to the potential for prosecution following an incident.

The risk for an installation is built up of many different elements with, for example, transportation risks being largely similar from one installation to another and other risk, such as process related ones varying significantly due to the nature of the produced fluids, amount of equipment, operating pressures and other factors. Thus, an individual risk target for personnel on an onshore, or offshore installation is a relatively broad brush approach, but a sensible one since someone working on an installation will accrue risk from the different sources mentioned.

The situation for a pipeline is slightly different. Being a simpler system, there are far less failure modes, which are usually dominated by third party interference, and the consequence is usually a fireball and a flame dependent on the size of the hole/rupture. The difference is that pipelines run through populated areas and therefore the consequences can be high in terms of societal risk and so guidance contains FN curves that can inform planning and other decisions.

For specific hazards on an installation, it is more common for the Operator to define a risk limit. This may be qualitative using a risk graph for task risk assessment, or quantitative such as IEC61511 for instrumented systems.

For the risk framework in PEES, a risk framework that covers pipeline-type hazards using the FN curve approach and offshore installations using the individual risk approach could be defined in guidance.

10.6 SAFETY CASES

In the UK, the format of an offshore Safety Case has developed to be a relatively standard five sections:

- Introduction;
- Description (including safety systems);
- Safety management system;
- Management of major hazards; and
- Justification for continued operation (or report of thorough review);

This format is similar across the world, however, the emphasis can change. In the Australian regulations and, to a lesser extent in the UK COMAH regulations, the emphasis in the safety case is to give an explanation of how the described safety measures manage the risk and are sufficient for this purpose. The following text is taken from the Australian ALARP guidance [N-04300-GN0166] for design.

> *Consequently, information presented in the safety case should not simply focus on promoting the chosen design option but rather a discussion on the merits of different options and a justification that the chosen option is indeed the one that reduces risk to a level that is ALARP.*

In some safety cases it is possible for this vital linkage and reasoning of alternative safety measures to be lost.

Some safety cases, most notably Australian, include occupational hazards. Although Australian regulations are primarily major hazard based, they also cover occupational issues. In contrast to Ireland, the regulator for major hazard and occupational issues is usually the same in the other areas reviewed here.

One recent development of safety case legislation has been the requirement for a demonstration of continued safety. In the UK, this is embodied in the 5 yearly thorough review, where the entire system for management of major hazards must be reviewed to consider improvements in technology and changes to the installation which could affect safety. This is with the aim of ensuring that the safety case remains valid and incorporates best practice. In addition, the HSE run sizable initiatives to reduce risk on an ongoing basis e.g. KP3 for asset integrity. In Australia, the (new) regulations call for ALARP assessments to include statement on how continuous improvement will be achieved. The Australians take the view that if something is designed to be ALARP, it may not necessarily be so a number of years later.

Recent changes to legislation have also seen a greater emphasis on specific consultation with the workforce, since they are the persons at risk and also have the best knowledge of the facility. This practice is therefore seen as best practice.

Standardisation of safety cases has been carried out for mobile drilling units. For example, the International Association of Drilling Contractors (IADC) has a Safety Case template that is designed to be applicable worldwide and some regulators suggest that this format will be acceptable to them in the legislation. The CER should consider whether their Safety Case format should also fit into a similar framework.

10.7 OVERALL COMPARISON

In the review of the different legislation, it is apparent that there is a significant degree of similarity. All are risk-based, although some refer more directly to standards in the legislation and all have safety cases, or almost equivalent documents. All counties reviewed operate a permissioning regime whereby permission to operate is only given if documentation is received and approved by the regulator. However, three differences are apparent, the inclusion of occupational hazards, the use of third parties for compliance assurance activities and the level of detail in the legislation.

- Occupational hazards are included in the same legislation as major hazards for all countries reviewed apart form the UK. Thus inclusion could be considered best practice. To achieve this in Ireland, the CER will have to liaise with the HSA, who are responsible for occupational matters offshore;
- In all areas some compliance assurance is undertaken through third parties. This is most often concerned with design and is termed, validation, verification or similar, though in the UK it extends to operations as well; and
- Different regulators have significantly different amounts of guidance and detail in their legislation. Larger and more established regulators in the UK, Norway and Australia have either produced detailed legislation (Norway), or significant guidance (UK and Australia). Denmark has little guidance, but refers to the UK HSE. Canada and Norway refer to standards which, by definition do not need guidance, but for the goal setting elements in Canada, there is little guidance. Denmark and Canada, with little guidance, spend more time on inspection per installation that UK, Norway, or Australia.

11 REFERENCES

A comprehensive range of information concerning the regulators and the regulatory regimes employed by the countries that have been reviewed in this report can be accessed on the following websites:

The United Kingdom

The UK Health and Safety Executive www.hse.gov.uk

Denmark

The Danish Energy Agency www.ens.dk

Western Australia

The National Offshore Petroleum Safety Authority www.nopsa.gov.au

The Government of Western Australia Department of Mines and Petroleum www.dmp.wa.gov.au

Norway

The Norwegian Petroleum Directorate www.npd.no

The Petroleum Safety Authority www.psa.no

Canada - Nova Scotia

The Canada-Nova Scotia Offshore Petroleum Board www.cnsopb.ns.ca

The National Energy Board www.neb.gc.ca

Other specific references are given below:

[1] Acceptance Criteria in Denmark and the EU, Danish Ministry of the Environment, Environmental Project No. 1269 2009

[2] http://www.ptil.no/getfile.php/Regelverket/TX-15924%20OD_Eng.pdf

[3] http://www.hse.gov.uk/offshore/busplan1011.pdf

[4] NOPSA ALARP Guidance Note N-04300-GN0166 Revision 0, August 2010

[5] A Framework for Risk Related Decision Support, UKOOA, May 1999

[6] Evaluation of Goal-Orientated Regulation, Matrix Solutions Inc., 2004.

[7] Future Arrangements for the Regulation of Offshore Petroleum Safety, Dept. of Industry, Science & Resources, 2001.

[8] Denmark's Oil and Gas Production 2009 DEA

[9] How Offshore Helicopter Travel is Regulated, HSE, http://www.hse.gov.uk/pubns/indg219.pdf

Appendix A EXAMPLE SAFETY SYSTEM

This appendix compares legislation for a flammable gas detection system for the five different countries in order to give a sense of the differences in approaches applied in each country. Direct copy from the legislation is given in Italic. Subsidiary legislation is not given. For example PUWER, which defines a general fitness for purpose requirement for work equipment and regulations relating to electrical equipment being installed in a potentially hazardous area (the gas detector must not be a source of ignition) are not considered.

In all areas, there is a requirement for the risk to be ALARP (or similar terminology) and this will affect the choice of gas detection also.

A.1 UK

PFEER is the relevant regulation for gas detection.

> *The duty holder shall take appropriate measures -*
>
> *(a) with a view to detecting fire and other events which may require emergency response, including the provision of means for -*
>
> *(i) detecting and recording accumulations of flammable or toxic gases; and*
>
> *(ii) identifying leakages of flammable liquids; and*
>
> *(b) with a view to enabling information regarding such incidents to be conveyed forthwith to places from which control action can be instigated.*

The following is taken from the associated ACOP for PFEER:

> *detecting and recording accumulations of flammable or toxic gases means that the duty holder should take steps to ensure that predetermined levels of gas in a designated location are detected and that a record is kept of all instances where gas is detected at or above a level which prompts automatic or manual executive action;*

Thus the PFEER regulations means that gas detection is almost always installed on an installation. In addition, the general principle of PFEER applies in that performance standard for gas detection have to be defined and assessed by an ICP.

The legislation does not contain further detail, but the HSE has published guidance on gas detector layout and bodies such as the API publish guidance. Thus, the provision of gas detection is purely defined by the Operator, who can refer to available standards and guidance is desired.

A.2 NORWAY

In Norway, the facilities regulations define the need for gas detection:

> *Facilities shall have a fire and gas detection system which ensures rapid and reliable detection of outbreak of fires and gas leakages. The system shall be able to perform the intended functions independently of other systems. In fire and gas detection, automatic actions shall limit the consequences of the fire or gas leakage. Placing of detectors shall be based on relevant scenarios, simulations and tests.*

NORSOK technical safety standard S-001 provides seven pages of detailed requirements for gas detection. An example from this text is given below:

> *low alarm limit for point detectors is maximum 20 % LEL. For turbine enclosure the alarm limit shall be 10% LEL;*

low alarm limit for IR open path detector is maximum 1 LELm;

low alarm limit for IR open path detectors in air inlets is maximum: "detection distance x 20 % LEL" (not >1 LELm);

high alarm limit for point detectors is maximum 30 % LEL. For turbine enclosure the alarm limit shall be 15% LEL;

high alarm limit for IR open path detector is maximum 2 LELm;

high alarm limit for IR open path detectors in air inlets is maximum: "detection distance x 30 % LEL" (not >2 LELm).

A.3 AUSTRALIA

In Australia, there is a requirement for the Operator to develop performance standards for safety systems, including gas detection. Relevant standards are expected to be used to determine the exact gas detector requirements and this may include standards such as;

- AS/NZS 60079.29.1:2008 Explosive atmospheres - Gas detectors - Performance requirements of detectors for flammable gases

However, it is unlikely that this standard would detail, for example, the number of detectors required to be used.

A.4 CANADA

Clause 32 of the Canada Oil and Gas Installations Regulations contains the requirement for a gas detection system.

32.(1) Every offshore installation shall be equipped with a gas detection system that is capable of detecting, in every part of the installation in which hydrogen sulphide or any type of hydrocarbon gas may accumulate, the presence of those gases.

(2) The gas detection system required by subsection (1) shall, on detection of gas, activate automatically

(a) an audible and visual signal on the fire and gas indicator panel in the control station of a manned installation; and

(b) an audible alarm that has a tone different from any other alarm in any part of the installation.

(3) Every offshore installation shall be equipped with

(a) at least two portable gas detectors capable of

(i) measuring the concentration of oxygen in any space, and

(ii) detecting hydrogen sulphide and any type of hydrocarbon gas in any space; and

(b) a means of testing the portable gas detectors described in paragraph (a).

(4) A gas detector shall be provided

(a) at every ventilation inlet duct leading to a nonhazardous area on every installation;

(b) in every Class I, Division 1, hazardous area on every onshore installation; and

(c) in every enclosed hazardous area on every offshore installation.

(5) Every gas detector provided in accordance with subsection (3) shall be appropriate for the area and installed and operated in accordance with

> *(a) Appendix C of American Petroleum Institute RP14C, Recommended Practice for Analysis, Design, Installation and Testing of Basic Surface Safety Systems for Offshore Production Platforms; and*
>
> *(b) section 9.2 of American Petroleum Institute RP14F, Recommended Practice for Design and Installation of Electrical Systems for Offshore Production Platforms.*

The requirement is prescriptive in defining where gas detectors needs to be located, but provides no information on how many detectors should be installed, or exactly where. The two standards quoted also provide no relevant information. In addition API14G on safety systems only provides very high level guidance on gas detection and asks for a review of their location to be undertaken.

A.5 DENMARK

The Danish Guidelines for Design of Fixed Offshore Installations 2009 state:

> *Gas detection shall be established in wellhead and process areas, in air intakes to internal combustion engines and rooms containing equipment which is not approved for use in a classified area.*

The guide adds further detail:

> *At a concentration of hydrocarbon gas of max. 25% LEL, the alarm shall be sounded. At a concentration of hydrocarbon gas of max. 75% LEL, the alarm shall be sounded, and automatic activation of the emergency shutdown system or parts thereof carried out, as described in chapter 4: "Process Equipment".*

However, the guidance does not give detail on where a detector should be located, or their number.