
Offshore petroleum drilling and risk

A study of proposed deep-sea exploration drilling
in Commonwealth Regulated Waters of the Great Australian Bight



Professor Tina Soliman Hunter

Professor of Petroleum Law
Director, Aberdeen University Centre for Energy Law

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1. Introduction and background

This report considers the exploitation¹ of petroleum² resources from the Great Australian Bight (GAB), an area which extends westwards from Cape Catastrophe in South Australia to Cape Paisley, east of Esperance in Western Australia – a distance of approximately 1,200km (McLeay, et, al., 2003, 8). The width of the continental shelf in the GAB varies, extending up to 260km (McLeay, et, al., 2003, 8), and depth varying from 100m to 4600m.

For over 20 years there has been an expectation that the GAB will contain petroleum resources within it, being a basin similar to the oil rich Bass Strait that was explored and developed from the mid 1960s. Indeed, Geoscience Australia notes that ‘not only is the Ceduna Sub-Basin (CSB) one of the largest under-explored basins in Australia, it is considered by many in the petroleum industry to be one of the largest in the world (Geoscience Australia, 2017, 6). Hence, the basin has attracted the attention of large international oil companies with Chevron and Equinor,³ as well as smaller companies such as Bight Petroleum and Murphy. Petroleum exploration in the GAB/CSB has occurred in three major periods. Firstly, in the late 1960s/early 1970s major companies including Shell, BP, and Esso explored the region as part of their investigation of the Bass Strait. The same companies returned to the region for further exploration in the 1990s, leaving empty-handed. The most recent exploration phase commenced in 2000 with a Woodside/Anadarko/PanCanadian joint venture exploring in the CSB. Exploration was subsequently abandoned,⁴ with the basin acquiring a reputation of poor prospectivity. Attempts to revive interest in the basin led Geoscience Australia to undertake a geoscientific study of the CSB, identifying world-class marine oil-prone potential source rocks (Geoscience Australia, 2017, 12).

The CSB was again offered for frontier exploration in the 2009 licensing round, with four exploration permits (EPP 37-40) awarded to BP⁵ In 2011. The criteria for the award of these licences was a guaranteed primary work program (three years)⁶ of \$605 million, and a secondary (further three years) work program in excess of \$800 million (Geoscience Australia, 2017, 12). In 2013 Equinor (then called Statoil)⁷ acquired a 30% interest in these permits, with BP remaining operator.

In October 2016, BP announced a withdrawal from its drilling program in the GAB, citing competition with other BP upstream investment opportunities.⁸ In 2017 Equinor and BP agreed to the following: for permits EPP 37 and EPP 38 Equinor transferred its 30% interest to BP and exited those licences. In Permits Epp 39 and EPP 40 BP has transferred its 70% interest to Equinor and exited the licences, with Equinor holding 100% of the interest in EPP39 and EPP 40 (Equinor, 2017).

The National Offshore Petroleum Titles Administrator (NOPTA) has approved the extension of the work commitments for EPP39 and EPP 40, with the drilling of one exploration well in

¹ The term exploitation does not hold any negative connotations in this report. Rather it is a well-recognised term that refers to both exploration and production of petroleum

² In this report the term petroleum refers to both oil and gas together, as defined by the Schlumberger Oilfield Glossary

³ Previously known as Statoil.

⁴ This well was abandoned due to physical conditions and will be considered further in section 3 below.

⁵ This was a most unusual licence application for two reasons. Firstly, was the amount of money bid for the work program, over 1.4 billion dollars over six years. Secondly, was the exposure of BP, given that this was not a joint venture. This is exceptionally rare in any petroleum province, even where prospectivity is assured, and unheard of in a Frontier Basin.

⁶ The award of a licence in Australia is made to the successful bidder of a work program, as required by ss 104-109 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth).

⁷ Statoil changed its name to Equinor in May 2018.

⁸ See https://www.bp.com/content/dam/bp-country/en_au/media/media-releases/bp-decides-not-proceed-with-great-australian-bight-exploration.pdf for BP's announcement of its withdrawal from the GAB.

EPP 39 to be completed before 30 October 2019. To incentivise companies to explore for petroleum in frontier areas in offshore Commonwealth Waters, in 2004 the Australian Government introduced new tax measures, enabling explorers in designated frontier areas (including the GAB) to claim 150% of the costs associated with exploration expenditure for the purposes of determining Petroleum Resource Rent Tax Payable.⁹

The proposed exploration well in EPP 39 is the first to be undertaken in that license area and is likely to be completed by Equinor in 2020. The water depth in EPP 39 ranges from 1200m to 4600m (South Australia Energy Resources Division, 2015, 11). This drilling will be undertaken in water depths of approximately 2239m. The drilling of wells in EPP 39 has been a focus for two reasons firstly due to the depth of the well (which is greater than the depth of the ill-fated well in Deepwater Horizon (DWH)) and secondly because the original permit holder was BP, the company responsible for DWH.

Australia's preeminent research body, CSIRO, recognises that there is limited knowledge on the marine system of the GAB and its interaction with the larger Southern Ocean (CSIRO, 2018). Consequently, there is discussion as to whether the research and knowledge should precede the exploitation of petroleum, or whether the acquisition of knowledge and petroleum exploitation can occur together. Combined with this lack of knowledge is widespread community concern about drilling for petroleum in a pristine and ecologically significant area of Australia, one which is home to a huge fishing industry as well as containing a Marine Reserve that is home to significant and endangered marine mammals and other species.

Much of the concern regarding drilling operations in the GAB is centred on the capacity of the Australian regulator, the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) to effectively regulate petroleum exploitation to ensure that oil spills do not occur, particularly in light of the DWH disaster in the Gulf of Mexico in 2010. Given such concerns, this report provides an analysis of the risks associated with deep-water drilling and the capacity to regulate such activities to ensure the protection of the marine and coastal environments. To that end, this report addresses why oil drilling in the Great Australian Bight is exceptional in terms of the risk of a drilling accident occurring and the difficulties in responding to a drilling incident.

It is important to note that the scope of this report does not extend to the economic, environmental or social value of the GAB, which has been considered in great detail in other publications.¹⁰ Rather, it will be confined to a consideration of risk and response in relation to petroleum activities within the GAB.

2. Terms of Reference of report

This report has been provided pro bono, at the request of Greenpeace Australia. The terms of reference requested by Greenpeace include:

1. What are the prevailing conditions in the Great Australian Bight that make offshore drilling in the area of higher risk than other areas?
2. What are the primary causes of incidents in offshore installations, and do ultra-deep-water drilling operations, particularly exploration drilling, present a relatively higher likelihood of an incident occurring?

⁹ See Part V Division 3 of the *Petroleum Resource Rent Tax Assessment Act 1987* (Cth).

¹⁰ For an excellent summary of the environmental issues, see

3. What are the challenges in effectively responding to incidents in the GAB including the physical environment and infrastructure?

Each of these questions will be considered below.

3. Physical environment of the Great Australian Bight and its impact on risk in offshore drilling operations

The offshore environment of the Great Australian Bight (GAB) is recognised as an area of high threat with regards to petroleum activities. It is a unique ocean area, with the GAB coast part of the world's longest south-facing continental margin, sitting adjacent to the only circumpolar ocean in the world, The Southern Ocean, which has a major influence on the physical environment of the GAB.

Although the tidal heights are small (in contrast to northern Australia), it is exposed to strong wind (part of the Roaring Forties wind system) and wave regimes generated in the Southern Ocean (Australian Senate, 2017, 7). Coupled with this is the presence and effect of intense low-pressure systems traversing the Southern Ocean and intruding into the GAB region (Australian Senate, 2017, 7).

Oceanographic conditions in the GAB are complex and to some extent little understood. While the broad oceanographic features of the GAB and Southern Ocean are well known, finer-scale knowledge of circulation is not well known at present, and needs further investigation (CSIRO, 2018). Conditions vary over the year, thereby having a major influence on the movement of oil should a spill occur. This complexity makes response planning difficult, and the impact of a spill varies according to the time of year.

Yearlong the Flinders Current travels northwest along the continental shelf. During early winter the Leeuwen Current intrudes onto the central and western basins of the GAB, and an anti-clockwise gyre develops over the surface of the shelf in the summer and autumn. In the winter shelf currents flow towards the southeast, with westerly winds favouring downwelling (McLeay, 2003, 17). Southwest winds in the summer and winter favour upwelling, as well as assisting the movement of water from the Flinders Current to the broader shelf region. Together the currents and climatic conditions create seasonal mixing of water within the GAB (McLeay, 2003, 17-18). Such upwelling and mixing provide elevated nutrient concentrations, including high densities of zooplankton which support enhanced level of ocean productivity (McLeay, 2003, 18). The Great South Australian Upwelling System, which occurs from Ceduna (SA) to Portland (Vic) link the continental shelves of the GAB to the nutrient rich depths of the Southern Ocean. Petroleum exploitation is to occur where nutrient exchange occurs.

Since the GAB is located next to the circumpolar Southern Ocean, the oceanographic processes in the GAB are influenced by frequent gales and heavy seas arising in the Southern Ocean (Edyvane, 1998), exposing the coastline of the GAB to moderate to high-energy waves. (McLeay, 2003, 18). Although the CSB has been identified by Geosciences Australia as the most prospective for hydrocarbons, Geosciences Australia has also said that its remoteness and physical features is the basis for risk in petroleum operations: "the remote location of the Bight, its deep water and the risk of violent storms for at least half of the year are major causes of the lack of historical exploration."¹¹

¹¹ <https://www.geoexpro.com/articles/2015/02/the-great-australian-bight-an-emerging-global-hotspot>

Such risk was demonstrated in 2003 when a Woodside led joint venture was awarded six exploration licences in the Ceduna Sub-Basin. One well (*the Gnarlyknots 1A Well*) was drilled, in 1316m of water, but plugged and abandoned at 4736m total well depth, above the target geology, due to the harsh ocean conditions (Geosciences Australia, 2017, 11-12).

The onshore physical environment is essentially remote, and some of the most sparsely populated areas of Australia. The GAB is adjacent to the Nullabor Plain, perhaps the most remote and driest region in Australia. It is relatively uninhabited, with most of the population of the GAB collected around the eastern fringes. Such geographical isolation is similar to that of the North-West Shelf (NWS), Australia's dominant petroleum producing area.

However, unlike the relatively flat paleo- deltaic geography of the NWS, the coastline of the GAB is dominated by limestone cliffs, up to 120m high in places (Geosciences Australia, 2017, 14). Such cliff formations, combined with remoteness, poor infrastructure and lack of population, present extensive barriers to land occupation in the region. Indeed, the barriers to response that the remoteness of the NWS region presented was highlighted in the Montara blowout and subsequent oil spill in 2009.

The harsh offshore physical environ of the GAB has been compared to the North Sea where similar wave and wind events and intensities occur. However, it should be noted that there are three main differences between the North Sea and the GAB. Firstly, the North Sea is sandwiched between several countries (and dominated by the UK and Norway), which have highly populous coastal communities. Secondly, there is a large amount of infrastructure (both onshore and offshore) in the area which provides support and fast response in the event of an offshore petroleum incident, such as an explosion or well blowout. Thirdly is the geography of the area – along the coastal regions of the North Sea population has occurred due to the relatively hospitable nature of the physical environ. The combination of high population in geographically accessible locations means that not only can petroleum operations be supported from the region, but timely responses to critical incidents with suitably qualified personnel can occur. Experience in Australia (the Montara blowout and oil spill) demonstrate that responses to oil spills in remote areas is slow and unwieldy.

4. Risk and offshore petroleum operations

The risks associated with petroleum exploitation are well known, given activity has occurred for decades. After over five decades of offshore petroleum activities in environs ranging from the warm and calm Gulf of Mexico to the tempestuous North Sea, risks and responses associated with offshore oil exploitation are well understood. Previous incidents, including the Ekofisk Bravo blowout in 1977, Aleksandr Kielland platform collapse in 1980, the Piper Alpha explosion in 1988, the Montara blowout and oil spill in 2009 and Deepwater Horizon (DWH) in 2010 all demonstrate how major accidents occur in the offshore environ. Each incident has also contributed to a growing body of knowledge on how to regulate offshore petroleum activities more effectively.

In particular, the aftermath of the Piper Alpha disaster, where 167 men died, saw a shift from prescriptive, rule-based regulation to objective-based regulation, where the focus is on achieving a specified outcome rather than dictating how operations should be undertaken. The principle reasoning for this comes from Lord Cullen, who in his report on Piper Alpha noted that those who create the risk should manage the risk (Cullen, 1990, vol 2). Consequently, a new objective-based regime for regulating offshore petroleum activities was implemented, which was adopted in Australian offshore petroleum jurisdiction in the early 2000s.

The regulation of offshore petroleum activities today under the objective-based framework centres around the concept of risk. Every activity, and especially that of petroleum exploration and production, creates risk. Therefore, it is necessary to manage the identification and reduction of risk. At the heart of the risk management framework is the safety case regime. A safety case is a document produced by a facility operator that identifies the hazards and risks, describes how the risks are controlled, and describes a safety management system that is in place to ensure that controls are effectively and consistently applied. Under the safety case system the risk must be reduced to 'as low as reasonably practicable' (ALARP).

A number of risks (that present as a threat) occur in the exploitation of offshore petroleum: the physical environ (threatening the platform), the well (and loss of well control) and ongoing day-to-day activities. As demonstrated in figure 1 below, the regulation of petroleum activities requires the threats associated with such an activity be controlled. Whilst some jurisdictions use objective-based regulation and the safety case system,¹² still others continue to use the prescriptive approach to regulation.¹³ whilst the legislative requirements vary from jurisdiction to jurisdiction, all have one commonality – the requirement for barriers to prevent an event (or incident) from occurring. Such prevention can be implemented through either a prescriptive or goal-setting approach¹⁴. Failure of the barriers under the designated regulatory framework and a resultant event, such as an oil spill, requires a response.

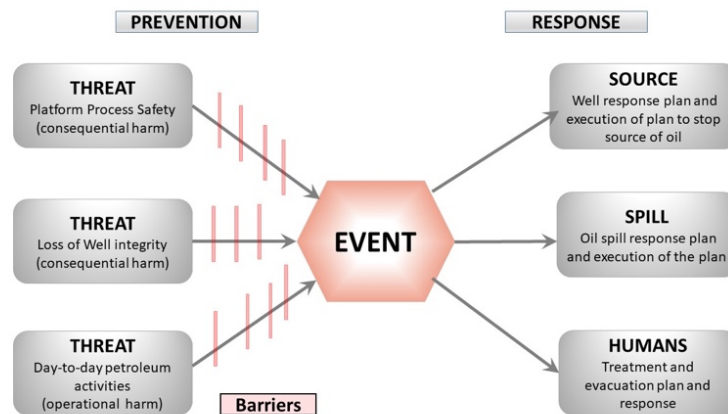


Figure 1: Bow-tie diagram illustrating threats (hazards), prevention and response in Arctic offshore petroleum development.

(Source: Adapted Bow TieXP diagram compiled by Author)

A comprehensive and effective regulatory framework will provide two primary attributes. Firstly, it will seek to *prevent* an incident or event through the identification and reduction of risk. Such a reduction of risk occurs using barriers (in accordance with the 'swiss cheese model'),¹⁵ whether through the safety case or other means (such as fitness to drill, used under Norwegian legislation). Secondly, there will be a requirement for effective *response*

¹² Principally UK, Australia, and Canada.

¹³ Especially the USA.

¹⁴ For an excellent consideration of the prescriptive approach prior to the Piper Alpha incident and the subsequent shift to a goal-setting approach, see John Paterson, 'Health and Safety at Work Offshore' in Greg Gordon, John Paterson and Emre Usenmez, UK Oil and Gas Law: Current Practice and Emerging Trends Volume 1 (Edinburgh, 3rd ed., 2018).

¹⁵ For an excellent discussion on Swiss Cheese Model see James Reason, *Managing the Risks of Organizational Accidents* (1997).

should an event occur. Such a response should be *planned*, and there should be an effective framework implemented for control over a response.

Together, the framework that deals with the risks associated with offshore petroleum operations comprises the prevention, planning and response framework (PPR). What follows is an assessment of the PPR for responding to an event that occurs during petroleum operations in Australian Commonwealth Waters.

5. Causes and prevention of harm in offshore petroleum operations

In offshore petroleum operations harm can arise from two distinct causes, as illustrated in figure 2 below: the platform itself, including the operations that occur on the platform; and the ships that supply the platforms and transport the oil and gas produced by the platform. Of the ten largest marine oil contamination incidents in history (excluding sabotage by retreating Iraqi who released 300 million gallons of oil into the sea) two have been caused by well blowouts.¹⁶ When undertaking exploration and production of petroleum, there are several possible sources of oil pollution. In particular there are three main sources of oil contamination: well blowouts and associated hydrocarbon release, platform failure and operational discharges.

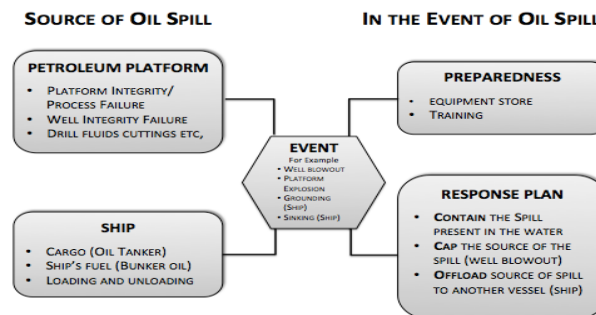


Figure 2: Offshore oil contamination sources, preparedness and response (Source: Compiled by Author)

5.1 Operational environmental harm

Operational discharges such as drill fluids and cuttings contribute small volumes of oil contamination in the environment. Such spills are usually controlled or managed through the well operations management plan (WOMP) and environmental management plan (EMP) that are required as part of the approvals process for exploration and production activities to be undertaken. Rarely, these activities cause a major event.¹⁷ The major contributor is that of well blowouts,

¹⁶ Deepwater Horizon well blowout and explosion in the Gulf of Mexico, and the Ixtoc 1 blowout and explosion, also in the Gulf of Mexico

¹⁷ An incidence of operational discharge resulting in the second largest oil contamination in Norwegian history occurred in 2007 at the Statfjord A Platform while loading oil into the Hilda Knutsen shuttle tanker via the OLS Landing Buoy in the Norwegian sector of the North Sea. A hose was severed while the transfer of oil from the platform to the tanker was underway, resulting in the accidental spill of 4400m³ of crude oil. Such events are rare. See PTIL, Order Issued to StatoilHydro Following Crude Oil Contamination on Statfjord (007) <http://www.ptil.no/news/order-issued-to-statoilhydro-following-crude-oil-spill-on-statfjord-article4409-878.html>.

5.2 Consequential environmental harm

5.2.1 Platform Failure - Process Safety

One major offshore incident is that of the Piper Alpha platform disaster in the British Sector of the North Sea on 6 July 1988. As a consequence of a series of events an explosion occurred on the Piper Alpha platform, engulfing the platform in a catastrophic fire, causing the death of 165 men on board the platform, and two rescue crew.¹⁸ The cause of this Black Swan¹⁹ event was identified as technical and organisational factors,²⁰ with a failure of both the design of the platform and the decisions made in its operation the root cause of the incident. This event and other such incidents have highlighted the need for robust processes and systems. This has subsequently developed into process safety, a disciplined framework for managing the integrity of operating systems and processes for hazardous substances including oil and gas.²¹

Whilst the Piper Alpha disaster is synonymous with an explosion and vast loss of life, it also caused significant oil contamination resulting from damage to the subsea production, lasting several weeks. Given the enormity of the loss of life on the *Piper Alpha*, scant attention has been paid to the oil contamination aspects of the disaster. Although thankfully rare, failures in process safety leading to platform fires and damage to wells has the potential to be a source of offshore oil contamination.

The process for the approval of a facility for offshore petroleum operations in Australia is similar to that of the UK, requiring a full Safety Case for the design and operation of the facility. To date, there have been no major incidents attributable to process safety in Australia. There have been several incidents that could have caused a major disaster,²² however this was managed within the established safety regulatory framework of notices, enforcement and sanctions.²³

I have confidence in the ability of NOPSEMA to assess and respond to threats associated with platform safety to ensure that well blowouts are reduced to ALARP. NOPSEMA has much expertise in assessing safety, having been the safety regulator for almost 20 years.

5.2.1 Well Blowouts

When undertaking drilling operations, a well blowout (also known as loss of well control or loss of well integrity) can be a source of oil spill. Such loss of control can range from minimal, causing a minor spill, to major well blowouts resulting in huge oil spills with enormous consequences.²⁴ The incidence of well blowout and hydrocarbon release is recorded in the

¹⁸ Lord Cullen, *The Public Inquiry into the Piper Alpha Disaster*, Vols. 1 and 2 (1990) Report to Parliament by the Secretary of State for Energy by Command of Her Majesty, November 1990.

¹⁹ In relation to major incidents, the term 'Black Swan' was defined by Nicholas Taleb in his book *The Black Swan: The Impact of the Highly Improbable* (2007). A 'Black Swan' is defined as an event or occurrence that deviates beyond what is normally expected and that would be extremely difficult to predict. This definition contains two important aspects: that the event is highly improbable, and if it were to happen, its consequences and impact would be of a high magnitude.

²⁰ M Elisabeth Paté-Cornell, 'Learning from the Piper Alpha accident: a post-mortem analysis of technical and organizational factors' (1993) 13 (2) *Risk Analysis*, 215-232.

²¹ Bob Skelton, *Process Safety Analysis: An Introduction* (Newnes, 1997).

²² Since 2016 NOPSEMA had been highlighting potential issues relating to the ability to unintentionally deactivate the auto-position mode of dynamic positioning system on a semi-submersible rig, there have been sixteen such incidents worldwide, all attributable to poor design, and could have easily led to a loss of well control or blowout due to the fracture of the riser. In the UK such an incident occurred, and a blowout was only prevented when the drill pipe was sheared, and the lower marine riser package disconnected. For further information see https://www.osjonline.com/news/view/nopsema-highlights-dangers-of-inadvertent-operation_50354.htm

²³ See <https://www.nopsema.gov.au/resources/published-notices/for> published notices from NOPSEMA.

²⁴ Oil spills are rated according to a Tier System, which allows for international oil contamination preparedness and response. Tier 1 spills are small operational spillages at a local level, Tier 2 spills are regional and national, with Tier 3 spills international spills requiring globally available resources and coordinated response. IPIECA and IOGP, Tiered Preparedness and Response:

SINTEF Offshore Blowout Database,²⁵ which categorizes blowouts according to cause. There have been four blowouts of note that have had a major impact on the law regulating oil contamination from well blowouts.

The first was the 1977 *Ekofisk Bravo* well blowout, which occurred during maintenance work on a production well located in 75m of water.²⁶ It continued for seven days until the well was killed.²⁷

The second was the Ixtoc 1 blowout on 3 June 1979 when an exploratory well being drilled by the semi-submersible drilling rig operating in the Bay of Campeche, Gulf of Mexico in 50m of water.²⁸ The well was capped some ten months later on 23 March 1980, with 140 million gallons of oil contaminating into the Gulf of Mexico.²⁹

The third oil contamination of significance was the Montara H1 blowout ('Montara') on 21 August 2009 in a remote area northwest off the Western Australian coast, approximately 690km from Darwin.³⁰ The spill continued until 3 November 2009 (a total of 74 days), when a relief well successfully intercepted the uncontrolled well, enabling the well to be capped.³¹ Approximately 14,000 gallons of oil leaked daily. A total of approximately 1.5 million gallons (over 44,000 barrels) of oil leaked from the well.³² Although the Montara incident resulted in no deaths on the oil platform, and minimal environmental impact in Australian waters,³³ one of the significant issues relating to this incident was the failure of the operator to construct the well according to the approved WOMP.

The fourth, and perhaps most internationally well-known incident is the well blowout on the Deepwater Horizon (DWH) drilling rig and subsequent oil contamination in the Gulf of Mexico

Good Practice Guidelines for using the Tiered Preparedness and Response Framework (2015)

<http://www.ipieca.org/resources/good-practice/tiered-preparedness-and-response/>.

²⁵ Participants in the SINTEF Database include most major offshore petroleum companies, Det Norsk Veritas (DNV) and Lloyds Register Consulting. This comprehensive database contains information of 642 blowouts/well releases that have occurred since 1955. It particularly contains data for the Gulf of Mexico (GoM) and the North Sea (Norway and UK). In the period 1 January 1980 until 31 December 2014, there has been a combined total of 292 well blowouts/oil contamination in the GoM (208) and the North Sea (84). SINTEF, SINTEF Offshore Blowout Database (2018) <https://www.sintef.no/en/projects/sintef-offshore-blowout-database/> accessed 18 April 2018.

²⁶ Petroleum Safety Authority, Norway, Safety – Status and Signals, 2012-13: Ekofisk Bravo, (1977) (2013)

<http://www.ptil.no/articles-in-safety-status-and-signals-2012-2013/ekofisk-bravo-1977-article9121-1095.html> accessed 11 March 2018.

²⁷ A well kill refers to placing well mud of sufficient density to stop the flow of hydrocarbons from a well. See Schlumberger Oilfield Glossary <http://www.glossary.oilfield.slb.com/Terms/k/kill.aspx> accessed 25 March 2018.

²⁸ Bureau of Land Management and ERCO, Ixtoc oil contamination assessment: final report executive summary (1982) http://invertebrates.si.edu/boem/reports/IXTOC_exec.pdf

²⁹ Bureau of Land Management and ERCO, Ixtoc oil contamination assessment: final report executive summary (1982) http://invertebrates.si.edu/boem/reports/IXTOC_exec.pdf

³⁰ All other major oil contamination in Australia have been the result of ship-sourced pollution. For details of all major oil contamination in Australia's waters in the last thirty years, refer to Australian Maritime Safety Authority, Major Oil contamination in Australia (2009) <http://www.amsa.gov.au/Marine_Environment_Protection/Major_Oil_Spills_in_Australia/> at 21 April 2018.

³¹ As a result of the safety regulatory framework for offshore oil platforms in Australia (Offshore Petroleum and Greenhouse Gas Storage Act 2006 (Cth) and Offshore Petroleum and Greenhouse Gas Storage (Safety) Regulations (2009) a 2.5 nautical mile cautionary exclusion zone was implemented around the platform, preventing a well kill operation to regain control of the well. Instead, there was a need to drill an intervention well, which took over five attempts and three months, and ultimately brought the well under control. It took two weeks for a drilling rig to arrive on site from Singapore, and five attempts to drill into a 244mm well at a depth of almost 2600m

³² Australian Maritime Safety Authority, Major Oil contamination: Montara Well Head Platform (2009) Australian Maritime Safety Authority, Major Oil contamination: Montara Well Head Platform (2009)

http://www.amsa.gov.au/Marine_Environment_Protection/Major_Oil_Spills_in_Australia/Montara_Wellhead/index.asp at 14 April 2018.

³³ The spill did not reach the Australian coastline due to its distance from the Australian coast, nor were there any discernible impacts on wildlife. However, there have been numerous allegations from West Timor fisherman of impact on fisheries and sea weed farming, leading to a class action brought by West Timorese fishermen. See Gabrielle Dunlevy, 'Indonesian seaweed farmers to file \$200m class action over Timor Sea oil contamination' (2016) The Guardian,

<https://www.theguardian.com/world/2016/aug/02/indonesia-seaweed-farmers-class-action-timor-sea-montara-oil-spill-2009-australia> at 15 April 2018.

on 20 April 2010 at the BP-operated Macondo Prospect. Following a loss of well integrity, an explosion ripped through the Deepwater Horizon drilling rig, causing the death of 11 workers and rupturing the riser,³⁴ leading to the worst oil contamination in history. The Presidential Report³⁵ concluded that the immediate cause of the blowout and oil contamination was a loss of well integrity attributable to a series of identifiable mistakes made by BP, Halliburton and Transocean.³⁶ The well was capped 87 days later on 15 July 2010, and resulted in a spill of approximately 134 million gallons of oil into the GoM,³⁷

It is important to note that three of the four major oil spills from well blowouts occurred on exploration wells. This is no coincidence. An exploration well is at particular risk of blowout due to its very nature – an exploration well will enter into a formation for the first time, and should that formation be a high pressure and/or high temperature (as deep-water wells often are, such as the Macondo well in DWH), there is an enormous amount of pressure that is being held through a number of barriers.

The prevention of a blowout relies on the barriers in place. The presence of such barriers is, ultimately, a factor of regulation. For any well to be drilled, a field development plan and a Well Operations Management Plan (WOMP) is required to be approved. There are several frameworks for developing a WOMP – under the ‘safety case’ framework, where the risk of a blowout is reduced to ALARP, the ‘fitness to drill’ framework utilised in Norway and similar to ALARP, or that of good oilfield practice (GOP). In the instance of both Montara and DWH, the method required by the regulator was that of GOP, which is defined as ‘all those things that are generally accepted as good and safe in the carrying on of exploration for petroleum, or in operations for the recovery of petroleum, as the case may be’.³⁸ This differs considerably to that of ALARP, which requires the operator to prove in their WOMP that all that can be done that is reasonably practicable has been done to reduce the risk of a blowout has been undertaken.

As mentioned above, GOP was required for regulation at the time of the Montara incident. Since that time, changes in the regulatory bodies and structure, as well as a shift from GOP to ALARP have occurred, bringing Australia’s regulation of wells in line with world class regulators such as Norway and the UK. However, there are two things that Australia lacks compared to these jurisdictions, which may contribute to an increased risk of blowout in the GAB

1. Inspection of wells during construction. In Australia, the UK and Norway, all wells are constructed according to the WOMP that was submitted and approved by the relevant regulator. In Norway and the UK, the constructed wells are then inspected against the approved WOMP to ensure that the well meets the approved standard and therefore reduce the risk of a blowout occurring. Such inspection does not occur in Australia, meaning that a well may be constructed in a manner that is substandard to that which was approved. This disparity in the construction of the well versus the WOMP caused the Montara blowout, which may have been averted if inspection occurred.

³⁴ A drilling riser is a large-diameter pipe that provides a temporary connection between a subsea well to a floating surface rig.

³⁵ National Commission on the BP Deepwater Horizon Oil contamination and Offshore Drilling, *Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling* (2011).

³⁶ National Commission on the BP Deepwater Horizon Oil contamination and Offshore Drilling, *Deepwater: The Gulf Oil Disaster and the Future of Offshore Drilling* (2011), chapter 4.

³⁷ An estimation of the amount of oil released varies. For this chapter the estimation from the Smithsonian National Museum of Natural History Ocean Portal has been selected due to independence of source. See <http://ocean.si.edu/gulf-oil-spill> accessed 22 May 2018.

³⁸ *Petroleum Submerged Lands Act 1982* (SA)

2. The use of standards for well control. Norway requires [NORSOK DS-010](#) to be met for the construction of all wells. Similarly, the UK's [Guide to the well aspects of the Offshore Installations and Wells \(Design and construction, etc.\) Regulations 1996](#) provides detailed guidance on the requirements for offshore wells.

An examination of licenses where Equinor³⁹ is the operator highlights a number of 'near misses', including the loss of well control at *Gullfaks C* and *Gullfaks B* (but no blow-out) in 2010-11, demonstrating the fallibility of all companies in executing WOMPs and process safety. Table 1 below summarizes the safety and well control breaches that have occurred at Equinor-operated exploration and production facilities, as well as the oil refinery at Mongstad. An examination of the table demonstrates that Equinor is routinely involved in process safety and well incidents, averaging at least two a year. These incidents are occurring in a regulatory environment (Norway) that is regularly referred to as demonstrating best practice in safety and well control.

Date	Incident	Result of Investigation
13/03/19	Dropped Object, <i>Åsgard B</i> facility	Pending
13/12/18	LNG leak at onshore LNG processing facility, <i>Melkøya</i> , Hammerfest	Breach of Regulations
25/10/17	Naptha leak from cracker at <i>Mongstad</i> refinery	Breach of Regulations
16/3/17	Gas leak from <i>Deepsea Bergen</i> MODOU (Statoil was operator)	
7/3/17	Boom of pipe-handling crane fell to pipedeck on <i>Gullfaks B</i>	Breach of Regulations
12/10/16	Five people exposed to hydrogen sulphide leak at <i>Sture</i> Terminal	Serious Breach of Regulations
16/10/16	Fire in utility shaft of <i>Statfjord A</i> facility during transfer from storage cells to shuttle tanker	Breach of Regulations
15/10/16	<i>Songa Endurance</i> MODO at <i>Troll</i> Platform (Statoil Operator)- well blowout (gas). Stabilised 26 October – potential to be severe and life-threatening	Serious breach of Regulations
25/10/16	Gas leak at <i>Mongstad</i>	
8/10/16	Oil spill at <i>Statfjord A</i> platform when unloading oil from platform to the <i>Hilda Knutsen</i> shuttle tanker as a result of corrosion in the loading pipe	Nonconformity to Regulations
16/3.16	Well control incident (kick) at <i>Visund A</i> platform. Assumed that barriers were verified but were not – the Kelly cock valves below the topline were jammed, preventing normal well-control methods for well kill being used. Non-conformities relating to design of well barriers, maintenance of valves, configuration of BOP and verification of well barriers found during investigation	Breach of s 48 of the Facilities Regulations
22/9/15	Falling grating plate on <i>Heidrun TLP</i>	Nonconformity to Regulations
18/2/15	Condensate Leak from <i>Gudrun</i> platform. Caused by 2mm crack extending 90% across the circumference of a two-inch pipeline. Major incident that was potentially fatal.	Serious breach of Regulations
5/1/14	LNG leak at onshore LNG processing facility, <i>Melkøya</i> , Hammerfest. Caused by worn gasket in the stuffing box but cause of wear was unable to be determined. Could have been a major loss of life.	Nonconformity to Regulations
8/11/12	Ruptured blowdown pipe for feed in cracker at <i>Mongstad</i> . Released water at 245°C at a pressure of 78kg/s. no injuries but had potential for loss of life. Caused by corrosion under insulation.	Nonconformity to Regulations
26/5/12	Hydrocarbon leak from <i>Heimdøl</i> platform. Caused by testing of two emergency shutdown valves. (failure of process safety). Major leak with potential for loss of life.	Nonconformity to Regulations and Order

³⁹ Statoil changed its name to Equinor in 2018.

March 2011	Open letter to Statoil regarding serious gas leaks at <i>Gullfaks B</i> Well C-06 19 May 2010, which took two months to control. Letter detailed serious and generalized deficiencies including planning of drilling and completion work was below standard, with a major accident only narrowly averted. Open letter due to scale of deficiencies and potential for impact. Had been an order for a previous incident on <i>Gullfaks C</i> which was to come into force by December 2012, but serious incidents on <i>Gullfaks B</i> that were of similar origin led to the open letter. See http://www.ptil.no/well-integrity/gullfaks-new-approach-to-enduring-problem-article8303-900.html	Special measures
4/12/10	Gas leak on <i>Gullfaks B</i> platform. Investigation revealed serious deficiencies related to planning, approval and execution of activities. Required special consideration of measures necessary. Linked to previous leaks at <i>Snorre A</i> in 2004, <i>Statfjord A</i> shaft hydrocarbon leak in 2008 and loss of well control <i>Gullfaks C</i> in May 2010.	Serious breach of Regulations; required further measures (see above)
19/5/10	Loss of control of well 34/10-C-6 A on <i>Gullfaks C</i> . Loss of control lasted over two months. Like loss of control of well C-06 19 May 2010, which took two months to control, caused by serious and generalized deficiencies including planning of drilling and completion work was below standard, with a major accident only narrowly averted.	Serious breach of Regulations; required further measures (see letter above)

Table 1: Safety and well control breaches that have occurred at Equinor-operated exploration and production facilities (Source: compiled by author utilizing data from www.ptil.no)

The above table demonstrates that every company, including the highly reputable Equinor, can have well control issues. However, in each instance barriers, including behavioural barriers, ensured that little hydrocarbon escaped, and the incident was contained and prevented from becoming serious (or life threatening). Hopkins notes that organisational and human behaviour factors of an operator are as critical for the prevention/containment of hydrocarbon releases as that of physical barriers, (see Hopkins, 2012). In his study of DWH, Hopkins notes that had the organisational and decision-making processes of BP differed, it is possible that DWH may not have occurred (Hopkins, 2012). Indeed, NORSOK DS-010 specifically defines well control as ‘the application of technical, operational and *organizational* solutions to reduce the risk of uncontrolled release of formation fluids throughout the entire life cycle of the well’. Such an incorporation of organisational behaviour would be well served in preventing loss of well control and well blowouts.

5.3 Role of the Regulator

A strong regulator with vast experience in regulating the environmental, process safety and well aspects of exploration and production operations is critical for the prevention and containment of risk and harm associated with such activities. As table 1 illustrates above, in the last 8 years, Equinor has had twenty serious incidents that have been investigated and identified as breaches of or non-conformities to the relevant regulations. A strong, experienced regulator (PTIL) has investigated and found regulatory breaches in each case. That this is occurring in a mature jurisdiction with strong experienced environment and safety regulators is worrying for Australia.

NOPSEMA took over the regulation of wells and environmental aspects of petroleum operations in January 2012. Previously, the regulation of these aspects of petroleum operations was undertaken by the Designate Authority (the state/territory regulator). To date, Australian petroleum exploration and production activities have occurred in shallow water, whereas the Stromplo-1 well will be drilled at a depth of 2,239m, and is likely to be a high pressure/high temperature (HPHT) well, which will be drilled in the harshest of environments, one that the regulator has never regulated for previously.

Australia is presently the only mature jurisdiction that does not require well inspection during construction to ensure that the well is constructed according to the WOMP. A failure to inspect a well does not meet with world's best practice. Indeed, the failure to properly construct the Montara Well caused the worst oil spill in Australian petroleum history in 2009. In order to ensure that wells are properly constructed, particularly for wells that are likely to be HPHT, as a result of the water depth, it is critical that the wells are inspected. At present, there is no legal requirement to do so, and law reform is likely to be slow. An interim measure requiring third-party well inspection and certification can be made a requirement as part of the approval of the WOMP and EP. Organisations such as DNVGL are capable of undertaking such activity and would act as a third-party verifier of well integrity.

Given the lack of experience of the regulator, lack of well inspections requirements within the existing legislation, the environment where drilling will occur (described by Equinor as similar to that of the Norwegian Sea and the Arctic Barents Sea),⁴⁰ and a lack of suitable standard at present I do not have full confidence in NOPSEMA's capacity to prevent a well blowout in the GAB.

It is essential that both well inspection and well integrity standards are adopted before the commencement of any drilling operations in the GAB. Not only would this be best regulatory practice, it would also constitute good regulatory practice, as it would bring Australia into line with regulators of similarly harsh conditions in the North Sea.

6. Challenges in responding to an event in the Great Australian Bight

The Montara incident tested Australia's oil spill response planning, and there have been several papers written about the oil spill response regime after Montara and DWH.⁴¹ To date, much has been made of the oil spill modelling and response plan should there be an incident in the GAB. What is clear is two things:

1. If there is a loss of well control leading to an oil spill, oil will reach the coastline, with effects predicted to be as far away as the NSW South Coast and Esperance, depending on the time of year (BP, 2016, 14-15).
2. According to BP's modelling of an oil spill from the Stromlo-1 well, the effects of an oil spill are less in summer and highest in winter for most predicted affected areas. This could have implication for species that live in the water column or seabed sediments, since there is a higher likelihood of marine snow forming where oil spills occur in cold water (Daly, et al., 2016).

As can be seen from Figure 1 above, the appropriate response to an event such as a well blowout is threefold: rescue of people, containment and clean-up of the oil spill, and addressing the source of the spill. The rescue of people is assisted by the petroleum standby vessel that is always available near a platform, although experience in both Piper Alpha and Deepwater Horizon demonstrates that should a catastrophe occur, the rescue may be intense and of short duration, relying only on the available rescue personnel in the near vicinity.

⁴⁰ Equinor, *Environment Plan, Stromlo-1*, (2019), 54.

⁴¹ See for instance Tina Hunter, 'The Montara Oil Spill and the National Oil Spill Contingency Plan: Disaster Response or Just a Disaster?' (2010) 24 *Australian and New Zealand Maritime Law Journal*

The focus to date has been on the oil spill plan, which is required as part of the Environment Plan under r10A of the *Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009* (Cth). Section 3.8 of NOPSEMA's *Environment Plan Content Requirements* outlines the requirement for strategies for oil pollution emergency control plans and post spill monitoring. There are concerns regarding the capacity to respond to an oil spill in the GAB given the slow response to the Montara spill on the NWS, attributable to the remote location and lack of resources in the area. However, given that Australia's major response centre, AMOSC, is located in Victoria, the proximity is somewhat closer. Nevertheless, given the remoteness and lack of infrastructure and population, it is likely that there would be delays in response to an oil spill. Furthermore, a lack of surrounding infrastructure (both offshore and onshore) is likely to hamper containment efforts, since there is no capacity to rely on other platforms in the vicinity for response materials.

The physical environment is also likely to play a large role in spill response. Wave height can impact on the capacity to utilise mechanical cleanup methods such as boom and skim. The cold temperature of the water is also likely to interfere with and/or reduce the natural biodegradation of the oil on the surface and in the water column. However, on a positive note, the presence of waves and currents can also contribute to the degradation of oil. Environmental studies conducted by Equinor and CSIRO have concluded that microbial communities present are capable of degrading hydrocarbons in surficial seabed sediments to 2,800m.⁴²

One aspect of the response to a loss of well control and blowout is the need to address the source of the spill – the well. This has the potential to be devastating, since, unlike ship-sourced pollution, the spill will continue until the source is stopped. In both the Montara and the DWH incidents, well control took months. In the case of DWH, BP had no workable solution for capping the well for months, leaving the well to continue to leak. Equinor's Environment Plan for Stromlo-1 considers responses in the case of a blowout: blowout preventer intervention by ROV,⁴³ capping stack,⁴⁴ and the drilling of a relief well.⁴⁵ Detailed consideration is given to the analysis of each of these aspects using the ALARP assessment.

Equinor has indicated in the ALARP assessment for loss of well control, it would not adopt the option of providing a standby relief well rig as the costs are commercially non-viable (p23, Appendix 7.4). Equinor states that this option would only be utilised generally in areas where the sea freezes. This means that the option proposed to be adopted is requisitioning a relief well from the Northwest Shelf (NWS), assuming a rig capable of drilling in over 2,200m is available. The EP considers there is a chance that a rig might be available in Bass Strait. Experience with Montara demonstrates that acquiring a suitable vessel is difficult and time-consuming, particularly considering that the rig would likely have to break off from the drilling it is undertaking at the time.

According to the timings provided by Equinor,⁴⁶ the best-case scenario (*Risk Optimistic Duration*) for a rig to arrive at the required site and be ready to drill (activity 00060) is 17 days. The worst-case scenario (*Risk Pessimistic Determination*) is 39 days, and a goal scenario (*Risk Deterministic Duration*) is 26 days. Even taking the best-case scenario, this is well outside the requirement of 12 days to commence relief well drilling that is required

⁴² Equinor, *Environment Plan, Stromlo-1*, (2019), 57.

⁴³ Equinor, *Environment Plan, Stromlo-1, Appendix 7-4 ALARP Assessment for Loss of Well Control* (2019), section 3.1

⁴⁴ Equinor, *Environment Plan, Stromlo-1, Appendix 7-4 ALARP Assessment for Loss of Well Control* (2019), section 3.3

⁴⁵ Equinor, *Environment Plan, Stromlo-1, Appendix 7-4 ALARP Assessment for Loss of Well Control* (2019), section 3.4

⁴⁶ Equinor, *Environment Plan, Stromlo-1, Appendix 7-4 ALARP Assessment for Loss of Well Control* (2019), 23.

under s4.8.2 of NORSOK D-010 (Well integrity in drilling and well operations), the standard under which Equinor is required to operate in the Norwegian and Barents Sea).

The provision of a rig on standby in Port Adelaide as outlined (and rejected as too costly) in the Equinor EP⁴⁷ would enable Equinor to meet the NORSOK D-010 requirement of drilling within 12 days: best scenario 4 days; worst scenario 9 days.

It is essential that a standby rig is required in order for Equinor to meet the standards required for the Norwegian and Barents Seas, which Equinor acknowledges is a similar operating environment.⁴⁸ It is critical to understand that the remote location means that there is far less support available in the area and far greater distances for any support vessel and operations to travel. Thus, the environment's harshness and remoteness warrants a requirement for a standby-by rig.

7. Further issues for consideration

The identification of environmental risks necessarily includes an analysis of the identification and evaluation of platform safety (both worker safety and process safety), as well as an analysis of the Well Operations Management Plan (WOMP). Both of these are designed to *prevent* incidents.

In the case of process safety, this is to prevent an event that will contribute to environmental harm, like the Piper Alpha platform incident in 1988. Unless and until the safety analysis is undertaken, it is not possible to undertake a full analysis of the environmental impacts.

Most importantly, a major environmental risk arises in the case of a well blowout. The Equinor EP makes mention of the WOMP, but this has not been provided for consideration. How a well is constructed and operated has a major bearing on the prevention of a well blowout through well control, as well as the identification and evaluation of environmental risks.

Equinor notes in chapter 2 that the environment for petroleum activity at Stromlo-1 is similar to that of the North Sea. Therefore, it would make sense that North Sea Standards are required in this instance. One important question is whether the standard for construction and operation of the well will be that adopted in the Norwegian and Barents Seas. For all Norwegian North Sea well operations, Equinor is required to ensure that wells are constructed and operated according to NORSOK D-010 standards. Given the similar operating conditions in the GAB to the North Sea, the use of NORSOK D-010 standards would be prudent. In addition, these are the standards that Equinor is most familiar with.

However, none of this can be assessed without an examination of the Stromlo-1 WOMP. Therefore, it is prudent that the WOMP is also released for public comment.

⁴⁷ Equinor, *Environment Plan, Stromlo-1, Appendix 7-4 ALARP Assessment for Loss of Well Control* (2019), section 3.4.5

⁴⁸ Equinor, *Environment Plan, Stromlo-1*, (2019), 54. (Note that the Barents Sea is in the Arctic and drilling requirements there usually include a standby relief drilling rig).

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