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BEST PRACTICE AND REGULATORY REFORM FOR PLUGGING AND PERMANENT ABANDONMENT OF OFFSHORE PETROLEUM WELLS IN AUSTRALIA

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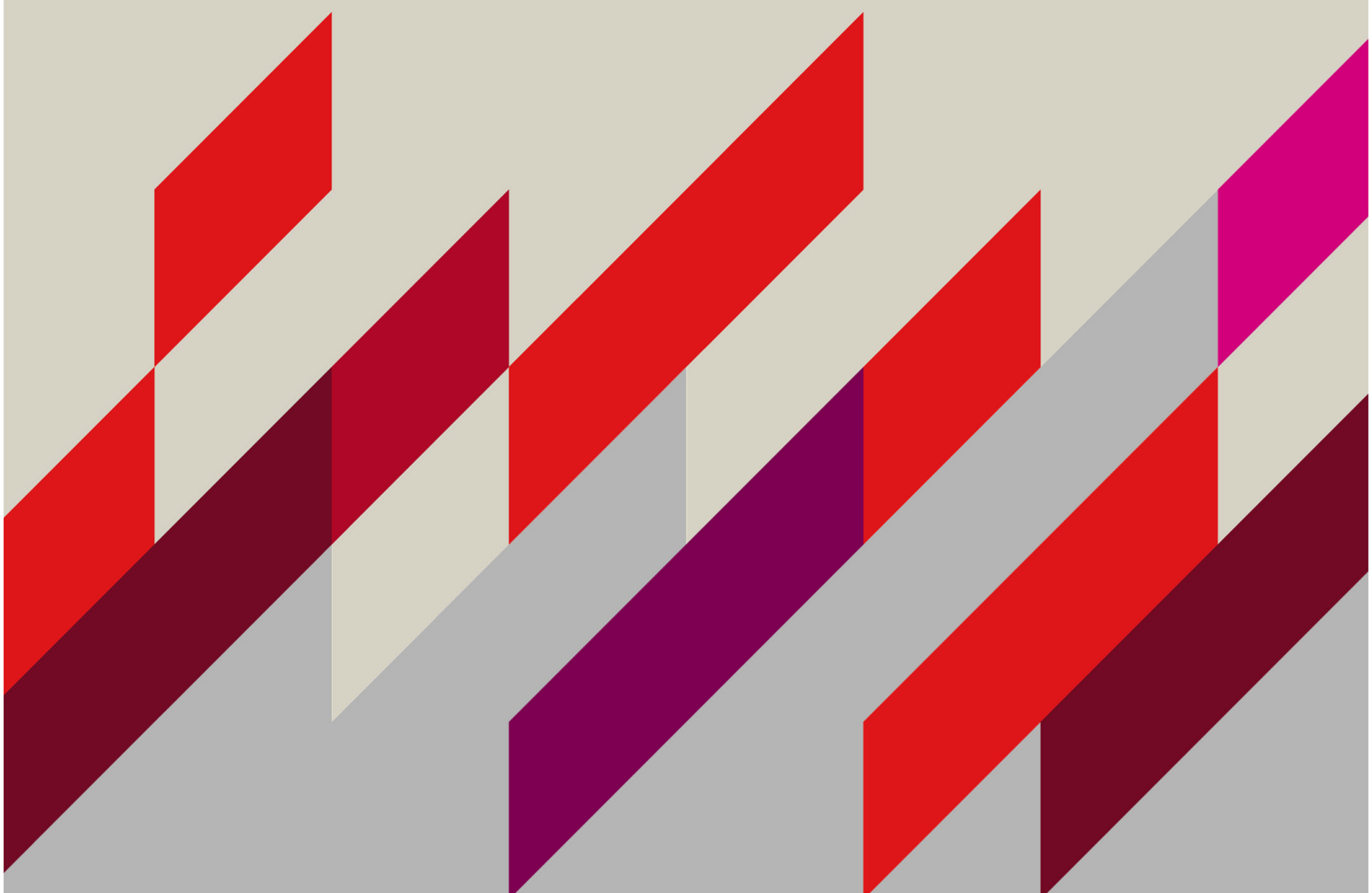

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ABBREVIATIONS

ALARP	As Low as Reasonably Practicable
Cth	Commonwealth (of Australia)
EPSDA	*Environment Protection (Sea Dumping) Act 1981* (Cth)
FDP	Field Development Plan
GHG	Greenhouse gases
GOP	Good oilfield practice
IOGP	International Association of Oil and Gas Producers
IRF	International Regulators Forum
LCP	London Convention and Protocol
MAD	Minimum abandonment depth
NCS	Norwegian Continental Shelf
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority (Australia)
NORSOK	Norsk Sokkel (Norwegian Continental Shelf)
NOPTA	National Offshore Petroleum Titles Authority (Australia)
NPD	Norwegian Petroleum Directorate
OEUK	Offshore Energies UK
OI&I	Offshore installations and infrastructure
OPGGSA	*Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth)
P&A	Plug and abandon
PSA	Petroleum Safety Authority (Norway)
RMA Regs	*Offshore Petroleum and Greenhouse Gas (Resource Management and Administration) Regulations 2011* (Cth)
UK	United Kingdom
UKCS	UK Continental Shelf
UNCLOS	United Nations Convention on the Law of the Sea
WOMP	Well Operations Management Plan
ZoPF	Zone of potential flow

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EXECUTIVE SUMMARY

Studies have demonstrated that around 25% of all offshore wells (including those in operation, suspended, or plugged and abandoned) on the Norwegian continental shelf, 10% of wells on the UK continental shelf, 43% of wells in the Gulf of Mexico, and 20% of offshore Canadian wells have experienced either well integrity issues or failures.[1] Historically, wells have often been poorly plugged and abandoned since it is a cost incurred with no financial return to the operator. Although there is no accessible data is available for Australia, it can be assumed that well integrity issues also arise, demonstrated by several wells in the Legendre field which have been leaking post-decommissioning in 2014, and still not subject to a Direction from the regulator, NOPSEMA.

This report considers the integrity of wells which are plugged and abandoned (P&A) as part of the decommissioning of a field. A consideration of the legal framework for P&A of offshore wells in Australia, compared to similar jurisdictions (UK, Norway and Canada). The IOGP assessment of 35 legal frameworks for well P&A reveals Australia to be the only mature offshore petroleum jurisdiction, and the only jurisdiction that participates in the *International Regulators Forum*, to not set out requirements for P&A or stipulate guidelines/standards. Also according to IOGP, Australia continues to be the only mature jurisdiction that has no guidance for companies seeking to P&A wells. Of the 35 countries considered by the IOGP, a similar lack of guidance is also seen in Algeria, Spain, Kazakhstan, Oman, Angola, Gabon, Nigeria, South Africa, Myanmar, and Venezuela, all poorly developed regulatory jurisdictions. The summary of P&A requirements by the IOGP for Norway, UK, Canada, and Australia is found in Appendix 1.

Australia's absence of minimum requirements and no set standards for well P&A, combined with a lack of well inspection, establishes a substandard regime with poor oversight of well P&A. The following recommendations will assist in bringing Australia's practice up to standards akin to comparator countries Norway, the UK, and Canada.

Recommendations

Recommendation 1: Amend Offshore Petroleum and Greenhouse Gas (Resource Management) Regulations to adopt a best practice standard for plugging and abandonment of wells.

Recommendation 2: Amend OPGGSA and Regulations to require mandatory inspection of permanently plugged and abandoned wells to ensure independent verification that Well Operations Management Plan is complied with and ensure no surrender of title (s.270) without 3rd party inspection.

Recommendation 3: As part of Well Operations Management Plans for plugging and abandonment of wells, flagging by titleholder of well construction that deviates from good oilfield practice.

Recommendation 4: Establish a living map of P&A wells including location, dates of activity and P&A, challenges/concerns with well abandonment, and any infrastructure remaining.

Recommendation 5: Amend the OPGGSA to make a remediation direction under s587 mandatory, to compel former titleholders to remediate leaking wells under direction of either Regulator or Responsible Minister.

Recommendation 6: The OPGGSA and EPSDA should be amended to require well plug integrity to be monitored after wells are plugged and abandoned, with monitoring coordinated with the Department of Climate Change, Energy, the Environment, and Water

[1] Richard Davies, et. al., 'Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation' (2014) 56 *Marine and Petroleum Geology* 239-254.

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1. INTRODUCTION

Decommissioning is the final phase of petroleum field cycle. Part of the process involves the plugging and abandoning (P&A) of petroleum wells, removing petroleum infrastructure, and undertaking site remediation. The plugging of a petroleum well for abandonment entails sealing the well with necessary materials, which includes cement, bentonite, drilling mud, and mechanical plugs, to prevent the leakage or migration of reservoir fluids and other gaseous substance into surrounding reservoirs or to the surface. Failing to properly decommission petroleum wells through P&A can pose future health safety and environmental risks and so necessarily the P&A of wells should reflect best practice.

In line with such requirements, in Australia the titleholder of offshore petroleum (oil and gas) fields[2] are legally required to decommission the existing offshore installations and infrastructure (OI&I). [3] According to the Australian Department of Industry, Science, Energy and Resources (DISER), the purpose of decommissioning is to remove or otherwise satisfactorily deal with, in a safe and environmentally responsible manner, structures, equipment and property previously used to support activities in the offshore area. This includes the P&A of wells, the rehabilitation of the site, and carrying out any necessary monitoring where directed.[4]

1.1 AIM OF REPORT

The aim of this report therefore is to provide an independent review and analysis of the Australian legal requirements and practice for the decommissioning (permanently P&A) of offshore oil and gas wells, measured against contemporary best practice regulation of decommissioned wells in analogous (mature) overseas jurisdictions, particularly in the North Sea, which are more explicit in their requirements and provide a wealth of knowledge and techniques to ensure that best practice in well decommissioning is achieved.

As part of this analysis, this report also provides a set of recommendations to ensure the long-term regulation of permanently abandoned wells to ensure that leakage of Australian offshore petroleum wells does not pose a risk to human health or the environment.

2. SCOPE OF REPORT

This report will undertake a review of the regulation of well decommissioning by examining:

1. The well decommissioning process;
2. Longevity of permanent well abandonment, and potential risks;
3. Risks associated with permanently abandoned wells;
4. Analysis of what constitutes best practice;
5. International law and agencies influencing offshore well decommissioning in Australia;

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[2] In the context of this report, offshore oil and gas activities will pertain to those activities in Commonwealth Waters only. According to the offshore constitutional Settlement 1980, the states/Northern Territory regulate petroleum activities in *Coastal Waters* (0-3 nautical miles from baseline), with the Commonwealth regulating all activities three nautical miles seaward – see s 6 *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth). In coastal waters, the states/Northern Territory 'mirror' Commonwealth legislation, and therefore the legislative requirements are the same.

[3] Offshore installations refer to both fixed and floating structures that are utilised to produce oil and gas. Infrastructure refers to the pipelines, risers, well heads, Christmas trees, and other kit required for exploration and production. Such decommissioning is required under the s572 of the *Offshore Petroleum and Greenhouse Gas Storage 2006* (Cth) (OPGGSA) and accompanying regulations.

[4] DISER, *Guideline: Offshore Decommissioning in relation to the Offshore Petroleum and Greenhouse Gas Storage Act 2006* (2022)

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6. Analysis of the regulation and practice for permanent abandonment of offshore wells in Australia, encompassing:
   a) Law and regulation
   b) Requirements for companies (transparency, financial assurance and financial disclosure)
   c) Liability and responsibility for decommissioned wells
   d) Monitoring and long-term security for decommissioned wells
7. Analysis of what constitutes best practice in permanent well abandonment; and
8. Analysis of the regulation and practice for permanent well abandonment in analogous jurisdictions (Norway, UK, and Canada);

This review will contain specific conclusions and recommendations that can be utilised to guide and secure the development of best practice regulation in Australia.

3. WELL DECOMMISSIONING

The primary risks associated with poorly P&A wells are two-fold: leakage of formation fluid (oil, gas, drilling mud, etc), and leakage of methane, a greenhouse gas (GHG) accounting for around 16% of global GHG Emissions, and 28 times more potent than CO2 at trapping heat in the atmosphere.[5] A detailed study of well integrity datasets noted that around 25% of offshore wells on the Norwegian continental shelf (NCS) have experienced well barrier failures and/or well integrity issues, 10% of wells on the UK continental shelf (UKCS) have been shut in (closed) due to structural integrity issues, 43% of wells in the Gulf of Mexico have well issues (including sustained casing pressure, either in surface casing, intermediate casing or conductor pipe), and 20% of offshore Canadian wells have experienced integrity failure.[6] In this study,[7] data pertaining to Australia is not provided and therefore a consideration of well leakage in Australian offshore wells cannot be made.

3.1 PLUGGING AND ABANDONING OF WELLS

The decommissioning of a well is achieved through P&A, whereby the whole well, or a lower section of the well, is permanently sealed off to prevent any chance of formation fluids (oil, gas, natural formation water) from escaping to the surface,[8] or to other shallower formations.[9] This differs from temporary suspension of a well, where barriers are installed to contain well pressure and/or flow for a period of time prior to a planned operation subsequently taking place.[10] Subsea wells are recognised as the most complicated type of well compared to their onshore counterparts, due to their complexity, including a greater number of casing strings,[11] higher reservoir pressure, and complex trajectories.[12]

[5] USEPA, *Importance of methane* (2023) https://www.epa.gov/gmi/importance-methane#:~:text=Methane%20is%20the%20second%20most,trapping%20heat%20in%20the%20atmosphere.
[6] Richard Davies, et. al., 'Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation' (2014) 56 *Marine and Petroleum Geology* 239-254.
[7] Ibid.
[8] The escape of formation fluids to the surface is known as a blowout.
[9] The escape of formation fluids to a shallower formation is known as an underground blowout, or crossflow.
[10] Angus McKay, Abandoned Wells (inc. Well Abandonment & Well Plugging & Abandonment), in Tina Soliman Hunter, Angela Dobb and Ernst Nordtveit (eds) *Encyclopaedia of Oil and Gas Law* (Edward Elgar, 2024)
[11] A casing string is a long section of connected oilfield pipe that is lowered into a wellbore and cemented
[12] Complex well trajectories are required in offshore wells to achieve specific objectives, such as accessing multiple reservoirs, enhancing production, avoiding geological hazards. See I E Obodozie, S. J Trahan, & L C Joppe, Eliminating sustained casing pressure in well abandonment ((2016).) *Offshore technology conference Asia. Presented at the offshore technology conference Asia, Offshore Technology Conference, Kuala Lumpur, Malaysia. https://doi.org/10.4043/26432-MS*

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For a subsea well, either standalone or part of a subsea template[13] development, the typical requirement for decommissioning is to recover all seabed infrastructure (well template, production or Christmas trees,[14] etc.) and for the wellhead to be severed at least 3 metres below the seabed (mud line) so it no longer poses any threat to fishing or maritime industries. For a platform well, the conductor and all other casing strings are usually recovered to at least 10ft below seabed, prior to the platform itself being removed.[15]

Well P&A involves setting plugs as barriers, at various depths, to prevent interzonal communication of formation fluids and/or fluid migration to the surface.[16] A plug can be defined as any object or equipment inserted into the wellbore with the intent of obstructing a hole or passageway,[17] leading to the isolation of the well and enabling well abandonment to occur.

Fundamental to well P&A is to design and implement the P&A process in a manner that the barrier placement will prevent flow from a reservoir (oil & gas, or over pressured water) to surface and hence cause a hydrocarbon spill or contamination of the surface area with formation water, which could be highly salt laden, and prevent crossflow to a shallower, weaker formation.[18]

Critical to well P&A design is the re-establishment of a secure cap over the formation to stop any potential flow to surface.[19] This area also known as a 'zone of flow potential' (ZoFP). Thus, there should be cement on the outside of the casing string, the casing metal, and also a cement barrier inside the casing, creating a complete reinstatement of the cap rock integrity below the 'minimum abandonment depth' (MAD), which is the depth at which, if the barrier is placed any shallower, would not prevent fluid flow to surface and maintain the integrity of the well.

For most wells, at least two or three physical barriers in the well will be required to achieve a full P&A of the well. As a 'rule of thumb', the deeper the well, the more MAD intervals will be exposed and require barriers to be placed. Usually, a plug is placed both above the perforation to isolate the production zone, and another at the bottom to prevent upward fluid movement. A supplementary surface plug should also be positioned near the surface in addition to the other barriers.[20]

An easy way to visualise this is to look at a cross section of the well and there should be no open voids that could provide a conduit for formation fluids to flow to the surface, as demonstrated in Figure 1 below.

[13] Subsea templates are steel structures used to support subsea well components. Normally, they are installed on the target location on the seabed to be used as d as bases for various subsea structures including wells and subsea trees and manifolds.
[14] A production tree or christmas tree is the top of the topside production equipment. The tree is typically comprised of a series of valves, junctions and tubing to enable control over the pressure and flow into and out of the well and subsequently the reservoir. They are a vertical assembly of valves with gauges and chokes that allow for adjustments in flow control as well as injections to stimulate production. The valves that comprise some of the decorations on the Christmas tree are opened when the oil or gas well is ready to produce, and the processing and storage facilities are ready to receive. Christmas trees are so-called because the collection of components can resemble a Christmas tree if you have the right amount of imagination. The 'decorations' are devices that facilitate pressure relief, monitoring and chemical injection.
[15] Angus McKay, Abandoned Wells (inc. Well Abandonment & Well Plugging & Abandonment), in Tina Soliman Hunter, Angela Dobb and Ernst Nordtveit (eds) *Encyclopaedia of Oil and Gas Law* (Edward Elgar, 2024)
[16] McKay, ibid.
[17] Arash Dahi Taleghani and Livio Santos, *Wellbore Integrity: From Theory to Practice* (Springer, 2023), chapter 10.
[18] Angus McKay, Abandoned Wells (inc. Well Abandonment & Well Plugging & Abandonment), in Tina Soliman Hunter, Angela Dobb and Ernst Nordtveit (eds) *Encyclopaedia of Oil and Gas Law* (Edward Elgar, 2024)
[19] McKAy, bid.
[20] Arash Dahi Taleghani and Livio Santos, *Wellbore Integrity: From Theory to Practice* (Springer, 2023), chapter 10.

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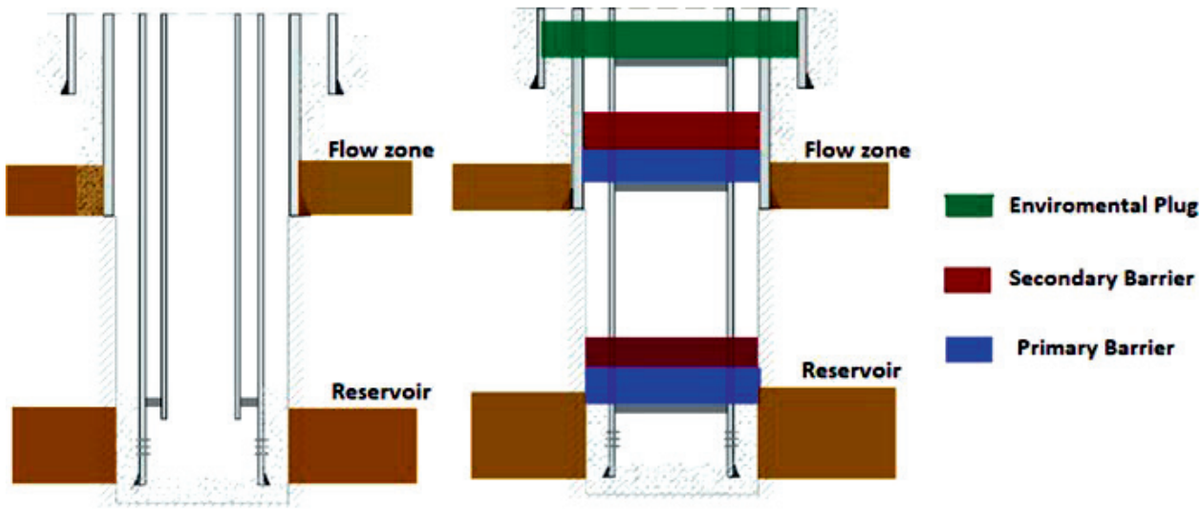

Figure 1: Simplified schematic of a well before and after P&A (Source: Taleghani and Santos).

Wells have often been poorly plugged since well P&A is a cost incurred with no financial return to the operator,[21] and therefore corners are cut to save costs. In some jurisdictions, where regulations were lax or inadequate and standardisation was limited, many petroleum wells were left unplugged or, when P&A, there was little emphasis on, or incentive to, ensure a secure seal.[22] In Australia, there have been historical examples of such instances, which is likely to make well P&A difficult for these wells.[23] Such legacy wells exist, and greater regulation and increased public scrutiny in many jurisdictions means that both regulators and operators are keenly focussed on ensuring all wells are properly P&A, leaking does not occur,[24] and liability apportioned to those legally responsible.[25]

3.2 LONGEVITY, MONITORING AND LIABILITY OF PERMANENTLY ABANDONED WELLS

To ensure longevity of a closed and abandoned well, the plugging of the well should be reviewed and verified by an independent well examiner and/or the regulator, to ensure that the well had been securely plugged and the site has been reinstated back to its pre-operative state.[26] Only when a well is properly isolated can surface structures (such as templates, wellheads, and christmas trees) [27] be removed, and the well is determined to be abandoned.

The permanence aspect of the abandonment should be considered over "geological time", and not just for the next 100-200 years.[28] Generally, legislation provides that once all wells in a title area are P&A and all structures are removed from the title area, the title is usually returned (surrendered) to the State. Therefore, it is imperative that prior to title surrender, that there is an assurance that the P&A has been done correctly and securely to prevent leakage of

[21] Taleghani and Santos, ibid.
[22] Taleghani and Santos, ibid.
[23] NOPSEMA, *Cradle to Grave: Planning for decommissioning* (2022) DrillWell Forum Presentation 1 June 2022.
[24] Arash Dahi Taleghani and Livio Santos, *Wellbore Integrity: From Theory to Practice* (Springer, 2023), chapter 10.
[25] Those legally responsible include current or former titleholders. The issue of legal responsibility is encompassed in hew trailing liability provisions established under OPGGSA and considered in section 4.4 below.
[26] Angus McKay, Abandoned Wells (inc. Well Abandonment & Well Plugging & Abandonment), in Tina Soliman Hunter, Angela Dobb and Ernst Nordtveit (eds) *Encyclopaedia of Oil and Gas Law* (Edward Elgar, 2024)
[27] A Christmas tree is an assembly of valves casing spools and fittings to control the flow of oil and gas to the surface, as well as a hub for testing, servicing, regulating, and choking off an oil and gas stream when necessary.
[28] Offshore Energies UK, 'OEUK Well Decommissioning Guidelines Issue 7', 2022 https://oeuk.org.uk/product/oeuk-well-decommissioning-guidelines-issue/

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formation fluid over geological time, or once title is surrendered, there is a manner that the titleholder can remain responsible for the well. This is the concept of trailing liability, explored in depth in section 4.4 below.

4. WELL DECOMMISSIONING INTERNATIONAL AND AUSTRALIAN PRACTICES

To determine what regulatory practice in well P&A is appropriate for offshore well decommissioning in Australia, it is necessary to consider best practice in analogous jurisdictions. For this study the UK, Norway, and Canada are analysed. The US Gulf of Mexico (GoM) is excluded from the study since they utilise a different regulatory approach (prescriptive regulation), and the regulatory requirements are complex since there are five state jurisdictions (0-3 nautical miles), and the federal jurisdiction (beyond 3 nautical miles).

4.1 CONCEPTUALISING BEST PRACTICE

Although the concept of best practice may vague, and subjective, it implies that the that best occurs when compared to an alternative course of action, where the practice is designed to achieve some deliberative end. [29]

Best practice can be described as a framework for petroleum activities that is 'robust',[30] with robust determined to be a regulatory regime whose basic design principles stay the same over time, or are restored after a challenge, but whose detailed operationalization adapts to changing demands and situations.[31] Amendments to OPGGSA demonstrate some robustness, where amendments to incorporate trailing liability have been introduced to ensure that titleholders remain financially responsible for wells after surrender of title. Examining overseas regulatory frameworks, such as Canada, Australia, and Norway herein, provides an opportunity to examine and determine such best practice.

Operational best practice relates to the use of best practice standards, guidelines, and practices in individual operations within an activity, such as well abandonment, to achieve best practice regulation. These include API Standards, NORSOK Standards (e.g. NORSOK D-010 Standard), Offshore Energies UK (OEUK) guidelines for well abandonment, and the industry concept of *good oilfield practice*. Operational best practice is the focus of this study.

4.2 THE INFLUENCERS: IOGP AND IRF

There are two international bodies that particularly influence the practices of the Australian regulator, the *National Offshore Petroleum Safety and Environmental Management Authority* (NOPSEMA). The first is the *International Association of Oil and Gas Producers* (IOGP),[32] with its expert well committee that acts as a relevant and effective technical authority on the prevention and mitigation of high consequence well control events, and provides a reference list of standards and guidelines for well integrity and well control.[33] The second is the *International Regulators Forum* (IRF), an affiliation of the offshore oil and gas safety regulators of 11 countries.[34] The standards and documents

[29] Stuart Bretschneider, Fredrick J Marc-Auroele Jr., and Jiannan Wu 'Best Practices Research: A Methodological Guide for the Perplexed' (2005) 15 (2) *Journal of Public Administration Research and Theory* 307-323, 309.
[30] Andrew Hale, 'Advancing Robust Regulation: Reflections and Lessons to be Learned' in Preben Lindøe, Michael Baram, and Ortwin Renn, *Risk Governance of Offshore Oil and Gas Operations* (2015).
[31] Hale, ibid.
[32] The IOGP is an association of integrated energy companies, national oil companies, independent upstream operators, service companies, and industry associations operate around the globe, supplying over 40% of the world's oil and gas demand. IOGP has been established almost 50 years, as a forum for sharing know-how and good practices in the areas of safety, health, environment, engineering and now, industry and energy transitions, working with 2,250 experts across all sectors of the industry to from to identify and share knowledge and good practices.
[33] IOGP, *Recommended practice for pore pressure and fracture gradient analysis for well design – construction, intervention and abandonment* (2022) IOGP Report No. 608; IOGP, *Overview of International Offshore Decommissioning Regulations Volume 2 – Wells Plugging and Abandonment* (2023) (Report 585). See also International Energy Agency, *golden Rules for a Golden Age of Gas: World Energy Outlook Special report on unconventional gas* (2012), 37.
[34] These members are Australia, Brazil. Canada, Denmark, Ireland, Mexico, Netherlands. New Zealand, Norway, the United Kingdom and the United States.

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published by the IOGP are in general relied upon by regulators that form the IRF,[35] with IOGP forming committees and working groups to address risks in well control practices in alignment with the IRF's objectives and focus areas.[36]

As a member of the IRF, NOPSEMA embraces and relies upon IOGP's standards and documents.[37]

4. 3 Regulatory FRAMEWORKS for Well P&A – International and Australian Practice

There is no international 'law' or agreed legislation pertaining to the P&A of offshore wells. Rather, each country has developed their own legislation to suit based on constitutional requirements, legal system and local political position. Often, regulators will incorporate the use of various standards into their legislative framework. In other instances, drilling contractors and operators align their practices, either partially or fully, with internationally recognized best practice standards such as:

- NORSOK,[38] *Standard D-010: 2021*, *Well integrity in drilling and well operations. Revision 5*,
- Offshore Energies UK, OEUK Well Decommissioning Guidelines Issue 7, 2022

The above standards have been developed by world class jurisdictions (Norway and the UK) throughout the years from lessons learned, especially accidents, and the introduction of new technologies and techniques.[39] The Ekofisk Bravo blowout in 1977, the Alexander Kielland accident (1980), and the Piper Alpha tragedy in 1988 caused a major rethink of how offshore petroleum activities are regulated in each of the jurisdictions, and caused regulators to completely alter their regulatory regime from a prescriptive regime where the regulator prescribes what the operator is required to do in detail, to an objective-based framework where the responsibility for managing the risks associated with petroleum activities is managed by those who create the risk, meaning operators are required to prove to the regulator that they have identified the risks, then mitigated the risks by reducing the risk to the level required in the legal framework (such as to 'as low as reasonably practicable, or ALARP).

Other standards that may be used, depending on jurisdictions, include:

- International Organization for Standardization ISO 16530-1:2017, *Petroleum and natural gas industries — Well integrity — Part 1: Life cycle governance*: https://www.iso.org/ standard/63192.html
- American Petroleum Institute API RP 65-3 1st Edition:2021, *Wellbore Plugging & Abandonment*; https://www.api.org/products-and-services/standards/important-standards- announcements/65-3.

Approaches to Regulation

There are two main regulatory approaches to the regulation of petroleum activities, including well integrity – the prescriptive approach, and the performance-based (or risk-based) approach in the regulation, developed in response to grave accidents and incidents offshore in the 1970s and 1980s.

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[35] IRF, *Prevention of Well Control Incidents Problem Statement – Briefing Pack* (2022) https://irfoffshoresafety.com/wp-content/uploads/2023/02/Attachment-1-IRF-General-Briefing-Pack.pdf.

[36] IOGP, *New safety guidance addresses role of pore pressure fracture gradient in well control incidents* (2022) https://www.iogp.org/blog/well-control/new-safety-guidance-addresses-role-of-pore-pressure-fracture-gradient-in-well-control-incidents/

[37] For example, IOGP, *Overview of International Offshore Decommissioning Regulations – Volume 1: Facilities* (2023) (Report 584; IOGP, *Overview of International Offshore Decommissioning Regulations Volume 2 – Wells Plugging and Abandonment* (2023) (Report 585)

[38] NORSOK is an acronym that means *Norwegian Shelf Competitive Position* in Norwegian. Developed over 40 years by the Norwegian petroleum industry, these standards are developed to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as references in the authorities regulations. These standards are managed by Standards Norway.

[39] IOGP, *Overview of International Offshore Decommissioning Regulations Volume 2 – Wells Plugging and Abandonment* (2023) (Report 585), 12.

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The prescriptive approach to regulations sets all and defines all the aspects required to ensure well integrity can be achieved. It sets all the specific technical and procedural requirements, leaving the operator no choice but to comply with the design parameters set in the regulation, and requires the regulator to enforce only what is in the regulations. If something is required further than that set out in the regulations, then the Regulator has no legal capacity to require that this be done – only that which is set out in the regulations is required. Under the prescriptive regulations, well integrity is a fixed concept, achieved when a certain set of rules is followed. For example, under a prescriptive regime, the regulatory framework will stipulate the number of barriers required and testing required. These will be all that is required to achieve well integrity, regardless of the type of reservoir, reservoir pressure, reservoir depth, and temperature.

Under objective-based regulation (also known as risk-based or performance-based regulation) well integrity is seen as a much more fluid concept, regulated using mathematical analysis of risk and the application of risk mitigation strategies which is necessary due to different requirements for well depending on pressure, temperature, geology and depth, reducing the risk to a defined level, often to the level of 'as low as reasonably practicable' (ALARP). A performance-based regulatory approach specifies a safety goal that is to be reached, and it is up to the operator to implement the technical solutions required to achieve that goal, utilizing standards that are most suitable to achieve that goal, or that are required by the regular in that jurisdiction. The regulator then leaves it to the operator to undertake a risk assessment for that well, identifying the risks (in this instance a well leaking fluid formation after the permanent P&A of a well) and then reducing the risks to ALARP. This approach was developed by the US Nuclear Regulatory Commission in the 1970s for the nuclear industry, defining the performance-based approach as one which 'relies upon measurable (or calculable) outcomes (i.e., performance results) to be met, but provides more flexibility to the licensee as to the means of meeting those outcomes'.[40]

The term ALARP arises from UK legislation (*Health and Safety at Work etc. Act 1974*), which requires Provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health. The phrase *So Far As is Reasonably Practicable* (SFARP) in this act is interpreted as leading to a requirement that risks must be reduced to a level that is ALARP. The key question in determining whether a risk has been reduced to ALARP is the definition of *reasonably practicable*, which was considered in *Edwards v. National Coal Board* (1949). The court ruled in this case that risks identified must be averted unless there is a gross disproportion between the costs and benefits of doing so. The concept of 'gross disproportion' means more than a simple cost benefit analysis, but rather weighted to favour carrying out the safety improvement.

Norway was the first country to introduce performance-based regulations in its oil industry, implemented following an inquiry into the *Ekofisk Bravo* blowout in 1977. In developing performance-based regulations, the Norwegian Petroleum Directorate (NPD) set out regulations which required the operator to set their well design, basing this approach to regulation on the philosophy that an operator is responsible for the safety of their installation, and therefore the operators are tasked with identifying all the risks involved and reducing them to an appropriate standard. The current supervisory body for the Norwegian oil industry, the Petroleum Safety Authority (PSA), publishes guidelines to supplement its regulations. In and of themselves these guidelines are recommendations and not legally-binding (guidelines are not legal instruments),[41] however, as the relevant regulations require the use of NORSOK, their use becomes legally binding.

[40] US Nuclear Regulatory Commission, *Risk-Informed and Performance-Based Regulation* (1998) https://www.nrc.gov/docs/ML1522/ML15223A685.pdf. The white paper has since been updated and redrafted in 2021, retaining the original performance-based approach to regulation: see US Nuclear Regulatory Commission, Risk-Informed and Performance-Based Human-System Considerations for Advanced Reactors (2021) https://www.nrc.gov/docs/ML2106/ML21069A003.pdf

[41] J. Dagg, et. al., (2011). *Comparing the offshore drilling regulatory regimes of the Canadian Arctic, the US, the UK, Greenland and Norway*. The Pembina Institute.

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The UK petroleum industry shifted from prescriptive to performance-based regulation after the Piper Alpha disaster in 1988 in which 167 workers lost their lives.[42] Although the Piper Alpha disaster was caused by a pipeline explosion and not a well integrity failure, it nevertheless resulted in a shift in regulatory approach to an objective-based framework, shifting the responsibility from the regulator who previously prescribed the requirements, to the operator. The basis of this shift was similar to Norway's reasoning: Lord Cullen, the Head of the Piper Alpha Inquiry, stipulated that those who create the risk are responsible for controlling the risk.[43] The report resulted in significant reform in safety criteria in all aspects of the oil industry, including well integrity.

Not all mature petroleum jurisdictions have shifted to a performance-based approach for regulating well integrity, and the most notable of these exceptions is the United States. Interestingly, although objective-based regulation arose in the US, the US approach to safety legislation is prescriptive, and it continues to be so. Like the UK's Piper Alpha, the US has also experienced severe events, especially the Deepwater Horizon blowout caused by a loss of well integrity. In the aftermath of Deepwater Horizon, the Presidential Commission of Inquiry recommended the performance-based approach to regulation be adopted. However, the favoured prescriptive approach to regulation has been retained.

In its review of the national offshore petroleum legislation and guidelines for 35 countries across the world, the IOGP found that different regions of the world have taken varying approaches to understanding and managing the environmental impact of petroleum activities and the regulation of decommissioning and P&A activities. The IOGP noted that in some countries, specific well P&A legislation or guidelines are minimal or absent, and it is the operator that determines the optimal approach through the implementation of an objective based framework.[44] Australia is one such country, [45] although there are guidelines for the content and level of detail of the well operations management plan (WOMP).[46] However, just because guidelines are not entrenched in law, this does not mean that the regulator does not determine the requirements or practices. Instead, in some approaches, regulators require the operator to meet the objective of maintaining well integrity using practices accepted by the regulator.

PRACTICE IN OTHER JURISDICTIONS

Table 1 below outlines the regulatory framework for in Norway, the UK and Canada (all of whom have implemented international law pertaining to wells into their legislation), followed by an overview and analysis of Australian regulatory practice for well P&A, and recommendations to the Australian regulatory framework to ensure the regulatory practices are in line with international best practice. Legislation in each of these jurisdictions adopts objective based regulation, requiring the operator to prove to the regulator that their plan (whether it be a well operations management plan, or environment plan), meets the objective stipulated, and the regulator then accepts the plan.

[42] T. Macalister, *Piper Alpha disaster: How 167 oil rig workers died* (2013).
[43] William Cullen, *The public inquiry into the Piper Alpha disaster – Volume one* (1990)
[44] IOGP, *Overview of International Offshore Decommissioning Regulations Volume 2 – Wells Plugging and Abandonment* (2023) (Report 585). The countries considered in the Report are Abu Dhabi, Algeria, Angola, Australia, Argentina, Azerbaijan, Brazil, Brunei, Canada (East and West Coast), Denmark, Egypt, Equatorial Guinea, Gabon, Republic of Guinea, India, Indonesia, Italy, Kazakhstan, Malaysia, Myanmar, Netherlands, New Zealand, Nigeria, Norway, Oman, Qatar, Russian Federation, Spain, South Africa, Thailand, Trinidad & Tobago, UK, US (Gulf of Mexico, Alaska and California) and Venezuela.
[45] Please refer to Appendix 1 for a summary of the Well P&A summaries by IOGP for UK, Norway, Canada, and Australia.
[46] NOPSEMA*, Guidance Note: Well operations management plan – content and level of detail* (2020)

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Table 1: Regulatory Framework for well P&A, selected countries. Note that The IOGP summary of all regulatory requirements for the four jurisdictions assessed are found in Appendix 1.
(Source: Compiled by Author from IOGP Report 585 and relevant instruments)

COUNTRY	REGULATORY FRAMEWORK (Acts, Regulations, Guidelines) FOR WELL P&A
NORWAY	Chapter 7 of the *Petroleum Activities Act 1996* bans pollution arising from petroleum activities. Chapter VII, and especially r 48 of *Regulations Relating To Design and Outfitting of Facilities, Etc. in the Petroleum Activities* (*The Facilities Regulations*) require that: • Well barriers shall be designed such that well integrity is ensured, and the barrier functions are safeguarded during the well's lifetime. • Well barriers shall be designed such that unintended well influx and outflow to the external environment is prevented, and such that they do not hinder well activities. • When a production well is temporarily abandoned without a completion string, at least two qualified and independent barriers shall be present. • When a well is temporarily or permanently abandoned, the barriers shall be designed such that they consider well integrity for the longest period the well is expected to be abandoned. • When plugging wells, it shall be possible to cut the casings without harming the surroundings. • The well barriers shall be designed such that their performance can be verified. Use of NORSOK *Standard D-010: 2021*, *Well integrity in drilling and well operations. Rev. 5*
UK	Regulated under the *Petroleum Act 1998*, as amended by the *Energy Act* 2008 and 2016. The *Offshore Installations and Wells (design and construction, etc.) Regulations 1996*, especially Regulations 13, 15 and 16 are relevant to well P&A activities: r 13. The well-operator shall ensure that a well is abandoned so that a) so far as is reasonably practicable, there can be no unplanned escape of fluids from the well; and risks to the health and safety of persons from it or anything in it, or in strata to which it is connected, are as low as is reasonably practicable. r 15. The well-operator shall ensure that a well is so designed and constructed that, so far as is reasonably practicable: c) it can be suspended or abandoned in a safe manner; and d) after its suspension or abandonment there can be no unplanned escape of fluids from it or from the reservoir to which it led. r 16. The well-operator shall ensure that every part of a well is composed of material which is suitable for achieving the purposes described in Regulation 13 (1)." *Guidelines* OEUK *Well Decommissioning Guidelines: Issue 7 (Nov 2022)* - regarded as the definitive guideline for P&A planning and implementation operations: This guideline is reviewed regularly within the O&G industry and updated with current 'best practice,' incorporating new technologies as they come available.
CANADA	Canada Oil and Gas Operations Act 1985, and subsidiary *The Canada Oil and Gas Drilling and Production Regulations*, and especially regulations 56-58 which require that: r 56 The operator shall ensure that every well that is suspended or abandoned can be readily located and left in a condition that: a) Provides for isolation of all oil or gas bearing zones and discrete pressure zones; and, in the case of an onshore well, potable water zones; and b) Prevents any formation fluid from flowing through or escaping from the wellbore. r 57 The operator of a suspended well shall ensure that the well is *monitored* and inspected to maintain its continued integrity and to prevent pollution.

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	r 58 The operator shall ensure that, on the abandonment of any offshore well, the seafloor is cleared of any material or equipment that might interfere with other commercial uses of the sea (REQUIREMENT TO REMOVE WELLHEAD) *Regulations* SOR-2009-315; 2009, Canada Oil and Gas Drilling and Production Regulations http://laws-lois.justice.gc.ca/eng/regulations/SOR-2009-315/index.html C-NLOPB and CNSOPB; 2017, Drilling and Production Guidelines https://www.cnlopb.ca/wp-content/uploads/guidelines/drill_prod_guide.pdf

AUSTRALIAN PRACTICE

Australia's international law obligations regarding well integrity is primarily set out in the London Convention and Protocol (LCP)[47]and the United Nations Convention on the Law of the Sea (UNCLOS). The LCP is an agreement to control marine pollution by dumping. It covers the disposal of waste and other matter from vessels, aircraft and platforms, and therefore includes wells. It is implemented into Australian law through the *Environment Protection (Sea Dumping) Act 1981* (Cth).

UNCLOS is the primary international instrument pertaining to well decommissioning. Articles 192 of UNCLOS set out a general obligation to protect and preserve the environment, with Art. 194 requiring a State to take all necessary measures to prevent, reduce and control pollution of the marine environment from any source. Article 60(3) requires any installation or structure to be removed to ensure navigation, and must have due regard for fishing.

Obligations pertaining to decommissioning under UNCLOS and the LCP are implemented in Australia under the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth) (OPGGSA). **Section 572** sets out requirements regarding the decommissioning of a title area: at the end of the life of the field, the titleholder is required to remove from the title area all structures, equipment, and other property that is no longer used in connection with petroleum operations in that title area,[48] subject to the other provisions of OPGGSA, the regulations, or a direction given by NOPSEMA.[49]

Under Australia's objective-based regulatory regime, s161 of OPGGSA sets out the general right for a titleholder to recover petroleum from the licence area. Once these activities have been concluded, there is a requirement, set out in **s 572(3)** of OPGGSA, for the titleholder to remove all structures from the title area. As a part of the removal, well needs to be permanently P&A prior to the removal of the well head. The objective for the P&A of a well is set out in section 1.04A of the *Offshore Petroleum and Greenhouse Gas (Resource Management and Administration) Regulations 2011* (Cth) (RMA Regs), which stipulates that the objective of a WOMP is *the maintenance of the integrity of offshore petroleum wells, by ensuring the risks to well integrity are reduced to as low as reasonably practicable* (ALARP), which was first utilised by the UK post-Piper Alpha.

All well activities are regulated under **Part 5** of RMA Regs, with the WOMP the primary tool for well management. According to NOPSEMA,[50] the WOMP must be a plan of sufficient detail that identifies technical and managerial tools to maintain well integrity (i.e. prevent or stop well leakage),[51] and well control measures must demonstrate that the risk of loss of well integrity has been eliminated or reduced to ALARP.[52] The titleholder submits a WOMP, and

[47] Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972; Protocol 1996) (London Convention and Protocol)
[48] *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth), Section 572 (3)
[49] *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cth), Section 573 (4)
[50] NOPSEMA, *Well Operations Management Plan – content and level of detail* (Guidance Note) (2020)
[51] As required under rr 5.08 and 5.09 of the Offshore Petroleum and Greenhouse Gas (Resource Management and Administration) Regulations
[52] NOPSEMA, *Well Operations Management Plan – content and level of detail* (Guidance Note) (2020) (WOMP Guidance Note A461074).

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when this WOMP meets the object of the legislation (in the instance of well P&A reducing the risk of a loss of well to ALARP as required in r 1.04 of the RMA Regs), it is accepted by NOPSEMA, the regulator. It is important to note that in all the jurisdictions studied herein, including Australia, the well management plan will be accepted by the regulator thereby indicating that the regulator is satisfied the objectives are met, rather than approved, which occurs within a prescriptive framework.

The NOPSEMA WOMP Guidance Note[53] assists the titleholder by outlining the content and requirements for well abandonment in the WOMP.[54] A WOMP for a well that is to be P&A requires a well barrier philosophy and well barrier standards (i.e. what constitutes a well barrier, lengths of cement plugs, cement design and quality control, annulus plugs, elastomers and design standards), and barrier verification (methods and minimum acceptance criteria).[55] The Guidance Note requires that titleholders should consider internationally accepted guidelines and standards that are deemed best practice, such as:

- Offshore Energy UK – Guidelines on Relief Well Planning - Issue 2, March 2013
- NORSOK Standard D-010, Well integrity in drilling and well operations - Rev 4, June 2013
- International Association of Oil & Gas Producers (IOGP)- Capping & Containment, Global Industry Response Group recommendations - Report No. 464.

However, the guidelines do not stipulate which standard, guidance or report contents must be utilised. Rather, titleholders have the freedom to apply whichever that achieves the objective set out in r 1.04A of the RMA Regs.

According to **Regulation 5.17** of the RMA Regs, the WOMP ends when a well is permanently abandoned, the titleholder has reported to NOPSEMA the process undertaken to abandon the well and the outcome of that process, and NOPSEMA notifies the titleholder that it is satisfied that the process of abandoning the well has been undertaken in accordance with the WOMP. This essentially means that if NOPSEMA accepts that the well has been P&A in accordance with the WOMP and notifies the titleholder as such, then the WOMP ends.

It is important to note that in Australia, although production and suspended wells are inspected every five years, the construction of a well, nor the P&A well is **not inspected** by NOPSEMA,[56] nor is any certification required by a third-party certifier.

Aside from the OPGGSA and RMA regs, NOPSEMA has issued several guidance notes which, while informative, do not have legal enforceability. These guidance notes include:

- NOPSEMA, *ALARP in the context of well integrity* (2020) Guidance Note A462126
- NOPSEMA, *Inspections – monitoring and securing compliance* (2021) (Guidance Note A400923)
- NOPSEMA, *Notification, reporting and recording requirements for well-related incidents* (2023) (Guidance Note A462575)
- NOPSEMA, *Well Operations Management Plan – content and level of detail* (Guidance Note) (2020) (WOMP) Guidance Note A461074
- NOPSEMA, *Well operations management plan lifecycle management* (2020) Guidance Note A462131

[53] NOPSEMA, *Well Operations Management Plan – content and level of detail* (Guidance Note) (2020) (WOMP Guidance Note A461074).
[54] NOPSEMA, *Well Operations Management Plan – content and level of detail* (Guidance Note) (2020) (WOMP Guidance Note A461074).
[55] NOPSEMA, *Well Operations Management Plan – content and level of detail* (Guidance Note) (2020) (WOMP Guidance Note A461074).
[56] NOPSEMA, *Inspections – monitoring and securing compliance*(2021) (Guidance Note A400923)

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- NOPSEMA, *Well Integrity Control Measures and Performance Standards (*2020) Guidance Note A462129

Once all of the property that has been brought into a title area to produce petroleum has been removed, all wells P&A, damage to the seabed made good and NOPSEMA has accepted the P&A WOMP, s270 of OPGGSA enables a titleholder to surrender the petroleum title. Criteria for the surrender of the licence is set out in table 2 below. Once the title holder has demonstrated it has complied with the criteria, the Joint Authority may consent to the surrender of the title.[57]

Table 2: Criteria for consent to surrender title under s270, OPGGSA (Source: NOPSEMA, *Section 270 Consent to surrender title) – NOPSEMA Advice (Policy))*

Criteria in section 270 of the OPGGS Act	
(3)(b)(iii) & (v)	The registered holder of the permit, lease or licence has complied with the provisions contained in Chapter 6 of the OPGGS Act and in the regulations made under the OPGGS Act
(3)(c)(i) & (ii)	**The registered holder of the permit, lease or licence has, to the satisfaction of NOPSEMA, removed or caused to be removed from the surrender area all property brought into the surrender area by any person engaged or concerned in the operations authorised by the permit, lease or licence; or made arrangements that are satisfactory to NOPSEMA in relation to that property**
(3)(d)	The registered holder of the permit, lease or licence has, to the satisfaction of NOPSEMA, plugged or closed off all wells made in the surrender area by any person engaged or concerned in the operations authorised by the permit, lease or licence
(3)(e)	**The registered holder of the permit, lease or licence has provided, to the satisfaction of NOPSEMA, for the conservation and protection of the natural resources in the surrender area**
(3)(f)	The registered holder of the permit, lease or licence has, to the satisfaction of NOPSEMA, made good any damage to the seabed or subsoil in the surrender area caused by any person engaged or concerned in the operations authorised by the permit, lease or licence

However, under NOPSEMA's *s 270 Consent to surrender title* there remains no baseline requirement for inspection or verification of the P&A wells, infrastructure removal, and the seabed by NOPSEMA before this surrender of the title.

DISCUSSION AND ANALYSIS

Table 1 above clearly demonstrates that regulatory requirements for well P&A for the jurisdictions vary, but all frameworks rely on both an enabling act and subordinate instruments (regulations) to implement the regulatory requirements. Compared to practices in the jurisdictions outlined, there are several weaknesses in Australian practice, indicating that Australian practice does not necessarily represent best practice.

Firstly, although all international jurisdictions stipulate the use of a specific standard or guideline for the P&A of wells, the Australian regulatory framework does not. NOPSEMA has issued guidance notes for various activities, as outlined above, but as guidance notes, these are not legally binding on title holders. In addition, NOPSEMA suggests

[57] NOPSEMA, *Section 270 Consent to surrender title) – NOPSEMA Advice (Policy)*

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that when P&A wells, title holders should *consider* the use of one of the standards listed, but there is no legal requirement to do so.

Another major flaw in the Australian regulatory framework is the failure of the regulator to require P&A wells to be inspected or certified by a third party to ensure that they comply with the approved WOMP. Instead, the regulator relies on the title holder to self-report that they have complied with the approved WOMP. In addition, there is the capacity under s270(5) for the surrender of a title even where the provisions of the regulations have not been complied with if the Joint Authority (JA) is satisfied there are grounds to warrant a title being surrender. This allows the Joint Authority (the responsible Commonwealth and state ministers, but NOT the regulator) to consent to titles being handed back even if the required work is not complete. The long-term security of wells must be carefully considered when utilising this provision, which to date has not been exercised.

4.3.1 RECOMMENDATIONS

Recommendation 1: Amend Offshore Petroleum and Greenhouse Gas (Resource Management) Regulations to adopt a best practice standard for plugging and abandonment of wells.

Recommendation 2: Amend OPGGSA and Regulations to require mandatory inspection of permanently plugged and abandoned wells to ensure independent verification that Well Operations Management Plan is complied with and ensure no surrender of title (s.270) without 3rd party inspection.

Recommendation 3: As part of Well Operations Management Plans for plugging and abandonment of wells, flagging by titleholder of well construction that deviates from good oilfield practice.

Recommendation 4: Establish a living map of P&A wells including location, dates of activity and P&A, challenges/concerns with well abandonment, and any infrastructure remaining.

4.4 CORPORATE RESPONSIBILITY, LIABILITY, AND FINANCIAL BONDS

PRACTICE IN INTERNATIONAL JURISDICTIONS

Corporate responsibility centres around the need for financial assurance, financial disclosure and liability for abandoned wells. The responsibilities vary between jurisdictions, as does the clarity of corporate responsibility.

Table 3: Corporate requirements for well P&A, selected countries.
(Source: Compiled by author from IOGP Report 585 and relevant legal instruments)

COUNTRY	FINANCIAL ASSURANCE AND FINANCIAL DISCLOSRE	LIABILITY AND/OR REQUIREMENT FOR BOND
NORWAY	• The costs of decommissioning, including well P&A, are shared between the company (around 1/3) and the Norwegian State (2/3) . Calculated on an individual basis, the state's contribution is the average effective corporate income tax rate the company has paid on net income from the field (78%) - comprising 28% company tax % and 50% special petroleum tax. • The Norwegian Government requires all parties to sign the binding uniform *Joint Operating Agreement* (JOA) prior to petroleum activities occurring.	LIABILITY S 5-4, *Petroleum Activities Act 1996:* • If abandonment occurs, the licensee shall be liable for damage or inconvenience caused wilfully or inadvertently in connection with the abandoned facility, unless otherwise decided by the Ministry. • In the event of decisions for abandonment, it may be agreed between the licensees and the owners on one side and the State on the other side that future maintenance, responsibility

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	• Articles 30-32 of the JOA sets out abandonment provisions, including the requirement for a budget approved by the management committee, and the structure and content of the budget set out in the article 12 of the JOA. • All foreign companies are required to establish a subsidiary company in Norway,[58] with the foreign 'parent company' required to guarantee the fulfilment of Norwegian subsidiary's obligations (*Morselskapgaranti).*	and liability shall be taken over by the State based on an agreed financial compensation. S7-3, *Petroleum Activities Act 1996* • The licensee is liable for pollution damage without regard to fault, unless the state has agreed to assume liability, as set out in s5-4. Note - A dedicated forum for well P&A of wells was established in 2009 by the Norwegian Oil and Gas Association (Norsk Olje og Gass) to exchange experience between companies and fields.
UK	Section 75 of the Energy Act grants the Secretary of State has the power to request relevant well abandonment information. This action includes the provision of financial security for the purpose of ensuring that a body will be capable of P&A a well when required to do so. This is governed by the terms of the licence.	*Decommissioning of Offshore Oil and Gas Installations and Pipelines Guidance Note 2018* - Section 17: The persons/parties who own an installation or pipeline, or are a Section 29 holder, at the time of its decommissioning will remain the owners of any residues and remains after decommissioning.
CANADA	Once abandoned, operators continue to be subject to Sections 167 and 162 of the Nova Scotia and Newfoundland and Labrador Offshore Accord Acts as they relate to liabilities, losses and damages from the discharge, emission or escape of oil or gas.	Regulations 56-58 of the *Canada Oil and Gas Drilling and Production Regulations 2009,* Canada Oil and Gas Operations Act 1985, and Part 6 of the Canada Oil and Gas Drilling and Production Regulations 2009. The C-NLOPB (Newfoundland and Labrador Offshore Petroleum Board) and the Canadian Nova Scotia Offshore Petroleum Board (CNSOPB) have produced guidelines for drilling and production which capture well P&A (outlined in table 1 above – C-NLOPB and CNSOPB, 2017).

AUSTRALIAN PRACTICE

The issue of liability for a well in a title area that has been surrendered to the State is critical, since liability means that should there be a well failure, either the State or the company will be financially liable for remediation of the leaking well.

Under Part 2.12 of OPGGSA, once a field has been completely decommissioned in accordance with the requirements of s 572 of OPGGSA, the titleholder can apply under s270 of OPGGSA to the National Offshore Petroleum Titles Administrator (NOPTA) to surrender the title of the decommissioned area. Under common law, based on the notion of property rights of production titles in Australia, upon the surrender of the petroleum licence liability for the title area, including the wells would revert to the Crown (Commonwealth government).[59] This liability has been shifted to the *titleholder* or *former titleholder* under Part 6.4 of OPGGSA (trailing liability). Under the part of OPGGSA, former titleholders, related bodies corporate, or related persons of current or former titleholders may be 'called back' by a

[58] This is to ensure that the benefits accrue to Norwegian society, and to prevent transfer pricing.
[59] Tina Soliman Hunter, Characterisation of Australia's petroleum licences: property capable of acquisition on 'just terms'? in Tina Soliman Hunter, Jørn Øyrehagen Sunde and Ernst Nordtveit *The Character of Petroleum Licences* (Edward Elgar, 2020)

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direction from NOPSEMA (s586 and s587) or the responsible Commonwealth Minister (s 586A or 587A), and required to under undertake remedial work, where necessary. These provisions are known as 'trailing liability provisions'. Section 587(1) of OPGGSA allows NOPSEMA to issue remedial directions for titles that cease to be in force. Such directions made under s 587(2) of OPGGSA can include, inter alia, plugging or closing off wells in the surrendered title area, and to make good any damage to seabed or subsoil. Similarly, s 587A of OPGGSA enables the responsible Commonwealth Minister to issue remedial directions for titles that cease to be in force.

DISCUSSION AND ANALYSIS

In Norway, UK and Canada, liability for a P&A well remains with the titleholder/operator, and the exercise of remediation where leaking occurs is mandatory. In Norway, further liability is introduced through the *Morselskapguaranti,* which requires a Norwegian-incorporated company's *mother company* to assume financial responsibility if the Norwegian-registered company becomes financially insolvent. Although the Australian legislative framework or the trailing liability provisions do not overtly specify the liability of the parent company, this is inferred in the trailing liability legislation, and it is NOPSEMA's intent to hold the parent company financially responsible.

In Australia, the legal framework does not expressly infer mandatory liability to the titleholder. Rather, it gives the regulator or Responsible Commonwealth Minister the discretion to issue remedial direction to the former titleholder.[60] Sections 587 and 587A mean that where a title has been surrendered and well integrity is lost (i.e. the well is leaking), NOPSEMA or the responsible Commonwealth Minister can issue directions to companies for remediation and/or make good any damage caused to seabed or subsoil.

However, the loophole is that the use of the words *may* and *can* in s587 and s587A mean that the regulator or the Responsible Minister can exercise *discretion* in the issuing of a direction, rather than it being mandatory such as in Norway, the UK, and Canada. An example of the exercise of such discretion is Santos' Legendre Field, where an unknown number of P&A wells have been leaking from the seabed since first identified in 2013. The small leaks (187m^3/y from 26 locations) are yet to be subject to a Direction from either NOPSEMA or the Responsible Minister, even though the objective of maintaining well integrity has not been met.[61]

4.4.1 RECOMMENDATIONS

Recommendation 5: Amend the OPGGSA to make a remediation direction under s587 mandatory, to compel former titleholders to remediate leaking wells under direction of either Regulator or Responsible Minister.

4.5 POST-ABANDONMENT MONITORING

PRACTICE IN INTERNATIONAL JURISDICTIONS

In the overseas jurisdictions studied, there were varying regulatory requirements for monitoring abandoned wells for leakage (esp. methane), and attribution of responsibility to regulatory requirements, as demonstrated in table 4 below.

[60] See section 4.3 above for a detailed explanation.
[61] Kerry Hebden, 'Abandoned Santos gas wells off Western Australia coast leaking for a decade, environmental documents reveal' *The Chemical Engineer,* 16 June 2023 https://www.thechemicalengineer.com/news/abandoned-santos-gas-wells-off-western-australia-coast-leaking-for-a-decade-environmental-documents-reveal/#:~:text=AN%20UNKOWN%20number%20of%20decommissioned,by%20Santos%20in%20early%202022.

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Table 4: Post well P&A monitoring requirements, selected countries.
(Source: Compiled by author from IOGP Report 585 and relevant legal instruments)

COUNTRY	MONITORING REQUIREMENTS	LEGISLATIVE BASIS/STANDARD
NORWAY	Plug integrity shall be monitored regularly if access is available.	• s88 Petroleum Activities Regulations and s48 Facilities Regulations • NORSOK D-010 standards
UK	Risk-based monitoring: the scope and duration of the monitoring requirements will be agreed between the operator and OPRED in consultation with other Government departments and details will be included in the decommissioning programme, otherwise post-decommissioning monitoring surveys may be required.	OPRED (Offshore Petroleum Regulator for Environment and Decommissioning)
CANADA	Monitoring only of suspended wells. Permanently abandoned wells not monitored.	None

AUSTRALIAN PRACTICE

Regulation 5.09(1)(h) of the RMA Regs requires the monitoring, auditing and well integrity assurance of wells throughout their lifecycle, including the monitoring of wells that are not permanently abandoned (either operational or non-operational). However, there is no requirement for monitoring of permanently abandoned wells or wells in a surrendered title under the OPGGSA or its subordinate regulations.

Monitoring may be required under s 19(9) of the *Environment Protection (Sea Dumping) Act 1981* (Cth) (EPSDA) - the relevant Commonwealth Minister *may* require the applicant for a sea dumping permit to enter into an agreement with the Commonwealth. However, again this requirement is discretionary.

DISCUSSION AND ANALYSIS

As articulated in table 4 above, only Norway requires post-abandonment monitoring. All other jurisdictions do not require it, although liability remains with the titleholder in the UK and Canada with a mandatory requirement to remediate leaking wells. In Australia there are no mandatory monitoring requirements under either the OPGGSA or the EPSDA, and titleholder responsibility is limited to discretionary direction from the regulator or minister. Given well failure rates of 10-40%, as outlined in Section 3 above, coupled with long-term liability that may accrue to the state should the responsible company no longer exist, this is perhaps surprising.

Since oil and methane leaks pose significant risk to the environment and human health, and the likelihood of leakage over geological time,[62] there may be a long-term need for monitoring of abandoned wells, including permanently installed systems to detect methane leakage and periodic physical inspection of wells. However, monitoring requirements in the EPSDA, like those in OPGGSA, are discretionary.

4.5.1 RECOMMENDATIONS

Recommendation 6: The OPPGSA and EPSDA should be amended to require well plug integrity to be monitored after wells are plugged and abandoned, with monitoring coordinated with the Department of Climate Change, Energy, the Environment, and Water.

[62] Richard Davies, et. al., 'Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation' (2014) 56 *Marine and Petroleum Geology* 239-254.

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APPENDIX 1: SUMMARY OF WELL P&A REQUIREMENTS

Source: IOGP, *Overview of International Offshore Decommissioning Regulations Volume 2 – Wells Plugging and Abandonment* (2023), Report No. 585

AUSTRALIA

Item		Minimum requirement	Legislation driving requirement
Do P&A activities need to be planned in advance?		Yes, NOPSEMA require 21 days notice for P&A operations.	OPGGSA Regulations
Barrier	Type (material)	No Guidance	-
	Verification	No Guidance	-
Plugging requirements	Reservoir	No Guidance	-
	Intermediate zones	No Guidance	-
	Surface	No Guidance	-
Annular barrier requirements		No Guidance	-
Casing stump requirements		No Guidance	-
Control line and cabling		No Guidance	-
Seabed		No Guidance	-
Post abandonment monitoring		No Guidance	-

NORWAY

Item		Minimum requirement	Legislation driving requirement
Do P&A activities need to be planned in advance?		P&A activities can be included in Decommissioning Plan, or a separate permit application can be made.	Petroleum Activities Act, 1996.
Barrier	Type (material)	See NORSOK D-010 (2021) Section 10.6.2 Table 26 – well barrier material requirements	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations
	Verification	Open hole: Depth verification by tagging. Cased hole: Depth verification by tagging. Pressure test, which shall: a) be 70 bar (1000 psi) above estimated leak off pressure test below casing/ potential leak path, or 35 bar (500 psi) for surface casing plugs; and b) not exceed the casing pressure test and the casing burst rating corrected for casing wear. If the cement plug is set on a pressure tested foundation, a pressure test is not required. It shall be verified by tagging.	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations

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Item		Minimum requirement	Legislation driving requirement
Plugging requirements	Reservoir	Primary barrier to 50 m above and below the top of bearing zone. Secondary barrier as back up to Primary, minimum 50m MD by displacement or 30m MD behind casing verified by bonding logs with 50 m MD internal cement plug.	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations
	Intermediate zones	Barrier must be installed to prevent flow between zones of different pressure regimes, minimum 50 m MD by displacement or 30 m MD behind casing verified by bonding logs with 50m MD internal cement plug. This can also act as the primary barrier for the lower reservoir	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations
	Surface	To permanently isolate flow conduits from exposed formation(s) to surface after casing(s) are cut and retrieved and contain environmentally harmful fluids 50 m MD if set on a mechanical plug otherwise 100 m MD	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations
Annular barrier requirements		Cement in the liner lap/casing annuli or in tubing annulus can be accepted as a permanent Well Barrier Element (WBE) when The liner is centralized in the overlap section. The annulus cement in the liner lap shall be logged. The annulus cement between the casing and tubing shall be verified by pressure testing. The cement plug (inside tubing) shall be tagged and pressure tested. 1. 30 m MD verified by bonding logs. 2. 50 m MD verified by displacement calculations. 3. 2 * 30 m MD verified by bonding logs when same casing cement will be part of the primary and secondary well barrier.	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations
Casing stump requirements		Minimum 50 m MD internal and in tubing annulus	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations

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Item	Minimum requirement	Legislation driving requirement
Control line and cabling	In general, continuous cables and control lines shall not form part of the permanent well barrier. However, cables and control lines may form part of a permanent barrier if isolation of these control lines is achieved. Assessment of potential leak paths and the plugging thereof, as well as degradation of the cable or control line material itself, shall be conducted.	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations
Seabed	In water depths < 600 m wellhead and casings shall be removed below the seabed at a depth which ensures no stick up in the future. In deeper waters it may be acceptable to leave or cover the wellhead/structure. The location shall be inspected to ensure no other obstructions related to the drilling and well activities are left behind on the sea floor.	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations
Post abandonment monitoring	Plug integrity shall be monitored regularly if access is available	NORSOK D-010 standards in line with The Activities Regulations and The Facilities Regulations

UK

Item		Minimum requirement	Legislation driving requirement
Do P&A activities need to be planned in advance?		Yes. As soon as the need for well suspension or abandonment is known. Permits to be submitted to BEIS in line with Well Intervention application requirements.	Petroleum Act 1998
Barrier	Type (material)	Cement is the primary material, but this does not preclude the use of other materials.	Offshore installations and wells (design and construction, etc.) regulations 1996
	Verification	Verification requirements are dependent on the individual well and job design. Will include; Tagging, pressure test and/or inflow test.	Offshore installations and wells (design and construction, etc.) regulations 1996

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Item		Minimum requirement	Legislation driving requirement
Plugging requirements	Reservoir	All zones with flow potential require a minimum of one permanent barrier. Hydrocarbon bearing or over pressured and water-bearing zones require two permanent barriers. Barriers are required to be of 100ft of good cement, set above the zone of flow potential and across suitable caprock. Two permanent barriers may be combined into a single large permanent barrier as long as it is as effective and reliable as the two barriers. The combination barrier is typically 200ft MD. An internal cement plug is to be placed adjacent to the annular good cement over a cumulative distance of 200ft MD overlap.	Offshore installations and wells (design and construction, etc.) regulations 1996
	Intermediate zones	All zones with flow potential require a minimum of one permanent barrier. Hydrocarbon bearing or over pressured and water-bearing zones require two permanent barriers. Barriers are required to be of 100ft of good cement, set above the zone of flow potential and across suitable caprock. Two permanent barriers may be combined into a single large permanent barrier **only if the combination barrier can be shared** and as long as it is as effective and reliable as the two barriers. The combination barrier is typically 200ft MD. An internal cement plug is to be placed adjacent to the annular good cement over a cumulative distance of 200ft MD overlap.	Offshore installations and wells (design and construction, etc.) regulations 1996
	Surface	1 permanent barrier, for shallow zone with flow potential, of 100ft of good cement.	Offshore installations and wells (design and construction, etc.) regulations 1996
Annular barrier requirements		Sufficient annular isolation through the original cement job. If the quantity of the annular cement (estimate TOC) is to be based on differential pressure or monitored volumes during the original cement job (rather than logs for example), then a longer cement column may be required to allow for uncertainty. In this case, a 1,000ft MD column may be considered adequate for the equivalent of two barriers or a combination barrier based on the assumption that sealing has occurred somewhere in the annulus cement.	Offshore installations and wells (design and construction, etc.) regulations 1996
Casing stump requirements		No guidance	-
Control line and cabling		Cables and control lines can form part of permanent barriers. Assessment of potential leak paths and the plugging thereof should be conducted.	Offshore installations and wells (design and construction, etc.) regulations 1996

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Item	Minimum requirement	Legislation driving requirement
Seabed	Remove casing to a minimum 10ft below seabed. Review on well by well basis. Subsea / wellhead equipment to be removed and debris retrieved where practical to a minimum radius of 70 m and seabed clearance certificate issued.	Offshore installations and wells (design and construction, etc.) regulations 1996
Post abandonment monitoring	Well examination is not required once wells are "Phase 3" abandoned (i.e., wellhead and conductor removed (definitions of Phase 1 and 2 abandonment provided in Guidelines for the Abandonment of Wells)).	Offshore installations and wells (design and construction, etc.) regulations 1996
Note: Although the Offshore Installations and Wells Regulations 1996 are the legislative driver, all the specific requirements are given in the O&GUK Well Decommissioning Guidelines, Issue 6 June 2018		

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CANADA

Item		Minimum requirement	Legislation driving requirement
Do P&A activities need to be planned in advance?		Notification to abandon well to be submitted no later than five working days prior to commencement of activities	The Accord Acts Submitted to C-NLOPB
Barrier	Type (material)	Cement Mechanical plus cement If the shoe track is to be used as a barrier it should be negatively pressure tested (inflow test) prior to setting any further suspension or abandonment plugs. A negative pressure test should also be conducted prior to setting the surface plug. Negative pressure tests should be made to a differential pressure equal to or greater than the anticipated pressure after displacement. Any alternative method that provides an equivalent (or better) degree of security against any formation fluid from flowing through or escaping from the wellbore to that described in these guidelines may be used if such methods are approved by the appropriate Board.	Oil and Gas Operations Act
	Verification	Tagged to confirm depth and pressure tested to at least 3,450 kPa above the fracture pressure, to a pressure differential of not less than 6,900 kPa.	Oil and Gas Operations Act
Plugging requirements	Reservoir	Cement plugs should be at least 100 m if set in open hole and 30 m if set in casing, or if this is not feasible due to wellbore conditions, the plugs should be as long as practicable.	Oil and Gas Operations Act
	Intermediate zones	Cement plugs should be set I) to isolate any abnormally pressured formations; II) to plug any lost circulation intervals; or III) to isolate any hydrocarbon zones or potable water zones.	Oil and Gas Operations Act
	Surface	No Guidance	-
Annular barrier requirements		Any annulus that is open to a hydrocarbon-bearing zone, a discrete pressure zone or a potable water zone should be sealed at the time of well abandonment. This may be accomplished by perforating the casing as close to the zone as practicable and squeezing cement into the annulus.	Oil and Gas Operations Act

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Item	Minimum requirement	Legislation driving requirement
Casing stump requirements	Casing stub should be plugged by setting a cement plug across the stub that extends at least 15 m below and 15 m above the stub, or by setting a bridge plug as close as practicable to the top of the stub and setting a cement plug on top of the bridge plug.	Oil and Gas Operations Act
Control line and cabling	No Guidance	-
Seabed	The operator is expected to sever the casing strings at a depth below expected maximum scour depth and at least 1 m below the seafloor and recover the wellhead and any other associated subsea equipment. The operator shall ensure that, on the abandonment of any well, the seafloor is cleared of any material or equipment that might interfere with other commercial uses of the sea.	Oil and Gas Operations Act C-NLOPB & CNSOPB Guidelines (2017)
Post abandonment monitoring	Once abandoned, operators continue to be subject to sections 167 and 162 of the Nova Scotia and Newfoundland and Labrador Offshore Accord Acts as they relate to liabilities, losses and damages from the discharge, emission or escape of oil or gas.	Nova Scotia and Newfoundland and Labrador Offshore Accord Acts

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