



Guideline for mineral exploration drilling; drilling and integrity of petroleum exploration and production wells

Mining Act 1992 and Petroleum (Onshore) Act 1991

Published by NSW Department of Industry, Skills and Regional Development, Division of Resources and Energy

Title: Exploration and production guideline; drilling and integrity of petroleum exploration and production wells

Last published: August 2016

More information

This guideline forms part of a suite of codes and guidelines issued by the NSW Department of Industry, including:

- Exploration code of practice: community consultation
- Exploration code of practice: environmental management
- Exploration code of practice: produced water management, storage and transfer
- Exploration code of practice: rehabilitation
- Exploration guideline: petroleum land access
- Exploration guideline: work programs for prospecting titles
- ESG 5: assessment requirements for exploration activities
- Exploration and production guideline: petroleum drilling and well servicing - competencies
- Exploration guideline: annual activity reporting for prospecting titles
- ESG 2: guideline for preparing a review of environmental factors
- Guideline for mineral exploration drilling; drilling and integrity of petroleum exploration and production wells.

Document control

Authorised by: Geological Survey of NSW

RM8 Reference: V15/7452 PUB16/99

Amendment schedule		
<i>Date</i>	<i>Version #</i>	<i>Amendment</i>
1 March 2016	1.0	First published
12 August 2016	2.0	Updated references to new legislation

© State of New South Wales through the NSW Department of Industry, Skills and Regional Development 2015.

This publication is copyright. You may download, display, print and reproduce this material in an unaltered form only (retaining this notice) for your personal use or for non-commercial use within your organisation. To copy, adapt, publish, distribute or commercialise any of this publication you will need to seek permission from the NSW Department of Industry, Skills and Regional Development.

Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (June 2021). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the NSW Department of Industry, Skills and Regional Development or the user's independent advisor.

Contents

Guideline for mineral exploration drilling; drilling and integrity of petroleum exploration and production wells	1
Part A: Introduction	1
Regulatory purpose.....	1
Risk-based regulation for drilling.....	1
Objectives	1
Principles	2
How to use this guideline	2
Part B	2
Part C	2
When this guideline applies	2
Compliance requirements	3
Related codes, policies and guidelines.....	4
Contact details	4
Review	4
Part B: Guidelines for all drilling activities	5
1. Safe siting and design	5
1.1. Guidelines	5
2. Safe drilling and operation	6
2.1. Guidelines	6
3. Long term integrity	7
3.1. Drillhole and well monitoring and maintenance	7
3.2. Drillhole or well suspension and decommissioning.....	7
Part C: Detailed risk assessment and controls	9
4. Risk assessment	9
5. Risk control measures – all drilling	18
5.1. Natural disasters and events	18
5.2. Mechanical and electrical safety	18
5.3. Stored energy	19
5.4. Biodiversity protection	19
5.5. Heritage protection.....	19
5.6. Drilling fluids.....	19
5.7. Dangerous materials located on site.....	20
5.8. Surveys and logs	20
5.9. Casing.....	21
5.10. Subsurface separation	22

5.11. Cementing or grouting a hole.....	22
5.12. Suspension	23
5.13. Monitoring	23
5.14. Decommissioning/rehabilitation	24
5.15. Corrosion	24
5.16. Loads and pressures	24
5.17. Flaring	25
5.18. Gas detection.....	25
5.19. Control barriers	25
5.20. Wellheads	25
5.21. Blow-out prevention	25
6. Additional guidelines and risk controls for petroleum wells	26
6.1. Petroleum wells.....	26
6.2. Fracture stimulation	30
Appendix 1: Recording and reporting requirements	31
Recording and reporting data	32
Drillhole and well lifecycle records	33
All drilling.....	33
Petroleum drilling only	33
Drillcore, percussion chips and cutting samples	33
Opal prospecting licence drillhole logs.....	33
Reporting and notification requirements specific to the <i>Petroleum (Onshore) Act 1991</i>	34
Notification to drill	34
Location surveys	34
Operational reporting.....	34
Well completion reports.....	34
Cementing reports.....	34
Department of Primary Industries - water notification	34
Work health and safety requirements	34
Safety management systems.....	35
Incident reporting	35
Appendix 2: Definitions	36
Appendix 3: Industry standards.....	40

Part A: Introduction

Regulatory purpose

Authorities and titles issued under the *Mining Act 1992* and *Petroleum (Onshore) Act 1991* are granted with the objective of encouraging ecologically sustainable development, social responsibility and the building of economic wealth for the people of NSW.

This guideline sets out objectives and guidance to manage the risks associated with mineral and coal exploration drilling, as well as the drilling and integrity of wells for the exploration and production of petroleum resources. It provides information to the industry and community on the identification of risks associated with various stages of the process of drilling, and seeks to inform industry practices to:

- adopt a risk-based approach to drilling, and the development and maintenance of the integrity of drillholes and wells
- monitor performance and take corrective action if outcomes are not being achieved, and
- keep and maintain relevant records of activities and/or actions.

This risk-based approach allows titleholders to adopt innovative solutions and best practice techniques to meet performance requirements.

Risk-based regulation for drilling

This guideline identifies potential risks that may be associated with drilling activities and provides suggested guidelines for risk mitigation. It should not be read as a proscriptive document as many of the potential risks that are identified within this guideline will not apply to a given drilling project. In particular, mineral exploration drilling is typically shallower, and involves smaller-scale equipment and consequently significantly less ground disturbance than petroleum drilling. Mineral exploration drilling is also inherently much lower risk than petroleum drilling, so does not require the same level of control.

Objectives

The objectives of this guideline are to:

1. ensure the completion of drillholes and wells which enable material to be extracted safely and in a manner which minimises pollution and negative impacts on the environment
2. ensure the consideration of the long term impacts on health and safety of people and the environment in the planning, development, operation, suspension and decommissioning of drillholes and wells
3. minimise the impacts of the drillhole or well on the long term use of the site
4. ensure that chemicals and materials used in the development and operation of the drillhole or well are stored and handled in a way that reduces the risk to persons or the environment
5. ensure that waste products generated from the process of drilling and well construction are safely and appropriately managed
6. ensure that the integrity of the drillhole or well is maintained during its lifetime
7. ensure that consideration is given to the risk of equipment failure and the preparation of contingency plans to respond to failures or underperformance of the drilling rig and support equipment, downhole equipment and control infrastructure.

Principles

In order to meet the above objectives, the following general principles should be followed in the design, construction, operation, and decommissioning of all drillholes and wells:

- a) Drillholes and wells should be located, designed, constructed, operated and decommissioned in a way that will minimise the:
 - (i) potential risk to workers, landholders and other persons
 - (ii) impact on the environment
 - (iii) impact on nearby sensitive receivers
 - (iv) need for engineering measures to reduce risk and negative impacts.
- b) Drillholes and wells should be designed to:
 - (i) prevent migration paths and interconnection between zones of differing pressures and water quality
 - (ii) minimise the risk of leaks from the drillhole or well, below and above the ground level.
- c) The integrity of the drillhole or well should be maintained throughout the operational lifetime of the drillhole or well. For mineral exploration drillholes, the operational lifetime is limited to the exploration activity, whilst for petroleum wells, operational life may include exploration, production and reinjection of fluids.

How to use this guideline

Part B

Part B of this guideline contains general provisions relevant to all drilling techniques and targets and which should be considered for the planning, operation and decommissioning of all drillholes and wells. **Part B should therefore be read in its entirety and understood by all explorers and drillers.**

Part C

All explorers must conduct comprehensive risk assessments of their exploration programs, including risk assessment of the major known drilling related hazards and site specific hazards for their drilling programs. **Part C** of this guideline can be used as a tool to assist with the identification of hazards and potential risk control measures associated with drilling programs.

Section 4: This section presents a list of major potential hazards, risks and suggested control measures. The table should be used as a guide to identify those elements of Section 5 and Section 6 that are relevant for an individual drilling program.

Section 5: This section presents hazards and risk control measures that may be relevant to any given drilling program. The drilling related tasks and hazards identified will not apply equally to all forms of drilling, and the reader should read this section in conjunction with Table 1 in Section 4 to identify which risk controls relate to a given hazard.

Section 6: This section presents hazards and risk control measures which are exclusively relevant to drilling wells for exploration and production of petroleum and for undertaking fracture stimulation activities. Many of the provisions in this section may also be applicable when prospecting for, or producing from geothermal energy resources.

When this guideline applies

This guideline should be used by title holders who plan to carry out exploration drilling for scheduled minerals (Groups 1-11 under the *Mining Act 1992*) or exploration and/or production drilling for petroleum resources (as defined in the *Petroleum (Onshore) Act 1991*) within NSW.

This guideline provides guidance material only. A titleholder is not required to comply with any of the provisions in the guideline. It is however recommended that titleholders review the contents of this guideline before beginning drilling activities.

In this guideline, the terms drillhole and well are generally used interchangeably unless otherwise stated. The term drillhole includes most mineral exploration drillholes, boreholes, cored holes and open holes. The term well refers primarily to holes drilled to produce hydrocarbons or geothermal energy. Well may also refer to some types of exploration drilling carried out to test hydrocarbon or geothermal energy production capabilities of certain reservoirs.

Drilling for the purposes listed below are not within the scope of this guideline:

- waterbores
- bores for hydrological monitoring
- blastholes
- gas drainage holes
- in-seam drilling
- sampling and coring using hand held equipment
- underground drilling.

Compliance requirements

A titleholder must comply with a range of regulatory requirements when carrying out drilling operations in NSW. The titleholder is responsible for gaining all required approvals or licences before starting the activity. Guidance with respect to approval requirements and processes is provided on the department website.

Exploration and production drilling in NSW must be carried out in accordance with the requirements of the *Work Health & Safety Act 2011* and also with those of the *NSW Work Health & Safety (Mines and Petroleum Sites) Act 2013* and the *NSW Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*.

For titles issued under the *Petroleum (Onshore) Act 1991*, and where a condition on title or activity approval refers to compliance with the *Code of practice for coal seam gas well integrity* or the *Code of practice for coal seam gas fracture stimulation* the provisions of these codes apply and are to be complied with.

For all mechanical exploration drilling activities carried out under the *Mining Act 1992* and *Petroleum (Onshore) Act 1991* an activity approval is necessary. This approval is granted under Part 5 of the *Environmental Planning and Assessment Act 1979* (the EP&A Act). The determining authority for these approvals is the NSW Department of Industry.

For production drilling associated with petroleum and geothermal resources a development consent granted under part 4 of the EP&A Act is required. Drilling on a mine site is generally captured under the mine's part 4 consent and may not require further approval.

Exploration and production titles granted under the *Mining Act 1992* and the *Petroleum (Onshore) Act 1991* may require notification to the Department of Primary Industries – Water of the intention to drill. You are advised to contact the department to establish the requirements in this regard.

The assessment and approval of an activity under the *Mining Act 1992* or *Petroleum (Onshore) Act 1991* does not affect any obligation to comply with the requirements to obtain an approval, licence, permit or concurrence under other legislation.

Examples of legislation which may also apply include:

- *Fisheries Management Act 1994*
- *Forestry Act 2012*

- *Heritage Act 1977*
- *National Parks and Wildlife Act 1974*
- *Protection of the Environment Operations Act 1997*
- *Roads Act 1993*
- *Rural Fires Act 1997*
- *Water Act 1912*
- *Water Management Act 2000.*

The department is responsible for regulating compliance for work health and safety matters relating to prospecting under both the *Petroleum (Onshore) Act 1991* and the *Mining Act 1992*. The department is also responsible for regulating environmental compliance of activities carried out under the *Mining Act 1992*. The department's approach to compliance and enforcement is set out in its Compliance and enforcement policy.

From 1 July 2015, under the NSW Gas Plan, the Environment Protection Authority is the sole authority to regulate compliance with and enforcement of all conditions (excluding work health and safety) contained within petroleum titles. This includes any conditions imposed in relation to specific activity approvals.

Compliance with this guideline is not a defence to actions taken under any legislation or statutory instrument.

Related codes, policies and guidelines

Codes, policies and guidelines set out requirements and provide information to assist with the performance to be achieved during the term of an authority of title. In relation to addressing the potential risks associated with drilling and integrity of drillholes or wells, titleholders are to have particular regard to the mandatory requirements of the *Exploration code of practice: community consultation*, *Exploration code of practice: environmental management*, and the *Exploration code of practice: rehabilitation*. Compliance with the requirements of these codes, in addition to compliance with conditions on title and commitments made in the application documents, will ensure that risks associated with drilling and integrity of drillholes and wells are addressed and managed.

Contact details

NSW Department of Industry
Division of Resources and Energy
516 High Street, Maitland NSW 2320
PO Box 344, Hunter Region Mail Centre, NSW 2310
Telephone 02 4931 6666
Fax 02 4931 6790
Email imer.enquiries@industry.nsw.gov.au
Website www.resourcesandenergy.nsw.gov.au

Review

This guideline will be reviewed six months after its publication, and then every five years. The effectiveness of this guideline will also be monitored on an ongoing basis.

Part B: Guidelines for all drilling activities

1. Safe siting and design

This section refers to the selection of the site and the initial design of the drillhole or well. In addition to technical considerations around effectively testing the desired target, when locating a drillhole or well, consideration of a range of factors needs to be given due consideration to ensure that as far as is practicable, the site and drillhole or well is safe and will have minimal impact on human health and the environment.

1.1. Guidelines

1.1.1. Drill sites should be designed and constructed to:

- a) be of a size capable of accommodating drilling equipment, and the safe operations of the site and drillhole or well
- b) be appropriately fenced or secured to ensure the safety of persons, livestock and wildlife
- c) provide a stable platform for all equipment and operations on the site.

1.1.2. All drillholes and wells should be designed to:

- a) prevent, as far as practicable, any interconnection between aquifers containing water suited to beneficial use and zones containing substances that may contaminate such aquifers
- b) prevent, as far as practicable, any interconnection between different beneficial aquifers and other water bearing zones
- c) ensure that any gas/ fluid that is encountered during drilling is contained within the drillhole or well, and associated pipework and equipment, without uncontrolled leakage
- d) minimise water inflow into the drillhole or well
- e) isolate, as far as practicable, any beneficial aquifers to ensure their long term protection.

Construction of a borehole should be to a standard equal to or exceeding those set out in the Minimum Construction Requirements for Water Bores in Australia issued by the National Uniform Drillers Licensing Committee (NUDLC). See: www.aditc.com.au/water-driller-licensing/minimum-construction-requirements/

1.1.3. Adequate separation of aquifers and other zones, including appropriate barriers (e.g. cement plugs, casing, seals), should be incorporated into drillhole and well design. Such measures should be installed and implemented to ensure that water quality is maintained and environmental impacts are minimised in the long term.

Other zones may include coal seams, hydrocarbon reservoirs and radioactive rock units.

1.1.4. The design of the drillhole or well should be developed with reference to available nearby, relevant drilling data, and geological modelling of the area.

1.1.5. Site location and design should incorporate measures to reduce or mitigate the impacts of natural hazards, for example flooding and fire.

- 1.1.6. Workers and visitors should undertake a site specific induction covering safe work practices, environmental practices and site emergency response procedures.
- 1.1.7. Before drilling, assessment of the potential of encountering historic or active mine workings or natural voids (e.g. karst environments) should be made. When drilling in a known mining area, mine survey plans should be sought from the department to determine whether a void is present in the sub-surface at the planned drilling location.
- 1.1.8. When carrying out excavations at the drill site the potential for underground services to be damaged should be considered. A Dial Before You Dig check should be performed and the landholder consulted about the presence of any electrical, communications, water or petroleum transmission lines and pipes.

An application to access mine survey plans can be made to the department on the *Request for mine survey plans* form found at www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health/applications/mine-survey-plans

2. Safe drilling and operation

This section refers to the conduct of the drilling operation and will generally include the commencement of drilling, drilling to the planned total depth, recovery of samples, downhole logging and testing. This phase of the drilling operation will typically involve the most hazards and risks to health, safety and the environment, and as such requires special attention during the planning process to ensure the operations are carried out safely.

2.1. Guidelines

- 2.1.1. Adequate systems should be installed and implemented to ensure that the drillhole or well is drilled and operated in a safe manner that poses minimal risk to the health and safety of people on or near the site.
- 2.1.2. Measures to mitigate the impacts of noise and dust generated due to the drilling operation should be put in place and should include, where appropriate:
 - a) The injection or the use of water-based mud to reduce the generation of dust from air drilling methods
 - b) the use of PPE such as dust masks or respirators, and safety glasses, and
 - c) where dust may be generated due to large numbers of vehicle movements on access tracks, dust suppression by track watering is advised.
- 2.1.3. Drilling fluids should be stored in portable, self-contained tanks during drilling operations.
- 2.1.4. Where self-contained tanks are not practicable for logistical, operational or safety reasons, in-ground or above-ground sumps may be used and should:
 - a) be constructed to provide adequate storage for drilling fluids
 - b) include a freeboard under normal operating conditions to prevent overflow of the fluids in the event of rainfall or reasonably foreseeable fluid influx during drilling
 - c) be designed so that surface water cannot enter into the sump, under normal conditions
 - d) include an impermeable barrier (such as plastic or clay) to prevent the loss of drilling fluids into the soil profile
 - e) include appropriate mechanisms that allows for egress from the sump such as battered pit sides, ramps, ladders, ropes etc.

- 2.1.5. All drill cuttings, fluids and groundwater returned to the surface as part of the drilling process should be appropriately contained, pending re-circulation or disposal.

3. Long term integrity

This section covers the final phase of the drilling operation. It involves the safe suspension of drilling operations or decommissioning of a drillhole or well. During both types of activity, the primary objective of a titleholder should be to ensure that the hole is left in a safe manner and that it will not pose a risk to human health or the environment.

3.1. Drillhole and well monitoring and maintenance

- 3.1.1. Monitoring and maintenance frequencies of suspended or completed exploration drillholes and suspended or exhausted petroleum exploration and production wells should be determined by a risk assessment. In most cases, mineral exploration drillholes, once completed, will not require ongoing monitoring.
- 3.1.2. Where required, a monitoring plan should be developed and implemented that:
- provides for the regular inspection of the drillhole or well to assess its integrity
 - includes regular maintenance to safeguard the integrity of the drillhole or well
 - provides for the repair of all surface equipment installed at a drillhole or well site.
- 3.1.3. The condition of the equipment may provide important information regarding the suitability of the equipment for the use, or indicate that there are particular issues in the hole such as the presence of corrosive substances or elevated temperatures that may require additional mitigation. The mechanical integrity of the drillhole or well casing and other drillhole or well equipment should be determined using appropriate methods which may include mechanical pressure monitoring and inspection for evidence of corrosion.
- 3.1.4. Records should be kept of:
- inspections and any repairs made to the drillhole or well, and
 - any intervention procedures and materials used.

3.2. Drillhole or well suspension and decommissioning

- 3.2.1. Upon suspension, the drillhole or well should be left in a condition that:
- facilitates the safe recommencement of operations at the site
 - will not have detrimental impact on the health and safety of people or the environment
 - is secured from entry by unauthorised people, livestock or wildlife
- 3.2.2. Upon decommissioning, reasonable attempts should be made to ensure that:
- all equipment and tools not intended to remain in the hole are removed from the drillhole or well
 - surface infrastructure and wellheads are removed
 - fill is not deposited on the surface in such a way that may interfere with any land use, and
 - rehabilitation is completed in accordance with the department's *Exploration code of practice: rehabilitation* or any other requirements set out in the title conditions.
- 3.2.3. Drillholes and wells should be filled in a manner that ensures the long term integrity of the hole and the ongoing sub-surface separation of formations and aquifers.

3.2.4. Where cementing is necessary (generally only common for petroleum wells), cement used to fill drillholes and wells should:

- a) be designed to support the maximum allowable length of grout
- b) be poured in volumes no greater than that which will enable the setting of the cement, and
- c) provide an effective seal within the hole. An effective seal is one that prevents vertical movement of materials within the hole or horizontal movement of materials into intersected units.

In near-vertical, open-hole sections of the borehole or well, cement is generally to be placed in plugs of not more than 200 m lengths with a setting period of 6 hours between placements.

3.2.5. Where plugs (cement or other materials) are used, the position of these should be determined before further grouting by tagging the top of the plug with the drillstring.

3.2.6. Details of the borehole or well should be accurately recorded including:

- a) kelly/ drill collar/ drill floor height (AHD)
- b) downhole positional surveys (if any)
- c) downhole geophysical logs (if any)
- d) the method used to seal the hole
- e) the volumes and types of materials used
- f) any loss of cement mixture (where used) and the method used to overcome this
- g) information on the drillhole or well such as depth, diameter, and casing strings left in the hole, and
- h) any subsurface equipment retained in the hole.

Positional surveys should be recorded to an accuracy of one metre.

Part C: Detailed risk assessment and controls

4. Risk assessment

Without adequate controls mineral exploration and petroleum exploration and production drilling has the potential to cause impacts upon health, safety, and the environment.

As part of the overall risk management of exploration activities, title holders are required to ensure all significant drilling related risks to safety or the environment are managed through an effective risk management process that includes identification of hazards, assessment of risks, implementation of control measures, and monitoring of the integrity and effectiveness of these measures.

A risk assessment should be used, not only to establish a basis for managing risk when planning an activity, but also used and updated (as required) to continuously evaluate risk and the effectiveness of controls used to prevent or minimise impacts. In this regard a documented risk assessment should be undertaken and should include:

- a) identification of the hazards or consequences
- b) identification of the associated risks
- c) evaluation of the risk
- d) control measures to be implemented to eliminate or minimise the risk
- e) monitoring of the control measures
- f) review of the control measures.

Titleholders are advised to use *AS/NZS ISO 31000:2009 Risk management –principles and guidelines* to support risk assessments. The guidelines provided in this document are intended to assist in the development of practices and procedures that will help in the management of these risks. However, title holders should undertake a robust risk assessment process for their particular title and activity, with the implementation of measures appropriate to manage the identified risks.

In addition to considering these guidelines in the mitigation of risks associated with drilling and integrity of drillholes and wells, title holders should also consider compliance with relevant standards and specifications, outlined in Appendix 3 Industry Standards, and good industry practice.

The table below shows hazards and associated risks that may occur at a drill site before, during or after operations take place. **For a given drilling program, it is highly unlikely that all of these risks will be encountered.** If the risk assessment indicates that a hazard or risk is likely to be encountered then the associated guidance section and potential control measures, outlined in the table, should be considered.

This is not intended to be an exhaustive list of all hazards and risks that may be present during a drilling operation. A comprehensive risk assessment should be carried out before drilling to identify risks. The detail provided in this table may provide a starting point for this assessment.

The following documents are referenced in:

Table 1: Directory of major known drilling related hazards and risks

Reference	Title of document
SMS in Mines	<p>Safety management systems in mines code of practice</p> <p>www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health/publications/codes-of-practice</p>
EM code	<p>Exploration code of practice: environmental management</p> <p>www.resourcesandenergy.nsw.gov.au/miners-and-explorers/codes-and-guidelines/codes-of-practice/environmental-management</p>
Rehab code	<p>Exploration code of practice: rehabilitation</p> <p>www.resourcesandenergy.nsw.gov.au/miners-and-explorers/codes-and-guidelines/codes-of-practice/rehabilitation</p>

Table 1: Directory of major known drilling related hazards and risks

Use this table to identify the hazards or risks that are likely to be encountered during your drilling program and refer to the sections of this guideline that are highlighted in the table as relevant to each identified risk.

The table is structured and colour-coded to present drilling hazards in three broad categories:

1. **Green-coded hazards** (numbered 1 to 5) are relevant to all drilling techniques and targets
2. **Yellow-coded hazards** (numbered 6 to 21) are relevant to advanced drilling techniques (eg: deep percussion, diamond core, directional drilling, water boring), petroleum drilling, and drillholes or wells which are likely to intercept significant groundwater aquifers
3. **Red-coded hazards** (numbered 22 and 23) are only relevant to drillholes or wells that are likely to intercept liquid or gaseous hydrocarbons (some coal and oil shale exploration and all petroleum drilling).

Hazards relevant to **all** drilling techniques and targets

	Hazards present during the drilling operation	Risk related to hazard	Do you expect to encounter the hazard/risk during your drilling operation? Y/N	If you answer Yes refer to the relevant section/s of the guideline shown in this column	Quick reference - possible controls to consider	Other references
1	Natural events e.g. storms, bushfire, lightning strike, flood etc.	<ul style="list-style-type: none"> Worker injury Equipment damage 		5.1 Natural disasters and events	<ul style="list-style-type: none"> Evacuation plans Locate site out of floodways Clear ground around site in bushfire prone areas 	SMS in Mines Code
2	Mechanical systems e.g. rotating parts, high pressure systems etc.	<ul style="list-style-type: none"> Worker injury 		5.2 Mechanical and electrical safety	<ul style="list-style-type: none"> Install barriers between moving parts and workers Regular maintenance of systems Induction on high danger/ no go areas at the site Use of PPE - coveralls, eye protection 	SMS in Mines Code
3	Electrical systems e.g. generators, motors etc.	<ul style="list-style-type: none"> Worker injury 		5.2 Mechanical and electrical safety	<ul style="list-style-type: none"> Regular maintenance by licenced electrician Isolation when working on systems Insulation and barriers between electrical source and workers 	SMS in Mines Code
4	Stored energy e.g. lifting systems, tensioned wires etc.	<ul style="list-style-type: none"> Worker injury 		5.3 Stored energy	<ul style="list-style-type: none"> Regular maintenance of systems by mechanic Certification of lifting wires and ropes No- go zone under raised loads Trained operators in hoisting work Use of PPE- helmet 	SMS in Mines Code
5	Drilling fluids kept on site	<ul style="list-style-type: none"> Spills and overflow of fluids Worker injury 		3 Safe drilling and operation 5.6 Drilling fluids	<ul style="list-style-type: none"> Above ground tanks Lined mud pits Bund walls Battered pit walls Egress ladder 	EM Code

Hazards relevant to **advanced** drilling techniques

	Hazards present during the drilling operation	Risk related to hazard	Do you expect to encounter the hazard/risk during your drilling operation? Y/N	If you answer Yes refer to the relevant section/s of the guideline shown in this column	Quick reference - possible controls to consider	Other references
6	Ground disturbance e.g. excavation, levelling etc.	<ul style="list-style-type: none"> • Damage to biodiversity or heritage items • Damage to underground services 		2 Safe siting and design 5.4 Biodiversity protection 5.5 Heritage protection	<ul style="list-style-type: none"> • Site survey and clearance prior to earthworks • Dial Before You Dig check • Check with landholder about underground services 	EM code SMS in Mines code
7	Clearing of vegetation	<ul style="list-style-type: none"> • Damage to biodiversity or heritage items 		5.4 Biodiversity protection 5.5 Heritage protection	<ul style="list-style-type: none"> • Site survey and clearance prior to vegetation clearing work 	EM code
8	Open excavations	<ul style="list-style-type: none"> • Worker injury • Animal injury 		2 Safe siting and design	<ul style="list-style-type: none"> • Fencing around excavations • Warning signage 	SMS in mines code
9	Moving plant at the drill site and on access routes	<ul style="list-style-type: none"> • Worker injury • Animal injury 		5.2 Mechanical and electrical safety	<ul style="list-style-type: none"> • Vehicles to abide by low speed limit on site • Use by trained and licenced operators only • Use of PPE - hi-vis • Movement alarms • Designated parking areas 	SMS in mines code
10	Dust resulting from drilling operations including access routes	<ul style="list-style-type: none"> • Worker exposure and illness • Loss of amenity 		3 Safe drilling and operation	<ul style="list-style-type: none"> • Use drilling mud to prevent dust generation • Use of PPE - masks/ respirators • Dust suppression on roads with numerous vehicle movements 	SMS in mines code
11	Noise from plant and other equipment	<ul style="list-style-type: none"> • Worker illness • Disturbance to local fauna 		3 Safe drilling and operation	<ul style="list-style-type: none"> • Use sound attenuation systems on site equipment • Use sound barrier fencing • Use of PPE - ear protection • Limit operational times 	SMS in mines code EM code

	Hazards present during the drilling operation	Risk related to hazard	Do you expect to encounter the hazard/risk during your drilling operation? Y/N	If you answer Yes refer to the relevant section/s of the guideline shown in this column	Quick reference - possible controls to consider	Other references
12	Geological faults	<ul style="list-style-type: none"> • Slow drilling • Fault slip • Induced seismicity 		2 Safe siting and design 5.9 Casing 5.11 Cementing or grouting a hole 6.2 Fracture stimulation	<ul style="list-style-type: none"> • Identify fault zones when planning drilling activity • Cement and drill through if fault movement is suspected whilst drilling • If conducting fracture stimulation use appropriate cement mix (at least 10-14 Mpa UCS) and placement (>150m above a frac. zone) 	EM code
13	Caving/ swelling rock units	<ul style="list-style-type: none"> • Slow drilling • Lost equipment downhole • Poor sealing outlook 		5.6 Drilling fluids	<ul style="list-style-type: none"> • Use stabilising mud mixtures when drilling • Plan for recovery of equipment lost in hole 	
14	Underground workings/ voids/ services	<ul style="list-style-type: none"> • Inrush to workings • Sudden loss of drilling fluids to void • Blow-out • Damage/ destruction of underground services 		5.9 Casing 5.11 Cementing or grouting a hole. 5.20 Wellheads 5.21 Blow-out prevention	<ul style="list-style-type: none"> • Identify potentially hazardous areas when planning drilling • Source mine plans if possible • Survey site using a licenced surveyor • High precision survey of borehole location in areas with possible future mining • Dial Before You Dig check 	SMS in mines code
15	Aquifer/ reservoir units	<ul style="list-style-type: none"> • Migration pathways • Cross-contamination of aquifers/ reservoirs • Loss of drilling fluid to formation 		5.9 Casing 5.10 Subsurface separation 5.11 Cementing or grouting a hole 5.14 Decommissioning / Rehabilitation 5.16 Loads and pressures 6.1 Petroleum wells	<ul style="list-style-type: none"> • Use appropriate sealing methodology to ensure there is no communication between different units particularly between hydrocarbon zones and aquifers • Cement casing across zones during drilling 	Rehab code

	Hazards present during the drilling operation	Risk related to hazard	Do you expect to encounter the hazard/risk during your drilling operation? Y/N	If you answer Yes refer to the relevant section/s of the guideline shown in this column	Quick reference - possible controls to consider	Other references
16	Toxic sub-surface substances e.g. Asbestos, H ₂ S, CO, Uranium etc.	<ul style="list-style-type: none"> Worker exposure and illness 		2 Safe siting and design	<ul style="list-style-type: none"> Use of gas detectors Use of particulate matter detectors Radiation detectors/ dosimeters Training to identify asbestiform minerals in rockchips and core Use of PPE- Masks/ respirators, coveralls 	SMS in Mines Code
17	Explosive/ combustible substances kept on site	<ul style="list-style-type: none"> Explosion or fire on site Injury to workers Bushfire Equipment damage 		5.7 Dangerous materials located on site	<ul style="list-style-type: none"> Segregation from other materials on site Specified storage area away from work area Bunding of storage area No naked flames in area 	SMS in Mines Code EM Code
18	Toxic substances kept on site	<ul style="list-style-type: none"> Worker exposure and illness Contamination of waterways and soils 		5.7 Dangerous materials located on site	<ul style="list-style-type: none"> Specified storage area away from work area Store in accordance with MDS Use of PPE- Masks/ respirators, coveralls, gloves when using substances 	SMS in Mines Code EM Code
19	Radioactive substances kept on site	<ul style="list-style-type: none"> Worker exposure and illness Environmental contamination Resource sterilisation 		5.7 Dangerous materials located on site	<ul style="list-style-type: none"> Specified storage area away from work area with locked storage container Trained workers only to handle substances PPE when using substances 	SMS in Mines Code

	Hazards present during the drilling operation	Risk related to hazard	Do you expect to encounter the hazard/risk during your drilling operation? Y/N	If you answer Yes refer to the relevant section/s of the guideline shown in this column	Quick reference - possible controls to consider	Other references
20	Suspended drillhole	<ul style="list-style-type: none"> Leaks Groundwater or soil contamination Public safety 		5.8 Surveys and logs 5.9 Casing 5.10 Subsurface separation 5.11 Cementing or grouting a hole 5.12 Suspension 5.13 Monitoring 5.15 Corrosion 5.16 Loads and pressures 5.19 Control barriers 5.20 Well heads 6.1 Petroleum wells	<ul style="list-style-type: none"> Ensure drillhole is secured and safe while unattended Ensure re-entry into the drillhole is low risk 	Rehab Code
21	Sealed and abandoned drillhole	<ul style="list-style-type: none"> Leaks Groundwater or soil contamination Public safety Farm equipment damage 		4 Long term integrity 5.8 Surveys and logs 5.9 Casing 5.10 Subsurface separation 5.11 Cementing or grouting a hole 5.13 Monitoring 5.14 Decommissioning / rehabilitation 5.15 Corrosion 5.16 Loads and pressures 5.19 Control barriers 5.20 Well heads 6.1 Petroleum wells	<ul style="list-style-type: none"> Remove all equipment from drillhole before sealing Remove surface equipment Seal drillhole with cement if required to prevent leaks to surface or sub-surface movement of formation fluid 	Rehab Code

Hazards relevant to drilling for **petroleum**

	Hazards present during the drilling operation	Risk related to hazard	Do you expect to encounter the hazard/risk during your drilling operation? Y/N	If you answer Yes refer to the relevant section/s of the guideline shown in this column	Quick reference - possible controls to consider	Other references
22	High pressure sub-surface zones	<ul style="list-style-type: none"> Gas/ fluid kick Blow-outs Fire on site. Bushfire Injury to workers Equipment damage 		2 Safe siting and design 5.6 Drilling fluids 5.9 Casing 5.11 Cementing or grouting a hole 5.19 Control barriers 5.20 Wellheads 5.21 Blow-out prevention 6.1 Petroleum wells 6.2 Fracture stimulation	<ul style="list-style-type: none"> Drill using mud with weights suitable to the expected pressures Overbalanced drilling (mud weight greater than formation pressure) is always recommended Use of diverter systems Use of blow-out preventer systems Training of workers to recognise and respond to incident Fire-fighting equipment on site 	SMS in Mines Code
23	Explosive/ combustible sub-surface substances	<ul style="list-style-type: none"> Blow-out Fire on site Injury to workers Bushfire Equipment damage 		5.6 Drilling fluids 5.9 Casing 5.11 Cementing or grouting a hole 5.18 Gas detection 5.19 Control barriers 5.20 Wellheads 5.21 Blow-out prevention 6.1 Petroleum wells 6.2 Fracture stimulation	<ul style="list-style-type: none"> Use of diverter systems Use of blow-out preventer systems Training of workers to recognise and respond to incident Fire-fighting equipment on site 	SMS in Mines Code

5. Risk control measures – all drilling

This section provides risk control measures for all drilling related hazards, exclusive of those hazards and risk controls which are unique to drilling for petroleum (Section 6). The text is structured to generally advance from hazards that are common to all drilling techniques, through to hazards which are more specific to advanced drilling techniques (e.g: diamond core, deep percussion, directional drilling) and specific targets (e.g: minerals, water, coal, petroleum, geothermal energy).

This section should be read in conjunction with **Table 1** (Directory of major known hazards and risks) that provides guidance on which sub-sections of this text are relevant for addressing identified hazards.

5.1. Natural disasters and events

5.1.1. A procedure should be implemented to provide for work stoppages in the event of lightning storms.

5.1.2. At sites where flash flooding or bushfire may occur, a procedure should be put in place to allow for the evacuation of the site in the event of such events. The procedure should include a system to monitor local weather conditions, evacuation triggers, evacuation paths and communications methods.

5.1.3. The drill site should be located away from floodways and watercourses, where possible, to reduce the potential for inundation. Local experience should be sought regarding what areas flood during significant rainfall events.

5.1.4. Where bushfire is possible:

- a) Where practically feasible and consistent with environmental best practice, the drill site should be located in an area with at least 50 metres of open ground between the work area and nearby trees.
- b) Firefighting equipment that is consistent with the level of bushfire risk should be available for all drilling activities. This may include firefighting pumps (with adequate water supply), extinguishers and equipment should be located on site to mitigate the risk of a fire at the site escaping and starting a bushfire.

5.2. Mechanical and electrical safety

5.2.1. All equipment used for the activity should be suited to the task, and engineered and manufactured to relevant Australian Standards (international standards may be used where an AS does not exist).

5.2.2. Where moving parts, high pressure systems and electrical systems are present physical barriers between workers and the hazard should be put in place to prevent contact with the system and to reduce the likelihood and severity of injury in the event of system failure.

5.2.3. When repair or maintenance work on mechanical or electrical systems is undertaken, the system should be shut down and prevented from operating through a suitable lock-out mechanism.

5.2.4. 'No-entry' or 'restricted entry' areas should be designated around systems that present a significant hazard such as compressors, high pressure lines, moving parts etc.

5.2.5. High pressure hoses should be fitted with whip-checks.

5.2.6. Procedures should be developed and implemented to ensure that only qualified persons perform maintenance work on mechanical and electrical plant and that all workers using plant and equipment are trained in its safe operation.

5.3. Stored energy

5.3.1. Lifting and hoisting operations should only be conducted by appropriately trained and qualified people.

5.3.2. 'No entry' areas should be established under suspended loads and near tensioned line.

5.3.3. All lifting ropes and wires should be regularly inspected and replaced if found to be damaged.

5.3.4. Winch systems should be regularly maintained by an appropriately trained and qualified person.

5.4. Biodiversity protection

For requirements and guidance regarding the protection of biodiversity in the conduct of drilling activities, consult the department *Exploration code of practice: environmental management* (www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0007/565954/Exploration-Code-of-Practice-Environmental-Management.pdf).

In NSW all native animals are protected under the *National Parks and Wildlife Act 1974*. Additional protection may also be afforded under the *Threatened Species Conservation Act 1995*.

5.5. Heritage protection

For requirements and guidance regarding the protection of Heritage in the conduct of drilling activities, consult the department *Exploration code of practice: environmental management* (www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0007/565954/Exploration-Code-of-Practice-Environmental-Management.pdf).

In NSW clearing of native vegetation without approval is an offence under the *Native Vegetation Act 2003*.

5.6. Drilling fluids

5.6.1. Drilling fluid should be a carefully monitored and controlled mixture designed to:

- a) achieve best drilling results
- b) ensure efficient removal of formation cuttings
- c) control formation pressures, and
- d) minimise damage to formations.

5.6.2. Drilling fluid should be selected to ensure that it is appropriate to:

- a) the drillhole or well design
- b) any locally experienced drilling problems
- c) geological conditions anticipated to be encountered.

5.6.3. Preparation of the drilling additives should consider the properties of the water mix that is being used.

5.6.4. Sufficient reserves of drilling fluids and supplies of drilling fluid materials are to be available on site for immediate use to control blow-out or artesian flow.

5.7. Dangerous materials located on site

All practitioners on mining and exploration authorities have duties and obligations under the *NSW Work Health and Safety (Mines and Petroleum Sites) Act 2013*, the *NSW Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*, and *NSW Work Health and Safety (Mines and Petroleum) Amendment (Harmonisation) Regulation 2016* and should assess and manage hazards to safety in accordance with the requirements of this legislation.

For specific guidance regarding safety aspects of managing dangerous materials on site, consult NSW Workcover's Managing Risks of Hazardous Chemicals in the Workplace Code of Practice (www.workcover.nsw.gov.au/__data/assets/pdf_file/0005/19580/managing-risks-hazardous-chemicals-code-3837.pdf).

In NSW, radioactive sources must be handled and secured in accordance with the *Radiation Control Act 1990*. Refer to the Managing Radiation page of the NSW EPA website (www.epa.nsw.gov.au/radiation/).

In NSW, explosives must be handled and stored in accordance with the provisions of the *Explosives Act 2003*. Refer to the *Security Plan for Storage and Handling of Explosives and Security Sensitive Substances* published by NSW Workcover, and further associated guides referred to in that publication.

For environmental requirements regarding the storage of dangerous materials on drilling sites, consult the department's *Exploration code of practice: environmental management* (www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0007/565954/Exploration-Code-of-Practice-Environmental-Management.pdf).

5.8. Surveys and logs

5.8.1. Evaluation logs, tests and records for drillholes and wells are to ensure that adequate information is gained:

- a) to monitor the operation of the drillhole or well
- b) to identify any potential risks
- c) to identify any potential issues or unexpected impacts.

5.8.2. Downhole surveys and logging data should be recorded in an industry standard format, kept in a secure place and backed up to reduce the risk of lost data.

5.8.3. Any irregularities in the hole should be recorded and retained in a related database, including the intercept of any unexpected or anomalous volumes of groundwater, or the loss or abandonment of any downhole equipment, casing or rods that may pose a future hazard.

Secondary equipment may include wireline lubricators and pack offs.

5.8.4. When conducting wireline downhole logging operations in a borehole or well where pressure or temperature conditions or toxic gases pose a risk, the use of secondary pressure control equipment (PCE) should be considered.

5.8.5. When planning a logging operation, a risk assessment process should be carried out to give consideration to:

- a) the potential for logging tools or equipment to become stuck or lost in the hole
- b) measures to prevent logging tools and equipment from being stuck or lost in the hole, and

- c) procedures to retrieve logging tools and equipment where necessary.

5.9. Casing

- 5.9.1. Plastic or steel casing used in shallow holes to prevent drillhole collapse should be manufactured from a material capable of withstanding the compression expected in the drillhole.
- 5.9.2. Casing used for well control purposes should be designed to withstand:
- a) the various compressive, tensile and bending forces that are exerted while running-in the hole
 - b) the collapse and burst pressures that it may experience during different phases of the life of the drillhole or well.
- 5.9.3. A casing plan should be developed and implemented to include details of all equipment and consumables that are to be used including, where appropriate:
- a) casing centralisers
 - b) casing shoes
 - c) float collars
 - d) cement baskets
 - e) wiper/cementing plugs
 - f) cementing make up and procedure
 - g) landing collars
 - h) stage tools
 - i) external casing packers
 - j) casing running
 - k) make-up torque requirements
 - l) casing dope use, and
 - m) casing/ cement integrity testing.

For exploration or appraisal holes the minimum setting depth of the surface casing string should be the greater of 10% of the planned total depth of the well or 100 metres when no intermediate casing string is planned.

- 5.9.4. Casing design should take into account:
- a) geological considerations
 - b) abnormal pressured zones
 - c) lost circulation zones
 - d) unstable formations
 - e) casing mechanical properties and limitations.
- 5.9.5. Casing connections should be made up to ensure an aligned, round, secure, and leak proof joint.
- 5.9.6. Where casing or lost rods are left in the coal or ore horizon that has reasonable prospect of being incorporated into a future mining proposal, practitioners should make all reasonable efforts to remove or drill out the casing that may fall within the mining zone. Where removal is impracticable or impossible, the titleholder should record the location and depth of casing or rods and ensure that information is preserved to be considered during future mining activities.

5.10. Subsurface separation

5.10.1. The casing and cement within a drillhole or well should be designed to:

- a) prevent the unintended influx of formation fluids
- b) ensure the sub-surface separation of formations and aquifers, and
- c) prevent unintended flows to the surface.

5.11. Cementing or grouting a hole

Cementing or grouting refer to addition of a concrete mixture to a hole to seal the hole, preventing migration of formation fluids or groundwater, or to form a rheological contrast to divert the path of a drill string upon re-entry. Cementing is used as a procedural technique particularly for directional drilling and sealing casing, but is also a risk based control measure for preventing aquifer interference, formation fluid migration, and preventing inrush of fluids into existing or potential future underground workings.

5.11.1. When decommissioning a drillhole or well using cement mixtures the design of the cement job should:

- a) prevent migration paths and isolate the targeted zone from other formations or from actual or potential mine workings
- b) prevent interconnection between zones of differing pressures and water quality
- c) Prevent flow / leaks of formation fluids and gases to the surface
- d) ensure the long term effectiveness of the decommissioning method.

5.11.2. When using cement as part of the installation of casing for well integrity purposes, the cement job should:

- a) fully fill the annulus between the casing string and the drillhole wall or next casing string
- b) form an effective seal between the casing and the drillhole wall or other casing string to prevent fluid flow behind the casing.

5.11.3. Before a cementing job is conducted, the drillhole or well should be cleared of obstructions and impurities by circulating at least one (1) full hole volume of drilling fluid prior to pumping the cement mixture. If casing is being installed circulation should occur after the casing has been run to its seating depth.

5.11.4. All cementing operations should:

- a) be carried out with proper mixing, blending and pumping of the cement job at the drillhole or well site
- b) be properly supervised
- c) include determination and planning for the use of spacers (including their volume and composition) to allow for appropriate contact time during pumping, and
- d) be recorded, including recording any cementing problems encountered.

5.11.5. Should cement recede after coming to the surface, top-up should occur as soon as possible and before any downhole activity begins.

5.11.5. Where drillhole and well design does not provide for cementing to be brought to the surface:

- a) an appropriate overlap distance back inside the previous casing string should be provided
- b) a secondary barrier should be installed in the annular space

- c) pressure testing should be performed and recorded to verify zonal isolation has occurred.

An overlap distance of at least 50 meters back inside any previous casing string should be provided.

- 5.11.6. The setting time for cement should be adequate to ensure that the cement will achieve an appropriate compressive strength.
- 5.11.7. When carrying out a cement job, rotation or vertical movement (i.e. reciprocation) of the casing should be considered to improve cement placement and drilling mud removal.
- 5.11.6. Cement mixtures used in a cement job should be:
 - a) selected to minimise shrinkage
 - b) selected to reduce the potential for propagation of fractures and leakage paths
 - c) calculated to account for the potential for shrinkage during setting, and
 - d) chosen based on the specific conditions in the sub-surface at the drilling location.
- 5.11.8. Calcium chloride or other chloride-based accelerants should not be added to the cement mix unless the free water content of the cement is specified as <2%.

5.12. Suspension

The suspension of drilling for further activities is common practice when drilling petroleum wells. Drilling can also be suspended on coal or cored minerals drillholes, and risk control measures similar to those required for petroleum drilling are then required to maintain drillhole integrity and site security.

- 5.12.1. When a drillhole or well is suspended measures should be put in place to ensure that the hole can be safely re-entered upon restarting drilling or decommissioning.
- 5.12.2. A suspended drillhole or well must be made safe before the site is put on hiatus. This includes:
 - a) securing the hole to prevent leakage of fluids or gas to the surface, and
 - b) securing the site to prevent unauthorised or inadvertent access by people, livestock and wildlife.

5.13. Monitoring

- 5.13.1. When a drillhole or well is suspended during drilling for an extended period, measures should be put in place to monitor the status of the hole during the suspension including:
 - a) checking for surface leaks
 - b) checking for equipment damage/failure
 - c) ensure downhole equipment is not seized by in-hole clays or debris
 - d) checking for unauthorised access to the site
 - e) ensuring the site is generally maintained in a safe state.

Testing of the casing integrity may include pressures tests to determine whether there are any failures of the casing string that may have occurred during the operation.

5.14. Decommissioning/rehabilitation

5.14.1. All drillholes and wells should be decommissioned in such a way to as far as practicable:

- a) maximise the long term integrity of the well or drillhole, and
- b) minimise the impact on human health and safety, and the environment.

Generally, collar casing should be cut a minimum distance of 1.5 meters below the surface to reduce the impact on future land use.

The removal of casing from a coal seam may be a condition of title requiring an exemption from the department to leave it in place.

5.14.2. Where an exploration drillhole has no casing, holes should:

- a) be either plugged or backfilled, so that the hole is not open to surface
- b) if there is a requirement to relocate the hole, install an in-collar marker that does not interfere with future land use options.

5.14.3. Upon decommissioning, the collars of drillholes and wells should:

- a) have no open annulus to the surface
- b) where casing is to temporarily remain; have a marker plate installed
- c) where casing is to be removed; ensure PVC collar casing, steel hole casing, and sub-surface infrastructure is cut below the surface at an adequate distance to minimise potential impact on future land use.

5.14.4. Steel casing should generally be removed from the drillhole or well where it crosses a coal seam or mineral ore zone. Where this is not possible, an accurate downhole positional survey should be undertaken.

5.15. Corrosion

5.15.1. Where a significant risk of corrosion from groundwater or other formation fluids is identified, the use of corrosion resistant equipment or using corrosion inhibitors in the drilling mud should be considered.

5.16. Loads and pressures

5.16.1. In-hole loads and pressures are a risk generally associated with petroleum drilling, however the risk is also applicable to coal drilling and advanced exploration, particularly where extended casing lengths are used.

5.16.2. Casing, casing connections, cement, wellheads, and valves used in a drillhole or well should be designed to withstand the loads and pressures that may act on them throughout the entire drillhole and well life cycle.

Loads and pressures may include casing running and cementing, any treatment pressures, production pressures, any potential corrosive conditions, and other factors pertinent to local experience and operational conditions.

5.17. Flaring

5.17.1. Where flaring may be required, a flare pit or stack should be constructed a safe distance from the drillhole or well.

5.18. Gas detection

5.18.1. Where drilling is likely to intersect coal or petroleum formations, a gas detection system should be used at the drillhole or well site to identify hydrocarbon bearing formations and potential gas influx.

5.18.2. Gas detectors used at a drill site should be capable of detecting and sounding an alarm when dangerous concentrations are reached for the following gases:

- a) Methane (CH₄) at <50% of the Lower Explosive Limit (LEL) of 5% air concentration
- b) Hydrogen Sulphide (H₂S) at 10 ppm (0.005%) concentration
- c) Carbon Monoxide (CO) at 200 ppm (0.02%) concentration.

5.19. Control barriers

5.19.1. The use of control barriers is required in any situation where there is a risk of loss of petroleum formation fluids, or cross-aquifer contamination. Where applicable, control barriers should be installed to ensure that:

- a) individual aquifers are isolated and sealed, and
- b) formation fluids are unable to escape from the drillhole or well
- c) interconnections between formation fluids and groundwater do not occur.

5.19.2. When hydrocarbon release is possible, at least two drillhole or well control barriers should be provided.

5.20. Wellheads

5.20.1. Where casing is to be installed for well control purposes on petroleum wells or deeper coal or minerals drillholes, drillholes or wells should incorporate a wellhead that should:

- a) form an integral part of the drillhole or well
- b) incorporate equipment to control surface pressure and manage the extraction of hydrocarbons or other liquids or gases from the drillhole or well
- c) ensure drillhole and well integrity at the surface
- d) enable the installation of equipment to ensure that risks associated with blow-out and fugitive emissions can be minimised.

Wellheads should be integrated through the use of threading or welding onto the first string of casing which has been cemented in place during drilling operations.

5.21. Blow-out prevention

5.21.1. When there is a risk of encountering high pressure formations during drilling blow-out prevention control equipment should be:

- a) incorporated into the design of the drillhole or well

- b) facilitated through the design of the casing strings
- c) function and pressure tested
- d) be maintained on the wellhead until such a time as the well is suspended or decommissioned.

6. Additional guidelines and risk controls for petroleum wells

The following section provides additional guidelines and risk control measures which are unique to the design, construction and operation of wells for the exploration and production of petroleum, including coal seam gas. Certain exploration and production wells drilled for geothermal energy resources should also consider the guidance provided in this section.

This section should be considered in conjunction with the other, general and risk specific guidelines contained in Parts B and C, and should be read in conjunction with **Table 1** (Directory of major known hazards and risks) which provides guidance on which sub-sections of this text are relevant for addressing identified hazards.

6.1. Petroleum wells

- 6.1.1. Production wells should be constructed with at least two strings of casing including the surface control casing and the production casing.
 - 6.1.2. The wellhead should be appropriate to ensure the surface integrity of the surface casing annulus (between the production casing and surface casing).
 - 6.1.3. Conductor casing should be designed and located to ensure that:
 - a) it is within a competent formation, where possible
 - b) it is able to circulate drilling fluids to the shale shakers without eroding the surface sediments below the rig and rig foundations
 - c) it will adequately protect the drillhole or well, and equipment against surface formation instability.
- For exploration or appraisal wells the minimum setting depth of the surface casing string should generally be the greater of 10% of the planned total depth of the well or 100 metres when no intermediate casing string is planned.

If an intermediate casing string is planned then the surface casing string need only be 10% of the planned depth of setting of the intermediate casing shoe.
- 6.1.4. Conductor casing may also be used to structurally support some of the subsequent casing or wellhead loads.
 - 6.1.5. Surface casing should be designed and located to ensure that:
 - a) it will be able to prevent cave-in of unconsolidated, weaker near surface sediments
 - b) it is able to contain the flow without fracturing the shoe in the event of a kick while drilling the next hole section
 - c) shallow groundwater is protected from contamination.

- 6.1.6. All surface casing should be cemented from shoe to surface.
- 6.1.7. Production casing should be set at the base of the proposed production interval and extend to the surface.
- 6.1.8. Where production casing is run as a liner string the top of the liner should be at least 25 metres above the intermediate casing string shoe depth, unless casing design indicates otherwise.
- 6.1.9. Production casing for horizontal coal seam wells should:
- enter or tag the coal
 - be set within a competent formation.
- 6.1.10. Horizontal wells that are drilled into the target formation should have casing cemented from casing total depth back to surface.
- 6.1.11. Wiper plugs should be used for displacing production casing cement. Top wiper plugs should be used for surface casing to enable plug bump and the pressure testing of the casing before the cement cures.
- 6.1.12. Production casing cement on vertical drillholes or wells excluding barefoot casing designs should be at least 30 metres below the deepest target formation (30 metre rathole sump).
- 6.1.13. Casing should be pressure tested:
- prior to drilling out for the next hole section (in the case of surface or intermediate casing)
 - prior to starting completion operations (in the case of production casing).

Laboratory testing procedures should be carried out in accordance with API RP 10B-2 - Pressure testing should be performed and recorded after all the cement has reached a compressive strength of 500 psi. Testing pressures should be no less than 500 psi (3.5 MPa) over the previous casing Leakoff Test at the shoe.

Prior to slacking off or removing the BOPs, the compressive strength achieved should generally be a minimum of 100 psi (0.7 MPa).

Prior to drill out the compressive strength should equate to the laboratory testing time for cement surrounding the casing shoe and should generally achieve a minimum compressive strength of 500 psi (3.5 MPa).

Repetitive success may be measured by the adequacy of cement bond for five wells in each new field or area of different geological conditions.

- 6.1.14. The cementing of casing strings should consider the impact of internal casing pressures on cement bond quality.
- 6.1.15. Testing of the cement mixture should include:
- slurry density
 - thickening and setting times
 - fluid loss and free water
 - compressive strength vs. time at bottomhole pressures

- e) compatibility of the cement with mix water
- f) drilling mud and spacer fluids
- g) mechanical properties of the cement once it has set.

6.1.16. Cement laboratory testing procedures should be carried out in advance of the well being drilled to ensure the resulting slurry meets the requirements of the design. The testing should include compressive strength development with time.

6.1.17. Samples of the cement mixture should:

- a) be taken periodically during the cement job to enable assessment of the quality and provide a visual indication of the cement setting rates
- b) be kept at the drill site for the duration of the drilling activity
- c) be retained following the end of operations as a record of the cementing work undertaken in the well.

6.1.18. Calliper logs in well sections, where available, should be used to confirm cement volume requirements

6.1.19. Baseline cement bond log evaluation should:

- a) be considered in each new field area where confirmation of cement placement has not been demonstrated
- b) be used to confirm the integrity of the cement annulus between the wall of the well and the entire length of the production or lower casing
- c) continue until repetitive success of slurry design and cement jobs, and adequacy of cement bond for zonal isolation is confirmed.

6.1.20. Monitoring and recording should be taken of:

- a) cement returns to surface to confirm the effectiveness of the cement placement, and
- b) pressures during the cement job and in particular immediately prior to plug bump as a potential indicator of height of cement column and downhole problems.

6.1.21. Where a zone has been perforated for testing or production purposes the well should be tested above this zone to ensure there are no failures of the casing across beneficial aquifers higher in the well.

6.1.22. Where a well is completed for production purposes a sampling point should be incorporated into the well design to enable the taking of samples of the final mix of additives and fluids to be used, prior to the use in any drilling, fracture stimulation, or well servicing activities.

6.1.23. Regular monitoring of the seals between the wellhead and casing, and other control equipment should be carried out to confirm the integrity of the wellhead sealing components and test whether the wellhead is capable of containing expected pressures in the well. Testing should occur, in particular:

- a) when the wellhead is first installed
- b) whenever control equipment is installed (including reinstallations)
- c) following any well interventions or workovers.

Testing should confirm the integrity of the wellhead sealing components and whether the wellhead is capable of containing expected pressures in the well.

6.1.24. Leak-off tests or formation integrity tests should be used on the drill out of casing shoes as a potential guide to shoe integrity (i.e. good cement around the casing shoe) as well as assisting with well design for risk control.

The test pressure should be greater than the anticipated formation pressure possible at the surface, but should not exceed 60% of the burst pressure rating of the casing with the safety factor applied.

6.1.25. Testing of the seals between the wellhead and casing and other control equipment should be carried out following any well interventions or workovers.

6.1.26. Drilling rigs should be equipped with a penetration rate recorder that:

- a) will give a clear indication of a change in formation
- b) can be used as a guide to warn against approaching areas of abnormal pressure
- c) is maintained in good working order and in continuous operation while drilling.

6.1.27. Deviation surveys should be used where necessary to ascertain the deviation of the well from vertical.

6.1.28. Accurate downhole surveys of each well should be carried out using fit-for-purpose logging tools in vertical drillholes or wells, or measurement while drilling (MWD) techniques in deviated drillholes or wells.

6.1.29. When re-entering a well during interventions and workovers, the opportunity should be taken to:

- a) inspect, and repair or replace faulty or damaged surface equipment when it is removed from the well
- b) test the mechanical integrity of the casing.

6.1.30. Samples of gas taken during the monitoring of leaks or the measurement of annulus pressures should be taken and analysed to assist in the determination of the source, type and scale of the leak and the method of repair.

6.2. Fracture stimulation

- 6.2.1. A minimum required ultimate compressive strength for cement slurries to be used across zones which may be hydraulically fracture stimulated should be determined and documented in the well procedures.
- 6.2.2. A cement mixture with appropriate compressive strength for the planned fracture stimulation jobs should be placed across and extend at least 150 metres above the zone to be hydraulically fractured.
- 6.2.3. Additives and fluids used for the purpose of any drilling, fracture stimulation, or drillhole or well servicing activities should:
- a) not contain benzene, toluene, ethylbenzene and xylene (BTEX) compounds
 - b) be certified BTEX free by:
 - (i) the manufacturer, for original, unopened chemical stock, or
 - (ii) a laboratory certified by NATA to undertake testing for the presence of BTEX, where chemical stock that has been previously opened prior to introduction/importation onto the project site, and
 - c) maximise the use of biodegradable substances.
- 6.2.4. Samples of all additives, fluids or chemical stock used in any drilling, fracture stimulation or drillhole or well servicing should be routinely taken and monitored to ensure they maintain the required properties set out in any associated drilling plan or those determined by a competent drilling engineer or mud engineer during drilling operations

Appendix 1: Recording and reporting requirements

Before, during and after a drilling activity there are requirements to submit notifications and reports to the department. The authority or title holder should ensure that they understand all relevant notification and reporting requirements by familiarising themselves with the legislation, regulations, codes of practice and guidelines that may be found on the Division of Resources and Energy website

(www.resourcesandenergy.nsw.gov.au) or the NSW Legislation website (www.legislation.nsw.gov.au/).

Titleholders should also review the conditions of title, and conditions of any activity approvals that have been granted, to ensure compliance with the reporting requirements for a specific title.

The following table provides an outline of the documents that may contain notification and reporting requirements relevant to the conduct of drilling operations.

From time to time these documents may be amended, replaced or repealed or additional documents published. Contact the department for up-to-date information about notification and reporting requirements.

APPLIES TO BOTH Minerals authorisations (including metals, coal and geothermal energy) and Petroleum titles
<p><i>Exploration code of practice: community consultation</i> Refer to Division of Resources and Energy website page on codes of practice: www.resourcesandenergy.nsw.gov.au/miners-and-explorers/codes-and-guidelines/codes-of-practice</p>
<p><i>Exploration code of practice: environmental management</i> www.resourcesandenergy.nsw.gov.au/miners-and-explorers/codes-and-guidelines/codes-of-practice/environmental-management</p>
<p><i>Exploration code of practice: produced water management, storage and transfer</i> www.resourcesandenergy.nsw.gov.au/miners-and-explorers/codes-and-guidelines/codes-of-practice/produced-water</p>
<p><i>Exploration code of practice: rehabilitation</i> www.resourcesandenergy.nsw.gov.au/miners-and-explorers/codes-and-guidelines/codes-of-practice/rehabilitation</p>

ONLY Minerals authorisations (including metals, coal and geothermal energy)	ONLY Petroleum titles
<p><i>Mining Act 1992</i> www.austlii.edu.au/au/legis/nsw/consol_act/ma199281/</p>	<p><i>Petroleum (Onshore) Act 1991</i> www.austlii.edu.au/au/legis/nsw/consol_act/pa1991224/</p>
<p><i>Mining Regulation 2016</i> http://www.legislation.nsw.gov.au/regulations/2016-498.pdf</p>	<p><i>Petroleum (Onshore) Regulation 2016</i> http://www.legislation.nsw.gov.au/regulations/2016-500.pdf</p>
<p><i>Exploration reporting: A guide for reporting on exploration and prospecting in New South Wales</i> www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/mineral</p>	<p><i>New guidelines for digital data submission and reporting of onshore petroleum exploration in new south wales</i> www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0005/534776/Guidelines-for-data-submission-and-report-structure-for-nsw-petroleum-onshore-exploration.pdf</p>
<p><i>ESG4: Environmental compliance reporting guidelines for coal and mineral prospecting operations</i> www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/mineral</p>	<p><i>OCSG F03- Notice of intention to carry out fracture stimulation form</i> www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/petroleum</p>
	<p><i>OCSG F04- Fracture stimulation completion report form</i> www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/petroleum</p>

ONLY Minerals authorisations (including metals, coal and geothermal energy)	ONLY Petroleum titles
	OCSG F05- Annual safety report form www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/petroleum
	OCSG F06- Notice of intention to drill. www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/petroleum
	OCSG F07- Well suspension and abandonment form. www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/petroleum

The following provides an indication of the reports and notifications that may be required for drilling activities issued under the *Mining Act 1992* or the *Petroleum (Onshore) Act 1991*.

Recording and reporting data

For details of requirements for recording and reporting of drilling activities, refer to:

In respect of coal and minerals titles where titles were issued and applications for renewal or transfer were submitted prior to 1 July 2015; *Exploration reporting: A guide for reporting on exploration and prospecting in New South Wales* (<http://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/mineral>)

In respect of all prospecting titles (including minerals, coal and petroleum) granted, renewed or transferred in relation to applications lodged after 1 July 2015; *Exploration guideline: annual activity reporting for prospecting titles* (<http://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/codes-and-guidelines/guidelines/annual-activity-reporting>)

In respect of all mining authorities, Exploration reporting: a guide for reporting on exploration and prospecting in New South Wales (<http://www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/mineral>) except where title conditions prevail over this guideline.

The *Petroleum (Onshore) Act 1991*, s 131 and *Petroleum (Onshore) Regulation 2016*, Parts 2 & 3 outline the records to be furnished in relation to a petroleum well.

The Mining Act 1992 s 163C, and *Mining Regulation 2016* pt 5 outline the records required in relation to mining titles.

Drillhole and well lifecycle records

Accurate information on the design, drilling, construction, reconditioning, and decommissioning of drillholes and wells should be recorded for future reference and should be maintained for the entire operational life of the drillhole or well.

Records to be maintained may include, but are not limited to, the following:

All drilling

- risk assessments
- daily rig reports
- daily geological reports, if relevant
- core or percussion chip logging reports
- records of drilling and cementing/grouting, including any problems encountered during the drilling
- casing tallies for all casing strings run (including lengths, weights, grades, inside diameter, outside diameter, setting depth)
- cementing records for each casing string in each drillhole or well
- records of chemicals used downhole, including any chemicals used in drilling fluid, treatment and workover or other well procedures (name, type, CAS number and volume of each chemical used should be recorded).

Petroleum drilling only

- engineering design basis
- kick tolerance/well control design assumptions
- BOP pressure testing requirements, and actual test records
- laboratory test results for cement slurries
- well drilling and completion programs including casing running and grouting or cementing procedures casing pressure test reports
- leak off test and/or formation integrity test reports
- wireline logs
- downhole installation records/schematic
- service company reports.

Drillcore, percussion chips and cutting samples

Conditions of authorisations require that all mineral exploration drillcore and representative percussion chips or cuttings from petroleum exploration drilling are preserved and, if necessary, made available to department officers for inspection and sampling. Drillcore and representative chips or cuttings must not be disposed of without approval from the department.

At the completion of a drilling program or the relinquishment or cancellation of an authority all drillcore, representative chips and cuttings no longer needed by the authority holder should be offered to the department for storage at a department core library.

Opal prospecting licence drillhole logs

The conditions of an opal prospecting licence require the holder to submit a satisfactory report on all prospecting conducted on the licence. This report should include a completed drillhole log sheet or sheets for all holes drilled, and plans showing the location of all holes drilled or shafts sunk.

Reporting and notification requirements specific to the *Petroleum (Onshore) Act 1991*

The following reports and notifications to the department, relating to petroleum wells, are required to be submitted by title holders.

Notification to drill

Titleholders must lodge a notification on the department's approved [Notice of intention to drill form](#), not later than 14 days before starting work, in accordance with Clause 8 of the *Petroleum (Onshore) Regulation 2016*.

Location surveys

As soon as is practicable after the location of a well is established and after spudding the title holder must survey the location of the well using MGA coordinates. These coordinates will be provided to the department as part of the reporting for the well.

Bottomhole location/total depth and the pathway for deviated and horizontal wells must be surveyed and survey data must be included in a report to the department.

Operational reporting

Title holders must submit a report to the department within six months following the completion of:

- drilling an exploration well
- drilling a production well
- a 'significant' component of a work program in the conditions of title.

Well completion reports

Well completion reports, inclusive of the plug & abandonment (decommissioning) report, are mandated in Part 3: Reports of the *Petroleum (Onshore) Regulation 2016*, and are required to be submitted within 6 months of the completion of any well drilled under the *Petroleum (Onshore) Act 1991*. The department guidelines for **digital data submission and reporting of onshore petroleum exploration reports (February 2012) details the requirements for this report**.

Cementing reports

Cementing reports, including all materials and compression strength vs time graphs, cement pump charts and pressure records, logging reports including well deviation details and details of centraliser placing must be completed and submitted to the department with well completion reports.

Department of Primary Industries - water notification

Exploration and production titles granted under the *Mining Act 1992* and the *Petroleum (Onshore) Act 1991* may require notification to the Department of Primary Industries – water of the intention to drill. You are advised to contact the department to establish the requirements in this regard.

www.resourcesandenergy.nsw.gov.au/miners-and-explorers/enforcement/exploration-reporting/mineral

Work health and safety requirements

Changes to the work health and safety framework in relation to petroleum commenced on 1 February 2016 with amendments to the *Work Health and Safety (Mines and Petroleum Sites) Act 2013* and *Work Health and Safety (Mines and Petroleum Sites) Regulations 2014* and the *Work Health and Safety (Mines and Petroleum) Amendment (Harmonisation) Regulation 2016*.

Please see the safety and health area of the website NSW Resources & Energy website for further information.

www.resourcesandenergy.nsw.gov.au/miners-and-explorers/safety-and-health

Safety management systems

A mine or petroleum site operator is required to apply a rigorous, risk-based approach to the safety of operations and implement a comprehensive system to manage work health and safety risks.

Under the ***Work Health and Safety (Mines and Petroleum Sites) Regulation 2014***, a mine or petroleum site operator must develop and implement a safety management system (SMS) at a mine or petroleum site. The SMS requirements also apply to those places where exploration by mechanical means, for either minerals or petroleum, is undertaken.

For further information about preparing an SMS refer to the [Safety management systems in mines](http://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0008/543941/NSW-code-of-practice-Safety-managment-systems-in-mines.pdf) approved WHS code of practice published by the department (www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0008/543941/NSW-code-of-practice-Safety-managment-systems-in-mines.pdf).

Incident reporting

In accordance with Part 3 of the *Work Health and Safety (Mines and Petroleum Sites) Act 2013*, a person who conducts a business or undertaking must ensure that the department's Mine Safety inspectorate is notified immediately after becoming aware that a notifiable incident arising out of the conduct of the business or undertaking has occurred.

There is a duty to report pollution incidents to the Office of Environment and Heritage under section 148 of the *Protection of the Environment Operations Act 1997*.

See www.epa.nsw.gov.au/licensing/dutytonotify.htm

Other incident reporting requirements may be applied through conditions on title.

Appendix 2: Definitions

Reference to a document in this **guideline** is a reference to that document as amended or replaced from time to time.

Terms	Meaning
aquifer	Has the same meaning as it has in the <i>Water Management Act 2000</i> being a geological structure or formation, or an artificial landfill, that is permeated with water or is capable of being permeated with water
barrier	Part of a drillhole or well designed to prevent fluids or gases from flowing unintentionally from a formation, into another formation or to escape at surface
beneficial aquifer	An aquifer containing water of sufficient quality and quantity for use in domestic, agricultural or industrial purposes
borehole	Means a hole made by drilling or boring, but excludes sampling and coring using hand held equipment and petroleum wells. The term is generally interchangeable with drillhole, but is generally used in reference to drilling for coal
casing	Oversize diameter pipe lowered into an open hole, either free standing or cemented in place. The drillhole or well designer must design casing to withstand a variety of forces, such as collapse, burst, and tensile failure, as well as chemically aggressive brines. Casing is run to prevent hole collapse, protect fresh water formations, isolate a zone of lost returns or isolate formations with significantly different pressure gradients
casing shoe	The bottom of the casing string, including the cement around it, or the equipment run at the bottom of the casing string
cement	Powder consisting of alumina, silica, lime and other substances that hardens when mixed with water. Different specifications of cement are used for different purposes. Extensively used to bond casing to the walls of the drillhole or well
cementing	The application of liquid slurry of cement and water to various points inside and outside the casing. This may also be termed 'grouting'
cement plug	A balanced plug of cement slurry placed in the wellbore
centraliser	A device fitted with a hinged collar and bowsprings to keep the casing or liner in the centre of the drillhole or well to help ensure efficient placement of a cement sheath around the casing string
circulation	The process of pumping a fluid down the drillhole or well and back up to the surface in a drilling or workover operation
decommissioning	The final sealing of a hole and removal of drilling equipment from the site. Generally the term 'decommissioning' is used in reference to petroleum bores, however many of the processes and risks equally apply to advanced drilling processes for coal and minerals. Equivalent industry terminology includes plug and abandonment, backfilling, permanent abandonment, grouting, rehabilitation etc.

Terms	Meaning
drillhole	Means a hole made by drilling, coring or boring, but excludes sampling and coring using hand held equipment and petroleum wells. The term is generally interchangeable with 'borehole', and is used as the preferred nomenclature in this Guideline to be inclusive of all coal and minerals drillholes, but exclusive of petroleum wells
drilling	Means the perforation of the earth's surface crust by mechanical means, whether the hole caused by the perforation is vertical, inclined or horizontal, and includes all operations for preventing collapse of the sides of any such hole or for preventing it from being filled with extraneous materials including water
drilling additives	Includes all substances (gas, solid or liquid) injected into the ground or used during drilling a drillhole or well or servicing with the exception of source water
drilling fluid	Any of a number of liquid and gaseous fluids and mixtures of fluids and solids (as solid suspensions, mixtures and emulsions of liquids, gases and solids) used in operations to drill drillholes into the earth
drilling mud	Water-based drilling fluid
fracture stimulation	The process by which target hydrocarbon bearing formations are 'stimulated' when fluids or gases are forced at high pressure to create a conductive flow path, resulting in enhanced flow of hydrocarbons to the wellhead
groundwater	Water that occurs beneath the ground surface in the saturated zone
horizontal well	Deviation of a drillhole from vertical so that the drillhole penetrates a productive formation in a manner parallel to the formation
hydrocarbon-bearing formation	A rock unit containing hydrocarbon fluids or gases
integrity (of a drillhole or well)	Maintenance of a drillhole or well such that: <ul style="list-style-type: none"> • the continuance of drilling is possible, • gas kicks and blow-out is prevented, and • rock units containing water, petroleum or other fluids/gases remain in isolation from each other and the surface

Terms	Meaning
heritage item	Means: <ul style="list-style-type: none"> • an Aboriginal object or place, or • an item of heritage significance being • any heritage items listed in one or more of the following: <ul style="list-style-type: none"> ▪ the Commonwealth Heritage List ▪ the World Heritage List ▪ the National Heritage List ▪ the State Heritage Register ▪ an Environmental Planning Instrument • any relic (being any deposit, object or material evidence which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and which is 50 or more years old) • within state conservation areas: <ul style="list-style-type: none"> ▪ items that are listed on the DECC historic heritage information management system ▪ any deposit, object or material evidence relating to the settlement or occupation of NSW or a part of NSW (not being Aboriginal settlement or occupation) if the deposit, object or material evidence is more than 25 years old at the date of the interference or removal.
PPE	personal protective equipment
production casing	A casing string that is set across the reservoir interval and within which the primary completion components are installed
prospecting title	An exploration licence, assessment lease or special prospecting authority granted under the <i>Mining Act 1992</i> or the <i>Petroleum (Onshore) Act 1991</i> .
sensitive receiver	Includes: <ul style="list-style-type: none"> • dwellings • items and places of cultural heritage • land reserved or acquired under the National Parks and Wildlife Act 1974 (NPW Act) • libraries • educational and research institutions (including schools, colleges and universities) • childcare centres • kindergartens • hospitals, surgeries and other medical institutions • places of public worship • milking sheds and holding yards associated with dairies • animal boarding or training establishments • aquaculture • intensive livestock agriculture, and • land identified as critical habitat.
surface	A natural ground surface or the top of the BOP flange when installed

Terms	Meaning
surface casing	Casing run from surface to suitably competent strata, fully fixed in position, and the connection point for blow-out preventers used to seal off water/hydrocarbon sands to prevent loss of circulation. Also used to seal off water sands, weak formations and/or lost circulation zones. In some cases surface and intermediate casing requirements are provided by the same string
title	An authority under the Mining Act 1992 or a petroleum title under the Petroleum (Onshore) Act 1991
titleholder	A person or company to whom a title has been issued
water bearing zone	Geological strata that are saturated with groundwater but not of sufficient permeability to be called an aquifer
well	Has the same meaning as the <i>Petroleum (Onshore) Act 1991</i> where well: means a hole made by drilling in connection with exploration for petroleum or operations for the recovery of petroleum, but does not include a seismic shot hole
wellhead	Means casing head, and includes any casing hanger or spool, or tubing hanger, and any flow control equipment up to and including the wing valves
well intervention	An operation carried out by re-entering an existing drillhole or well
well servicing	Means the process of performing maintenance or remedial treatments on a drillhole or well. Examples of drillhole or well servicing operations are pump repairs, drillhole or well deepening, plugging back, pulling and resetting liners, squeeze cementing, re-perforating, cementing, wire line operations, fracturing, down hole tool services and selective stimulation
well servicing rig	A rig designed and operated for the purposes of drillhole or well servicing
workover	The process of performing major maintenance or remedial treatments on a drillhole or well

Appendix 3: Industry standards

Titleholders should also consider the following industry standards that may be appropriate for the application of this guideline to manage drillhole and well construction issues associated with the whole of life cycle requirements. These standards and specifications are listed as a reference and should be used as and where appropriate to the overall management of integrity of drillholes and wells.

General web sites for purchase of standards include:

HIS Engineering 360 www.globalspec.com/

API Standards Store www.techstreet.com/api

SAI Global www.saiglobal.com/en-us/standards_and_legislation/

Standards Australia www.standards.org.au/Pages/default.aspx

Individual recommended standards include:

- ANSI/API Specification 15LR, Low Pressure Fibreglass Line Pipe and Fittings.
www.standards.globalspec.com/std/1670665/api-spec-15lr or <http://www.techstreet.com/products/933520>
- ANSI/API Specification 15R, High Pressure Fibreglass Line Pipe.
standards.globalspec.com/standards/detail?docid=9991820&familyid=ODWHHAAAAAAAAAAAA or
www.techstreet.com/api/products/1910824
- API Recommended Practice 10B-5/ISO 10426-5, Recommended Practice on Determination of Shrinkage and Expansion of Well Cement Formulations at Atmospheric Pressure.
standards.globalspec.com/standards/detail?docid=9958092&familyid=UNWQHBAAAAAAAAAAAAA or
www.techstreet.com/api/products/1212709
- API Specification 10D/ISO 10427-1, Specification for Bow-Spring Casing Centralizers.
standards.globalspec.com/standards/detail?docid=9958050&familyid=ZCNRHAAAAAAAAAAAA or
www.techstreet.com/api/products/957236
- API Recommended Practice 10F/ISO 10427-3, Recommended Practice for Performance Testing of Cementing Float Equipment.
standards.globalspec.com/standards/detail?docid=9958037&familyid=DBTZGAAAAAAAAAAAA or
www.techstreet.com/api/products/957237
- API Specification 13A /ISO 13500, Specification for Drilling Fluid Materials.
standards.globalspec.com/standards/detail?docid=9958456&familyid=QKKHHAAAAAAAAAAAA or
www.techstreet.com/api/products/1673286
- API Recommended Practice 13B-1/ISO 10414-1, Recommended Practice for Field Testing Water Based Drilling Fluids.
standards.globalspec.com/standards/detail?docid=9859391&familyid=JNXLHAAAAAAAAAAAA or
www.techstreet.com/api/products/1876478
- API Recommended Practice 13D, Recommended Practice on the Rheology and Hydraulics of Oil-well Drilling Fluids.
standards.globalspec.com/standards/detail?docid=1252824&familyid=YMKQHAAAAAAAAAAAA or
www.techstreet.com/api/searches/11639285
- API Recommended Practice 53, Blowout Prevention Equipment Systems for Drilling Operations.
standards.globalspec.com/standards/detail?docid=1560810&familyid=MZGABFAAAAAAAAAAAAA or
www.techstreet.com/api/products/1846173

- API Recommended Practice 54, Occupational Safety for Oil and Gas Well Drilling and Servicing Operations. standards.globalspec.com/standards/detail?docid=1670748&familyid=LQAEHAAAAAAAAAAAA or www.techstreet.com/api/products/23363
- API Recommended Practice 59, Recommended Practice for Well Control Operations. standards.globalspec.com/standards/detail?docid=1647218&familyid=MTANHAAAAAAAAAAAA or www.techstreet.com/api/products/1268327
- API Specification 16C, Choke and Kill Systems. standards.globalspec.com/standards/detail?docid=9987679&familyid=PMIBHAAAAAAAAAAAA or www.techstreet.com/api/products/1893233
- API Recommended Practice 5A5/ISO 15463, Field Inspection of New Casing, Tubing, and Plain-end Drill Pipe. standards.globalspec.com/standards/detail?docid=9958024&familyid=PWJYGAAAAAAAAAAAA or www.techstreet.com/api/products/1221367
- API Recommended Practice 5B1, Gauging and Inspection of Casing, tubing and Line Pipe Threads. standards.globalspec.com/standards/detail?docid=9958029&familyid=LUWCHAAAAAAAAAAAA or www.techstreet.com/api/products/13272
- API Recommended Practice 5C1, Recommended Practice for Care and Use of Casing and Tubing. <http://standards.globalspec.com/standards/detail?docid=9958031&familyid=OIDFHAAAAAAAAAAAA> or [/www.techstreet.com/api/products/13273](http://www.techstreet.com/api/products/13273)
- API Technical Report 5C3, Technical Report on Equations and Calculations for Casing, Tubing, and Line Pipe used as Casing or Tubing; and Performance Properties Tables for Casing and Tubing. standards.globalspec.com/standards/detail?docid=9962003&familyid=PSEALCAAAAAAAAAAAAA or www.techstreet.com/api/products/1596765
- API Recommended Practice 5C5/ISO 13679, Recommended Practice on Procedures for Testing Casing and Tubing Connections. standards.globalspec.com/standards/detail?docid=9958033&familyid=EKDOHAAAAAAAAAAAA or www.techstreet.com/api/products/1087582
- API Recommended Practice 5C6, Welding Connections to Pipe. standards.globalspec.com/standards/detail?docid=1679157&familyid=SPSYGAAAAAAAAAAAA or www.techstreet.com/api/products/1258871
- API Specification 16D, Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment. standards.globalspec.com/standards/detail?docid=1679136&familyid=QXODHAAAAAAAAAAAA or www.techstreet.com/api/searches/11640144
- API Specification 16RCD, Drill Through Equipment (Rotating Control Devices). standards.globalspec.com/standards/detail?docid=9955623&familyid=TWWEHBAAAAAAAAAAAA or www.techstreet.com/api/products/1902083
- API Specification 16ST, Coil Tubing Well Control Equipment Systems. standards.globalspec.com/standards/detail?docid=9958090&familyid=AHSNLCAAAAAAAAAAAA or www.techstreet.com/api/products/1608685
- API Technical Report 10TR2, Shrinkage and Expansion in Oilwell Cements. <http://standards.globalspec.com/standards/detail?docid=1410531&familyid=VIMCHAAAAAAAAAAAA>
- API Technical Report 10TR3, Temperatures for API Cement Operating Thickening Time Tests. standards.globalspec.com/standards/detail?docid=1409359&familyid=XDRWIAAAAAAAAAAAAA or www.techstreet.com/api/products/223948
- API Technical Report 10TR5, Technical Report on Methods for Testing of Solid and Rigid Centralisers.

standards.globalspec.com/standards/detail?docid=1093308&familyid=GHZAGCAAAAAAAAAA or www.techstreet.com/api/products/1568068

- API Guideline HF1- Hydraulic Fracturing Operations- Well construction and Integrity guidelines. standards.globalspec.com/standards/detail?docid=1198999&familyid=WOZXOCAAAAAAAAAA or www.techstreet.com/api/products/1654466
- AS 2634 – 1983 Chemical Plant Equipment – Made from Glass-Fibre Reinforced Plastics (GRP) Based on Thermosetting Resins. infostore.saiglobal.com/store/Details.aspx?ProductID=278120&gclid=CPOEo7elissCFcWUvQodgrcDsw
- AS 4326:1995 – The storage and handling of oxidizing agents. www.saiglobal.com/pdftemp/previews/osh/as/as4000/4300/4326.pdf
- AS/NZS 1200:2000 – Pressure equipment. infostore.saiglobal.com/store/Details.aspx?ProductID=356464
- AS/NZS 1477-1999 PVC Pipes and Fittings for Pressure Applications. infostore.saiglobal.com/store/details.aspx?ProductID=358749
- AS/NZS 3000:2007 - Electrical installations. infostore.saiglobal.com/store/Details.aspx?ProductID=366926
- AS/NZS ISO 31000:2009 – Risk management – Principles and guidelines. infostore.saiglobal.com/store/Details.aspx?ProductID=1378670
- AS1210-2010 – Pressure vessels. infostore.saiglobal.com/store/Details.aspx?ProductID=1433359
- AS1657-1992 – Fixed platforms, walkways, stairways and ladders – Design, construction and installation. www.saiglobal.com/PDFTemp/Previews/OSH/As/as1000/1600/1657.pdf
- AS1851 – Maintenance of fire protection systems and equipment. infostore.saiglobal.com/store/Details.aspx?ProductID=249829&creative=62165164155&keyword=australian%20standard%201851&matchtype=b&network=g&device=c&gclid=CNLO9Z-NissCFQQsvQodDkYDdA
- AS1940-2004 - The storage and handling of flammable and combustible liquids. infostore.saiglobal.com/store/Details.aspx?ProductID=253546
- AS3833:2007 - The storage and handling of mixed classes of dangerous goods, in packages and intermediate bulk containers. infostore.saiglobal.com/store/Details.aspx?ProductID=375161
- ASTM D2310 - 06 Standard Classification for Machine-Made “Fibreglass” (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe. infostore.saiglobal.com/store/Details.aspx?ProductID=1595913
- ASTM D2517 – 06 Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings. infostore.saiglobal.com/store/Details.aspx?ProductID=1516255
- ASTM D2996-01 (2007)e1 Standard Specification for Filament-Wound “Fibreglass” (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe. infostore.saiglobal.com/store/Details.aspx?productID=828258 superseded by; infostore.saiglobal.com/store/Details.aspx?productID=1808962
- MDG 1010 Minerals industry safety and health risk management guideline. www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0010/419518/MDG-1010-Guideline-for-Minerals-Industry-Safety-and-Health-Risk-Management-Updated-Jan-2011.pdf
- MDG 1016 – Guidelines for the management of acute workplace injury and illness. First aid in NSW coal mines. www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0003/419520/MDG-1016.pdf
- MDG 15 – Guidelines for mobile and transportable equipment for use in mines. www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0010/419446/MDG-15.pdf

- MEX-011 – Contractor Management Audit Checklist.
www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0007/291346/MEX-011-Contractor-Management-Audit-Checklist.pdf

The following publications may also provide important reference information to persons carrying out drilling.

- Minimum Construction Requirements for Water Bores in Australia. National Uniform Drillers Licensing Committee. www.water.wa.gov.au/__data/assets/pdf_file/0005/1796/Minimum-construction-guidelines-for-water-bores-in-Australia-V3.pdf
- The Drilling Manual. Australian Drilling Industry Training Committee Ltd. aditc.com.au/the-drilling-manual-available-now/