NSW NOW The new state of business

Well Integrity

Office of Coal Seam Gas

What is ‘well integrity’?

- Well integrity is defined as “*the application of technical, operational and organisational solutions to reduce the risk of the uncontrolled release of formation fluids throughout the life cycle of a well*”. (source NORSOK D-010)

- Important for environmental and safety reasons

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Well integrity regulation in NSW

- Schedule of Onshore Petroleum Exploration and Production Safety Requirements (August 1992)
- Code of Practice for Coal Seam Gas Well Integrity (September 2012)
- *Work Health and Safety Act 2011*
- Approvals required before drilling commences

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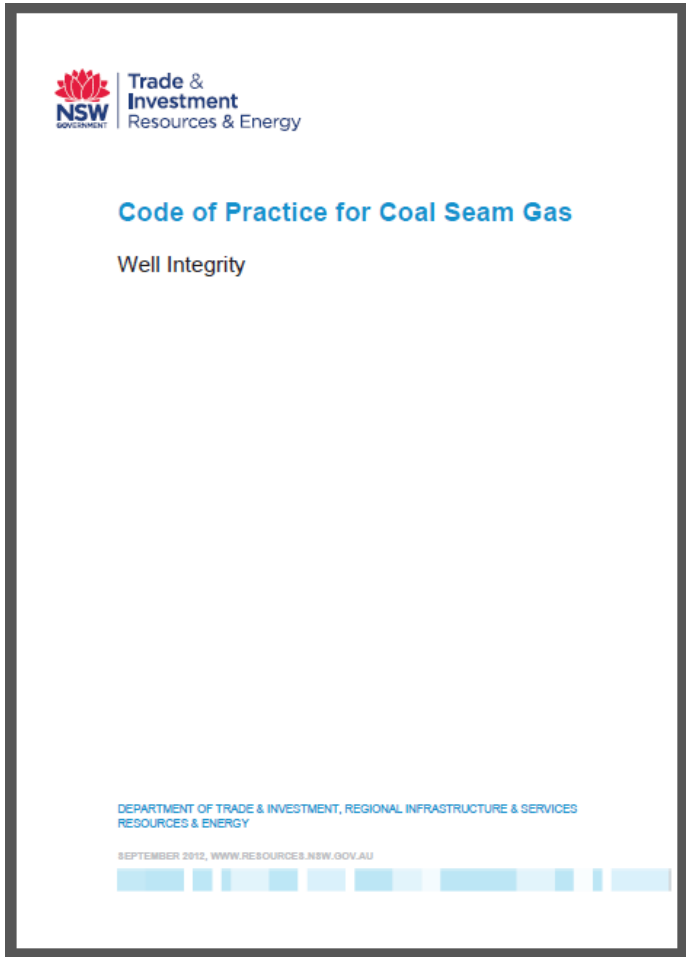
Well Integrity – Code of Practice



Code-of-Practice-for-Coal-Seam-Gas-Well-Integrity (1).PDF

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Compliance and Enforcement

- OCSG Compliance & Enforcement team focusing on petroleum activities.
- Continuous monitoring and inspections/audits - at all stages (WH&S and environment).
- Focus on compliance with title conditions, legislation, Codes, activity approvals, compliance and management systems etc
- Strategic risk based approach – focus on higher risk activities and titles
- Rehabilitation must be satisfactory to release security deposit.
- Gas Plan will make EPA lead regulator for all compliance and enforcement actions (except safety)

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Notifications - Well Integrity Code of Practice

Excerpt from *Section 3.2 Reporting and notification*

3.2.5 Well completion reports

Well completion reports, inclusive of the Plug & Abandonment Report, are mandated in Part 3: Reports of the *Petroleum (Onshore) Regulation 2007*. Refer to the guidelines for the submission of these reports within the *Guidelines for Digital Data Submission and Reporting of Onshore Petroleum Exploration Reports.*[12]

3.2.6 Cementing reports

In addition, 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.

3.3 Incident reporting

In accordance with Part 3 of the WHS Act, 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.

Reporting of Environmental incidents for all coal seam gas well activities must be reported immediately[13] to the department (Environment Branch).

There is a duty to report pollution incidents to the Office of Environment and Heritage. See http://www.environment.nsw.gov.au/licensing/Dutytonotify.htm

If well operations have caused inter-aquifer connectivity, the title holder must immediately contact the NSW Office of Water http://www.water.nsw.gov.au/About-us/Contact-Us/default.aspx

In addition, gas leaks ('wellhead reportable leaks' – refer to Glossary) must be reported to the department.

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Stages of a well's life

Design
- Geology
- Well objectives
- Engineering

Construct
- Drill, Case and Cement
- Test/Evaluate
- Stimulate

Operate/Maintain
- Produce
- Well checks
- Well optimisation
- Well service
- Suspension

Decommissioning
- Decommission well
- Rehabilitate site

(AGL), ST04 Gloucester

(AGL), Ensign Rig 67

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Well construction

Typical vertical well

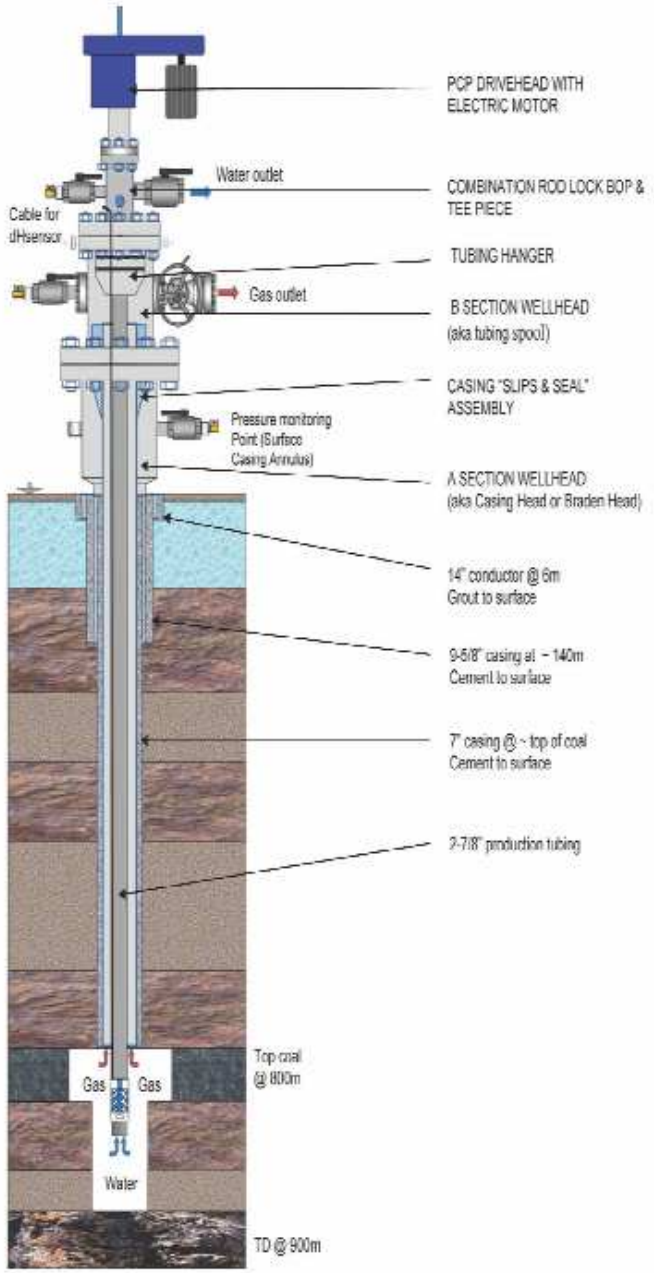

Figure 1: Typical vertical under-reamed completion

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Components

- Casing is fit for purpose – corrosion, collapse, burst, tension
- Casing is cemented with an engineered cement recipe
- Cement job parameters are recorded
- Casing is pressure tested post cementing
- Wellhead

Example of steel casing

Cemented casing cutaway

Typical Wellhead

(Summit Casing) Bow Spring Centralisers

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Construction – examples NSW

Section of casing AGL Camden Gas

Well head infrastructure during drilling, Santos Narrabri

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Construction - Well Integrity Code of Practice

Excerpt from *Section 4.3 Cementing*

4.3 Cementing

4.3.1 Principles

CSG wells need to be cemented to:

- prevent migration paths and isolate the targeted zone from other formations.
- protect beneficial aquifers from contamination.
- maintain aquifer pressures and quality.
- obtain and maintain well integrity.
- protect the casing from corrosion.

4.3.2 Mandatory requirements

a) To prevent interconnection between zones of differing pressure and water quality:

- All surface casing must be cemented from shoe to surface.
- For cementing production and intermediate casing, operators must design to ensure cement is either brought to surface or designed to an appropriate safety overlap distance of at least 50m back inside the previous casing shoe. Where cement is not returned to surface, pressure testing, or an alternative method accepted by the department, must be performed and recorded to verify zonal isolation has occurred after all the cement has reached a compressive strength of 500 psi. Testing pressures must be no less than 500 psi (3.5 MPa) over the previous casing Leak Off Test at the shoe.

b) Cement constituents and properties must be suitable for the intended conditions of use and used in compliance with the relevant MSDS requirements[15].

[15] Note: API RPs 10A, 10B, 10D and 65-2, Guidance Document HF-1 and Technical Report 10TR are the recommended benchmarks for cementing wells.

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Construction - Well Integrity Code of Practice

Excerpt from *Section 4.3 Cementing* - continued

c) Appropriate cement laboratory testing procedures must be carried out (see API RP 10B-2) in advance of the well being drilled to ensure the resulting slurry meets the requirements of the well design. The testing, as a minimum, must include Compressive Strength development with time. In the case where a number of similar wells are drilled in an area with constant cement materials and mix water properties, then a representative lab test may suffice.

e) Titleholders must ensure all zones (both hydrocarbon and beneficial aquifers) are isolated with cement with a minimum ultimate compressive strength of 500 psi (3.5 MPa).

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Construction - Well Integrity Code of Practice

Excerpt from *Section 4.3 Cementing* - continued

j) A minimum of 19mm cement sheath surrounding the nominal OD of the surface casing over the total cementing depth must be demonstrated. Calculations for a vertical well must include a deviation of 3 degrees from vertical at casing depth unless otherwise proven.

k) A minimum of 13mm cement sheath surrounding the nominal OD of the production casing over the total cementing depth must be demonstrated. Calculations for a vertical well must include a deviation of 3 degrees from vertical at casing depth unless otherwise proven.

l) Casing centraliser spacings are to be such that the requirements of (j) and (k) above are achieved.

m) Centralisers and their connections to the casing must meet API Recommended Practice 10TR4 or its equivalent.

n) It is mandatory that wiper plugs be used for displacing production casing cement. Top wiper plugs are recommended for surface casing to enable plug bump and pressure test of the casing before cement cures.

4.3.3 Standards and specifications

Appropriate API and Australian standards must be adhered in the selection and use of cementing products, including AS 3972-2010.

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Operation / Maintenance

- Well production trends monitored
- Well flowing and annular pressures monitored
- Water volume produced is recorded
- Wellhead seals and surface facilities pressure tested and checked for leaks

Well head infrastructure following drilling prior to partial rehabilitation, Santos Narrabri

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Well servicing

- Can be used to take corrective action for well integrity concerns
- Replace downhole components (such as a worn pump)
- Clean out wells
- Replace wellhead components
- Repair casing if required
- Stimulation

A Service Rig

Decommissioning

- Well has completed its set objectives
- Downhole equipment removed
- Well cemented from bottom to top
- Surface facilities removed
- Wellhead removed and casing cut below surface and marked with steel plate
- Program must be approved by OCSG prior to commencement

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Decommissioning - Well Integrity Code of Practice

Excerpt from *Section 4.9 Well abandonment*

4.9.2 Mandatory requirements

a) A well must not be abandoned or suspended without prior departmental approval.

b) All CSG exploration wells must be plugged and abandoned and the department notified on the approved form within 3 months of the last drilling or testing activity, unless the well is converted to another approved purpose.

c) The titleholder must ensure that an abandoned well is sealed by filling the near-vertical section from total depth to top with cement or other sealing program as approved by the department. There is to be no open annulus to the surface.

d) Any well or drill hole that is to be abandoned shall be sealed and filled in such a manner to prevent leak of gas and/or water.

e) Cement shall be used as the primary sealing material. Cement testing should be carried out as per requirements set out in Section 4.3 - "Cementing" of this Code.

f) The titleholder must ensure that an abandoned well is sealed by filling from total depth to top with cement of at least 24 hour laboratory strength of at least 500 psi (3.5 MPa). In near-vertical open hole sections of the well, cement is to be placed in plugs of not more than 200 m lengths with a WOC period of 6 hours between placement. The first plug across the surface casing is to be tested to 500 psi (3.5 MPa) above the estimated or previously recorded LOP. Squeeze-cementing or other method is to be used to effectively seal off abandoned frac zones from the wellbore.

g) BOPs and/or wellhead must not be removed until the cement plug across the surface casing shoe or plug across the uppermost perforations has been physically tagged for correct location and pressure tested.

Decommissioning - Well Integrity Code of Practice

Excerpt from *Section 4.9 Well abandonment - continued*

h) Wellheads must be removed, and casing must be cut greater than 1.5m below surface. A wellhead marker plate must be installed and must be placed and marked with details as per the department's requirements.

i) Complete and accurate records of the entire abandonment procedure must be kept, with these records submitted as part of the titleholder's legislative reporting requirements for the abandonment of CSG wells.

j) If a CSG well intended for abandonment is proposed for conversion to a water well, necessary approvals and licences must be obtained.

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Conclusion

- Ultimate goal of well integrity:
  - to ensure the environmentally sound, safe production of hydrocarbons by containing them inside the well,
  - protecting groundwater resources,
  - isolating the productive formations from other formations,
  - facilitating proper execution of hydraulic fracturing and other stimulation operations, and
  - protecting worker and public safety.
- A good casing and cement job is the foundation for good well integrity
- Well Integrity is a life cycle approach – not limited to drilling

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