Comparison of Well Construction Legislation, Regulations and Directives

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WEP Well Engineering Partners

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Contents

1 Introduction

This report is prepared by Well Engineering Partners (WEP) commissioned by the Swiss Federal Office of Energy (SFOE) / Bundesamt für Energie (BFE). The report aims to aid BFE in the process of developing a legislative framework for Switzerland focusing on the development of the subsurface for geothermal energy resources. This report provides an overview of the existing legislative context on well construction topics of a number of countries which have a well-established oil and gas industry. Legislative context of the neighbouring countries of Switzerland have also been included in this study.

The first step of this study was to complete a database with the context per country per subject. In the end the database has been established by consulting various sources found on the internet, and by digitally searching through the legislations of each individual country.

Brief evaluations and/or comparisons of the legislation per topic/theme and per country were done upon completion of the database. Chapter 2 of this report describes the scope of the study and useful background information. Chapter 3 describes the notable cases of the comparison exercise. Finally, Chapter 4 provides a list of references which have been used for the creation of this report. The actual legislation context database is included as appendix to this report. It is subdivided by the different well construction topics. **Link to Topics**

Disclaimer

No legal rights can be derived from the regulatory descriptions in this document, as they involve unofficial translations of the original documents or have been replaced/overruled by more recent material. The meaning of terms used in the different documents may differ and it is advised to consult the original documents in case more clarity is required.

2 Scope of Study

2.1 Well Life Cycle's Technical Requirements

This report presents an overview and comparison of regulations/directives of the selected countries related to technical requirements which are in place for well construction, stimulation, suspension and well abandonment activities. Requirements related to HSE (Health, Safety and Environment), environmental protection, safety, employment standards and work environment, health protection, emergency planning, oil spill response and liability for accidents are not part of this comparison study. This study focuses on technical requirements defined by industry regulations and standards related to the well life cycle.

2.2 Surveyed Countries

The selection of countries included in this report on the regulatory framework on well construction is based on two criterions and therefore not exhaustive.

1. Countries and regions/states which are predominantly engaged in oil and gas production, comprising well-established well construction industries:
    a. Norway, the Netherlands, United Kingdom, Australia, Canada, New Zealand and the United States of America.
2. Selection of neighbouring countries of Switzerland:
    a. Austria, France, Germany.

By all means, all countries do have federal legislation in place for drilling / well construction activities. However, the U.S.A., Canada and Australia also have state-organized (regional) legislation in place for this purpose. The following regional legislation has been looked into:

- Australia: Western Australia, Northern Territory, New South Wales and Queensland.
    - *The remaining states have mirror (similar) laws to any of these four.*
- Canada: Alberta.
    - *Highest onshore drilling activity in Canada.*
- U.S.A.: California, Colorado, Louisiana, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas and Wyoming.
    - *Evaluation/Comparison has been limited to 10 states; the selected states are considered representative (selection criterion: top ten of "rig count" as per World Oil Magazine).*

The countries falling under the first criterion were all found to have accessible regulatory data available in the public domain, all in English. The official regulations of the three countries falling under the 2nd criterion were found more difficult, mainly due to the fact that the official language of these countries are German and French, and no English translation available.

2.3 Regulatory Approach: Prescriptive vs. Performance-Based

Regulations of technical requirements can be positioned on a spectrum between prescriptive requirements (dictating) and performance-based (describing) or goal-based regulations. Regulations including elements of both approaches are called hybrid approach regulations. A prescriptive or dictating regulation specifies an exact method of compliance that operators are required to meet. For example, a prescriptive well construction regulation would dictate the exact depth, size, type, composition of materials and services required for well control during the drilling process. In comparison, a performance-based drilling regulation sets an exact standard for well control that crews must meet. “Operators must provide for IWCF well control training” is an example of a performance-based regulation.

Most countries have adopted a hybrid approach that combines the use of prescriptive and performance-based requirements depending upon which one is considered to be the most appropriate (or which level; e.g. act, decree or regulation level). Prescription is used when compulsory means of compliance are desired. Goals are used when circumstances can differ greatly among the regulated companies or where superior outcomes are likely to be achieved through innovation or new technology. Other countries’ systems range from prescriptive to performance-based.

2.4 Legislations versus Standards

The regulatory schemes and their regulatory document packages vary from one regulator/country to another. Most countries covered in this study modelled their regulatory framework around Acts, Schedules, Decrees and/or Regulations. Typically the Act is a high level framework legislative document; Schedules, Decrees (or general administrative orders) cover more detail; and the Regulations cover even more detail with implementing measures. Some countries even provide detailed directives, code of practices and are often referred to in the Acts, decrees and/or regulations. Typically these documents provide more detailed statements of preferred work practices. Beneath these are ‘guidelines’ which are self-explanatory in nature. In some countries the industry has, with or without the help of authorities, created standards. In general the authorities have been consulted. Figure 1 illustrates the hierarchy of the document type’s generally universal application.

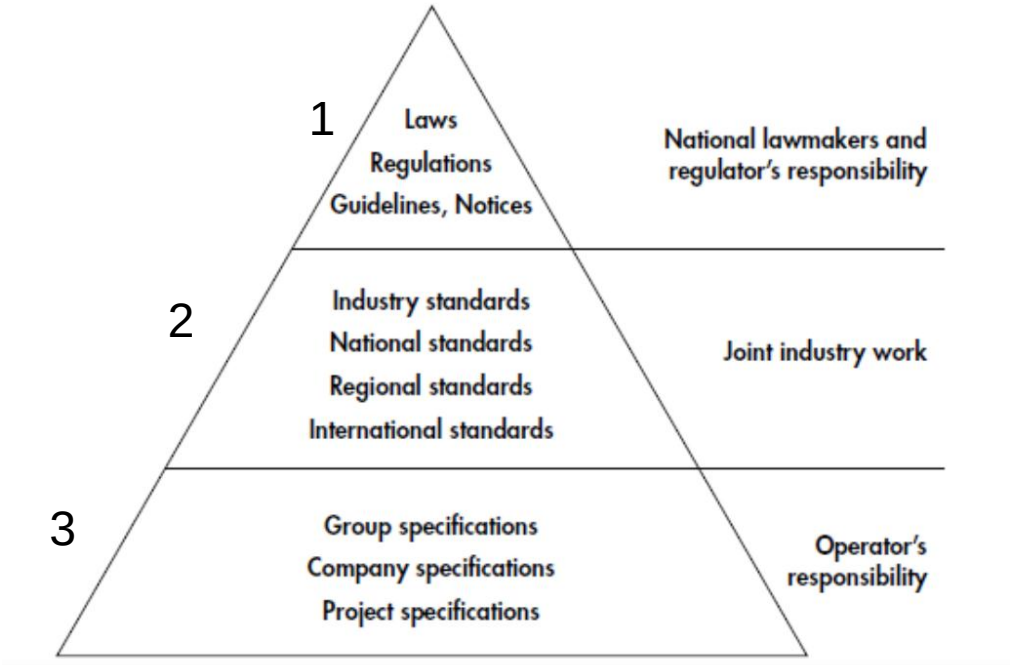


Figure 1: Typical (universal) hierarchy of document types[1]

2.5 Characteristics / Summary of Surveyed Countries

From the evaluated countries, the scope of legislation governing technical requirements for boreholes or wells can differentiate between commodities and activities; oil, gas, onshore, offshore, geothermal, coal bed methane, shale gas etc. Some countries have dedicated legislation for each of these topics. Most countries have combined legislation for a selection of activities / commodities.

[1] OGP, „Regulators' use of standards, report no. 426, March 2010

Country *Main regulatory framework*	Organized by:		Regulatory Approach:			Activities Differentiated*:							National (Industry) Standards / Guidelines:	Overall Summary:
	Federal	State / Province	Prescriptive	Performance based	Hybrid	Onshore O&G	Offshore O&G	Geothermal	CBM (Coal seam gas)	Shale & Tight Gas	Brine (salt)	CO_2 Storage		
European:													ISO	
Austria *Bohrlochbergbau-Verordnung (BB-V)*	x			x		x								Performance-based
France *Decree no.2000-278*	x			x				x		x		x		Performance-based
Germany *Bundesberggesetz (BBergG)*	x	x		x		x	x	x			x		WEG	Performance-based
The Netherlands *1. Mining Act* *2. Mining Decree* *3. Mining Regulations*	x				x	x	x	x			x		NOGEPA	Hybrid regulatory approach; combination of prescriptive (Mining Regulations) and goal-setting legislation (Mining Act & Decree) in combination of industry standards (API)
Norway *Petroleum Act*	x			x	(?)		x						NORSOK	Performance-based approach with non-binding guidelines and recommended (prescriptive) standards (NORSOK)
United Kingdom *Petroleum Act*	x	x		x		x	x			x			O&G UK	Performance-based approach that requires companies to continually demonstrate that they are taking measures to minimize hazards and risks to "as low as reaonably practicable"
Non-European:														
Australia *1. Petroleum Act, 2. Schedules on different activities*	x	x			x	x	x	x	x					Hybrid regulatory approach; mainly performance-based approach with the underlying principle: the primary responsibility for ensuring health and safety should lie with those who create risks and those who work with them.
Canada *1. O&G Conservation Act,* For **Alberta**: *2. Rules. 3. Directives*	x	x			x	x (x)	x							Hybrid approach that uses prescriptive and performance-based requirements depending upon the circumstance. Directives are documents that set out AER (Alberta Energy Board)requirements or processes for implementation. Licensees, permittees, and other approval holders under the jurisdiction of the AER are required to obey all directives.
New Zealand *H&S in Employment (Petroleum Exploration and Extraction) Regulations*	x			x		x	x	x	x					Performance-based approach. Standards are mirrored against those from jurisdictions around the world. Separate Geothermal Energy Regulations
United States *various names* (considered 10x states only)	x	x	x			x	x	x	x	x		x	API	Mainly prescriptive regulations, often requiring industry standards through regulatory incorporation

Table 1: Summary of legislative characteristics of surveyed countries

European Countries:

Austrian, French and German legislations are performance-based with some prescriptive elements (minimum requirements, often based on API (American Petroleum Institute) standards. The Dutch Mining Act consists in fact of three levels, the Act itself, then the performance based (goal-setting) Decree and on the 3rd level the prescriptive Regulations.

Norway's regulatory regime is mainly performance-based, supplemented with prescriptive elements. In some performance-based systems, such as the Norwegian regime, non-binding guidelines (NORSOK) containing recommended practices are sometimes provided, but regulated entities are permitted to adopt other approaches if they can demonstrate that they are at least as effective in achieving the performance objective. In the table above the regulatory framework of Norway is defined as performance-based. However the NORSOK documents contain prescriptive as well as performance-based requirements, therefore Norway could also be labelled hybrid. The U.K. uses a performance-based approach, referred to as "goal-setting," that requires companies to continually

demonstrate that they are taking measures to minimize the risk of oil and gas releases to ‘as low as reasonably practicable.

Non-European Countries:

The U.S. system, more specifically the specific state legislations, is the most prescriptive. Australia’s and New Zealand’s regimes are also performance-based and require operators to adopt to the best international practices (very often API references). Canada’s drilling regulations are written in a goal- or performance-based style with clear regulatory objectives or goals. Prescriptive elements are present in the management system elements, information requirements for reporting and information requirements related to applications for authorizations and well approvals.

3 Evaluation / Comparison per Topic

This chapter describes the main findings of the evaluation of the different well construction requirements. For each of the 7 main themes / topics separately, a short summary, evaluation and recommendation is included.

3.1 Casing and Cementing Requirements

This part covers the requirements regarding Surface Casing Depth, Casing Cementing and Casing Design Requirements. There exists no uniform regulation regarding casing and cementing requirements.

3.1.1 Surface Casing Depth Requirements

Refer to **Appendix A**: "Surface Casing Depth Requirements" (left column) for the specific regulations for each country, including links to sources. **Link to Appendix A**

Prescriptive:

In all the American states evaluated a minimum depth of the surface casing, which is intended to secure the aquifer, is required. It varies from 50 to 100ft (15 – 30m) below the lower edge of fresh water aquifers. In Western Australia and Northern Territory the minimum setting depth should be at least 25m into a competent formation, and minimum 200m in length or 15% of total depth (for exploration wells). In Alberta, Canada, a mandatory surface casing depth calculation form should be used.

Performance-based:

In the European countries and Australian regions other than Western-Australia and Northern Territory the regulations on this topic are on a common sense basis, with the intent to cover/protect unconsolidated and fresh water aquifers (no influx and outflow to the external environment).

Prescriptive		Performance-Based	
Petroleum Act, Schedule of Onshore petroleum exploration and production safety requirements *Article 506,* *(7) Surface casing shall be set at least 25m into a competent formation, and minimum surface casing requirements are -* *(a) 200 metres; or* *(b) (i) in relation to an exploration well where normal pressure gradients are anticipated, at least 15 per cent of the total depth to which uncased hole will be drilled to a depth of 2,500m, plus 5 per cent of the incremental depth of uncased hole beyond 2,500 metres;*	 Western Australia & Nothern Territory	Petroleum Act, Schedule of Onshore petroleum exploration and production safety requirements *Article 505,* *(5) The titleholder must ensure that adequate surface casing is designed and set in accordance with good oilfield practice.*	 New South Wales
Australia (WA, NT), Canada (Alberta), USA (most states)		Austria, France, Germany, Netherlands, Norway, UK, Australia (NSW, QL), New Zealand	

Table 2: Example prescriptive vs. performance based – Surface casing depth requirements

Useful documents / Joint Industry Work:

- n/a (no (industry) standards do cover surface casing setting depth).

WEP Recommendation:

Setting depth of surface casing should be in line with kick tolerances (not exceeding the Maximum Allowable Annulus Surface Pressure MAASP at the casing shoe). Therefore the mandatory calculation **form (Internet Link)** used in Alberta (in combination with the **directive (Internet Link)**) which includes the kick tolerance methodology, is the best available to ascertain that operators are making the right choice (choosing the correct depth).

The protection of fresh water aquifers should also be considered when determining the surface casing setting depth. Nowadays also formations with light brackish water have to be properly protected by double barriers (casings).

3.1.2 Cementing Requirements

Legislation of the European countries (French legislative context has not been identified) are performance-based and in general state that casing strings have to be sufficiently cemented and tested for reliability. Typically the Non-European countries and states specify/prescribe the methods and requirements to achieve the cementation; minimum quality of cement to be used, minimum setting times, mandatory fixed pressure regime for well cementing ‘leak off test’ and running of a Bond Log for quality verifications. For the European countries this level of detail is often found in the guidelines referred to (e.g. WEG, NORSOK, API).

Refer to **Appendix A**: "Casing Cementing Requirements" (middle column) for the specific regulations for each country, including links to sources. **Link to Appendix A**

Prescriptive		Performance-Based	
Petroleum Act, Schedule of Onshore petroleum exploration and production safety requirements *§ 78.85. Cement standards.* *(a) When cementing surface casing or coal protective casing, the operator shall use cement that meets or exceeds the ASTM International C 150, Type I, II or III Standard or API Specification 10.* *(b) After the casing cement is placed behind surface casing, the operator shall permit the cement to set to a minimum designed compressive strength of 350 pounds per square inch (psi) at the casing seat.*	Penn-sylvania	Mining Decree, *Article 69* *2. Each series of tubing as referred to in Article 69.1 shall be cemented over a sufficient distance and then tested for reliability.*	Nether-lands
		Petroleum Safety Authority: Regulations relating to conducting petroleum activities (the Activities Regulations) CHAPTER XV DRILLING AND WELL ACTIVITIES, Re Section 85 *In order to fulfil the requirement relating to the barrier as mentioned in the first subsection, the **NORSOK D-010 standard**, **Chapters** 4.2, 4.3, 4.4, 5.1, 5.2, 5.3 and **15** should be used in the area of health, working environment and safety.*	Norway
State of WA Petroleum Act 1967, Schedule of Onshore Petroleum Exploration and production requirements, 1991 *507 Cementing of Casing* *(2) Surface casing strings shall be cemented with a volume of cement sufficient to fill the annular space between the casing string and the hole to a height of at least 450 metres above the shoe of the casing string, or to the surface if such casing string is less than 450 metres in length.* *(5) After the cementing of casing strings, drilling shall not be commenced until a time lapse of -* *(a) 24 hours;*	Western Australia	Norsok D-010 (Prescriptive & Performance-based elements) 15 Well barrier elements acceptance tables 15.2 Table 22 – Casing Cement *6. Planned casing cement length:* *a) Shall be designed to allow for future use of the well (sidetracks, recompletions, and abandonment).* *b) General: Shall be minimum 100 m MD above a casing shoe/window.* *e) Production casing/liner: Shall be minimum 200m MD above a casing shoe. If the casing penetrates a source of inflow, the planned cement length shall be 200m MD above the source of inflow.*	standard norge NORSOK
Norway, Australia (WA, NT), Canada (Alberta), USA (most states)		Austria, France, Germany, Netherlands, UK, Australia (NSW, QL), New Zealand	

Table 3: Example prescriptive vs. performance based – Cementing requirements

Useful documents:

- API (2010): "API SPEC 10A/ISO 10426-1, Cements and Materials for Well Cementing"
- API RP 10B Recommended Practice for Testing Well Cements / ISO 10426-1 Petroleum and natural gas industries-Cements and materials for well cementing- Part 2: Testing of well cements
- NORSOK **D-010 Rev 2014 (Internet Link),** or older document **D-010 Rev 2004 (Internet Link)** §15.2, Table 22 – Casing Cement (Well barrier elements acceptance table)
- **Directive 9 (Internet Link),** (Alberta Energy Board)

WEP Recommendation:

Casing cement should be of sufficient quantity, quality and verified upon completion. For this purpose the documents referred to as 'useful documents' are advised to be adhered to. NORSOK D-010 is very clear with regards to the minimum casing cement requirements. Cementation quality and testing upon cementation are also important aspects. The API Specs 10A and API RP 10B are in most countries referred to as leading standard, and therefore considered a must read.

3.1.3 Casing Design Requirements

The actual casing design requirements are found to be poorly described or have not been identified in most of the countries considered for this study. Actual casing design factors have been specified

in standards or guidelines of Alberta (Canada), U.K. and Norway. Most countries do prescribe casing installation practices requirements and minimum specifications of casing to be used in line with API and or NACE (the Worldwide Corrosion Authority) standards. Most of these American standards have International (ISO) equivalents. It's noticeable that for the American states (except Ohio) no reference is made to the API standards related to casing, whereas most of the European countries do refer to API.

Refer to **Appendix A**: "Casing Design Requirements" (right column) for the specific regulations for each country, including links to sources. It has to be noted that for quite some countries/states no actual requirements regarding casing design have been identified. In some case context related to casing installation practices requirements is provided instead. **Link to Appendix A**

Table 1: Example Performance-based regulations vs prescriptive standards on casing design

Performance-based regulations		Standard / Guidelines	
Guidance on Regulations, A guide to the well aspects of the Offshore Installations and Wells (Design and Construction, etc) Regulations 1996 *Regulation 16 Materials* *30 This regulation requires the well-operator to ensure that all materials used in the construction and any subsequent modifications to the well are suitable for purpose, to ensure the safety of the well and so reduce to as low as is reasonably practicable any risks to the health and safety of people. This requirement will apply not only to such items as cement, casing or other well tubulars, but also the well-head equipment, e.g. drilling spools, casing heads, tubing heads and the well control equipment listed under the definition of 'well' in regulation 2.*	U.K.	Oil & Gas UK, Well Integrity Guidelines, issue 1, July 2012 *4.4 Casing design (note: extensive document, only small part included here!)* *Casing should be specified, manufactured, inspected and tested to the appropriate standard:* *- BS EN ISO 11960 (API Spec 5CT) Specification for Casing and Tubing* *- ISO 15156 (NACE MR 0175) Materials for use in H2S Environments, and* *- BS EN ISO 13680 (API Spec 5CRA) Specification for corrosion resistant alloy seamless tube for casing and tubing* *4.4.4 Casing design factors:* *Burst: 1.0, Collapse: 1.0, Tension (stuck pipe, cementing and pressure testing): 1.3* *Tri-axial stress: 1.25*	U.K.
Petroleum Safety Authority: Regulations relating to design and outfitting of facilities, etc. in the petroleum activities (the Facilities Regulations) CHAPTER VIII DRILLING AND WELL SYSTEMS, Re Section 48 Well barriers: *In order to fulfil the requirement regarding well barriers, the NORSOK D-010 standard Chapters 4, 5, 9 and 15 should be used in the area of health, working environment and safety.*	Norway	Norsok D-010 (Prescriptive & Performance-based elements) *15 Well barrier elements acceptance tables* *15.2 Table 2 – Casing* *3. All load cases shall be defined and documented with regards to burst, collapse and tension / compression.* *4. Casing design can be based on deterministic or probabilistic models.* *5. Casing exposed to hydrocarbon flow potential shall have gas-tight threads. See: ISO 11960 / ISO 13679 / ISO 10405* *The following design factors shall be used:* *(Table 6 – Design factors)* *Burst 1,10, Collapse 1,10, Axial 1,25* *For well testing a design factor of 1,50 should be used to cater for pulling the packer free at the end of the test. Tri-axial 1,25* *Tri-axial design factors are not relevant for connections* **The above design factors are based on wall thickness manufacturing tolerance of minus 12,5%.*	standard norge NORSOK

Useful documents:

- For, Casing Design requirements:
  - Alberta's (Canada) EAB **Directive 10 (Internet Link)** (minimum casing design requirements), NORSOK **D-010 (Internet Link)**, **UK O&G Well Integrity Guideline (Internet Link)**
- For, Casing material requirements:

- API RP 5 C1 Recommended Practice for Care and Use of Casing and Tubing / ISO 10405 Care and use of casing and tubing
- API RP 5C5 Recommended Practice on Procedures for Testing Casing and Tubing Connections / ISO 13679 Procedures for testing casing and tubing connections
- API documents (and/or ISO equivalents). E.g. RP 10B Specification for Casing and Tubing / ISO 11960 Steel pipes for use as casing or tubing for wells

WEP Recommendation:

The regulatory framework of Alberta and the well barriers philosophy (NORSOK-D010) of Norway which has been adopted by most of the O&G Operators in the world (refer to UK O&G well integrity guideline) are considered the best references with regards to the entire well design, of which casing design is only an element.

It must be noted that some major operators have three levels of casing/well design, which is depending on knowledge of the area and competency of the engineering staff.

3.2 Blowout Prevention Requirements

Legislation of the countries being considered prescribes the obligation of having a blowout preventer (BOP). In most countries a BOP should be installed before the surface casing or, even better described in the Netherlands, the “first pressure containing series of casing” is being drilled out. Most countries also prescribe the configuration and accessories; quantities and types required (e.g. control panels). The topics of BOP equipment testing, blowout prevention instructions and BOP plan requirements are only covered by legislations of a few countries. For pressure control equipment, Norwegian regulations require recertification of Blowout preventers (BOP’s) every fifth year while U.S. regulations do not require recertification. Not so much context has been identified on the BOP plan requirements, although in the Netherlands it is stipulated that a BOP must be tested to full working pressure (WP) prior to being installed on a project.

Refer to **Appendix B** for the specific regulations on blowout prevention requirements for each country, including links to sources. Four specific topics on BOP requirements have been looked up: Equipment, BOP Equipment Testing, BOP Instructions/Exercises/Procedures and BOP Plans Requirements set in the legislations of the countries considered

Link to Appendix B

Table 2: Example prescriptive vs performance-based – BOP equipment requirements

Prescriptive		Performance-Based	
Mining Regulation, *Article 8.3.1.4* *1. The safety protection installation as meant in Article 8.3.1.3.1 shall in any event contain the following borehole shutoff valves:* *a. a compression body shutoff valve;* *b. a gate valve that can shut off a borehole around the drilling tools present in the borehole, and* *c. a gate valve that can shut off a borehole in which no drilling tools are present.* *2. Following the incorporation and cementing of the second pressurised series of the casing, the safety protection installation shall, before drilling work is resumed, be extended by:* *a. a second gate valve as meant in Article 8.3.1.4.1.b, and* *b. a device for the gate valve referred to in Article 8.3.1.4.1.c for cutting the drilling tools present in the borehole at the level of this shutoff valve.*	 Nether-lands	Guidance on Regulations - A guide to the Borehole Sites and Operations Regulations 1995 Well control equipment *298 It includes surface, downhole and internal blowout preventers, rotating heads, circulating heads, tubing injection heads, diverters, wireline lubricators and stuffing boxes, kelly cocks, stabbing valves, choke lines and manifolds, mud gas separators, kill-lines, valves and other equipment required for killing a well including high-pressure kill pumps and plugs, valves and other devices necessary to prevent a well from flowing. It also includes all pipework associated with the above equipment.* *299 Well control equipment should be suitable for the type of operation being carried out in terms of size, connection type, pressure, temperature and the chemical properties of the formation fluids which may be encountered. It should be designed, constructed, installed, commissioned, used and maintained in accordance with appropriate recognised standards.*	 U.K.
Netherlands, Norway, Australia (WA, NT), Canada (Alberta), USA (most states)		Austria, France, Germany, UK, Australia (NSW, QL), New Zealand, USA (New Mexico)	

Useful documents:

- NORSOK **D-001 (Internet Link** (BOP specifications) & **D-010 (Internet Link)** (BOP as well barrier element)
- API RP 53, Recommended practices for blow-out prevention equipment systems for drilling wells

WEP Recommendation:

On the BOP equipment, testing and exercises requirements the Dutch Mining Regulations give a comprehensive description. Competency of crewmembers by means of IWCF certification is also considered to be an element of importance, as well as the BOP test to full WP prior to the project.

3.3 Well Data, Logging and Sampling Requirements

Requirements regarding reporting, data and or submission of samples to the authorities are discussed in this paragraph. The scope differs clearly per country. It has to be noted that for a few countries this particular content was not identified; for Austria, France and a few Australian and American states. For the U.K. only limited context has been identified. Reporting obligations structured per topic and details when and to whom to submit are clearly described in the regulations of most of the countries and states refer to the table below for some facts. In addition, Norway, Canada and the UK require the operator to submit all mandatory data into digital database systems.

Refer to **Appendix C** for the specific regulations on data filing, well logging and sampling requirements for each country, including links to sources. Requirements on the following topic have been considered:

- Data Filing / Reporting: daily reporting requirements. **Link to Appendix C**
- Geophysical & Borehole data: type of logs to be run, information to be acquired.

- Rock samples/cuttings: type and quantities of samples to be taken.
- End of Well reporting: final reporting of the well, when and what to be included.
- Data filing – exploitation/production phase: Reporting requirements during the production phase.

Table 6: Levels of scope on specific well data, logging and sampling requirements

Country / State	Daily Reporting Detailed breakdown	Daily Reporting to When submit	Geophysical & Borehole data	Rock samples / Cuttings	End of Well reports	Production Data	Digital System
Netherlands	Format	09.00hrs	X	250gram Wet/Dry	X, max 6 weeks	Monthly report, per day	
Norway	X	Preliminary: 08.00hrs Final: 12.00hrs	X, yellow book	unknown	X, blue book	Monthly report, per day	X
Australia – Western Australia	X, also week report	Before midday	X	100gram (dry)	X, max 6months	Monthly report, per day	
Australia – Queensland	X	05.00pm	X	250-500gram	X, max 6months	6-month report	
Canada – Alberta	X Direct.59	Not specified	X Direct.80	19 x 48 mm plastic vial (dry). Direct.56	X, max 30 days after Direct.59	Monthly report	X
New Zealand	X	No submission requirement	X	X	X	unknown	
U.S.A. – Most States	X	Not specified	X	X	X	Monthly report	
U.K.	Not located		X	X	X	X	X
Germany			X	X	X		

Not located for: Austria, France, other Australian states, Pennsylvania & Ohio (American states)

WEP Recommendation:

Prescribed requirements with regards to reporting and data acquisition is desired. Exact details on timing is related to the authority which has to administer and assess the information.
Good information is available on the Dutch website of TNO called **NLOG.NL (Internet Link)** and the website of NOGEPA **NOGEPA (Internet Link)** in particular the Guidelines 41 – 50.

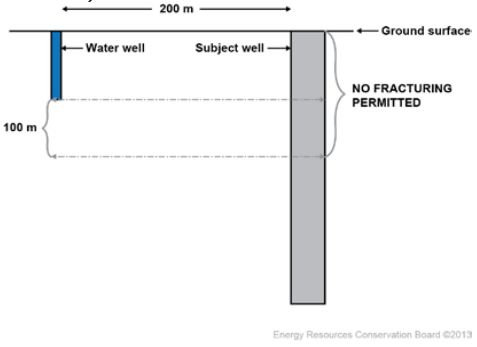
3.4 Well Stimulation Requirements

On the topic of well stimulation requirements the regulations of the studied countries have been analysed for general stimulation regulations, and also on specific stimulation techniques such as hydraulic stimulation (fraccing) and acid stimulation. In most European countries the topic of well stimulation is very minimally covered or not covered at all. In the consulted sources of Austria, the Netherlands and Norway no direct references have been found in legislative context. A UK guideline on onshore shale gas briefly covers the topic of stimulation. In France applying hydraulic stimulation for exploration and/or exploitation purposes is forbidden. In Germany the obligations with regards to hydraulic stimulation have been described in a federal "Rundverfügung" and by the WEG in a "praxis" or guideline / best practice. No performance-based legislative context has been found on the topic of well stimulation requirements

Refer to **Appendix D** for the specific regulations on stimulation requirements for each country, including links to sources. **Link to Appendix D**

Table 7: Example prescriptive legislative context on Well Stimulation requirements

<table>
<tr><th colspan="2">Prescriptive example #1</th><th colspan="2">Prescriptive example #2</th></tr>
<tr><td>Province of Alberta
Oil and Gas Conservation Rules
Hydraulic Fracturing Operations
3.062 A licensee of a well shall comply with Directive 083

Directive 083: Hydraulic Fracturing – Subsurface Integrity - 2013
<u>5 Hydraulic Fracturing Near Water Wells</u>
<u>5.1 Issue</u>
Communication between the subject well and water wells as a result of hydraulic fracturing operations may cause adverse effects.
<u>5.2 Regulatory Objective</u>
To prevent impacts to water wells.
<u>5.3 Requirements</u>
22) Licensees' hydraulic fracturing operations must not have an adverse effect on the water well's water quality or quantity.
23) Licensees must not initiate hydraulic fracturing operations within a zone that extends 200 m horizontally from the surface location of a water well and 100 m vertically from the total depth of the water well (see figure 3), except when using nitrogen as the fracturing fluid for coalbed methane completions (see section 7).
 
</td><td>Alberta, Canada</td><td>State of Western Australia Petroleum Act 1967, Schedule of Onshore Petroleum Exploration and Production Requirements – 1991.
<u>DIVISION 3 Special Services</u>
<u>540 Special Services</u>
(2) The installation and operation of well pumping units, and the operation of wireline and coiled tubing services, acidizing, fracturing, cementing, hot oil operations and other special services shall be carried out in accordance with these directions and the applicable recommended practices set forth in **A.P.I. RP54, "Oil and Gas Well Drilling and Servicing Operations**".</td><td>Western Australia & Northern Territory</td></tr>
<tr><td colspan="2"></td><th>Prescriptive example #3</th><td></td></tr>
<tr><td colspan="2"></td><td>Décret n°2011-835 du 14 julliet 2011

<u>Article 1</u>
Under the Charter of the 2004 Environment and principle of preventive and corrective action under Article L. 110-1 of the Code of the environment , exploration and mining of oil and gas by drilling followed by hydraulic fracturing of the rock are prohibited in the country.</td><td>France</td></tr>
</table>

WEP Recommendation:

Well stimulation, especially hydraulic stimulation is a politically sensitive topic. Alberta's EAB **Directive 083 (Internet Link)** (Hydraulic fracturing – subsurface integrity), German **"Rundverfügung" (Internet Link)** and **UK Onshore Shale Gas Well Guidelines (Internet Link)** contain good elements which could be of use for any country's regulatory framework on this topic.

3.5 Well Testing Requirements

Initial well testing equipment and/or well evaluation requirements are defined for most countries considered, except for United Kingdom, New Zealand, California and North Dakota (U.S.A.), where no regulatory context was identified. With the exception of one Australian source on water wells, all identified regulatory context on testing and sampling of formations is related to oil and/or gas wells. Non-European countries cover prescriptive context on test type (e.g. multi-rate), equipment to be used (e.g. bottom hole pressure and/or temperature gauges, safety valves), duration of the test(s) and administrative requirements. European regulatory context on the topic of well testing is limited. French regulatory context contains prescriptive elements on well testing equipment. Flaring and/or venting during well testing is prohibited in most countries (exceptions and exemptions do apply).

Refer to **Appendix E** for the specific regulations on well testing (equipment) and flaring requirements for each country, including links to sources. **Link to Appendix E**

Table 8: Example prescriptive vs. performance based – Well Testing requirements

Prescriptive		Performance-Based	
Wyoming Oil and Gas Conservation Commission Rules, Chapter 3 Operational Rules, Drilling Rules *Section 35. Production Test and Gas-Oil Ratio Report. (Forms 10 through 13).* *(b) the initial tests shall be multipoint back-pressure tests (stabilized multipoint or constant time multipoint or isochronal multipoint) or acceptable one-point back-pressure tests. The results shall be furnished to the Supervisor on acceptable forms. The methods prescribed in the Interstate Oil and Gas Compact Commission's "Manual of Gas Well Testing" or an alternate method approved by the Supervisor shall be used.* *(c) As a guideline for multipoint tests, each flow rate duration shall be set at a minimum of thirty (30) minutes and a maximum of two (2) hours depending on stabilization. The shut-in period shall be a minimum of seventy-two (72) hours.*	 Wyoming	Petroleum Safety Authority: Regulations relating to conducting petroleum activities (the Activities Regulations) *Section 69 Discharge from formation testing and clean-up of wells* *Oil or oily water from well testing or well clean-up shall not be discharged to sea, unless the discharge is cleaned, cf. Section 60. This does not apply during testing or clean-up of exploration wells from facilities without treatment plants. For such facilities, comprehensive assessments shall be carried out to ensure that the best environmental solution is selected.* *Formation testing shall be carried out with the least possible strain on the external environment. Flaring of hydrocarbons shall be avoided to the extent practically possible. The operator shall obtain a permit pursuant to Chapter 3 of the Pollution Control Act (in Norwegian only) to inject the well stream*	 Norway

Useful documents:

- Alberta's (Canada) AEB **Directive 40 (Internet Link)** (Pressure and Deliverability Testing Oil and Gas) and **Directive 34 (Internet Link)** (Gas well testing, theory and practice)

WEP Recommendation:

Dedicated well testing requirements for geothermal wells has not been identified. Safety considerations are different to oil and gas operations, therefore the well testing requirements described in the considered documents is likely not suitable. Likely the **code of practice for deep geothermal wells (Internet Link)** (New Zealand) is of interest, at least for this particular topic.

3.6 Storage & Waste Management Requirements

This topic shows the most variation amongst the studied countries whether the requirements of waste management and storage of substances are located in the typical documents like petroleum or mining acts, schedules and/or regulations. This was at least the case for almost all the other topics considered in this report. Nevertheless in some countries, these are mostly Non-European countries and states, details on this topic can be found in the same documents as where the other well construction topics of this study are mostly located. Typically the European countries do cover these topics in dedicated waste management acts, schedules, and/or regulations (e.g. Austria, U.K., the Netherlands). The prerequisite of having a waste management plan when drilling wells is present in all countries and states studied. Also regulations on storage of well construction related substances is present in most countries and states.

Refer to **Appendix F** for the specific regulations on storage & waste management requirements for each country, including links to sources. **Link to Appendix F**

Useful documents:

- Alberta's (Canada) AEB Directive **Directive 050 (Internet Link)** (Drilling Waste Management) and **Directive 055 (Internet Link)** (Storage Requirements for the Upstream Petroleum Industry)

WEP Recommendation:

Again, the regulatory framework of Alberta, with references to the directives with specific guidance is considered to be a good example of how this type of legislation could be set up.

3.7 Well Suspension & Abandonment Requirements

Most countries have specified policies and procedures for permanent closure (abandonment) of wells. A few countries also have regulations in place for temporary closure, or suspension of wells. Unlike abandonment, suspension is a reversible process to ensure the safety of a well when it is not producing. For the German States no (temporary) Plug & Abandonment (P&A) legislative context has been identified.

Refer to **Appendix G** for the specific regulations on well suspension and abandonment requirements for each country, including links to sources. **Link to Appendix G**

> IEA Greenhouse Gas R&D Programme's (2009) study (referred to below) concluded the following:
>
> *"The evaluated regulations primarily comprise prescriptive requirements for plugging and abandonment of oil and gas wells. A general distinction can be observed between European and non-European countries. The main differences lay in the length requirements of the plugs near the deepest casing shoe. While in Europe the length of the cement plug is between 50 to 100 meter, in non-European regulations the length of the plug is between 30 and 60 meter. When plugging perforated cased sections, the required plug length is in the range of 50 to 100 meters in the European countries. The required plug lengths for the studied non-European countries fit in the range of 30 to 60 meters. An exception is formed by the United Kingdom where approximately 30 meter (100 ft) is required in both cases described above, although where possible 150 meter (500 ft) plugs are set. In addition, when mechanical plugs are used, additional cementing is often required. It can be noticed that the required length for additional cementing differs significantly between the countries studied. For instance, in the Netherlands and in China 50 m additional cementing is required, whereas API requires 6 m of cement. Considering the plugs that isolate the permeable zones, the required plug length is again in the range of 50 to 100 meters in most considered countries, both within and outside Europe. Exceptions are the United Kingdom and Alberta (Canada), where a minimum plug length of 30 meters (or 100 ft) is prescribed*." (p.100)

Useful documents:

- **IEA Greenhouse Gas R&D Programme (IEA GHG), "Long Term Integrity of CO2 Storage – Well Abandonment", 2009/08, July 2009 (Internet Link)** .

  "Well Abandonment" regulations comparison for Denmark, France, Germany, Norway, The Netherlands, U.K., Australia, Canada (Alberta), China, Japan, U.S.A. (chapter 5).
- Alberta's (Canada) AEB Directive **Directive 013 (Internet Link)** (Suspension requirements for wells) and **Directive 020 (Internet Link)** (Well abandonment)
- NORSOK **D-010 (Internet Link)** , §15.24, Table 24 – Cement Plug (Well barrier elements acceptance table)

WEP Recommendation:

The makers of the regulatory framework on well suspension and abandonment are recommended to consider differentiating between existing and new/future wells. Existing wells likely do require more stringent and demanding rules and procedures on operations/material in order to achieve a safe and durable decommissioning.

For new/future wells the requirements might be less demanding in case the wells are designed, drilled and completed using latest standards (techniques and materials developed and employed over the past decades in O&G industry) keeping future abandonment in mind.

4 References

Useful studies which are highly recommended, because they provide a comparison of regulations on well construction topics:

- **Pembina Institute, "Comparing the offshore drilling regulatory regimes of the Canadian Arctic, the U.S., the U.K., Greenland and Norway", June 2011 (Internet Link).**
  Offshore drilling regulations comparison on "drilling and well activities" (chapter 4) and "well control requirements" (chapter 6) for Canada, U.S.A., U.K., Greenland and Norway
- **IEA Greenhouse Gas R&D Programme (IEA GHG), "Long Term Integrity of CO2 Storage – Well Abandonment", 2009/08, July 2009 (Internet Link).**
  "Well Abandonment" regulations comparison for Denmark, France, Germany, Norway, The Netherlands, U.K., Australia, Canada (Alberta), China, Japan, U.S.A. (chapter 5).
- **Karlsruher Institut für Technology, "Kurzgutachten Bohrung Verrohrung und Zementierung", April 2012 (Internet Link).**
  Comparison of German and U.S.A. standards/regulations on "casing and cement" (chapter: 5). Note: document is written in German language.
- **U.S. Department of Energy – Office of Fossil Energy, "State Oil and Natural Gas Regulations Designed to Protect Water Resources, May 2009 (Internet Link)** (link: **Addendum (Internet Link)**)
  Comparison of oil and natural gas regulations designed to protect water resources for thirty American states, covering topics as "well construction", "well plugging" and "well treatment, stimulation and fracturing". Besides, this document encompasses an extensive addendum which includes the regulatory requirements for each state (appendices of this document is inspired on this reference).
- **OGP, Regulators' use of standards, Report No. 426, March 2010 (Internet Link).**
  Report on current situation of selected national regulator's reference and use of national, regional, international and industry standards in their regulatory documents, with a particular focus on standards for materials, equipment, systems and structures for the offshore petroleum industry.
- **Bureau Veritas, Prescriptive and performance-based regulation for deep water drilling, May 2011 (Internet Link).**
  The paper proposes that a performance-based approach has significant advantages over prescription particularly in situations where there are significant technical challenges, the risks are not well understood, and a best practice is not well-established. Prescription has a role to play within the performance-based framework.

In a lesser degree, because they do not zoom in on 'well construction' related regulations:

- **Pembina Institute, "Building a regulatory framework for geothermal energy development in the NWT", March 2011 (Internet Link)**
  Overview of geothermal energy development and regulations in U.S.A. (federal, Nevada, California), Canada (British Columbia), Australia, New Zealand, Iceland, Italy and Germany (chapter 3) Note: does not include topics on well construction.

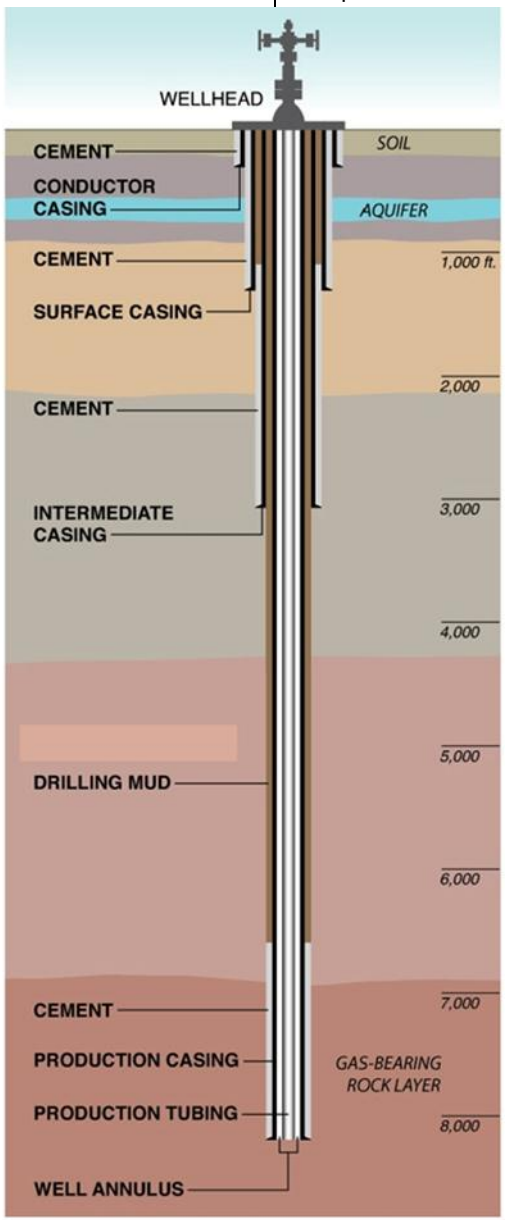
- **GeoElec, "Report presenting proposals for improving the regulatory framework for geothermal electricity – Appendix 1: Overview of National rules of licensing for geothermal", September 2013 (Internet Link)**
  Overview of existing licensing systems governing geothermal exploration and development in European countries, France, Iceland, the Netherlands, Switzerland, U.K., Italy, Germany, Hungary, Slovakia, Austria

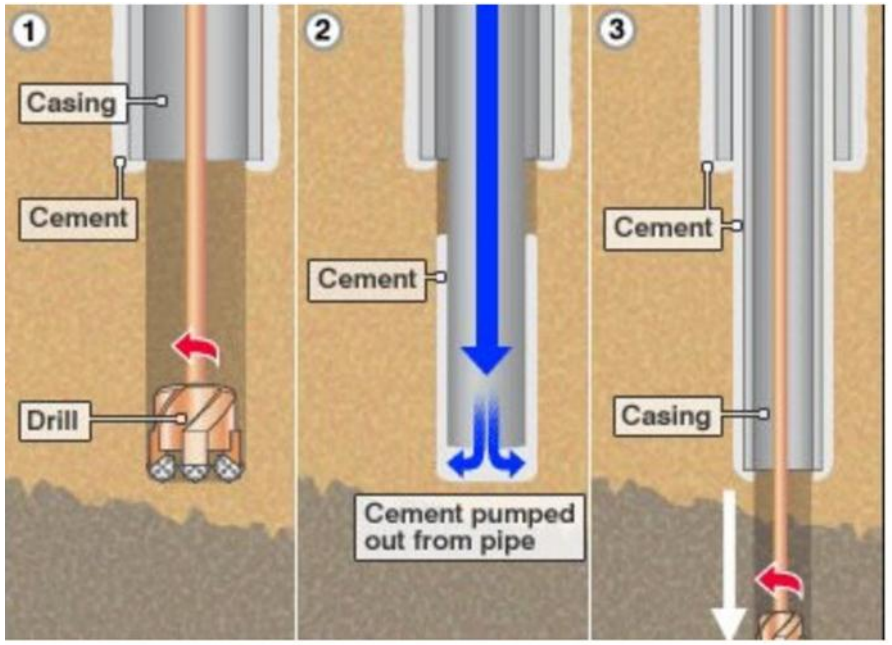
Appendices

Regulatory Frameworks for the selected countries on:

A. Casing & Cementing Requirements

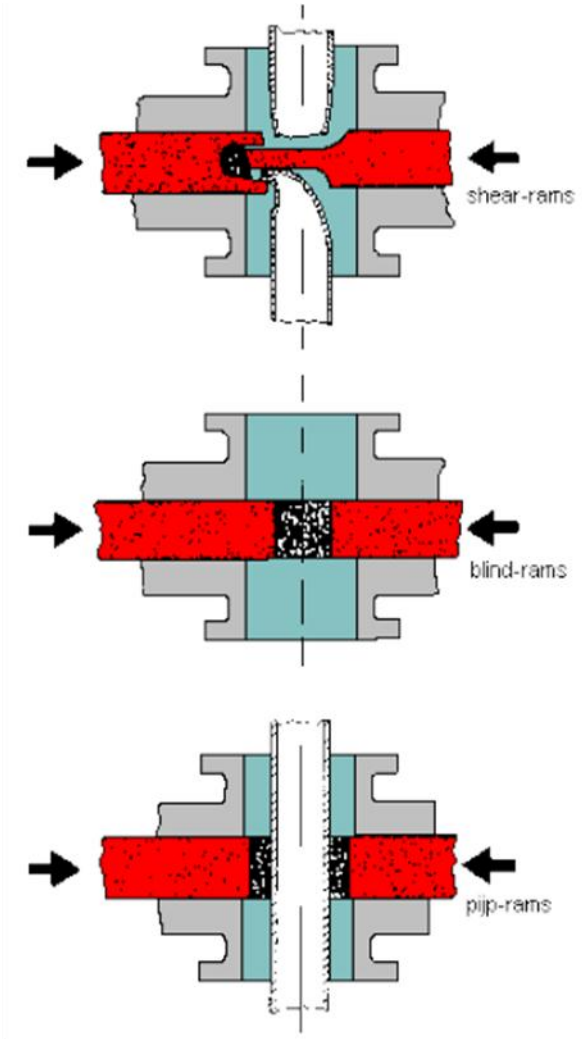
On the next page some pictures are presented of casing and cement.


WELLHEAD
CEMENT
CONDUCTOR CASING
CEMENT
SURFACE CASING
CEMENT
INTERMEDIATE CASING
DRILLING MUD
CEMENT
PRODUCTION CASING
PRODUCTION TUBING
WELL ANNULUS
SOIL
AQUIFER
1,000 ft.
2,000
3,000
4,000
5,000
6,000
7,000
GAS-BEARING ROCK LAYER
8,000


1
Casing
Cement
Drill
2
Cement
Cement pumped out from pipe
3
Cement
Casing

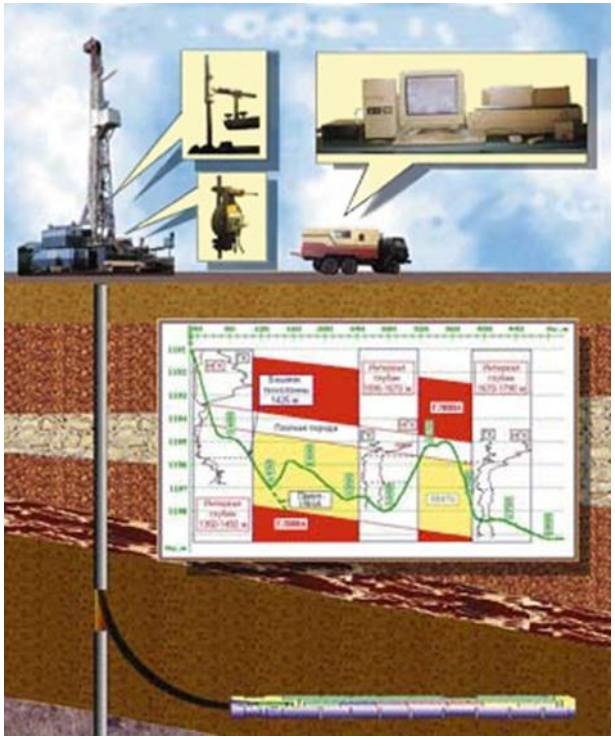
A. Blowout Prevention Requirements

On the next page some pictures are presented of a Blow Out Preventer (BOP)

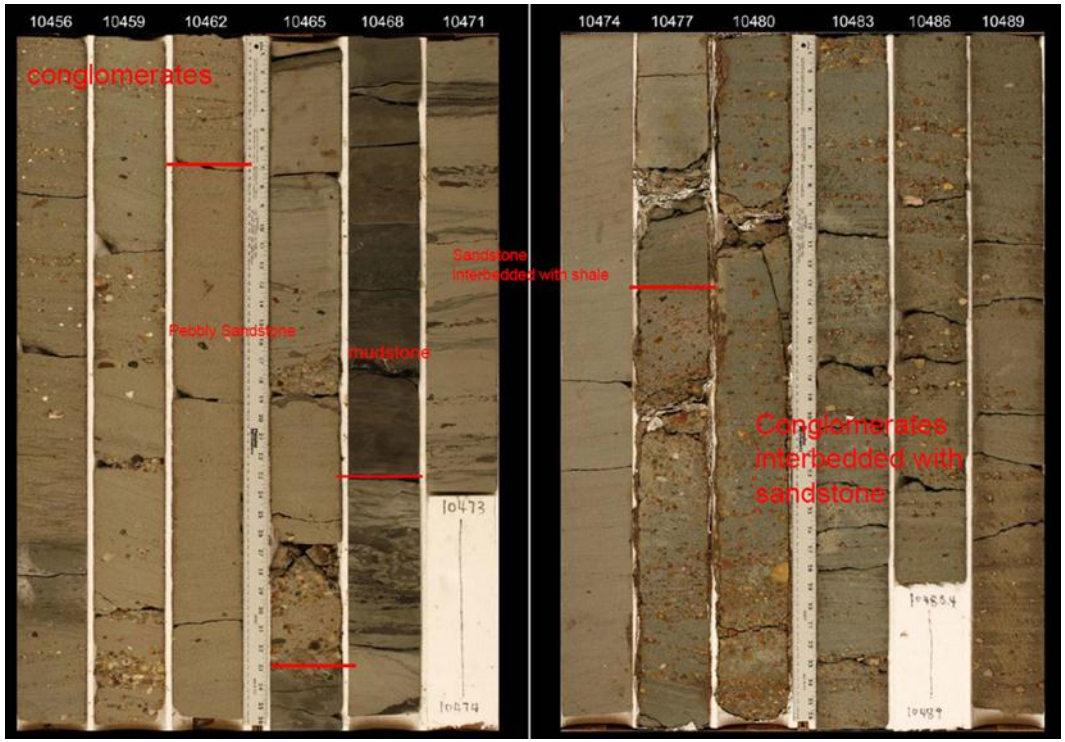

shear-rams
blind-rams
pijp-rams

B. Well Data, Logging and Sampling Requirements

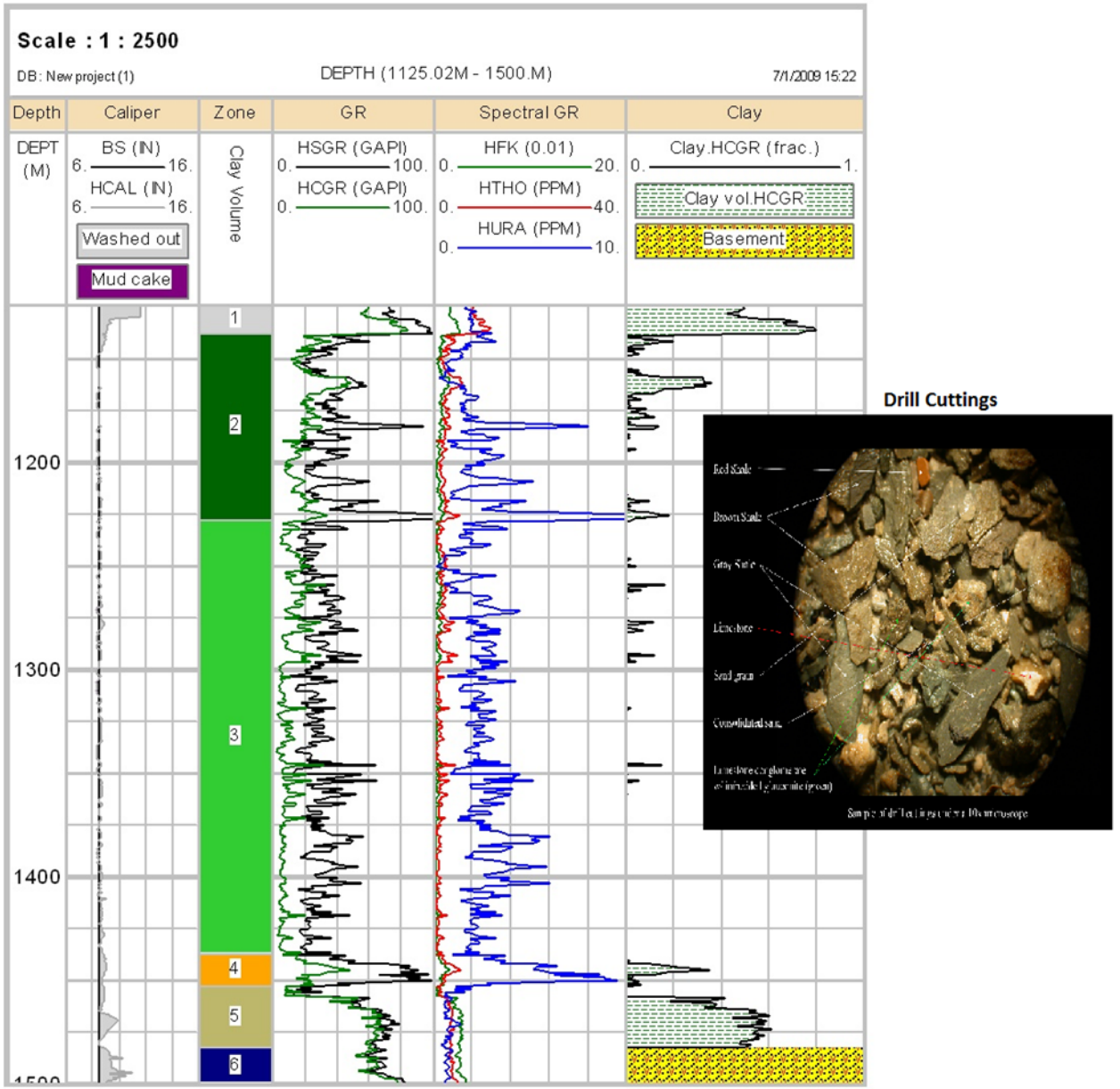
Wireline Logging



Example of a core (formation sample)

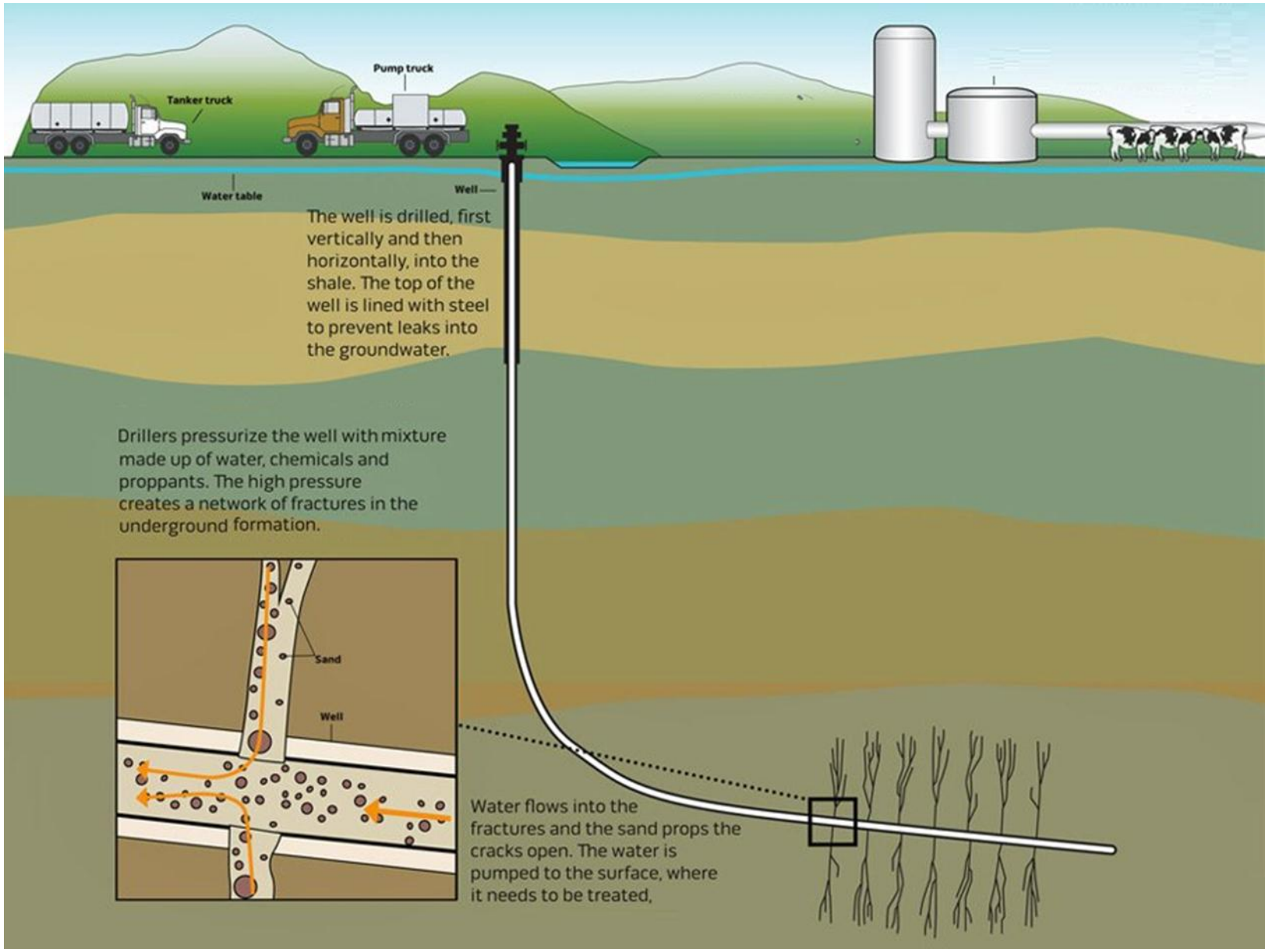


Example of a mudlog (geological description)



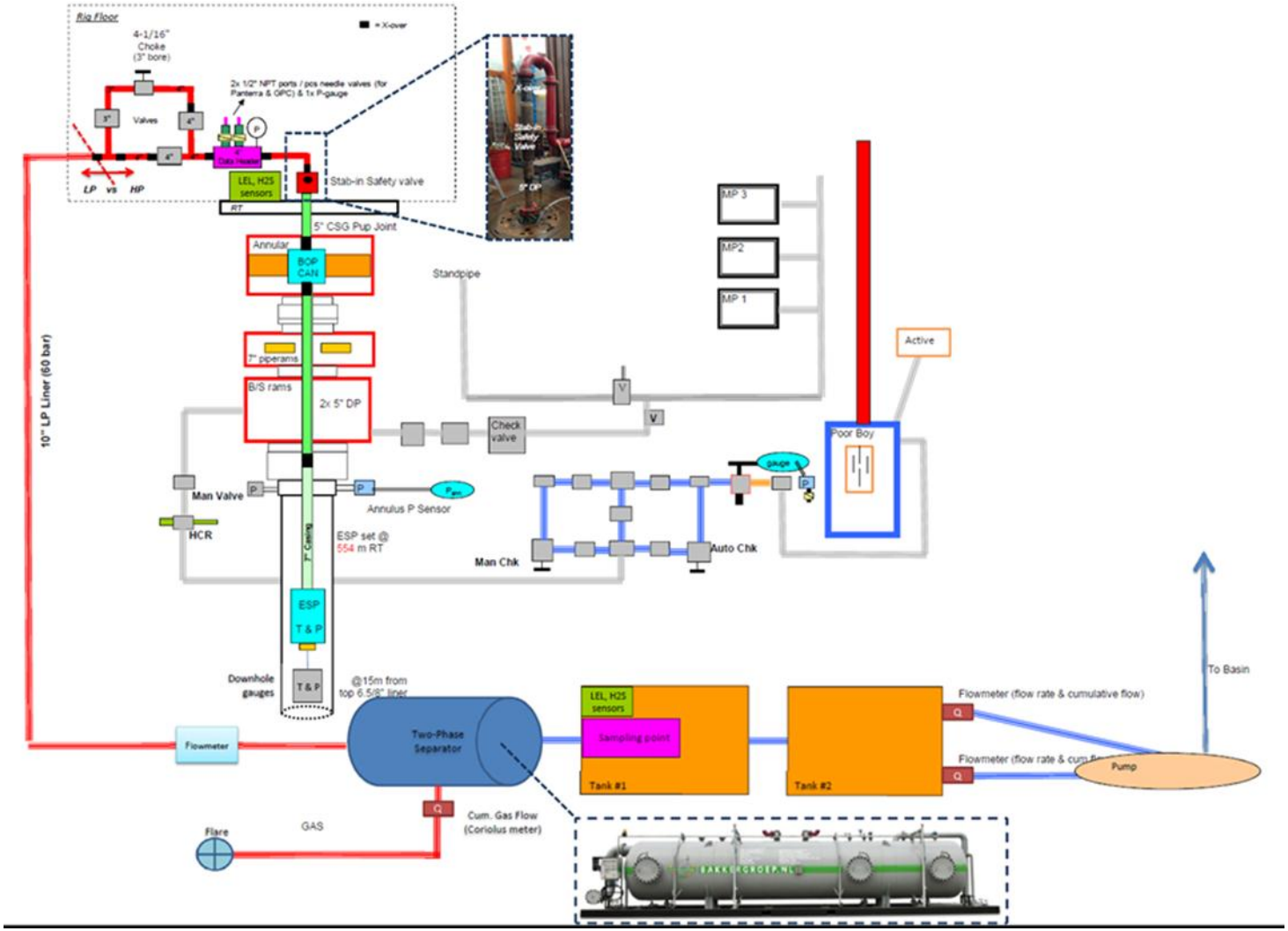
C. Well Stimulation Requirements

On the next page a pictures is presented of a typical well stimulation


Pump truck
Tanker truck
Water table
Well
The well is drilled, first vertically and then horizontally, into the shale. The top of the well is lined with steel to prevent leaks into the groundwater.
Drillers pressurize the well with mixture made up of water, chemicals and proppants. The high pressure creates a network of fractures in the underground formation.
Sand
Well
Water flows into the fractures and the sand props the cracks open. The water is pumped to the surface, where it needs to be treated.

E. Well Testing Requirements

A typical well test installation with fluid-gas separate and flairs



F. Storage & Waste Management Requirements

Cutting collection and storage

Normal garbage collection

Fluid storage

Waste and dirty fluid collection

G. Well Suspension & Abandonment Requirements

Well suspended for later use