NOGEPA
NEDERLANDSE OLIE EN GAS EXPLORATIE EN PRODUCTIE ASSOCIATIE

INDUSTRY STANDARD NR. 45

Decommissioning of Wells

This version is a translation of the Dutch version
as published in the Staatscourant on 6 December 2019.
The published Dutch text will always prevail.

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Document management

Information sheet	
Responsible Committee	OPCOM
Title of document	Decommissioning of Wells
Type of document	NOGEPA Industry Standard
Control number	45
Control status	Controlled/uncontrolled when printed
Issue status	This document has been published electronically on the NOGEPA Website. In order to maintain this document as a "controlled copy" any formal revisions will be published via this Website and should replace all previously issued revisions.

Document Review timeframe	C3	
C1 - 12 months	C2 - 24 months	C3 – 36 months

Endorsed by		
Environment Committee	Name	
	Date:	
Health and Safety Committee	Name	
	Date:	
Legal Committee	Name	
	Date:	
Operations Committee	Name	
	Date:	
Approved by		
Executing Committee	Committee	
	Date:	

Revision Overview

	Date	Description	Author	Revision	Approved
	02 Jan 2021	Translation into English	JS	JS	

This document will be controlled in accordance with the NOGEPA Industry Standard No. 80 on Standards and Document Control.

Abbreviations

DMR	Dutch Mining Regulations *(Mijnbouwregeling Mbr)*
HPHT	High Pressure High Temperature
HSE	Health, Safety and Environment *(Gezondheid, veiligheid en milieu)*
PEC	Program Execution Checklist (used in well examination scheme)
SodM	State Supervision of Mines *(Staatstoezicht op de Mijnen)*

Definitions

Borehole	A drilled hole that forms the path of the Well from the well origin to the terminating point of such hole. A Borehole is a not-completed Well.
Caprock	Formation layer that seals an underlying Zone with Flow Potential.
Fluid	As a clarification, this word refers to both liquids and gases.
Good Operating Practice	The application of those methods and practices customarily used in good and prudent oil and gas field practice in the Netherlands and/or on the Netherlands Continental Shelf with that degree of diligence and prudence reasonably and ordinarily exercised by experienced operators engaged in the Netherlands and/or on the Netherlands Continental Shelf in a similar activity under similar circumstances and conditions.
HPHT Well	High pressure and high temperature Well with expected shut-in pressure exceeding 69 MPa, or a static bottom-hole temperature higher than 150°C.
Material Change	As defined in the EU Offshore Safety Directive (2013) and means: a) in the case of a report on major hazards, a change to the basis on which the original report was accepted including, inter alia, physical modifications, availability of new knowledge or technology and operational management changes; b) in the case of a notification of Well Operations, a change to the basis on which the original notification was submitted including, inter alia, physical modifications, replacement of one installation with another, availability of new knowledge or technology and operational management changes.

Maximum Anticipated Pressure	The maximum foreseeable pressure that could develop following decommissioning.
Mining Company	The operating company that holds the license to explore for or produce hydrocarbons. In case of more than one license holder, it is the assigned license holder that conducts the activities or issues the orders to do so.
Offshore Well	Well with the Well Origin located on the Dutch continental shelf, or within the territorial sea (12 nautical miles from the low water line).
Onshore Well	Well with the Well Origin located on Dutch land or inland waters, but not located within the territorial sea.
Isolation	A combination of durable seals that collectively prevent flow of Fluids via the Well.
Tubulars	Designates pipes in a Well, i.e. tubing, casing, liners, conductors.
Useable Water	Water with such low salinity that it represents a natural resource, determined by the local geo-hydrological base.
Well	A well is a Borehole after construction and completion. A well can consist of multiple ids with the same surface origin, e.g. the original Borehole, any sidetracks and any multilaterals. Note: Where in this Standard the term "Well" is used, the statement applies equally to all Boreholes.
Well Decommissioning	The necessary actions to permanently isolate penetrated Zones with Flow Potential in a Well that will not be re-entered and subsequently remove the Well's surface equipment.
Well Operator *(uitvoerder)*	This term is used in the Mining Regulations and is equivalent to the Mining Company in as far as this Standard is concerned.
Well Origin	The location of the wellhead that gives access to the well.
Zone with Flow Potential	Sequence of rock layers that is capable of flow of Fluids to or from rock layers outside the zone or to surface.

Legal Requirements

Mining Law	Article 33 (*Mijnbouwwet*)
Mining Decree	Articles 67, 68, 69, 72 (*Mijnbouwbesluit*)
Mijnbouwregeling	Chapter 8 (Mijnbouwregeling)

Related NOGEPA Industry Standards

Standard 42	Well Examination
Standaard 83	RIGG (Report on Major Hazards / *Rapport Inzake Grote Gevaren)*
Standard 65	NORM
Standard 80	Standards and Document Control

Important directive for this Standard

The text below describes in general terms the status of the various requirements in this Standard. A colour code is used throughout this Standard to indicate the status of a requirement. Three compliance levels have been defined below.

In the context of this NOGEPA Industry Standard and when so used to describe a method or practice:	
'**shall**'	means that such method or practice reflects a mandatory provision of law (in Dutch: *dwingend recht*). Such method or practice is mandatory for those who are the addressees of such provision (mostly the Well Operators). A Standard can describe or quote, but not amend, mandatory provisions. When a Well Operator in exceptional cases cannot comply for technical, operational or HSE reasons, exceptions shall be documented and reported, and risks mitigated. Please note that this does not release the Well Operator from the obligation to comply with the law.
'**should**'	means that such method or practice reflects a Good Operating Practice. A Well Operator is generally expected to apply such method or practice, but a specific situation may require a specific alternative. In other words: the Well Operator complies or explains, and documents the explanation.
'**could**'	means that such method or practice is of an advisory nature or mentioned by way of example. A Well Operator is not obliged to comply and is not obliged to explain if he does not comply.

1 Executive Summary

This NOGEPA Industry Standard 45 addresses decommissioning of a Well by the Well Operator when there is no further use of the Well, or part thereof.

This NOGEPA Industry Standard no. 45 describes the requirements for Well Decommissioning and addresses position, properties, and verification of Isolations to permanently prevent flow of Fluids across key sealing geological strata. It furthermore provides comments and considerations of an advisory nature to assist with the correct interpretation of the requirements and their context. It also elaborates on several special cases.

NOGEPA Industry Standards are requirements and operating practices, agreed upon by the member companies of NOGEPA, which can be more detailed or demanding than the regulatory requirements. Following approval by the NOGEPA EXCOM, Well Operators are bound by the NOGEPA Industry Standards except for a conflict between the national legislative regime and the NOGEPA Industry Standards, in which case the national legislative regime prevails.

In accordance with the requirements in Standard no. 80, there will be a 3-year review cycle of this Standard, or sooner as required, to reflect changes in regulations, interpretation, industry practices and experience, international standards, technologies, documentation requirements, etc..

This standard is a translation from the equivalent Dutch document "*Het Buiten gebruik stellen van putten*". The Dutch version is linked to the Dutch Mining regulations by means of a policy *(beleidsregel)* and prevails over this translation.

2 Scope and application of this Standard

2.1 Scope Description

The legal basis for this Standard is provided by the articles in Chapter 8.5 of the Dutch Mining Regulations (DMR) and its supporting comments, valid as from April 1st 2019.
This Standard applies to Wells with no further use, e.g. due to cessation of further economic opportunities, integrity status, end of license period, etc.. This Standard is also applicable to partial decommissioning of, for instance (1) phased decommissioning activities, (2) in preparation for side-tracking of a Well, or (3) an exploratory well awaiting possible re-use in future field development.
This Standard applies to all onshore and Offshore Wells that are related to the oil and gas industry in The Netherlands and the Dutch continental shelf, as operated by NOGEPA members.

2.2 Application

The purpose of this NOGEPA Industry Standard no. 45 is to assist Mining Companies and the supervisory authorities in the assessment and decision-making that accompanies Well Decommissioning activity. Application of this NOGEPA Industry Standard will lead to a safe, efficient and effective approach, by examining the circumstances of the individual Well and identifying the key requirements in compliance with the DMR.
It is anticipated that a Well Operator may wish to develop its own internal procedures which can be applied simply and effectively, to achieve an adequate quality in Well Decommissioning in compliance with the requirements in this Standard. The Well Operator's procedures may vary as formations and Fluids vary in depth and pressure, and Well configuration and status vary between Wells.
The Well examination scheme of article 45L of the Mining Law **shall** be applied to Well Decommissioning to assure compliance with this Standard.

3 Overview of relevant regulations

3.1 Definitions of Shall, Should, Could

The meaning of the words shall, should, and could, as used in this Standard is explained on page 9 'Important Directive for this Standard'.

3.2 Regulations for Decommissioning of a Well

For ease of use, a translation of the Mining Regulations and the associated Release Notes are provided in Appendix A and B, respectively. The Dutch text was published in Staatscourant nr. 16260 of 27th of March 2019.

The next chapters describe and clarify each article of chapter 8.5 DMR. Advisory notes are added based on agreed practices (should-terminology) and considerations (could-terminology).

This Standard is in line with ISO 16530, Chapter 10, regarding Well Decommissioning.

4 General

4.1 Application to Boreholes and Wells

> Article 8.5.1.1 Mining Regulation
> **This chapter:**
> **a. applies to the full decommissioning of boreholes and wells;**
> **b. comparably applies to the partial decommissioning of boreholes and wells, including the decommissioning of sidetracks;**
> **c. comparably applies to the decommissioning of boreholes and wells made for other purposes than the exploration and development of hydrocarbons or storage of substances.**

The Release Notes that accompanied the Mining Regulations (see Appendix B, section I.1) clarify the difference between a Borehole and a Well. Where in chapter 8.5 DMR and in this Standard the term “Well” is used, the text is always also applicable to “Boreholes”.

The Release Notes for article 8.5.1.1 DMR also clarify the terms suspension and Decommissioning of Boreholes and Wells. This Standard does not provide rules for suspension of Boreholes and Wells, although partial decommissioning usually results in suspension.

Considerations for the partial decommissioning of a Well are provided in Section 7.1. Considerations for the construction of a sidetrack are described in Section 7.2.

The Release Notes to this article explain that chapter 8.5 DMR also applies to the decommissioning of Boreholes and Wells that are used for other purposes than developing hydrocarbons. It is not applicable to wells used for the extraction of water.

The regulation does not apply to Boreholes and Wells, or parts thereof, that have been decommissioned in the past in compliance with the regulations valid at that time, as per article II of the Release Notes: “This regulation takes immediate effect. This is without prejudice to previously undertaken activities for the decommissioning of wells, provided these were performed in accordance with the regulations in force at the time, such as the submission of a work program to the inspector-general of the mines (article 8.2.4.1 of the Mining Regulation, as published in the Staatscourant of December 19, 2002, no. 245, page 17). After coming into force, the new chapter 8.5 fully applies to every activity for decommissioning a well.”

4.2 Zones with Flow Potential

Article 8.5.1.2 Mining Regulation
In preparation for the decommissioning of a well, a well operator shall identify all zones with flow potential and shall investigate which measures can prevent the flow of fluids and gasses to or from rocks outside the zone or to the surface.

Decommissioning of Wells is concerned with the isolation of rock formations that can cause flow in the Well. An assessment of the flow potential of rock formations penetrated by the Well (zones) **should** be documented as this is key input to the number and location of Isolations.

For Onshore Wells, the protection of shallow Useable Water Layers **should** be addressed as a particular case. This can include a study that assesses the potential of disturbance in the shallow geohydrology; such study may have been performed before, e.g. during the well construction phase. Geohydrology maps are available to ascertain the depth of Useable Water Layers at a specific location.

Most rocks contain Fluids, like water, brine, oil, gas or mixtures of these, but do not necessarily flow. Flow potential is mostly associated with formations that exhibit permeability and a pressure differential with other formations or surface. Rock layers with very low or no permeability, like shale and chalk, may however also exhibit flow potential (e.g. if fractured with connectivity; fractures may be natural or induced by Well or production activities).

Indications of flow potential can be based on drilling records (gains/losses/gas levels) and log evaluation (including from adjacent Wells), as well as time of build-up of any sustained annulus pressures. Evidence of flow potential can also emerge during decommissioning operations. Precautionary measures could be required for adequate pressure control during such operations.

Formations could be grouped into a zone of similar Fluids and/or pressures if inter-zonal isolation is not required to prevent damage. Such a group of formations could be isolated by a common Isolation.

The extent of measures to prevent damage and mitigate possible consequences of flow **should** consider risks of harm to people, the environment and natural resources. The assessment could include such Well and area specific information as formation Fluids, pressures, re-charging, formation strength, spill points, non-sealing faults, potential flow rates and its sustainability, environmental impact, location, geo-hydrology, feasibility of remedial activities and response time. Considerations could also include underground flow into Usable Water layers where applicable.

The determination of the Maximum Anticipated Pressure that could develop below an Isolation following Well Decommissioning includes the (partial) recovery of pressure in a produced reservoir to its original pressure and possible effects of future use of the formation. When the Isolation is placed significantly shallower than the source of the pressure, it could also include an assessment of the hydrostatic column present.

Note: Assessment of underground seepage flow has to be seen in the context of naturally occurring migration of Fluids through the earth's crust, including subsurface microbial activity and upward movement of hydrocarbons to surface. Such migration continuously takes place through all strata, at varying rates of movement, and may be unrelated to a Well.

4.3 Importance of the Caprock and durability

> Article 8.5.1.3 Mining Regulation
> **For the decommissioning of a well, the Well operator shall install an effective and durable isolation that prevents flow of subsurface gasses and fluids through the caprock to other rock strata or to surface.**

The specification of a Caprock is provided in section 5.2 and the requirements for an Isolation in sections 5.3, 5.4 and 5.5.

Cement of proper composition and quality is generally accepted as a suitable material to create a durable Isolation. Where in this document the term cement is used, a suitable substitute material is also acceptable, provided it results in an equivalent Isolation in terms of effectiveness and durability. See also article 8.5.1.4, sub d DMR, and article 8.5.3.1, sub 4 DMR, as well as section 7.3 of this Standard which addresses suitable materials.

4.4 Rules for exemption

Article 8.5.1.4 Mining Regulation

1. **The Minister can grant an exemption of the articles in this chapter, provided an effective and durable method for decommissioning will be accomplished, in case of:**
   a. **a partial decommissioning;**
   b. **the decommissioning of a borehole or well that:**
      - **Is not used for the exploration or development of hydrocarbons**
      - **Is used for the storage of substances;**
   c. **an obstruction in the wellbore that dictates another method of decommissioning;**
   d. **the use of a sealing material other than cement; or**
   e. **the license holder has applied all measures for decommissioning that can reasonably be expected from him, and after decommissioning an isolation proves to be less effective or less durable than expected, with requirements for monitoring of the decommissioned well and taking necessary mitigating measures.**

2. **The exemption can be granted with requirements or limitations.**

This article creates a framework for possible exemptions of the articles in chapter 8.5 DMR by the minister. After all, situations can arise whereby it is not possible to comply with all articles. Such situations can be an obstruction in a Well that prevents access below a certain depth, for instance due to stuck tools or deformed pipe due to formation movement, or a risky and extraordinary activity to improve the decommissioning, but that is excessive in comparison with the possible damage. Requirements for mitigation measures can be formulated for such cases in order to limit damage to a tolerable level.

In article 8.5.1.4, sub 1b, DMR, the legislator means wells for other purposes, such as salt mining or geothermal applications.

5 Rules for the Decommissioning of Wells

5.1 Main activities

> Article 8.5.2.1 Mining Regulation
> **The well operator shall decommission a well by:**
> **a. an isolation across every caprock**
> **b. a top isolation**
> **c. removal of well material near surface**

This article describes the three key elements of Well Decommissioning. These elements will be further specified in further articles below.

Since there will often be more than one suitable Caprock in a Well, every Caprock in this article is meant in as far as it is relevant in achieving the objective as described in article 8.5.1.3.

5.2 Isolation across a Caprock

> Article 8.5.2.2 Mining Regulation
> **The well operator shall select an isolation across a caprock in such way that the isolation is opposite a caprock which is:**
> **a. impermeable and sufficiently thick and strong to withstand the anticipated maximum pressure of gases and fluids at that depth;**
> **b. does not exhibits fractures; and**
> **c. is located above a zone with flow potential**

A suitable Caprock extends across the field and represents a natural seal against Fluids migrating upwards, and hence provides a robust option for a permanent Isolation. One Caprock may serve several Zones with Flow Potential.

A suitable Caprock does not need to directly overlay the Zone with Flow Potential; it can be shallower. See Figure 1.

Salt (evaporites) and shale are generally suitable Caprocks. These rocks have very low permeability and are often self-healing in case of fracturing. Marls and Chalk are also suitable if not fractured; these rocks have high porosity but low permeability.

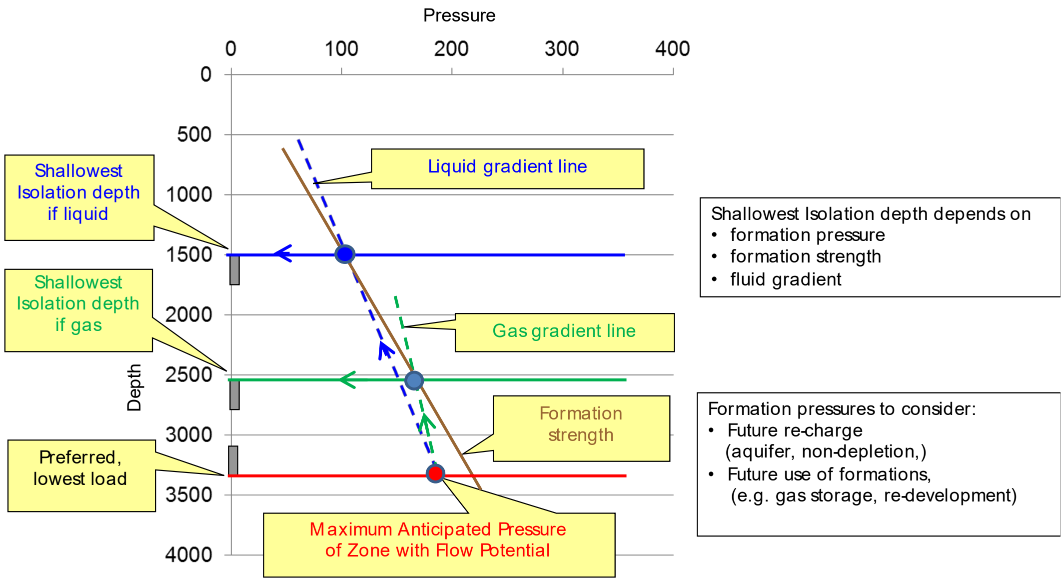

Figure 1: The shallowest (vertical) depth of an Isolation depends on Maximum Anticipated Pressure of the Zone with Flow Potential, the expected Fluid gradient, and the formation strength of Caprock. The illustration shows two scenarios, one for a gas gradient and one for a liquid gradient.

To determine the depth of the Isolation in a Well, one **should** identify and document:

1. every Zone with Flow Potential to be isolated;
2. Maximum Anticipated Pressure from a Zone with Flow Potential;
3. Fluid gradient related to every Zone with Flow Potential (gas, oil, brine, or mixture);
4. Top and bottom of a suitable Caprock (low permeability, not fractured);
5. Formation strength of the Caprock – the pressure that the Caprock cannot sustain and thereby allows Fluid to pass; and
6. Assessed Isolation in the annuli between Tubulars, if present, and the Caprock.

In case the Isolation is placed immediately above the Zone with Flow Potential, then information as listed under 2 (Maximum Anticipated Pressure), 3 (Fluid gradient), 5 (Formation strength) is in general not relevant and not required.

The requirement of the article cannot be met when there is no suitable Caprock, or the Caprock cannot be restored (e.g. due to obstructed access to the required depth, casing collapse, casing rupture, etc.). An alternative approach **should** be defined to minimise risk. An exemption **shall** be submitted as per article 8.5.1.4.

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5.3 Lateral requirements for an Isolation

> Article 8.5.2.3 Mining Regulation
> **An isolation in the subsurface shall extend across the full cross-section of the well and all annular spaces.**

As illustrated in Figure 2 an Isolation comprises of a number of seal elements. A cement column set inside a casing is one part of the Isolation, which further comprises of the cement outside and between Tubulars, any Tubulars and the surrounding Caprock formation. This is also referred to as a rock-to-rock Isolation.

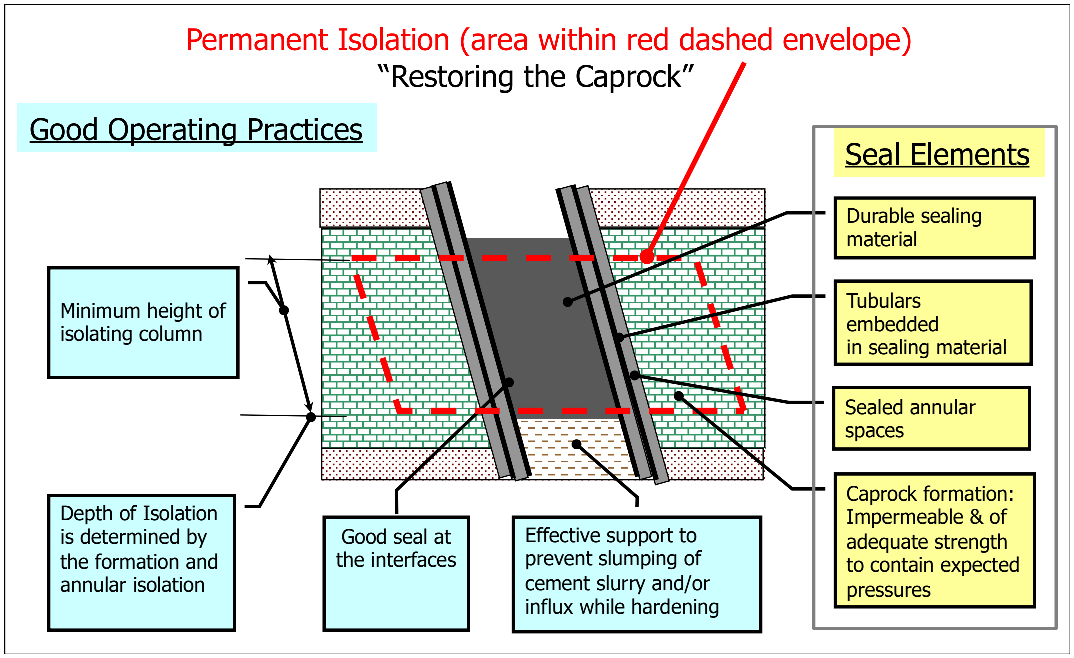

Figure 2: Illustration of an Isolation in which different sealing elements together restore the Caprock (red dashed envelope).

5.4 Cables and Lines in the Isolation

> Article 8.5.2.7 Mining Regulation
> **In an isolation there shall be no cables or lines.**

Refer to Section 7.15 for elaborations and considerations regarding this article.

5.5 Length of an Isolation

Article 8.5.3.1 Mining Regulation

1. **The isolation across the caprock shall be created with cement.**
2. **The hardened cement shall have a length along the borehole of**
   a. **at least hundred meters; or**
   b. **at least fifty meters, if the cement has been placed on top of a mechanical or solid support.**
3. **If these methods of isolation cannot be used, then an alternative method or technique shall be applied which shall result in an equivalent effective and durable isolation.**
4. **If the well operator submits an application for an exemption of article 8.5.1.4, sub 1, part d, for the use of a sealing material other than cement, then the well operator shall apply where possible in deviation of the stipulations under sub 2, specifications that shall accomplish an equivalent effective and durable isolation.**

This article determines the length of the isolation for both the inner cement column and the cement in the annular space(s). Both will be separately addressed next. For application of materials other than cement, please refer to section 7.3.

5.5.1 Length of the inner cement column

The inner cement column is that part of the Isolation that is placed in the innermost casing or, in case of an uncased wellbore, against the surrounding rock.

The length values in article 8.5.3.1 include significant redundancy to cater for contamination of cement slurry and inaccuracies inherent to placement with drillpipe. Placement on top of a mechanical or solid support makes the risk of contaminated cement slurry small, in which case a short cement column of 50 m will suffice.

When the thickness of the Caprock is less than 50 m, then a shorter length of the cement column is acceptable, the cement volume pumped **should** be adjusted to minimise contaminated cement adjacent to the Caprock. The placed cement column then extends beyond the Caprock. This also applies if different Zones with Flow Potential require an Isolation but are less than 50 meters apart.

The mechanical support mentioned under 1b is to prevent slumping of the cement slurry during placement until final hardening, as well as to prevent consequences of any losses and/or influx to/from formations. A mechanical support can be the bottom of the wellbore, a previously set hardened cement column, or a mechanical plug, such as, for instance, a bridge plug, closed retainer packer, inflatable packer, production packer with a tested nipple plug.

The mentioned length values are valid for cement. Sealing materials other than cement could allow or require other length values. These **should** be documented, against which the well examiner, as meant in article 45L of the Mining Law, can assess. A request for an exemption **shall** be submitted as required by article 8.5.1.4.

5.5.2 Length of cement in annular spaces

In order to demonstrate the presence of an effective and durable isolation in the annular spaces opposite the Caprock, the length and quality of the existing annular isolation **should** be assessed and documented by means of:

a) Reports of cement operations, using conservative assumptions;
b) Logs (if present); and
c) Absence of sustained annulus pressure or flow, for land and platform wells.

The lengths stated in article 8.5.3.1 apply on the understanding that the effectiveness and durability of the Isolation is of decisive significance. When a log shows varying quality, it can be considered to increase the length of the inner cement column, as a means to increase the reliability of the entire Isolation and to cumulatively comply with the lengths of article 8.5.3.1 for the annular spaces.

When the length of annular cement is calculated based on volumes pumped and/or differential pressures during the original cement job, documented conservative assumptions **should** be used, such as for volumes, losses and Borehole geometry. Casing centralization data, if available, can be included in the assessment of the quality. Consideration could be given to perform state-of-the-art cement placement simulation of the original cementing operations. If in doubt, a relevant pressure test through perforations or a cement log could be planned to increase the confidence level. Note that acoustic cement bond logs are limited to the first annulus and do not measure hydraulic isolation directly but are interpreted from acoustic transmission measurements.

Natural mobility of certain formations can provide a hydraulic seal around casing which is equivalent to good quality cement. See section 0 for details and qualification requirements.

In case of no or insufficient cement in the annular space adjacent to the Caprock, the Isolation will usually be restored to comply with section 5.3 (lateral requirements) and section 5.5 (length). A number of techniques are available for this:

1. Casing cutting and retrieving; see section 7.11
2. Casing perforating and circulating cement into the annular space; see section 7.12
3. Casing perforating, washing and cementing; see section 7.13
4. Casing section milling and placement of cement in the created space; see section 7.14

The feasibility of the listed techniques depends on the situation in the Well. Overlapping Tubulars (liner overlaps, scab-liners, etc.) opposite the Caprock are a particular area of attention.
In case none of the techniques is feasible, an alternative technique **should** be selected to minimize risks and be submitted to SodM for assessment. This also applies for innovative techniques not listed. A request for exemption **shall** be submitted in accordance with article 8.5.1.4.

5.6 Verification of Isolations

Article 8.5.2.5 Mining Regulation

1. **The well operator shall verify the presence of an isolation with a method that is meaningful for that purpose.**
2. **The well operator shall perform the verification without causing damage to the isolation.**

The objective of the verification of an Isolation is to ascertain the position in the Well and its sealing effectiveness. This is part of the quality assurance process of an Isolation which also involves job planning, cement properties, slurry mixing and placement, as described in section 7.4. The records and reporting of the operational execution are important for quality assurance and may at times represent the only meaningful verification.

Verifying the position of the cement column could be done by tagging the hold-up depth or by placement records of pumped/lost/returned volumes for a known Wellbore geometry (see Note 1 below).

Verifying the presence of an internal cement column **should** be based on at least one of the following:

i. Weight test to confirm that the pumped cement has hardened, using a value of 10 MT. If 10 MT cannot be applied safely, then SodM requires a justification and risk assessment in the program. For such cases, Table 1 provides guidance. See also Notes 1, 2, 3 below; or
ii. Pressure test to confirm no leakage when applying 5,000 kPa (50 bar), unless this would cause damage to existing Isolations. The minimum duration is 15 minutes to reach a stabilised pressure (see Notes 4, 5 below); or
iii. Inflow test to confirm no Fluid ingress. (this test is rarely feasible for a depleted reservoir).

Onshore Wells **should** be monitored for at least three months after all subsurface Isolations have been installed but before the conductor is removed (see Note 6 below).

The employed verification methods **should** be specified in the work program and results should be recorded and reported. Refer to Chapter 6.1.

Note 1: Circulating when lowering the work string (washing down) is a good operating practice to confirm firm cement and complements a weight test. Whenever cement is not in place or still soft, lack of resistance will be observed.

Note 2: The weight testing value depends on the work string size. An overload may cause damage to the work string or coiled tubing if used. As relevant, the work string frictional drag along the hole **should** be considered to ensure that sufficient weight is applied to the cement.

Table 1: Guidance for safe weight test values for different sized cementing stingers (1 MT (metric Ton) is equivalent to the weight of 1,000 kg)

Stinger OD	Safe weight test
5”	10 MT
4.1/2”	8 MT
3.1/2”	4 MT
2.7/8”	2 MT
2.3/8”	1 MT
1.3/4” (CT)	0.5 MT

Note 3: The tagging depth (hold-up depth) is determined by the volume pumped and Borehole geometry. For a correct calculation, deep tagging may indicate soft cement, slumping or losses. Shallow tagging in contrast may indicate displacement inefficiency (by-pass) of the present liquid, channelling or shallow cement bridges.

Note 4: A pressure test from above is only meaningful if a leak path below the Isolation exists, or if compressibility effects below are large enough to allow detection. Pressure integrity above the Isolation also needs to be present. The mentioned 50 bar is the pressure above the value at which flow would occur in case of a leaking Isolation. It is usually not meaningful to perform a pressure test on an Isolation above a previously pressure tested Isolation or Mechanical Plug due to lack of a leak path. In special circumstances may compressibility effects be measurable; this typically requires large fluid volumes below the column relative to the volume above, and negligible casing ballooning effects. A pressure test in open hole is not meaningful due to lack of pressure integrity.

Note 5: A pressure test of a Mechanical Plug and/or internal cement column **should** be assessed with respect to potential damage to other isolation elements, in particular the annular cement seal. Damage **should** also be prevented to Well components, such as casings, wellhead, or X-tree. It has been observed that a pressure test can crack-open the interface between casing and cement. Any leak through such a micro-annulus will be very small, hence difficult to detect. To prevent such damage, the pressure during the test could be lowered.

Note 6: Applicable only to Onshore Wells, a long term monitoring period is required after all subsurface Isolations have been installed. This is confirmation of absence of pressure build-up and/or gas bubbles. Monitoring is applied before the conductor is removed to facilitate any remedial work if needed. Note that residual gas may be present in annuli, which has to escape as visible bubbles before the Well can stabilise. The time required for this is Well dependent. Also consider performing a gas analysis to distinguish between natural shallow biogenic sources of methane and gas from deeper strata.

5.7 Properties of remaining Fluids

Article 8.5.2.6 Mining Regulation
Gases and fluids that remain in the well, shall not cause more than minimal damage, including damage from corrosion, to the isolations, the caprock and the casings and have a pressure gradient that exceeds the formation pressure gradient in the zones with flow potential.

A number of discrete Isolations are placed during Well Decommissioning. Between Isolations the Wellbore will remain filled with liquids of such composition that corrosion of steel and cement is minimised and no damage is done to mineral deposits or other natural resources. Formations with Usable Water require particular attention.

The specific gradient of the liquid between two Isolations **should** be selected to withstand any expected pressure during the Well Decommissioning, such that operations can be conducted safely. In the long term, the liquid could become inhomogeneous; this is acceptable because of the Isolations that are then present.

As a precautionary measure to minimise corrosion, the pH of the liquid could be raised using additives. In addition, oxygen scavengers, biocides and/or a high salinity can be used. The latter two will suppress bacterial growth and thus microbial induced corrosion due to locally generated H2S. Environmental considerations could influence the selection of liquids and additives.

5.8 Top isolation and surface requirements

5.8.1 Top isolation

Article 8.5.3.2, sub 1, Mining Regulation
A top isolation shall be placed:

a. **On land: near surface, whereby the planned use of the terrain is taken into account;**
b. **Below surface water: near ground level in case a risk of environmental damage exists.**

Article 8.5.2.4 Mining Regulation
The top isolation extends across all annular spaces.

The top Isolation **should** be 100 m long, or 50 meters if placed on a Mechanical Plug or equivalent. The top isolation does not need to be verified unless risks of pollution by remaining Fluids exist.

A top isolation is not required offshore because of abundance of settling solids in the Dutch part of the North Sea that will rapidly fill-up the hole after removal of the conductor below the seabed.

The top Isolation is placed at a shallow depth opposite weak formations, hence is not an Isolation against hydrocarbons or over-pressured Fluids (a pressure-competent Isolation will be present at a suitable depth in the Well). However, onshore it could aid in geo-hydraulic isolation of Useable Water.

The top depth of the top Isolation **should** be selected to allow for compliance with Section 0 and allow for a possible shallower re-cut in case of a failed first attempt.

5.8.2 Removal of Well equipment

Article 8.5.3.2 section 2 Mining Regulation
Well materials shall be removed:

- **a. On land to a depth of 3 meters below surface or deeper as required by the planned use of the terrain;**
- **b. Below surface water to a depth of 6 meters below ground level, or deeper if a potential change of ground level so requires.**

Offshore, casings and conductors which stand proud of the seabed can become a hazard for fishery or other marine activity (a fishing trawler may capsize when beams catch behind such obstruction). The depth of the cut **should** take into account the movement of sediments; moving sediments in the southern North Sea can develop into sand dunes of several meters in height. Due to currents and scouring, a pit may have developed around the conductor. These effects could be assessed by a bathymetry survey of the water depths in a wider area around the Well.

Any debris on the seabed around the Well **should** be removed and an inspection (debris survey) **should** be conducted to confirm a clear seabed.

Onshore, the cutting of the surface pipe is usually combined with site restoration. This activity can be many years after the subsurface decommissioning. The planned cut-depth **should** be checked with respect to plans for underground infrastructure development e.g. with the municipality or land owner. Such plans (e.g. roads, tunnels, underground parking facilities, etc.) could require a deeper top-of-cement and a deeper cut, or sand fill to allow for a deeper cut later.

For a use of explosives for cutting of multiple cemented strings offshore, e.g. conductor, surface casing, intermediate casing, etc., precautions **should** be taken to prevent harm to sea life and minimise deformation of the remaining pipe.

The retrieval of multiple-strings in Offshore Wells involves heavy loads and carefully planning. Safe retrieval and handling could involve boring and pinning equipment to keep multiple-strings together. Safe transport of sectioned pipe can be enabled by pins and end-caps.

The subsea part of a conductor will have growth of shells that represent a hazard to handling. As it is being retrieved, the pipe could be cleaned with special high pressure water jets.

The conductor removal could optionally be deferred to the time of platform removal and be performed by a heavy lift vessel.
Retrieving an offshore conductor could be obstructed by platform guides; welding of guides may have taken place after initial installation, which can prevent lifting and may necessitate work

underneath the platform. Also, certain conductor connector types may have lost integrity which can result in dropped object hazards. This may also be the case for heavily corroded conductor.

Severe corrosion has occasionally been observed on surface casings around ground level or seabed. As a result, this can part during lifting. A low-pressure test on the respective annuli could reveal such issues before the pulling operation.

6 Reporting and Documentation

6.1 Work program / Notification of Well Activities

Article 8.2.4.2 Mining Regulation

1. **The work program for the decommissioning of a well shall be in the possession of the inspecteur-generaal of Mining at least four weeks before the start of the activities in question.**
2. **Article 8.2.1.2, second and third subsection, similarly applies.**

Article 8.2.1.2 Mining Regulation, as relevant to this standard:

1. **(…)**
2. **Major changes shall only be made to a work programme after these have been notified in writing to the inspecteur-generaal of Mining.**
3. **If unforeseen circumstances prevent such prior written notification to be given in good time, then the inspecteur-generaal of Mining shall be notified immediately of the change by telephone or otherwise, which notification shall immediately be confirmed in writing.**

Appendix C describes the minimum content of the work program for the decommissioning and the Well designation. These are based on article 8.2.4.1 of the DMR.

The work program **should** provide an assessment of the quality of the existing isolations in the Well, based on cement in annular spaces, formations, job records, any logs and annulus pressure observations.

The work program **should** show a Well schematic of the intended final status after completion of the decommissioning activity. This **should** include the underground situation with formations and their Fluids, casings size and top/bottom depths, packers/plugs, remaining fluids/pills, annular cement, planned depth and length of Isolations, verification methodology for each Isolation, and the Well's inclination.

When a phased execution is adopted by which activities will be suspended for a longer time period, then a Well schematic of the intended temporary situation of the Well after the decommissioning activity **should** be included in the work program.

The work program **should** list PEC items of safety critical activities to enable control through the Well Examination scheme.

6.2 Final Well status reporting

Article 8.2.2.2 Mining Regulation, as relevant to this standard:

The final report of the (…) well decommissioning contains the details set out in the appendices (…) 12a, is drawn up in accordance with these appendices, and will be submitted within four weeks after the activity.

The final report **shall** in accordance with article 8.2.2.2 DMR and the related appendix 12a, be submitted at the latest four weeks after completing the activity. It is paramount that an up-to-date Well schematic is available as soon as possible in case unforeseen circumstances develop at the Well.

Appendix 12a as referenced in article 8.2.2.2 has been reproduced for convenience in appendix D of this standard.

The Well status is required by appendix 12a, sub 2.1.1. This can be either In-Operation, Suspended or Decommissioned. A Well with the status Decommissioned will have all necessary underground Isolations installed and the Well equipment near surface removed in accordance with chapter 8.5 MBR. A Well with the status Suspended can be partially decommissioned. It is possible that all underground Isolations have been installed, but the Well Equipment near surface yet needs to be removed. It may be useful to state to which depth the Well has been decommissioned, i.e. the top depth of the shallowest Isolation that complies with chapter 8.5 DMR (or the regulations valid at that time).

The Well schematic is preferably based on that in the Work program, with changes as required to reflect the actual situation of the Well after completion of the activity.

Decommissioning of Wells can be executed in a number of separate activity periods, possibly years apart. Such separated activities can be for instance be the isolating of only the production zone, or the final removal of the conductor by a lift barge, or the conductor removal during site restoration, etc.. The Well status report **should** in such case be updated after each completed activity period and re-submitted, such that an up to date Well schematic is always available.

6.3 Further reporting requirements

In addition to the requirements of Section 6.1 and 6.2, the following reporting and notification requirements by the Well Operator apply to Well Decommissioning:

I) Before and during a Well Decommissioning activity:

- Notification of the well activity to the Inspector General of Mines, in compliance with article 45n of the Mining Law, six weeks before the start of the activity. With respect to the content of the notification refer to article 11a.6.1. sub 4b DMR;
- Notification to the Minister of the Well decommissioning activity, at least 4 weeks (onshore) or 2 weeks (offshore) before the start of the activity, in compliance with article 7 and 8 of the decree on general requirements environment mining (*Besluit algemene regels milieu mijnbouw; Barmm*);
- Report on Major Hazards (RoMH; RIGG) for a non-producing installation (n-PI), in accordance with paragraph 4.1a.1.2 of the Mining Law;
- If applicable, modification of the present license on the basis of the Wabo law (*Wet algemene bepalingen omgevingsrecht*) or the environmental license for mining (*Mijnbouwmilieuvergunning*) on the basis of the Mining law;
- If applicable, a nature impact test for a possible environmental licence on the basis of the nature protection law (*Wet Natuurbescherming*);
- Offshore: Notification of the planned activity to the hydrographical agency (Dienst der Hydrografie), Rijkswaterstaat, and the coast guard (Kustwacht);
- Onshore: Notification of the planned activity to the municipality, Waterschap, fire brigade, emergency services, as applicable; and
- Daily reporting to SodM during decommissioning activities, as per article 8.2.2.1 DMR.

II) After a Well Decommissioning activity:

- TNO NLOG: Update of the Well details and status;
- Offshore: Notification to the hydrographical agency (Dienst der Hydrografie), Rijkswaterstaat, and the coast guard (Kustwacht);
- Onshore: Notification to the municipality, Waterschap, fire brigade, emergency services, as well as the update of the KLIC database, as applicable.

7 Special cases and aspects

7.1 Partial decommissioning for suspending rig operations

This section applies to Wells that will be left unattended for an extended period of time, e.g. exploration Wells. The minimum requirements for decommissioning of this Standard applies with the exception that not all casing will not be cut/recovered. After all, the Well will need to be safely re-entered for re-use or further decommissioning activities. The Well **should** therefore be left in a state where safe re-entry is possible under full pressure control without compromising the Isolations in place.
Pressure underneath a cement column may have developed during the unattended period. The drilling of this can lead to the hazardous ejection of the drillpipe from the well (pipe-light condition).

If a shallow cement column is planned that will need to be drilled for re-entry, it can be considered to place this at sufficient depth such that the drilling assembly (BHA) can be fully in the Well without straddling the BOP's. The BOP's can then be closed on drillpipe instead of on the BHA.

Since re-entering a partially decommissioned Well can be complex and costly, consider the option to fully decommission instead of suspend and delay this activity to a later time.

7.2 Partial decommissioning before sidetracking

The original Wellbore below the kick-off point of the sidetrack will be no longer accessible after the sidetrack has been initiated. It **should** be abandoned in accordance with these guidelines before commencing the sidetrack unless the required Isolations to restore any Caprock can be placed above the kick-off point during the final decommissioning of the Well.

If the kick-off column is to be used as an Isolation, then the remaining length, after kick-off, **shall** conform to the mandatory requirements of an Isolation.

For a sidetrack in the reservoir below the Caprock, isolation from the original Wellbore, across the sidetrack point, may be required for reservoir management during production life. This is not an Isolations and is exempt from the requirements in this Standard.

A sidetrack to by-pass a stuck drilling assembly at the depth of a cap rock **should** follow the principles of this Standard as much as possible. The situation may limit available options however. If feasible, it could be attempted to cement through and around the drilling assembly, or otherwise as close as possible above. Refer to section 7.4 for quality assurance and area of attention for the placement of cement isolations. The selected design will much depend on the position of the stuck tools relative to the Caprock and casing shoe.

7.3 Materials and durability of an Isolation

Materials that constitute an Isolation should have the following main characteristics:

very low permeability – to prevent flow of Fluids through the bulk material.
provide an interface seal – to prevent flow of Fluids around the Isolation; the material provides a seal along the interface with adjacent materials such as steel pipe or rock; risks of shrinkage and de-bonding should be considered.
the material must remain at the intended position and depth in the Well.
long-term integrity – durable, long lasting isolation characteristics of the material; including a low risk of internal cracking and of de-bonding at the interface over time.
Sustained functional properties under foreseeable downhole conditions, including corrosive Fluids (e.g. CO2, H2S, hydrocarbons, brine), pressures and temperatures.
mechanical properties that are suitable to accommodate loads at foreseeable temperatures and pressure.

For almost a century, cement-based recipes have been used and accepted in Wells globally as the prime material for isolating purposes. This does not however preclude the use of other materials. These materials should conform to the requirements above. The assessment of compliance with the above requirements should be documented. The Guidelines on qualification of materials for the abandonment of Wells, Issue 2, Oct 2015 (published by Oil & Gas UK), could assist with this.

The international oil and gas industry accept steel as part of a durable Isolation. To extend its durability, the steel should be embedded, i.e. covered both inside and outside in cement or a sealing material with similar functional properties.

The following materials should not be part of an Isolation from a durability perspective:

- Elastomeric seals as used as sealing components in for instance in mechanical plugs, packers, are not acceptable as Isolations. Mechanical Plugs and packers could however be used as a foundation for cement slurry;
- Control lines and cables may create vertical leak paths through an Isolation, for instance via control lines, injection lines, electrical power cables, data cables, optical fibre cables, and plastic coated tubing and other Tubulars.

7.4 Quality assurance for placement of Isolations

Material properties, surface mixing and downhole placement are critical parts of the quality assurance process of Isolations that use cement. Operating practices are Well-dependent, but detailed job planning and keeping records of execution versus plan **should** be implemented for demonstrating quality of the Isolation.

For achieving a well-placed reliable Isolation, it is important that the cement slurry is not moving during its hardening process. An effective support (such as a Mechanical Plug, packer, hole bottom, previous cement column, a viscous pill, viscous heavy mud, or a blocked annular space) **should** be present to prevent slumping of the cement slurry. In order to mitigate the effect of cement contamination and/or shrinkage, allowances could be made on volumes.

Registration of the slurry density and volumes pumped/returned/lost are important indicators of the quality of a cement Isolation and supports the verification.

The design of abandonment cement Isolations **should** account for uncertainties related (but not limited) to:

- Downhole placement techniques;
- Depth and size of the cement column
- Minimum volumes required to mix a homogenous slurry;
- Pumped and returned volumes;
- Pump efficiency and parameters;
- Causes of losses;
- Contamination by Fluids; and
- Shrinkage of cement or sealing material.

A minimum cement slurry volume could be specified to compensate for contamination during pumping and placement.
When using a heavy viscous pill as a support for the cement slurry, a laboratory set-up could confirm that this itself does not slump in the resident Well Fluid/mud.

The stinger size and outlet ports could be optimised for minimal slurry contamination.
A stinger could optionally be cemented in place to reduce the risk of disturbing the setting process of cement. Longer cement columns are possible with this technique. For this application there is a hydraulic disconnect available. The same principles and practices apply as for a primary casing cementation.

There is no requirement to squeeze perforations or remove a production packer if Caprock restoration is achieved by placing an Isolation above.

7.5 Horizontal Wells

The decommissioning of a horizontal Borehole is not different from a standard (non-horizontal) Borehole, although practices for installing a satisfactory isolation at high inclinations will require more attention.

In many cases the formations that the horizontal section of a Borehole will penetrate can be treated as one single Zone with Flow Potential. In this case it is not required to place Isolations in the horizontal section; restoring the Caprock above with an Isolation will provide an adequate seal.

In general, this Standard specifies Isolations with 100 m of cement, or 50 m if placed on a mechanical foundation; these lengths are along hole measurements. In a highly inclined Borehole (i.e. close to 90 degrees), a practical extended length could be selected such that the final vertical thickness of the Isolation is increased. This would also cater for increased risk of slurry contamination and sagging/separation after placement.

Careful planning is required if annular and internal isolations are required in a non-cemented production liner in the horizontal or near horizontal Wellbore. Options to be considered are large cement volumes, multiple placements and auxiliary pump-through packers. If a Well has a non-cemented production liner, it is likely that the Wellbore will contain only one Zone with Flow Potential. Annular isolations (e.g. External Casing Packers) may be present for controlling production behaviour, but these would not necessarily present a need for placing an Isolation.

The placement of Isolations in a horizontal Well can be facilitated if this has been taken into account during the planning and construction stages of the Well.

7.6 Multilateral Wells

The decommissioning of a multilateral Well (whereby production takes place from several branches) is not different from a standard (non-multilateral) Well. In many cases, the formations that the Boreholes of a multilateral Well penetrate can be treated as the same Zone with Flow Potential. It is then not required to place Isolations in the branches, provided a suitable Caprock is restored above by an Isolation.

The following considerations apply for the design of multilateral Wells:

- future decommissioning, in particular the location of the Caprock;
- presence of cement at the junctions to the branches;
- possibly different pressure regimes in the lateral branches of the Well;
- annular isolation above the branches;
- maintaining availability of special tools for access into the individual multilaterals branches.

7.7 HPHT Wells (High Pressure High Temperature)

Two Isolations **should** be placed above an oil or gas reservoir with HPHT conditions (see Definitions) with each capable of providing an adequate Isolation for the HPHT reservoir.

The decommissioning of a HPHT Well (see Definitions) is not different from a standard (non-HPHT) Well. However, with the increased complexity of these Wells and consequences of failures, special aspects **should** be considered, such as potential recharging to high pressure, the integrity of the Caprock in case of deformation, thin pressure transition zone, deformation of casing, temperature cycling, degradation of cement due to high temperature, and, in case of a large reservoir thickness, possibly reservoir compaction and subsidence, etc..

Furthermore, placement of cement in a high weight Fluid in the Borehole requires careful planning. Extending the length of the Isolation can mitigate placement risks.

7.8 Fracked Wells

The principles for decommissioning a hydraulically fracked Well is not different from other Wells.

7.9 Non-accessible Boreholes

Restoration of the Caprock may not be feasible, if the Well is not accessible to the required depth. This can be the result of, for instance, deformed or parted Tubulars, collapsed Borehole or stuck equipment.
For such cases, it may not be feasible to satisfy all mandatory requirements of this Standard. Refer to page 9 how to proceed in such situation.

7.10 Liner laps

If Caprock(s) will be restored below (deeper than) a liner lap, then the liner top does not need to be covered by cement. Similarly, if a suitable Caprock is located above (shallower than) the liner lap and will be restored, then the liner top does not need to be covered by cement. In case the depth of the liner top coincides with the Caprock and the cement quality in the liner lap is uncertain, then the Isolation should be placed either above, or above and below the liner lap (i.e. not only below).

During Well construction the liner top packer is often set immediately after the cement job. The liner lap and packer can then not be tested separately; it is then not possible to know whether the cement in the liner lap or the packer is holding the pressure. Furthermore, a liner top packer does not qualify as Isolation.

7.11 Cutting and retrieving of casing

Freeing casing for retrieval as referred to in section 5.5.2, sub 1, often proves impossible as a result of blockages in the annulus or partial cementation. If casing can only be recovered from a shallow depth, it may not be feasible to restore the Caprock. It can be useful to have a contingency plan prepared for such situation.

When cutting and retrieving a casing, precautions **should** be taken for possible trapped gas or sources of pressure behind the casing. Although pressure can be encountered, the volumes will mostly be limited.

The cut-depth will in general have to be chosen significantly shallower than the calculated top of cement. This is due to uneven displacement during the primary cement job. Even when logs show free pipe, it may not be feasible to retrieve the casing from that depth; this is mostly caused by settlement of solids in the annulus or collapse of the formation. Punching the casing and establish circulation is a useful method before proceeding with cutting and attempting to pull. This of course also prevents problems due to unexpected pressure and the BOP configuration for such case.

Due to instability/collapse of formation and solids settlement, the retrieval of the casing from below a previous casing shoe is often impossible; this also limits re-entry into the deeper Borehole and any remediation options.

A so-called annulus top-fill with cement (as practiced in the past), will yield the casing mostly non-retrievable.

Casings are typically hung-off in tension. Cutting casing where free (not cemented) will release the tension and could cause the lower part to drop. The drop and/or shock wave could release trapped gas due to disturbing blockages in the annulus or damaging existing annular cement. This also applies when retrieving the hanger separately. Although such effects are rare, precautionary measures may be incorporated in the work program.

Cutting Tubulars with an explosive cutter at a shallow depth could cause a pressure wave and propel unconstrained pipe out of the hole.

When the casing has been recovered and a cement column is to be placed above the stump, then measures **should** be taken to prevent slurry slumping into the annulus, for instance by means of a bridge plug or a viscous pill above the stump as a foundation for the cement slurry, (see Figure 3). This also prevents any influx during the hardening process of the cement.

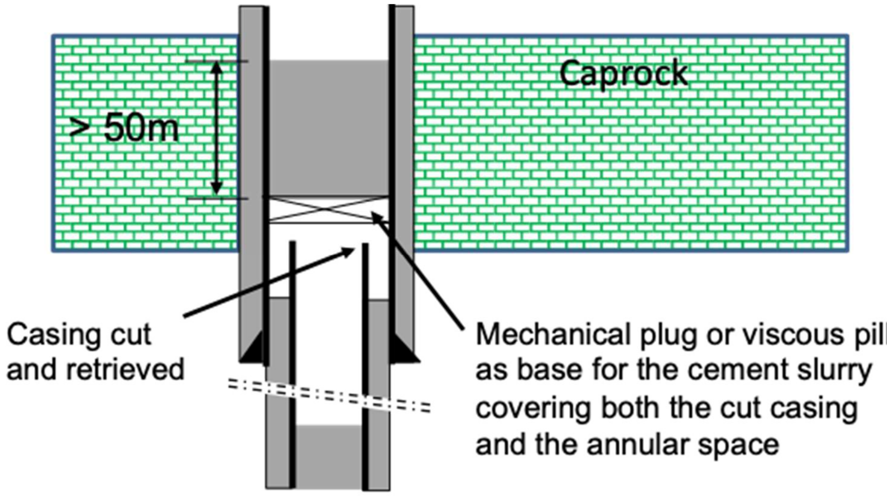

Figure 3: Isolation placement across the Caprock after cutting and retrieving the (inner) casing that was not cemented across the Caprock.

7.12 Perforate and cement placement

Placement of an annular cement column, as referred to in section 5.5.2, sub 2, involves circulating cement into the open annular space through perforated/punched casing. This technique has been used for more than 50 years.
It is often not possible to establish circulation after perforating, or only achieve small flow rates due to high flow resistance. Options then include a repeat at shallower depth, and/or different Fluids, and/or additional perforations for return flow (e. g. 50 or 100m shallower); a packer or cup-type tool is then required.
Because of sub-optimal cementing conditions, extended circulating times are advisable, possibly with cleaning-pills to clean the annular space, and to place long cement columns.
To prevent slumping of cement slurry, a viscous pill can be first placed into annulus through lower perforations, or an epoxy donut foundation placed on electric wireline.

7.13 Perforate, wash and cement

The technique referred to in section 5.5.2, sub 3, involves perforating tens of meters of casing, followed by a washing process with a cup-type tool or jetting-tool, and finally placement of cement in the annular space and the inner bore. This can efficiently be performed in a one-trip operation.
The PWC technique dates back to 2010. Tens of cases have been reported in which a sufficient cement quality has been demonstrated by drilling out the inner cement column and taking a log. This tedious verification method is no longer required unless the well condition or operational problems give rise to it. Most PWC experience relates to 9-5/8” casing. In a number of cases a dual PWC operation has been performed, mostly in 9-5/8” and 13-3/8” casing.

The success of the PWC technique also depends on the quality of the cement in the annulus. With competent cement in the annulus, the washing can have a limited effect. It is therefore common practice to take a cement bond log and to select the most suitable depth interval; selection criteria for this have been published.

7.14 Section milling of casing

The extensive remediation technique referred to in section 5.5.2, sub 4, involves the milling of casing over tens of meters, followed by a clean-out using underreaming, before placement of cement in the created space (casing window).
The technique is predominantly used in case of a non-sealing cement column in the annulus. A disadvantage is the loss of access to the deeper Borehole.

Section milling is often associated with operational problems. Precautionary measures are required to remove the produced steel chips/threads from the well and milling fluid. Certain BOPs require special attention w.r.t massive steel debris.

A milled section length of 50 m **should** be planned for, although a shorter length has been observed as adequate for remediation of sustained annulus pressure. The length is in accordance with section 5.5.2 for a case with a mechanical or solid foundation. For the annular space this is the likely case due to blockages by cement and mill chips that largely prevent slumping of cement slurry and influx.

The cleaning of the milled window aims to remove all old cement, chips and a thin rock layer. Centralisation and strength of the planned equipment require attention, as well as the properties of the milling fluid and the cut formation.
Some pressure can be kept on the well during hardening of cement without exceeding the formation strength as this could cause fluid losses to formation.

7.15 Removal of downhole equipment (packers, Tubulars, control lines, cables)

The removal of downhole equipment is not a requirement, except if the required Isolations cannot be achieved as a result. Downhole equipment in this context includes casing, liner hangers, packers, plugs, etc..

Cables and lines **shall** be removed at the Isolation and are not allowed to pass through an Isolation. These include cables and lines associated with the completion, like electric lines, data lines, control lines, injection lines, optical lines, etc..). Such components represent a potential leak path through the Isolation because they are not internally sealed, and the protection jackets are not made of durable materials.

If the Isolation is located above a production packer, then this (and its tail pipe) can remain in the Well. When equipped with a wireline plug, the packer can effectively be used as a base for cement slurry. The cement slurry can also be pumped into the perforations (bullheaded) as a result of which the lower part of the well will be filled with cement to above the production packer (see examples in Figure 4).

Both production liner and tailpipe can possibly hold a limited amount of scale precipitation with NORM that however cannot be removed.

7.16 Decommissioning of uncased Boreholes

This section relates to Boreholes without cemented casing as may be encountered in an exploration well or a barefoot completion.

The requirement of restoring the Caprock applies to both cased and uncased hole (as per section 5.2 and section 5.3).

Further, for uncased hole an additional Isolation **should** be placed above the shoe of the last casing or liner. This allows a more reliable verification by means of pressure testing or weight testing. This requirement can be satisfied by placing a separate cement column inside the casing, or by placing a cement column that extends from the open hole into the last shoe.

A first cement column in an uncased Borehole could be placed on the bottom of the hole. Long cement columns could be placed in several stages to prevent cement slurry disturbance when raising the stinger. Alternatively, long cement columns could be placed undisturbed by means of a long stinger that is cemented in place and from which the work string can be hydraulically disconnected. The potential for losses due to a long cement slurry column will have to be considered.

Note 1: In case an uncased Borehole is decommissioned as preparation for a sidetrack, there is not a requirement for an Isolation at the kick-off point. This section does not apply then. See section 7.2.

7.17 Through-Tubing Well Decommissioning

Through-Tubing Well Decommissioning involves cementing the production tubing partly in place as part of the Isolation. For this, circulation holes are punched in the tubing immediately above the production packer and cement is placed inside and outside the tubing. This technique enhances safety as an Isolation is placed before removal of the christmas-tree for the installation of BOPs.

It is currently not allowed to Decommission a Well without removing the tubing, as described. However, the Minister can grant an exemption in specific circumstances, e.g. if there is no other way to achieve an Isolation.

Pumping cement slurry through the tubing into perforations (bullheading) is an accepted practice for placing an Isolation in suitable wells, e.g. if tubing integrity and injectivity is confirmed. Also placing cement with coiled tubing below the production packer is an accepted practice. The recovered tubing can subsequently be used as a stinger to place additional Isolations as described in Section 7.18.

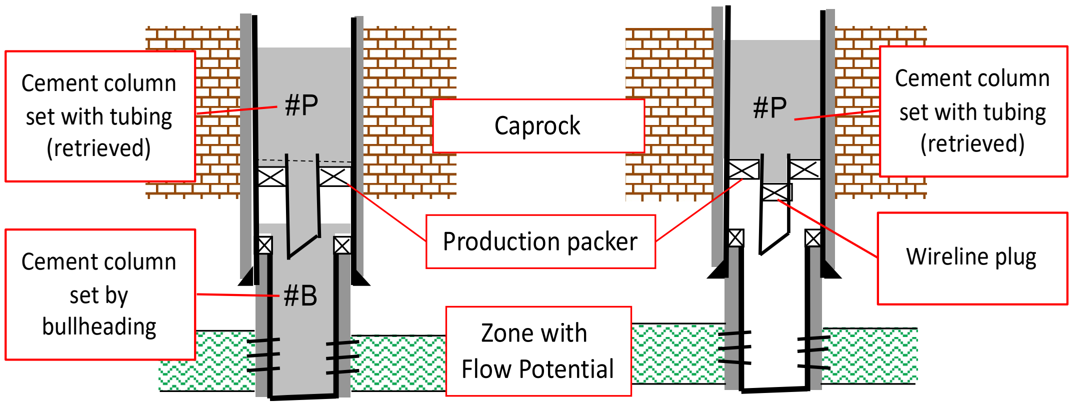

Figure 4: The production packer can stay in the well when the Caprock is located above and the Isolation can be created there. The illustration shows as examples options of bullheading (left) or a wireline plug in the tailpipe (right).

7.18 Tubing as a cement stinger

The tubing could be used as a cement stinger in suitable Wells. This technique requires the tubing to be cut and partially pulled in order to remove at least the control line for the safety valve. Subsequently it can be lowered for placing a balanced cement column and later for weight testing the cement.

Unless prohibited by other legislation, part of the tubing could remain in the well, e.g. landed on the cement column and cut at a shallower depth. The remainder of the tubing can be recovered or used to install the next shallower cement column. Refer to Section 7.4 for quality assurance and placement practices.

7.19 Sealing mobile formations

Certain formations (e.g. certain shales or salts) can deform as a result of stress differences and are able to close an open annular space. Typically, this is a geological feature that is observed in a larger area and is not an isolated Well related feature. Such formation can serve as Caprock, provided it is impermeable and of adequate strength.

If the resulting seal of the formation against the casing is adequate to prevent flow at the Maximum Anticipated Pressure, then such a seal could be accepted as at least equivalent to annular cement.

The qualification of a formation seal in a Well **should** include:

1. Proof that the formation has the required fracture strength to withstand the anticipated future pressures, in present or adjacent Wells, by means of a pressure test.

2. Verification that the length of the seal exceeds 50 m (or the Caprock thickness, if less), whereby the quality of the seal must be at least equivalent to that of a good cement seal. Two independent logging tools (e.g. an acoustic cement bond tool and an ultrasonic circumferential cement evaluation tool) **should** be run to confirm the good quality of the isolation between the casing and the formation. A specialist who is experienced in the evaluation of the used logs **should** interpret and document the logging results using formation-specific parameters.

3. Validation that the log response can be interpreted as not leaking at the Maximum Anticipated Pressure. This can be achieved by means of a pressure test between perforations that are (less than) 50 m apart. Once the quality of the formation sealing has been established on a few wells, this validation activity could be omitted.

7.20 Wells containing H_2S, CO_2

The Isolations placed in a Well with H_2S or CO_2 **should** be designed to withstand the potential effects of such gas on its components (like cement, steel, formation).

Sequestration of CO_2 (underground storage) is outside the scope of this Standard.

7.21 Releases of shallow hydrocarbons

Releases of gas from shallow formations are a widespread natural occurrence, amongst others in the west of The Netherlands. If gas bubbles are observed around decommissioned Wells, these releases do not necessarily indicate a failure of Isolations. Such gas is mostly of biogenic nature (like swamp gas) and can be differentiated from thermogenic gas by means of composition analysis (fingerprinting). Producing reservoirs contain thermogenic gas which is a result of thermal processes that occur over a geological time scale at elevated temperatures and pressures in deep rock layers.

7.22 Irretrievable radioactive instrument sources

Some downhole tools that are temporary lowered in a Borehole for measurements contain radioactive sources. In a rare event such measurement tool may become irretrievable. The relevant part of the Borehole shall then be isolated and decommissioned as per this Standard. Refer to Appendix E, or SodM Nieuwsbulletin 18: "Melding/procedure bij een vastzittende radioactieve bron in een boorgat of put".

Appendix A: Translated articles of Chapter 8.5 DMR

For reference, this Appendix provides the translated text of the Mining Regulations as published in the Staatscourant (27 March 2019, nr 16260). The associated release notes can be found in Appendix B. The Dutch text of the Mining Regulations prevails over the translated text.

Chapter 8.5. The decommissioning of boreholes and wells

§ 8.5.1 General

Article 8.5.1.1

This chapter:

a. applies to the full decommissioning of boreholes and wells;
b. comparably applies to the partial decommissioning of boreholes and wells, including the decommissioning of sidetracks;
c. comparably applies to the decommissioning of boreholes and wells made for other purposes than the exploration and development of hydrocarbons or storage of substances.

Article 8.5.1.2

In preparing for the decommissioning of a well, a well operator shall identify all zones with flow potential and shall investigate which measures can prevent the flow of fluids and gasses to or from rocks outside the zone or to the surface.

Article 8.5.1.3

For the decommissioning of a well, the well operator shall install an effective and durable isolation that prevents flow of subsurface gasses and fluids through the caprock to other rock strata or to surface.

Article 8.5.1.4

1. The Minister can grant an exemption of the articles in this chapter, provided an effective and durable method for decommissioning will be accomplished in case of:
   a. a partial decommissioning;
   b. the decommissioning of a borehole or well that:
      - is not used for the exploration or development of hydrocarbons
      - is used for the storage of substances;
   c. an obstruction in the wellbore that dictates another method of decommissioning;
   d. the use of a sealing material other than cement; or
   e. the license holder has applied all measures for decommissioning that can reasonably be expected from him, and after decommissioning an isolation proves to be less effective or less durable than expected, with requirements for monitoring of the decommissioned well and taking necessary mitigating measures.
2. The exemption can be granted with requirements or limitations.

§ 8.5.2. Rules for the decommissioning of wells

Article 8.5.2.1

The Well operator shall decommission a well by:

a. an isolation across every caprock;
b. a top isolation; and
c. removal of well material near surface.

Article 8.5.2.2

The Well operator shall select an isolation across a caprock in such way that the isolation is opposite a caprock that is:

a. impermeable and sufficiently thick and strong to withstand the anticipated maximum pressure of gases and fluids at that depth;
b. does not exhibits fractures; and
c. is located above a zone with flow potential

Article 8.5.2.3

An isolation in the subsurface shall extend across the full cross-section of the well and all annular spaces.

Article 8.5.2.4

The top isolation extends across all annular spaces.

Article 8.5.2.5

1. The Well operator shall verify the presence of an isolation with a method that is meaningful for that purpose.
2. The Well operator shall perform the verification without causing damage to the isolation.

Article 8.5.2.6

Gases and fluids that remain in the well, shall not cause more than minimal damage, including damage from corrosion, to the isolations, the caprock and the casings and have a pressure gradient that exceeds the formation pressure gradient in the zones with flow potential.

Article 8.5.2.7

In an isolation there shall be no cables or lines.

§ 8.5.3. Rules for the execution of well decommissioning

Article 8.5.3.1

1. The isolation across the caprock shall be created with cement.
2. The hardened cement shall have a length along the borehole of
   a. at least hundred meters; or
   b. at least fifty meters, if the cement has been placed on top of a mechanical or solid support.
3. If these methods of isolation cannot be used, then an alternative method or technique shall be applied which shall result in an equivalent effective and durable isolation.
4. If the Well operator submits an application for an exemption of article 8.5.1.4, sub 1, part d, for the use of a sealing material other than cement, then the Well operator shall apply where possible in deviation of the stipulations under sub 2, specifications that shall accomplish an equivalent effective and durable isolation.

Article 8.5.3.2

1. A top isolation shall be placed:
   a. On land: near surface, whereby the planned use of the terrain is taken into account;
   b. Below surface water: near ground level in case a risk of environmental damage exists.
2. Well materials shall be removed:
   a. On land to a depth of 3 meters below surface or deeper as required by the planned use of the terrain;
   b. Below surface water to a depth of 6 meters below ground level, or deeper if a potential change of ground level so requires.

Appendix B: Release Notes for Chapter 8.5 DMR

For reference, this Appendix provides a translation of the Release Notes that accompanied the update of the Dutch Mining Regulations as published in the Staatscourant (27 March 2019 nr 16260). The Dutch text of the Staatscourant publication prevails over the English translation.

I. General

1. Purpose and reason

This change to the Mining Regulation concerns the decommissioning of wells and boreholes. Boreholes and wells are needed to be able to find and extract minerals or geothermal heat, or for underground storage of substances. These activities begin with the construction of a borehole.

A well is a borehole that has been put into use after construction, installation and completion (article 8.1.1, first paragraph, part a, of the Mining Regulation). All wells are also boreholes according to this definition. Decommissioning a well is therefore decommissioning a previously constructed and completed borehole. Chapter 8.5 applies to the decommissioning of all boreholes, but it usually refers to the decommissioning of a well. In order to align with the use of speech, only the term "well" is used in this explanation. Nevertheless, this regulation also applies to all other boreholes.

After the construction of the borehole and the completion of the well, various other borehole activities can be carried out, such as the modifying, extending, testing, maintaining and repairing of a borehole and the stimulating of a reservoir via (usually) a well (article 67 of the Mining Decree). The well can be suspended between the various activities. Suspending a well is a temporary situation for economic or technical reasons. In that case, the Well operator intends to put the well back into operation to perform further activities. Article 72 of the Mining Decree applies to that situation.

The last borehole activity is decommissioning.
The purpose of decommissioning is to close the well by isolating all zones with flow potential. This can also be the case for the lower part of a well or a sidetrack of a well. In such case the well will be partially decommissioned. In that instance, this regulation also applies.

2. Work program and general rules for wells

Article 77 of the Mining Decree stipulates that a work program will be prepared for borehole activities, such as decommissioning, and that detailed rules will be imposed by ministerial regulation. Paragraph 8.2.4 of the Mining Regulation sets rules about the work program for the decommissioning of wells and similarly applies to boreholes (article 8.2.4.3). The Inspector General of the Mines receives the work program, the interim reports and a final report from the Well operator of the decommissioning.

Chapter 8.5 of the Mining Regulation covers general rules on the method of decommissioning wells. These rules concern the technical execution of the work in the subsurface. The Inspector General of the Mines checks whether the work program complies with these rules and how the work program is executed.

3. Why are there rules for decommissioning a well?

If there are no recoverable accumulations in the well or if the mineral or geothermal heat to be recovered is exhausted, it is necessary to decommission the well for reasons of safety and protection of the subsurface and groundwater. This is because a well connects the mining installation at surface with subsurface minerals accumulations or with the geothermal heat source, or with an underground storage that may be, or is, under pressure and can contain gases or liquids. As a result, when a well is decommissioned, there is a risk of gases and liquids escaping from the subsurface. It is therefore necessary to ensure that adequate control measures are taken.

4. How to control the risks of a well?

Chapter 8.5 of the Mining Regulation contains general rules how in a work program is established that in a specific case risks are minimised when decommissioning a well. This rule came into effect in 2003 and is largely a continuation of the applicable rules at that time. In the past fifteen years, however, new insights have emerged regarding the method of decommissioning wells. Moreover, new innovative methods have been developed for decommissioning wells. The current rules in the Mining Regulation are therefore partially outdated.

Furthermore, these rules are not tailored to geothermal heat and minerals other than hydrocarbons. In addition, wells can play an important role in the transition to a sustainable energy supply. For example, wells can be re-used for the storage of substances such as hydrogen and CO_2. Also for that reason, the rules regarding the decommissioning of wells are due to be updated.

5. What are the mining companies going to do?

The industry association Nogepa has formulated a number of general principles and technical possibilities for effective and sustainable isolation of the subsurface in the so-called "Industry standard No. 45, decommissioning of wells and boreholes".

The starting point is that when a well is decommissioned, the mining company restores the subsurface in such a way that the flow of underground liquids through isolated rock strata to other layers or to the surface is prevented. Thus, the mining Well operator creates an isolation at the level of a competent rock layer, which is called the caprock. The isolation extends over all annular spaces at the level of that caprock, so that a compact isolation is created that is able to permanently withstand the maximum pressure of gases and liquids.

For wells on land, the mining Well operator also places a top isolation near the surface. Such a top isolation must also extend over all annular spaces. The mining company removes all the well material up to 3 meters below ground level or deeper if the future use of the terrain this requires, for example due to the establishment of a business park.
A top isolation of a borehole subsea is less necessary, because the well will naturally be filled with sands. In case liquids are left in the well that pose a risk of environmental pollution, a top isolation is required. The location of the top isolation is in the vicinity of the surface, but so deep that the well material can be removed to a depth of 6 meters. If there is a chance of sediment erosion, it is necessary to remove the well material to a greater depth. The location of the top isolation is adjusted for this.

6. Mandatory requirements and good practices, framework and innovation

This change to the Mining Regulation sets mandatory requirements for the decommissioning of all wells that have been used for the exploration, or for the extraction of minerals, geothermal heat or the storage of substances. These rules replace, amongst other, the current chapter 8.5.
The implementation of the renewed chapter 8.5 is further regulated in a policy rule (article 4:81 of the General Administrative Law Act.) This policy rule will refer to the good practices that have been developed and laid down in the ´Industry Standard No. 45, the decommissioning of wells and boreholes´ of the Nogepa industry association.

The policy rule and good practices are, if necessary, periodically changed to the latest insights and techniques, so that innovation is not impeded.
If a mining company adheres to these good practices, the company complies with the general principles of chapter 8.5 of the Mining Regulation.

If, in a specific case, a mining company wants to use a different method for decommissioning a well, this can be accommodated under the provision that the mining company can justify it. Good practices will be adjusted from time to time. Both the mining companies and the Inspector General of the Mines can raise issues for modification. Should good practice prove to be insufficiently effective in the specific case, then the supervisory agency can always, with demonstrated necessity and explanatory documentation, deviate from the industry standard and proceed with enforcement, if necessary. Ultimately not all circumstances can be described in an industry standard. Nevertheless, an industry standard provides assurance that acting in accordance with these good practices is in principle supported by the mining companies and the supervisory agency and can be a starting point for decommissioning a borehole in a specific case.

7. Regulatory burden

With the renewal of the general rules in chapter 8.5 of the Mining Regulation, the Mining Regulation has been adapted to recent insights and experiences in the area of decommissioning wells, as developed in the aforementioned industry standard. With the renewed regulation, the compliance costs remain the same as the current compliance costs. The rules for the work program and the final report are not new but have only been renewed in order to align the work program and the final report with the new chapter 8.5.

The regulation does not lead to new administrative burdens, with the exception of an exemption system. The exemption system gives the possibility to grant an exemption to a mining company in cases where the minister deems it necessary to deviate from the general rules for decommissioning of a borehole. Due to the physical circumstances, this may occur when decommissioning a borehole that has not been constructed for the extraction of hydrocarbons but does not rule out other cases where an exemption must be granted in order to be able to decommission a borehole. The procedure for applying for an exemption is the same as the procedure for other exemptions granted under the Mining Regulation (article 1.2.1 of the Mining Regulation).

It is estimated that there is a maximum of six exemptions per year. The application for an exemption is quite complex and will therefore require 43 hours per exemption. At a rate of € 54,– the administrative burden of an exemption is € 2.322,–. The total costs of the administrative burdens with six exemptions amounts to € 13.932,– per year.

Article 133, first paragraph, part a, of the Mining Act stipulates that, in the case of extraction for hydrocarbons, a fee is charged for granting an exemption. The fee is € 3.600,– per exemption (article I, part R). The total fees amount to a maximum of € 21.600,– per year.
This regulation has been submitted to the Advisory Board for Regulatory Burden Assessment. The regulation was not selected by the Commission for formal advice to the Minister, because the consequences for the regulatory burden are not substantial.

8. Fixed date

This regulation enters into force on the fixed date of April 1st, 2019, but has not been announced two months in advance, in deviation from instruction 4.17, fourth paragraph, of the Instruction on Regulations. It is not desirable to suspend the introduction of the regulation until July 1st because mining companies, in particular regarding decommissioning of boreholes at offshore installations, want to know before spring and summer season whether the latest insights of the industry standard can be applied when decommissioning boreholes. For safety reasons, it is desirable that a borehole be decommissioned in a durable fashion as soon as possible. With the introduction of this regulation, and considering the target group, the season and the safety requirements, substantial disadvantages for private and public interests can be avoided (instruction 4.17, fifth paragraph, part a).

9. Consultation and internet consultation

Prior to the internet consultation, consultations were held with the Nogepa industry association on several occasions regarding the relationship between industry standard 45 and the Mining Regulation.
From January 11th, 2019 until February 12th, 2019 the draft version of the ruling was made public for internet consultation. Three responses were received during this period. De Vewin, industry association of water utility companies, has submitted a public response to internetconsultatie.nl. One company responded without disclosure. The industry association Nogepa has sent three position papers via e-mail in one document. This response by e-mail has been added to the file on internetconsultatie.nl.

De Vewin has made a few remarks about the monitoring of deep and shallow groundwater. The shallow and deep groundwater for the extraction of potable water is usually located in the upper earth layers, to a maximum of one hundred to two hundred meters below surface. This regulation concerns the decommissioning of boreholes by applying isolations at the depth of the caprocks in the deep subsurface of one hundred meters to the depth where the occurrence of minerals or geothermal heat is located (five hundred meters to three kilometers). The caprocks are sealing without leakage paths to the upper earth layers in a borehole. For the protection of the soil, including groundwater, rules have been laid down for mining installations in the decree on general environmental rules for mining that has been incorporated in the Environmental Act as the decree on activities in the environment and the soil module of that decree.

Vewin's request to extend these rules with monitoring of deep groundwater leads to new drilling and possible leakage paths between isolated layers. In addition, the Mining Regulation is not the applicable regulation for this subject, but rather the regulations under the Environment Act. The same applies to comments from Vewin on the re-use of the location with a decommissioned well and new drilling activities in the vicinity of a decommissioned well.
Vewin's remark about the re-use of wells for storage of substances does not pertain to this regulation, but rather to considerations on granting a storage permit as referred to in article 25 of the Mining Act.

The comments of one company have given cause for a change in paragraph 1 of the explanation regarding the term ‘borehole ’and the term ‘well.’
The first and third position papers, comment A, from Nogepa, have given cause to a supplement to these release notes regarding previously decommissioned wells (note in article II). Furthermore, Nogepa’s first position paper concerns the overall system of decommissioning of mining installations within the mining regulations, which is not applicable for this regulation. Nogepa’s second position paper concerns the implementation of the policy rule. The general basis of the policy rule is explained in these release notes and the specific details will be decided when implementing the policy rule.
The third position paper, comment B, by Nogepa, has given cause to the addition of article 8.5.1.4, first paragraph, part d, an extension of article 8.5.3.1 with a fourth paragraph and amendment of the change to article 8.2.4.1 second paragraph, part e, in which the new parts 2 and 8 contain a provision on the use of materials other than cement. Furthermore, in response to the third position paper, comments C and D, of Nogepa article 8.2.4.1, second paragraph, part b and part e, parts 2° and 8°, have been amended to provide information about a previous partial decommissioning activity, respectively the cementing depths. The information on previous partial decommissioning was insufficient in the proposal and the information on cementing depths in the original part 2° appeared to contain a duplication and was canceled. The parts 3° and 9° are renumbered to 2° and 8°.

II. Articles

Article I, part E

This section introduces concepts and terms that are important for well decommissioning. The concept of a zone with flow potential refers to rocks from which gas or liquid can flow, with a risk that these gases or liquids can no longer be controlled unless an isolation is provided (part k). An isolation is a measure that ensures that no gases or liquids can escape. The isolation of zones with flow potential means in practice that isolations are necessary to prevent flow (part I). At various depths in a well, rock strata can be found that can withstand the maximum expected pressure of the gases and liquids to be isolated. This relates to the maximum pressure that can be expected under an isolation (part m). This section introduces the term caprock. Rock strata that isolate a zone with flow potential is a caprock (part n).

Article 8.5.2.2 describes what the requirements of a caprock are.

Article I, parts J to L, P, Q and R

These items contain a change to the work program for decommissioning boreholes and wells in connection with the revision of chapter 8.5 on decommissioning of wells.
The Well operator will deliver the work program to the Inspector General of the Mines who will assess whether sufficient information has been supplied on the method of carrying out the decommissioning. The data to be supplied are in line with the general rules of chapter 8.5 (parts K and L). Part of this data is the geohydrological basis, including data on the depth of the transition from fresh to salt water, the level of water that can be used for the preparation of potable water. If the Well operator chooses to use a material other than cement to decommission a borehole, then the work program will contain the specifications of the operation (article 8.2.4.1, second paragraph, part e, under 2° and 8°, in conjunction with article 8.5.3.1, fourth paragraph). Among other things, these provisions (see also article 8.5.1.4, first paragraph, part d, and article 8.5.3.1, fourth paragraph) make the use of materials other than cement possible.

Following execution of the work program, a final report is made. The final report is made mandatory with the change in part J. The Well operator shall prepare a final report in accordance with appendices 12 and 12a, depending on which borehole activity has been carried out. Appendix 12 applies to the construction or repair of a borehole, or the stimulation of a reservoir via a well. This has been stipulated with the change in part P. Appendix 12a applies when decommissioning a well (part Q). The stratigraphic column is an important part of the final report. This is depicted in one overview next to the well data, in such a way that it is easy to check whether all zones with flow potential are isolated (see appendix 12a, point 2.1 under 2.).

Article I, part O

This part contains the updated chapter 8.5 on decommissioning of wells.

Article 8.5.1.1

With this article, chapter 8.5 applies to all types of decommissioning of boreholes and wells, or respectively applies equivalently. It therefore also applies to the decommissioning of wells used for salt extraction, geothermal heat extraction, observation or monitoring, and to the sealing of wells for the storage of substances such as hydrogen, and CO_2.

Article 8.5.1.2

This article states what is required before a well is decommissioned. Firstly, it will be determined which zones in the subsurface can give rise to flow and outflow of gases and liquids. Next, the Well operator determines which measures are needed to prevent that potential flow.

Article 8.5.1.3

This article states how escape of gases and liquids from the well can be prevented, in order to promote safety and prevent environmental pollution. That goal is achieved by creating an effective and durable isolation.

Article 8.5.1.4

Chapter 8.5 sets out general rules for all types of decommissioning of wells. The starting point for these rules is the most common type, namely the decommissioning of a well that is used for the development of hydrocarbons. The principles for wells that are used in other applications are no different, but different requirements for the implementation may be set.
Article 8.5.1.4 presents an exemption system which provides requirements for deviations whilst doing justice to the principles that apply for the decommissioning of wells. For example, the first paragraph, part a, regulates the case where a sidetrack is drilled that needs to be sealed, and the case that only the lower part of a borehole is decommissioned. Part b deals with the case where a borehole has been used for purposes other than hydrocarbon recovery. Parts c and d are for the unlikely event that an obstruction of the borehole interferes with the use of the common techniques, or, that all possible measures have been taken without achieving the desired result. A more positive opportunity for granting an exemption is the use of another, possibly innovative, material for sealing the borehole (part d). This may lead to a better isolation of the caprock at lower costs, but caution is required, because the use of other materials is still under development.
In addition to the exemption option, as an application of article 4:81 of the General Administrative Law Act (Algemene wet bestuursrecht), will the establishment of policy rules be provided for the implementation of the

decommissioning of wells. These policy rules are primarily about the decommissioning of wells after hydrocarbon development, such as the mentioned 'Industry standard no. 45, decommissioning of wells and boreholes', but other policy rules are also possible, for example for the isolation of boreholes in use for storage of substances. These policy rules can then also provide for considerations of options for granting an exemption as referred to in article 8.5.1.4, first paragraph.

Article 8.5.2.1

The decommissioning consists of several parts, namely isolations and the removal of well materials. The isolation opposite the caprock (article 8.5.2.1, part a) does not have to be directly above the zone with flow potential. What is relevant, is withstanding the pressure of gases and liquids in order to prevent flow and outflow. A shallower depth in the borehole than directly above a zone with flow potential can in a specific circumstance be more effective and durable. The top isolation is intended for safety at ground level or, where relevant, the prevention of pollution of the sea (see article 8.5.3.2). After the top isolation, well materials are removed near the earth's surface, which includes items such as the christmas tree, the wellhead and casings.

Article 8.5.2.2

The geological layer that together with the isolation forms one isolating layer (caprock), must always meet three geophysical requirements in order to be an adequate isolation. If the chosen geological layer does not meet one of these three requirements, an adequate isolation cannot be created during decommissioning. If the isolation appears to be insufficient during decommissioning, or later, due to geological circumstances, then the Well operator will provide additional measures, possibly after applying for an exemption.

Article 8.5.3.1

For the isolation at the caprock level, the Well operator places a quantity of cement that will form a column of one hundred meters after hardening. Alternatively, the isolation may consist of a column of fifty meters of hardened cement, provided a mechanical or solid support is present. The solid support may consist of a mechanical construction, cement, fill, formation, or other obstruction against slumping of liquid cement. The support prevents the cement from sagging before it has hardened. It is particularly important that the annular spaces will also be isolated over the mentioned length or are isolated by specific circumstances of the well. The creation of the isolation is checked with a relevant method, test or other form of verification (see article 8.5.2.5, first paragraph).

Additionally, the Well operator can choose another method of isolation (third paragraph,) if a method as referred to in the second paragraph is not applicable. Other methods include the use of potential caprocks with plastic properties, such as certain clay or salt layers, or placing a seal at a caprock that has a thickness of less than 50 meters. The Well operator can choose a new material other than cement. The specifications of the isolation are then different than in the second paragraph. It is up to the Well operator, before applying for an exemption, (see article 8.5.1.4, first paragraph, part d) and the submission of the work program (see article 8.2.4.1, second paragraph, part e, under 2° and 8°) to demonstrate that an equivalent effective and sustainable isolation is possible and that execution has created such isolation (fourth paragraph). The functioning of the isolation is checked with a relevant method, test or other form of substantiation (see article 8.5.2.5, first paragraph) and is reported (article I, part J, change article 8.2.2.2). The chosen method of isolation must not affect the effectiveness and durability of the isolation. If necessary, additional provisions are required to guarantee effectiveness, such that an equivalent effective and durable isolation remains.

Article 8.5.3.2

The top isolation in surface water is carried out differently than on land. On land, inadequate isolation carries a risk for or through future use of subsurface formations. On land, a top isolation is therefore always required near ground level. When determining the depth, the Well operator takes into account the planned use of the site. This avoids that a different top isolation is required later to fit the site's use.
Sand of the seabed naturally forms a top isolation for a borehole offshore. Only when safety or environmental risks can arise, for example due to residues of liquids, is it necessary to install a top isolation.
The Well operator removes well materials to a depth that is necessary for the planned re-use of the site. The depth is at least three meters to prevent that well materials is only removed for agriculture re-use of the land. At sea, the starting point is removal to a depth of 6 meters below seabed. If the borehole is in a location where seabed changes of more than 6 meters can be expected, for example due to sand movements, then the well materials are removed to a greater depth to prevent damage by ship anchors or for instance trawlers.

Article II

In various responses during the internet consultation, questions were raised about the status of wells that have previously been decommissioned. This regulation takes immediate effect. This is without prejudice to previously undertaken activities for the decommissioning of wells, provided these were performed in accordance with the regulations in force at that time, such as the submission of a work program to the Inspector General of the Mines (article 8.2.4.1 of the Mining Regulation, as published in the Staatscourant of December 19, 2002, no. 245, page 17). After coming into force, the new chapter 8.5 fully applies to every activity for the decommissioning of a well.

Appendix C: Work program for the decommissioning of a well

This Appendix lists the required minimum content of a work program for the Decommissioning of a Well as per the mining regulations.

Article 8.2.4.1 Mining Regulation

1. A work program for the decommissioning of a well shall contain:

a) for offshore Wells:

1. the alphanumeric designation of the offshore block within which the well is located;
2. the designation of the well and the sidetrack number, if applicable;
3. the location of the well's surface origin in geographical co-ordinates in accordance with the ETRS 89 System, and
4. specification of the height of the drill floor or of another reference point, to be further specified, expressed in metres relative to both the mean sea level and the sea floor;

b) for wells on land:

1. the name of the municipality within which the well is located;
2. the designation of the well and the sidetrack number, if applicable;
3. the location of the well's surface origin in geographical co-ordinates in accordance with the ETRS 89 System, and
4. specification of the height of the ground level and the drill floor or of another reference point, to be further specified, expressed in metres relative, in metres relative to N.A.P..

2. Furthermore, the work program shall contain at least:

a) the reason for the decommissioning of the well;
b) the date of the original completion and, if the well has been extended, modified, repaired or partially decommissioned, the date of the extension, modification, repair or partial decommissioning;
c) a drawing of the deviation and table of the related data;
d) a specification of the reference elevation from which depth measurements are quoted;
e) schematic drawings of the well before and after the decommissioning, with information of:

1. Sizes and depth of tubulars, including tubing, casings, liners and depths of packers and plugs, as well as any obstructions;
2. the depth of the top depth of cement columns in the annular spaces and in case another material then cement is used the corresponding specifications and verification of those specifiations for the depth of the top in these spaces;
3. the type of gas and liquid and the weight of the gas and liquid in the well and in the annular spaces;
4. the zones with flow potential: depths, gas and liquid type, and the geohydrological base level, if present;
5. the depths and type of caprocks;

6. the planned depths of tubular cuts and, as applicable, the planned circulation holes in tubulars, as well as the tubulars sections to be milled or otherwise to be removed;
7. the location and type of planned mechanical support;
8. the planned top and bottom of cement columns, with the method of verification;

f) the depth of the completed well and the depth of perforation intervals of the production casing;
g) a description of the surface completion of the well above or below water, including specifications of the christmas tree;
h) a description of the subsurface completion of the well;
i) the expected maximum closed-in surface pressure;
j) the formation pressure and the reference depth;
k) the subsurface and surface temperature of the well;
l) the content of the tubing and of the annular spaces with the expected annular pressures and released gasses and liquids during bleed-off, and, if available, the recharge rate thereof;
m) the name or type specification of the work unit with which the well will be decommissioned and the name of the drilling contractor;
n) a description of the planned pressure control installation for closing-in the well;
o) a chronological overview of the sequence of activities, taking into account assumed alternative approaches with an explanation of in particular operations that are critical from a safety perspective or otherwise;
p) with respect to the location of the well and if applicable: the method by which wells in the vicinity will be made safe;
q) geological information: the depths of the tops of geological strata, the formation strength if available, possible overpressures, presence of hydrocarbons and type, and onshore, the hydrological base level.
r) a description of Zones with Flow Potential including associated gasses and liquids, the maximum anticipated pressure, and the suitable caprocks with an estimated strength;
s) a well-founded assessment that no damage is anticipated as a result of cross-flow between zones in case zones with flow potential will not be isolated from each other;
t) the estimated duration of the planned activities for the well decommissioning.

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Appendix D: Final report of the Well Decommissioning activity

The final report of the Well Decommissioning activity comprises of a Well status drawing and appendices with associated information. The information package contains the following information as a minimum, with reference to DMR article 8.2.2.2 and DMR Appendix 12a. The report also applies to partial Well Decommissioning in preparation of drilling a sidetack.

Appendix 12a referenced by DMR article 8.2.2.2

Final report on decommissioning of a well or borehole

The final report comprises a status drawing of the borehole or the well and appendices, and contains the following information as a minimum:

1.0 Project information

1.1. General

1. The name of the mining company;
2. The name of the company that has executed the activities;
3. The name or number or designation of the mobile installation.

1.2. Well designation comprising:

1. for offshore Wells:
   a. the alphanumeric designation of the offshore block within which the well is located;
   b. the designation(s) of the well, and, if applicable, the number of the sidetrack
   c. the location of the well's surface origin in geographical co-ordinates in accordance with the ETRS 89 System;
   d. details of the height of the drilling floor or of another reference point (to be specified in more detail) in metres relative to both the mean sea level and the sea floor;

2. for Wells on land:
   a. the name of the municipality within which the well is located;
   b. the designations of the well, and sidetrack number if applicable;
   c. the geographical co-ordinates of the well's surface origin in accordance with the ETRS 89 System;
   d. the height of both the ground level and the drilling floor or another reference point (to be specified in more detail), in metres relative to N.A.P.;

1.3. The start date and finish date of the well decommissioning activity

1.4. All relevant depths of items of the well are in meters below the defined reference level.

2.0 Well information

2.1. Well status diagram:
1. well status;
2. a drawing of the decommissioned well with the data, as listed in paragraphs 2.2. and 2.3, depicted next to a schematic of the stratigraphic column with the details listed in paragraph 3.0, using comparative scaling and depth;
3. a drawing with the dimensions of the wellhead including the well shut-in valve and X-tree or cap, as present;
4. a tabled listing of deviation data in an appendix.

2.2 Isolations, tubulars, cement, mechanical devices in the well:
1. tubulars left in the well, type, weight per unit of length, bottom depth (shoe) and top depth;
2. mechanical devices: type and depth, verification;
3. cement columns: weight of the cement slurry, depth of bottom and top depth, verification.

2.3 Liquids and gasses left in the well, including liquids and gasses in annular spaces
1. the type of fluid per section, including pills and spacers;
2. the pressure gradient or specific gravity of each fluid.

3.0 Geological information

1. depth of the top of geological strata;
2. formation strength, if available;
3. abnormal formation pressures, if present;
4. formation pressure gradients;
5. observed presence of hydrocarbons and type, if present;
6. onshore: depth of water that is usable for the preparation of potable water.

Note related to 2.1.1: Well Status
The Well status after Decommissioning is either:
(1) Partially subsurface decommissioned
(2) Fully subsurface decommissioned
(3) Fully surface and subsurface decommissioned

For the legislator a well is 'suspended' (*buiten werking gesteld*) until it is 'fully surface and subsurface decommissioned', i.e. the conductor and other well material has been removed (*buiten gebruik gesteld*).

In case the well status is 'partially subsurface decommissioned', it is recommended to report the depth that this relates to, e.g. the top of the shallowest cement column that complies with the decommissioning requirements at the time of placement.

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Appendix E: Lost radioactive sources

The following reporting procedure for irretrievable radioactive sources has been published by SodM (Refer to Nieuwsbulletin 18 for full text in Dutch, which prevails):

The Well Operator (mijnbouwonderneming) notifies SodM of the incident.

1. The permit holder (logging-contractor) will, in cooperation with the Well Operator, request SodM to declare article 6.14 of the Decree Radiation Protection (‘Besluit basisveiligheidsnormen stralingsbescherming’ (Bbs)) applicable for continuation of activities. This request includes the data of the source certificate and registration of the permit as per the nuclear energy law (Kernenergiewet).
2. The Well Operator submits a work plan to the Inspector-General of Mines. The work plan will be established jointly between permit holder, Well Operator, drilling contractor, in order to adequately identify risks and mitigating measures. The plan includes geographical coordinates of the irretrievable source.
3. SodM assesses on behalf of the Minister the work plan as per article 6.14, sub 3c) and includes this in the decision.

Notes:
Ad 2. Article 6.14 assigns SodM to request measures from the permit holder and Well Operator and to approve the work plan. Such measures may include retrieving a source or leaving it safely behind, covered with one or more cement columns.
Ad 3. The work plan will be part of the (modified) work plan, as per article 74 of the Mining Decree (Mijnbouwbesluit).