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External cathodic protection of well casings

Äußerer kathodischer Korrosionsschutz von Bohrlochverrohrungen

Protection cathodique externe des cuvelages de puits

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Äußerer kathodischer Korrosionsschutz von Bohrlochverrohrungen

This European Standard was approved by CEN on 13 March 2022.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 15112:2022) has been prepared by Technical Committee CEN/TC 219 “Cathodic protection”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2022, and conflicting national standards shall be withdrawn at the latest by November 2022.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 15112:2006.

In comparison with the previous edition, the following technical modifications have been made:

— Requirements for CP personnel competences have been included.

— Additional requirements for insulation between the casing and other pipelines or well casings.

— In Annex A, the method to determine the CP current need has been simplified.

— Annex C (Calculation of the potential shift at the bottom of the well casing and the well casing to soil resistance) has been revised.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Gas, oil and water well casings are usually cemented for the purpose of anchoring the pipes in the borehole and isolating the various geological layers from each other. This is necessary to avoid liquid exchanges between these.

Steels in contact with the cement are generally passivated, and thus, protected from external corrosion, except if the cement contains chloride ions. However, it is not always possible to obtain a continuous cementation on all the external steel surfaces. These bare residual surfaces can be in contact with more or less aggressive layers. Furthermore, these surfaces can constitute electrochemical cells with the cemented metallic parts. The anodic areas, which are the poorly cemented parts, correspond to corrosion areas.

In general, external corrosion effects are rare, particularly on recent wells, since most of them are well cemented. However, cementation failures sometimes occur during the execution of borehole cementation programmes, and studies have shown that, corrosion phenomena being progressive, the mean time for the appearance of leaks is dependent on different factors such as geological formation, thickness of the layers and of the steel casing.

Experience has also shown that the situation can be significantly improved by applying external cathodic protection to the well casings.

Environmental aspects with regard to gas, oil or water wells should be considered when deciding on whether or not to apply cathodic protection.

1 Scope

This document provides information on methods suitable for assessing the likelihood of leakage due to external corrosion of well casings and to evaluate the need for cathodic protection, as well as methods of providing cathodic protection to the external part of these wells in contact with the soil. It also defines requirements for monitoring of performance of CP systems.

Onshore and offshore wells are included in the scope. However, for offshore wells where protection is provided by anodes on the wellhead structure, it is recognized that it might not be practical to achieve full protection of well casings.

This document applies to any gas, oil or water well with metallic casing, whether cemented or not.

However, in special conditions (shallow casings: e.g. 50 m, and homogeneous soil), EN 12954 can be used to achieve the cathodic protection and assess its efficiency.

The general requirements of EN 12954 apply; this document details additional, specific, requirements for CP of well casings.

This document applies to production and injection wells. References later in this document to production also apply to injection.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12954, *General principles of cathodic protection of buried or immersed onshore metallic structures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at https://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
casing
well casing
heavy steel pipe string used to line a borehole from the ground surface, and secured in the geological formations generally by cementing

Note 1 to entry: Casing is generally externally cemented over its total depth or over a length sufficient to obtain anchoring and stability between the production or storage zone and the ground surface or other intermediate layers.

This pipe string function is:

— to prevent the ingress of fluid from upper geological layers;

— to keep the hole from collapsing due to the pressure of the geological layers crossed;

— to isolate the inside part of the well from the surrounding soil;

— to continue drilling to the production or storage zone;

— to enable the installation of the tubing string from the surface to the production or storage zone.

There may be two or more strings of casing, one inside the other, in a single well:

— surface casing: casing that extends from the surface to a depth sufficient to avoid any entering of surface waters or earth into the well;

— intermediate casing: casing set from the ground surface down to an intermediate depth. This intermediate casing terminates in the intermediate casing shoe and the production casing extends below it to the production or storage zone;

— production casing: casing that extends through the surface casing and intermediate casing to the production or storage zone. The extremity of the production casing can be at the top or bottom of this zone.

3.2
cellar
excavation at ground surface, intended for housing the wellhead and safety shut-off devices

EXAMPLE safety valves

3.3
cementation
process, and its result, which ensures the anchoring of well casing in the borehole and the tightness between different geological layers

Note 1 to entry: In the same time, this cementation can mitigate corrosion.

3.4
centralizer
device constituted by a set of metallic blades which are fitted around the pipes of a string to keep them centred, either in the open hole (hole drilled in the ground), or inside pipes of larger diameter in which the considered string is installed

Note 1 to entry: This device can also be used to ensure electrical continuity between the two concentric pipe strings.

3.5
completion
process, and its result, which consists of fitting a well with the production or injection tubing to allow well operation in accordance with the applicable codes of practice and safety rules

3.6
electrical log survey
log recorded using an electrical wireline

Note 1 to entry: Electrical log survey can be pre construction well logs or post construction well logs.

3.7
flowline
pipe connecting a well to a gathering station

3.8
liner
bottom hole liner
pipe having the same function as the casing but hung inside a casing (or another liner) and not at the wellhead like a conventional casing

3.9
packer
production packer
device ensuring tightness of a pipe annulus

Note 1 to entry: The production packer seals the annulus between the tubing and the production casing or liner.

3.10
shoe
guide shoe
cylindrical element attached to the lower part of the casing, and allowing to place the casing in the borehole

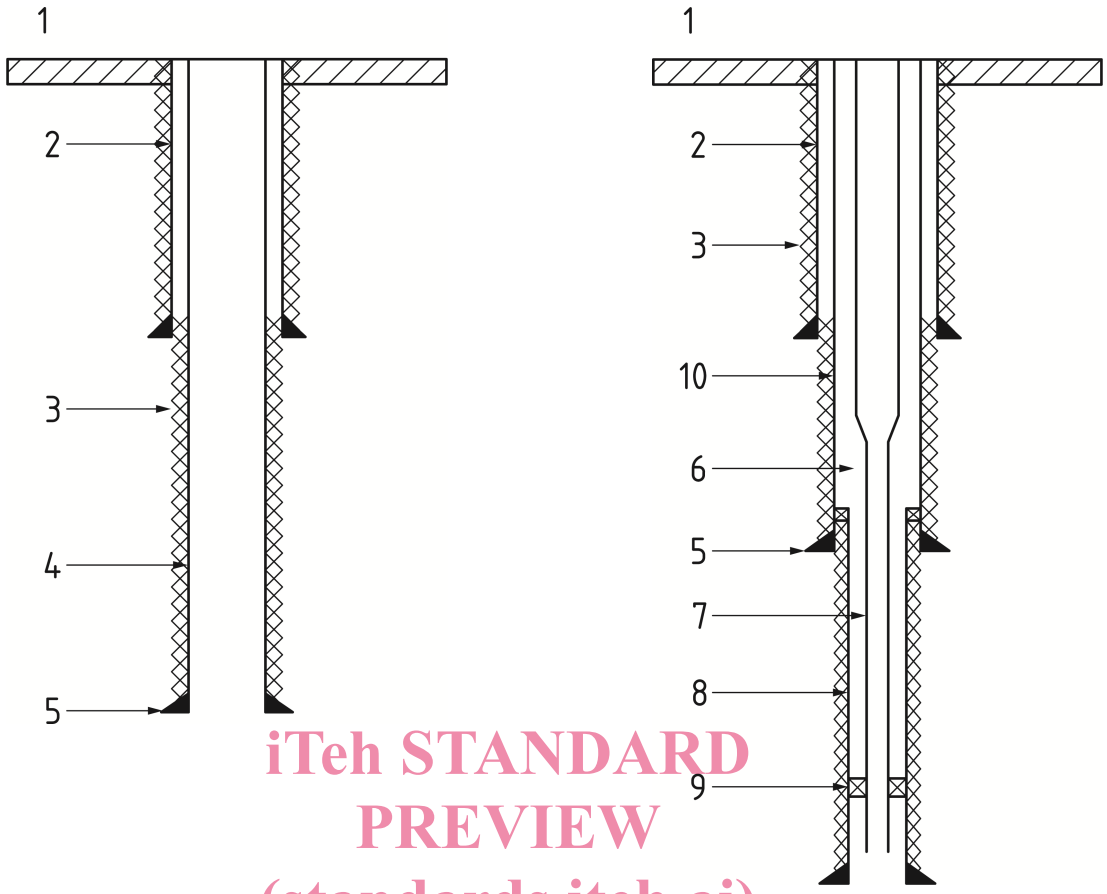
Note 1 to entry: If equipped with a valve, it makes the borehole cementation easier (cementing shoe).

3.11
tubing
production tubing
pipe string, with its additional equipment, inside the production casing to allow the flow of oil, gas or water between the production or storage zone and the ground surface

3.12
wellhead
device installed at the top of the well, designed to hang the different pipe strings and to ensure tightness between the various annular spaces

Note 1 to entry: See Figure 1.

Note 2 to entry: The wellhead is fitted with valves to allow access (pressure monitoring, sampling) to the different annuli. Such fitted wellhead allows well operation and the intervention on the different components of the well. This device allows a good electrical continuity between all the pipe strings.



Casing string for wells which include production casing | **Casing string for wells which separate production tubing within casing**

Key

1	ground surface	6	production annulus
2	surface casing	7	tubing
3	cementation	8	liner (bottom hole)
4	production casing	9	production packer
5	shoe	10	intermediate casing

Figure 1 — Typical well completion equipment

4 Cathodic protection personnel competence

Personnel who undertake the design, supervision of installation, commissioning, supervision of operation, measurements, monitoring, inspection, and supervision of maintenance of cathodic protection systems shall have the appropriate level of competence for the tasks undertaken.

EN ISO 15257 constitutes a suitable method of assessing competence of cathodic protection personnel.

Competence of cathodic protection personnel to the appropriate level for tasks undertaken can be demonstrated by certification in accordance with prequalification procedures such as EN ISO 15257 or by another equivalent scheme.

5 Description and assessment of corrosion risks

5.1 General

Corrosion can occur on the external surface of well casings.

This corrosion, if not controlled, can lead to harmful damage such as losses of products, water, gas or oil, damage to the well and its completion (internal equipment), damage to the environment, for instance in allowing exchange between different geological formations. There is also the possibility of harm for people living near such installations.

The risks of corrosion should be considered in order to decide if cathodic protection shall be applied to the structure.

5.2 Description of corrosion risks

In general, for technical reasons, well casings should be externally encapsulated by cement. In such conditions steel is normally passive, its potential is uniform under the cement and the corrosion hazards are reduced. In this case, cathodic protection should not be necessary.

In fact, due to the heterogeneity of the soils which are crossed during drilling and specifically due to the heterogeneity of the mechanical properties of these soils, it is not always possible to guarantee that a continuous cement layer covers the whole steel surface. Because of this non-homogeneous cement layer, some parts of the casing surface can be in contact with the external medium. Macro-electrochemical cells (steel/cement and steel/medium) can then be established and this can result in corrosion of the anodic parts of the cells (steel in the medium).

If there is no electrical isolation between the well and surface piping, such detrimental macro-cells can also appear between the casing and the bare or poorly coated parts of the buried structure surface which become the anodic parts of the macro-cell.

Corrosion caused by the currents generated by macro-cells is more severe where soil layers with low resistivity are crossed.

Risks of corrosion damage shall be considered particularly where:

— the designed service life is long (depending on location, operational conditions);

— the procedure and execution of the cementation results in areas not, or incorrectly, cemented;

— there are stray current sources;

— the geological layers crossed are of a different nature.