AS ISO 27916:2020
ISO 27916:2019

Australian STANDARD®

STANDARDS Australia

Carbon dioxide capture, transportation and geological storage — Carbon dioxide storage using enhanced oil recovery (CO_2-EOR)



AS ISO 27916:2020

This Australian Standard® was prepared by EE-002, Carbon dioxide capture, transportation, and geological storage. It was approved on behalf of the Council of Standards Australia on 20 October 2020.

This Standard was published on 30 October 2020.

The following are represented on Committee EE-002:

Australian Industry Group
Australian National Low Emissions Coal R&D
Australian Petroleum Production and Exploration Association
CSIRO
Department for Energy and Mining, SA
Department of Mines, Industry Regulation and Safety, WA
Engineers Australia
Geoscience Australia
Petroleum Exploration Society of Australia, Vic.

This Standard was issued in draft form for comment as DR AS ISO 27916:2020.

Keeping Standards up-to-date

Ensure you have the latest versions of our publications and keep up-to-date about Amendments, Rulings, Withdrawals, and new projects by visiting:
www.standards.org.au

ISBN 978 1 76113 018 2

AS ISO 27916:2020
ISO 27916:2019

Carbon dioxide capture, transportation and geological storage — Carbon dioxide storage using enhanced oil recovery (CO_2-EOR)

First published as AS ISO 27916:2020.

COPYRIGHT

© ISO 2020 — All rights reserved
© Standards Australia Limited 2020

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher, unless otherwise permitted under the Copyright Act 1968 (Cth).

Preface

This Standard was prepared by the Standards Australia Committee EE-002, Carbon dioxide capture, transportation, and geological storage.

The objective of this document is to specify requirements for the quantifying and documenting of carbon dioxide (CO_2) that is injected in enhanced recovery operations for oil and other hydrocarbons (CO_2-EOR) for which quantification of CO_2 that is safely stored long-term in association with the CO_2-EOR project is sought. Recognizing that some CO_2-EOR projects use non-anthropogenic CO_2 in combination with anthropogenic CO_2, the document also shows how allocation ratios could be utilized for optional calculations of the anthropogenic portion of the associated stored CO_2 (see Annex B).

This document does not apply to quantification of CO_2 injected into reservoirs where no hydrocarbon production is anticipated or occurring. Storage of CO_2 in geologic formations that do not contain hydrocarbons is covered by AS ISO 27914:2019 even if located above or below hydrocarbon producing reservoirs. If storage of CO_2 is conducted in a reservoir from which hydrocarbons were previously produced but will no longer be produced in paying or commercial quantities, or where the intent of CO_2 injection is not to enhance hydrocarbon recovery, such storage would also be subject to the requirements of AS ISO 27914:2019.

The conceptual boundary of this document for CO_2 stored in association with CO_2-EOR includes—

(a) safe, long-term containment of CO_2 within the EOR complex;

(b) CO_2 leakage from the EOR complex through leakage pathways; and

(c) on-site CO_2-EOR project loss of CO_2 from wells, equipment or other facilities.

This document does not include the following:

(i) Lifecycle emissions, including but not limited to CO_2 emissions from capture or transportation of CO_2, on-site emissions from combustion or power generation, and CO_2 emissions resulting from the combustion of produced hydrocarbons.

(ii) Storage of CO_2 above ground.

(iii) Buffer and seasonal storage of CO_2 below ground (similar to natural gas storage).

(iv) Any technique or product that does not involve injection of CO_2 into the subsurface.

(v) Emissions of any GHGs other than CO_2.

NOTE Some authorities might require other GHG components of the CO_2 stream to be quantified.

This document is identical with, and has been reproduced from, ISO 27916:2019, *Carbon dioxide capture, transportation and geological storage — Carbon dioxide storage using enhanced oil recovery (CO_2-EOR)*.

As this document has been reproduced from an International Standard, a full point substitutes for a comma when referring to a decimal marker.

Australian or Australian/New Zealand Standards that are identical adoptions of international normative references may be used interchangeably. Refer to the online catalogue for information on specific Standards.

The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

© Standards Australia Limited 2020

Contents

Preface ... **ii**

Foreword ... **v**

Introduction ... **vi**

1 Scope ... **1**
1.1 Applicability ... 1
1.2 Non-applicability ... 1
1.3 Standard boundary ... 1
1.3.1 Inclusions ... 1
1.3.2 Exclusions ... 1

2 Normative references ... **1**

3 Terms and definitions ... **2**

4 Documentation ... **4**
4.1 Purpose ... 4
4.2 Use of existing data ... 4
4.3 Initial documentation ... 5
4.4 Periodic documentation ... 5

5 EOR complex description, qualification, and construction ... **5**
5.1 General ... 5
5.2 Geological characterization and containment assessment of the EOR complex ... 6
5.3 Description of the facilities within the CO_2-EOR project ... 6
5.4 Existing wells within the EOR complex ... 6
5.5 Operations history of the project reservoir ... 7

6 Containment assurance and monitoring within the EOR complex ... **7**
6.1 Containment assurance and EOR operation management plan ... 7
6.1.1 EOR operations management plan ... 7
6.1.2 Initial containment assurance ... 7
6.1.3 Operational containment assurance ... 8
6.2 Monitoring program, methods, and implementation ... 8
6.2.1 Monitoring of potential leakage pathways ... 8
6.2.2 Monitoring methods ... 8
6.2.3 Monitoring program implementation ... 9

7 Well construction ... **9**
7.1 New well construction ... 9
7.2 Well intervention ... 9

8 Quantification ... **10**
8.1 General ... 10
8.2 Quantification principles ... 10
8.3 Quantification of input [m_{input}] ... 11
8.4 Quantification of loss ... 11
8.4.1 Quantification of operational loss [$m_{loss\ operations}$] ... 11
8.4.2 Leakage from facilities ... 12
8.4.3 Venting and flaring from operations ... 12
8.4.4 Entrained CO_2 in products ... 12
8.4.5 Transfer of CO_2 ... 12
8.4.6 Loss from EOR complex ... 12
8.5 Allocation ratio for anthropogenic CO_2 ... 13
8.6 De minimis losses ... 13
8.7 Avoidance of double-counting ... 13

9 Recordkeeping and missing data ... **13**
9.1 Record retention ... 13

9.2 Missing data procedures 13

10 Project termination 13

10.1 General 13
10.2 Periodic assurance of containment 14
10.3 Termination plan 14
10.4 Requisites for termination 14
10.5 CO_2-EOR project termination 14
10.6 Post termination 15

Annex A (informative) **Introduction to CO_2-EOR 16**

Annex B (informative) **Example quantification calculation 33**

Annex C (informative) **Unit conversion 41**

Bibliography 42

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 265, *Carbon dioxide capture, transportation, and geological storage*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

© Standards Australia Limited 2020

Introduction

This is the first edition of the standard entitled: *Carbon dioxide capture, transportation and geological storage — Carbon dioxide storage using enhanced oil recovery (*CO_2*-EOR).* The subject matter of this document is a new work product and does not cancel or replace any other documents in whole or in part related to the subject of CO_2-EOR.

Carbon dioxide enhanced oil recovery (CO_2-EOR) is a technique for increasing the recovery of hydrocarbons from an oil field.

The process involves using wells to inject volumes of CO_2 at pressures where the injected CO_2 usually mixes with the oil, changing the properties of the oil and enabling it to flow more freely to production wells. In most cases, a CO_2-EOR project is designed as a closed-loop system whereby some of the injected CO_2 is co-produced with the oil and then separated in above-ground recycling facilities prior to being reinjected into the oil reservoir. CO_2 that is injected into the project reservoir is contained as an inherent element of the injection and production operations, and this document requires that such containment be demonstrated. CO_2 that is injected and remains trapped in the project reservoir (or EOR complex) during and after oil production activities is not released to the atmosphere, and this trapping is referred to as "associated storage". Annex A provides a detailed description of the CO_2-EOR process as presently used (and potential "next generation" uses) and the associated storage that occurs as an intrinsic part of those operations. Although methane is often present in EOR project reservoirs, this document does not specifically address methane or other greenhouse gases. The demonstration requirements for safe, long-term containment, however, address assessment of trapping and potential leakage pathways that would likely assure containment of methane as well as CO_2. As detailed in Annex A, CO_2-EOR has been deployed internationally for several decades and has potential to expand. CO_2-EOR is commercially valuable today because it allows for the additional recovery of hydrocarbon resources while simultaneously trapping injected CO_2 for safe, long-term containment as a part of the process.

This document applies to quantifying and documenting the total CO_2 (and optionally the anthropogenic portion of the CO_2) that is stored in association with CO_2-EOR. The document recognizes that CO_2-EOR is principally an oil recovery operation. Associated with this oil recovery, however, safe and long-term CO_2 storage occurs. The absence of an accepted standard for demonstrating the safe, long-term containment of CO_2 in association with CO_2-EOR and documenting the quantity of associated stored CO_2 constitutes one of the barriers to the increased use of anthropogenic CO_2 in CO_2-EOR operations. The purpose of this document is to remove that barrier and thereby facilitate the exchange of goods and services related to the increased use and emissions reductions through associated storage by providing methods for demonstrating the safe, long-term containment of, and determining the quantity of CO_2 stored in association with CO_2-EOR. The document does not address the financial consequences that may or may not result from documenting storage of CO_2 in association with CO_2-EOR operations.

This document does not provide requirements for the selection, characterization or permitting of sites for CO_2-EOR projects because those sites are selected, characterized, and permitted pursuant to requirements and standards applicable to oil and gas exploration and production. Likewise, this document does not specify environment, health and safety protections or corrective action and mitigation requirements that are provided by the regulations and standards applicable to all hydrocarbon production operations. (A list of many of the existing standards applicable to CO_2 injection wells and oil and gas operations is presented in the Bibliography.) This document does provide requirements for demonstrating that the site in question is adequate to provide safe, long-term containment of CO_2, for demonstrating that the CO_2 flood is operated in a way to assure containment of the CO_2 in the EOR complex, and for quantifying associated storage.

This document provides for the quantification of the CO_2 that is stored in association with CO_2-EOR operations. The results of quantifications under this document could be used as input for calculations conducted in accordance with a number of other standards, protocols or programs for the quantification or reporting of greenhouse gas emissions, mitigation, or reductions, including those complying with ISO 14064-1, ISO 14064-2 and ISO 14064-3. Specifically, this document provides for the identification and quantification of CO_2 losses (including fugitive emissions) and quantification of the amount of CO_2

© Standards Australia Limited 2020

stored in association with CO_2-EOR projects. Such quantification could be used in a broader scheme for the quantification and verification of emissions and emission reductions over the entire carbon capture, transportation and storage chain. Specifically, using this document will provide quantification results that could be used as input to approaches described in ISO/TR 27915 for Quantification & Verification (Q&V). In addition, the quantification of CO_2 stored in association with a CO_2-EOR project pursuant to this document could be combined with the quantifications generated under ISO 27920, Carbon dioxide capture, transportation, and geological storage — Quantification and Verification, which is currently under development. The quantification of the storage associated with a CO_2-EOR project that occurs as part of a CCS project chain could be combined with the quantification of one or more capture, transportation and geological storage systems to produce a total quantification for the entire CCS project chain. Under some emissions quantification and reporting regimes, CO_2 quantities stored in association with CO_2-EOR are either treated as not emitted and excluded from calculations or subtracted as offsets.

© Standards Australia Limited 2020

NOTES

Australian Standard®

Carbon dioxide capture, transportation and geological storage — Carbon dioxide storage using enhanced oil recovery (CO_2-EOR)

1 Scope

1.1 Applicability

This document applies to carbon dioxide (CO_2) that is injected in enhanced recovery operations for oil and other hydrocarbons (CO_2-EOR) for which quantification of CO_2 that is safely stored long-term in association with the CO_2-EOR project is sought. Recognizing that some CO_2-EOR projects use non-anthropogenic CO_2 in combination with anthropogenic CO_2, the document also shows how allocation ratios could be utilized for optional calculations of the anthropogenic portion of the associated stored CO_2 (see Annex B).

1.2 Non-applicability

This document does not apply to quantification of CO_2 injected into reservoirs where no hydrocarbon production is anticipated or occurring. Storage of CO_2 in geologic formations that do not contain hydrocarbons is covered by ISO 27914 even if located above or below hydrocarbon producing reservoirs. If storage of CO_2 is conducted in a reservoir from which hydrocarbons were previously produced but will no longer be produced in paying or commercial quantities, or where the intent of CO_2 injection is not to enhance hydrocarbon recovery, such storage would also be subject to the requirements of ISO 27914.

1.3 Standard boundary

1.3.1 Inclusions

The conceptual boundary of this document for CO_2 stored in association with CO_2-EOR includes:

a) safe, long-term containment of CO_2 within the EOR complex;

b) CO_2 leakage from the EOR complex through leakage pathways; and

c) on-site CO_2-EOR project loss of CO_2 from wells, equipment or other facilities.

1.3.2 Exclusions

This document does not include the following:

a) lifecycle emissions, including but not limited to CO_2 emissions from capture or transportation of CO_2, on-site emissions from combustion or power generation, and CO_2 emissions resulting from the combustion of produced hydrocarbons;

b) storage of CO_2 above ground;

c) buffer and seasonal storage of CO_2 below ground (similar to natural gas storage);

d) any technique or product that does not involve injection of CO_2 into the subsurface; and

e) emissions of any GHGs other than CO_2.

NOTE Some authorities might require other GHG components of the CO_2 stream to be quantified.

2 Normative references

There are no normative references in this document.

© Standards Australia Limited 2020