CATO-2 Deliverable WP3.4-D06
Progress report: Monitoring strategies for inaccessible/abandoned wells

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1 Executive Summary

The work on this deliverable will be executed by TNO B&O and IF-WEP. Due to the limited funding available for this task in year 1 of CATO-2 the work will start in year 2 of CATO-2. This report will therefore consist of a brief introduction into the subject and a plan for the coming years.

When a potential site for CO_2 storage is evaluated in an area where drilling has taken place, one of the essential steps to ensure the integrity of the CO_2 storage site is to asses all current wells that might come into contact with the target storage interval. This is just as much important for the active wells as for the abandoned/inaccessible wells.

In this study we shall differentiate for the various types of abandoned/inaccessible wells that can be encountered in practise. For instance between wells that are completely inaccessible from ground level to wells that are partially accessible by industry standard, low-cost well intervention methods.

For the various types of abandonment stages different monitoring strategies shall be developed and evaluated on their ability to detect a CO_2 leak and their cost effectiveness.

Results from previous work carried out by IF-WEP show that current oil industry state of the art wellbore logging tools - when applied to CO_2 injection wells - are still inconclusive or even lack the ability to detect CO_2 flow behind casing. Furthermore, storage of CO_2 introduces new conditions to long-term integrity of wells. Previously abandoned wells are of specific interest as these may be plugged decades ago – when regulations and technology were not at current high levels – and mostly are not easily accessible. IF-WEP and TNO B&O therefore strongly support to carry out work to improve the ability to detect CO_2 leaks in storage wells.

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Document Change Record

(this section shows the historical versions, with a short description of the updates)

Version	Nr of pages	Short description of change	Pages
2010.08.30		Final deliverable	

Table of Content

2 Applicable/Reference documents and Abbreviations

2.1 Applicable Documents

(Applicable Documents, including their version, are documents that are the "legal" basis to the work performed)

	Title	Doc nr	Version date
AD-01	Beschikking (Subsidieverlening CATO-2 programma verplichtingnummer 1-6843	ET/ED/9078040	2009.07.09
AD-02	Consortium Agreement	CATO-2-CA	2009.09.07
AD-03	Program Plan	CATO2-WP0.A-D.03	2009.09.29

2.2 Reference Documents

(Reference Documents are referred to in the document)

	Title	Doc nr	Version/issue	Date
	n.a.			

2.3 Abbreviations

(this refers to abbreviations used in this document)

	n.a.

3 General text

3.1 General introduction

The work on this deliverable will be executed by TNO B&O and IF-WEP, due to the limited funding available for this task in year 1 of CATO-2 the work will start in year 2 of CATO-2. This report will therefore consist of brief introduction into the subject and a plan for the coming years.

3.2 Introduction into the subject

When a potential site for CO_2 storage is evaluated in an area where drilling has taken place, e.g. for oil and gas, geothermal energy or solution mining, one of the essential steps of ensuring the integrity of the CO_2 storage location is to asses all wells that might come into contact with the target storage interval. This is just as important for the active wells as for the previously abandoned wells because the reason for abandonment could well be problems during their construction or operating life and therefore imposes a risk for a reduced well integrity. This is applicable before or during injecting CO_2 and also and the end of the project when the injection wells will be plugged and abandoned.

The monitoring of active fully accessible wells will be discussed in another deliverable, this deliverable focuses on the monitoring strategies of abandoned/inaccessible wells. Detecting CO_2 in wellbore and in particular behind casing is a critical subject, which has many parallels with monitoring abandoned wells.

3.3 Plan

Before discussing the possible monitoring strategies for abandoned/inaccessible wells it is important to consider the various types of abandoned/inaccessible wells that can be encountered in practise. If for instance a well is sidetracked and the original wellpath abandoned according to the Dutch regulations the top part of the well above the plug is still accessible by common well intervention methods. This will allow for logging of the well, installation of sensors above the plugged area and direct geophysical measurements on the casing.

A different matter is when a well is completely abandoned as defined by Dutch regulations, e.g. the wellhead has been cut off to 3 meters below groundlevel or 6 m below the seafloor and a cement plug has been installed of at least 50 m under the cut-off part of the casing. This does not allow for well interventions without major additional cost associated nor does it allow for direct geophysical measurements on the casing.

The current status of technology only allows for monitoring of the injection or monitoring wells and in some cases partially abandoned wells. Moreover, the current state-of-the-art tools can be inconclusive to CO_2 detection, in particular for relatively small leaks behind the casing.
This is the starting point for listing detection functionalities, identifying tools and mapping shortcomings. All possible situations and their merits will be evaluated and this will form the basis for evaluating the subsequent monitoring strategies.

After having defined these groups of abandonment types and derived detection requirements, specific abandonment strategies will developed.

Essential is to understand the physical properties of CO_2 in relation to the (partially) abandoned wellbore and the contrast in properties of rock, fluids and well construction materials. One can think of measurements of:

- Pressure
- Temperature
- pH
- Resistivity
- Conductivity
- Noise
- Acoustic impedance
- Seismicity

These and other measurable parameters and their respective tools will be further identified and compared for their ability to detect a CO_2 leak as part of this study.

More subtle detection methods can be identified to detect contrasts in properties of CO_2-affected or altered materials so to develop circumstantial evidence of CO_2 presence. For example corroded steel (casing) shows up differently in some sonic tools. Time-lapsed measurements (i.e. measuring every 5 or 10 years) should reveal these changes of affected materials. This subject is part of this study. The above mentioned measurements can be done for instance by intervals of wireline measurements or installation of permanent sensors. The possibilities of these methods will be discussed, also including their potentially adverse effect to well integrity. The data line of a permanent sensor for instance can also form a potential leak path. Methods of mitigating this, such as wireless technologies, shall also be subject of this study.

For inaccessible wells, the options for well monitoring are limited. Investigation of potential monitoring techniques for the wellbore system therefore will specifically include general geophysical methods that can be employed from the surface or neighbouring wells.