

DRAFT - 28 May 2009

Hydrogen Energy International Limited

Draft pro forma regulations for the
geological storage of carbon dioxide

Introduction and Intent

This draft for a pro-forma set of regulations seeks to outline a model form of legislation in respect of the storage of CO₂. The paper seeks to address the issues most likely to be encountered in any jurisdiction and suggests some of the areas of interplay between CO₂ storage and likely existing legislation. This model will need to be adapted to fit the specific legislative environment into which it is to be placed.

Methodology and summary

As a starting point, this document is based on drafts of the European Union CCS Directive (2009) as well as the CCS consultation by the UK Department of Energy and Climate Change (*Towards Carbon Capture and Storage*, 2009). The document also draws on the consultation on geological storage of CO₂ conducted by the US Environmental Protection Agency in 2008.

Following the EU and UK model, these draft regulations establish a licensing regime for the storage of CO₂, monitoring, reporting and inspection requirements, as well as decommissioning and the provision of financial security.

This document assumes that:

- a "unitary" system of government will be in place in the jurisdiction in which these regulations are to apply and that the relevant "competent authority" has all the necessary authority vested in it to undertake or authorise the actions described herein; and
- the relevant state owns all the subsurface rights. More complex issues arise where such rights are privately owned.

It also incorporates some drafting in respect of the relationship between evaluation and storage permits and licences for the development and production of hydrocarbons which is based on comments that have been made on the draft EU CCS Directive and the UK CCS consultation by industry groups.

Issues not covered by these pro forma regulations

Other general provisions of local law will be relevant to any carbon capture and storage (CCS) regime, for example, there may be regulatory barriers to CCS projects which will need to be removed to facilitate CCS projects. These will likely include:

- the characterisation of CO₂ as "waste" which may prohibit the storage of CO₂ in geological structures and/or the transportation of CO₂ in pipelines;
- the requirement and detail of any environmental impact assessment;
- environmental issues relating to the preservation of potable groundwater quality;
- tax treatment for CO₂ storage evaluation costs;
- transport of the CO₂ to the injection facilities;

- liability for damage of third parties resulting from a breach of these activities;
- modifications to existing enhanced oil recovery authorisations to accommodate CCS activities;
- rights of appeal against decisions of the [Competent Authority];
- an enforcement regime in respect of breaches of this Regulation;
- unitisation of Storage Permits; and
- the impact of Evaluation and Storage Permits on the decommissioning obligations under Hydrocarbon Licences.

There are also a number of issues which go beyond the implementation of a simple CCS regime which include:

- **Funding** – should a model mechanism be adopted based perhaps on a carbon storage credit/payment system?
- **Mandatory CCS ready requirement** – to what extent should CCS be imposed on those industries, such as the power and refinery industries, which emit large amounts of CO₂?
- **Land rights** – and access to the storage space. Complex issues arise where such rights are not owned by the State but are in private hands.

Disclaimer

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1 CHAPTER 1 – SUBJECT MATTER

- 1.1 This [Regulation] establishes a legal framework for the long term storage of carbon dioxide (hereinafter "CO₂"), in geological formations in such a way as to prevent or reduce as far as possible negative effects on the environment and any resulting harm to human health and thereby reduce the level of CO₂ that would otherwise be released into the atmosphere.

2 CHAPTER 2 - SCOPE AND PROHIBITION ON ACTIVITIES WITHOUT A PERMIT

- 2.1 This [Regulation] applies to the storage of CO₂ in Geological Formations in [*insert name of country/state/territory*], under its territorial waters and on its Continental Shelf.
- 2.2 [This [Regulation] does not apply to storage of CO₂ undertaken for research, development or testing of new products and processes in situations where [the Competent Authority] has made specific alternative provisions].
- 2.3 The storage of CO₂ in the Water Column is not permitted.
- 2.4 No person may carry out Evaluation to identify a suitable Storage Reservoir other than in accordance with an Evaluation Permit.
- 2.5 [Save as permitted under Chapter 7,] no person may carry out the following activities other than in accordance with a Storage Permit:
- 2.5.1 the use of any Geological Formation in or under the [*insert name of country/state/territory*] for the storage of CO₂;
 - 2.5.2 the conversion of any natural feature in or under the [*insert name of country/state/territory*] for the purpose of storage of CO₂; or
 - 2.5.3 the establishment or maintenance of any an installation in [*insert name of country/state/territory*] for the purposes of activities within Sections 2.5.1 and 2.5.2.

3 CHAPTER 3 - DEFINITIONS

3.1 For the purposes of this [Regulation] the following definitions apply:

- 3.1.1 'Cap Rock' means a Geological Formation situated above or adjacent to any part of a Storage Reservoir that is expected to prevent material Migration of injected CO₂ from the Storage Reservoir;
- 3.1.2 'Closed' means the completion of those activities associated with Closure;
- 3.1.3 'Closure' of a CO₂ Storage Reservoir means the definite cessation of CO₂ injection into that Storage Reservoir, sealing the Storage Reservoir and the removal of those parts of the Injection Facilities not required for the ongoing containment of CO₂.
- 3.1.4 'Closure Plan' means the plan which describes the measures to be taken to cease injection of CO₂, to seal the Storage Reservoir and remove those parts of the Injection Facilities not required for the ongoing containment of CO₂ in accordance with Section 8.5 and Annex III;
- 3.1.5 ['Competent Authority' means *insert relevant authority within the country/state/territory*];

- 3.1.6 'Contamination' means the Migration of stored CO₂ or substances mobilised by stored CO₂ into subsurface potable water resources or Hydrocarbons or Mineral Deposits (as demonstrated by measured levels of CO₂ that are clearly above background levels and/or background flux of CO₂) where (i) the elevated levels of CO₂ are unequivocally attributable to the stored CO₂, and (ii) such Migration has a material adverse effect on the then current economic value of such potable water resources or Hydrocarbons or Mineral Deposits;
- 3.1.7 'Continental Shelf' means the continental shelf within the meaning of the United Nations Convention on the Laws of the Seas 1982 (Cmnd 8941) (UNCLOS).
- 3.1.8 'Corrective Measures' means any reasonable measures taken to correct or mitigate Significant Irregularities in order to prevent or stop Contamination or a Leakage;
- 3.1.9 'CO₂ Plume' means the dispersing volume of CO₂ in the Storage Complex;
- 3.1.10 'CO₂ Stream' means a flow of substances consisting primarily of carbon dioxide;
- 3.1.11 'Enhanced Hydrocarbon Recovery' means the use of a CO₂ Stream to enhance the extraction of Hydrocarbons;
- 3.1.12 'Evaluation' means assessing potential Storage Complexes by means of specific procedures including activities such as carrying out geological and geophysical surveys and drilling to obtain information about strata in the potential Storage Complex and characterise and assess its potential pursuant to the criteria specified in Annex I;
- 3.1.13 'Evaluation Permit' means a permit issued under Chapter 5;
- 3.1.14 'Financial Security' means, subject to a transparent risk based assessment, acceptable forms of financial security as determined by the [Competent Authority] with due regard to the range of products available on international markets and the associated costs including but not limited to bonds, guarantees, letters of credit, cash deposits and insurance;
- 3.1.15 'Geological Formation' means a lithostratigraphical subdivision which comprises a distinct sedimentary rock layer or layers that can be found and mapped, which can include without limitation, porous and permeable rocks containing hydrocarbons and/or water, coal beds, or non-porous or impermeable rocks;
- 3.1.16 'Geological Storage of CO₂' means injection into and long term storage of CO₂ Streams in underground Geological Formations;
- 3.1.17 'Hydrocarbons' means all crude oils, condensates, natural gas liquids and gaseous Hydrocarbons (including wet gas, dry gas and residue gas);
- 3.1.18 'Hydrocarbons Licence' means [conform to relevant local legislation];
- 3.1.19 'Injection Facilities' means the equipment located at or near the Storage Reservoir that is owned or operated by the Operator for the local distribution and injection of CO₂ into the Storage Reservoir and includes compressors, well-head assemblies, well casings, well tubing, meters, piping, valves and pumps;
- 3.1.20 'Leakage' means any materially significant release of CO₂ from the Storage Complex into the atmosphere or hydrosphere that would have a negative impact on human health or the environment, provided that where CO₂ is recovered as part of Enhanced Hydrocarbon Recovery operations such CO₂ shall not be treated as having Leaked provided that it is captured and re-injected into a permitted Storage Reservoir;
- 3.1.21 'Migration' means the movement of stored CO₂ within the Storage Complex;
- 3.1.22 'Mineral Deposit' means [conform to relevant local legislation];

- 3.1.23 'Mineral Licence' means [conform to relevant local legislation];
- 3.1.24 'Operator' means any natural or legal, private or public person who conducts Evaluation or owns or operates the Storage Reservoir or to whom decisive economic power over the technical functioning of the Storage Reservoir has been delegated according to [national] legislation;
- 3.1.25 'Post-Closure' means the period after the transfer of responsibility for a Storage Reservoir and the stored CO₂ to the [Competent Authority];
- 3.1.26 'Significant Irregularity' means any irregularity in the injection or storage operations or in the condition of the Storage Complex that materially increases the risk of (i) Contamination or (ii) a Leakage;
- 3.1.27 'Storage Complex' means the Storage Reservoir and any surrounding geological domains which can have a material effect on the risk of (i) Contamination or (ii) Leakage;
- 3.1.28 'Storage Permit' means a permit issued under Chapter 6;
- 3.1.29 'Storage Reservoir' means one or more defined areas within a Geological Formation (or a number of Geological Formations) used for the Geological Storage of CO₂, a single Storage Reservoir may include defined areas within separate Geological Formations at different stratigraphic levels;
- 3.1.30 'Water Column' means the vertically contiguous mass of surface water from the surface to the bottom sediments of a water body; and
- 3.1.31 ['Waste' means the substances defined as waste in *[relevant local legislation]*].

4 CHAPTER 4 - SITE SELECTION

- 4.1 The suitability of a Geological Formation for use as a Storage Reservoir must be determined through a characterisation and assessment of the potential Storage Complex pursuant to the criteria specified in Annex I.
- 4.2 A Geological Formation may only be selected as a Storage Reservoir if, under the proposed conditions of use, there is no significant risk of either Leakage or Contamination.

5 CHAPTER 5 - EVALUATION PERMITS

5.1 Evaluation Permits

- 5.1.1 The [Competent Authority] must publish objective non-discriminatory criteria upon which Evaluation Permits are to be granted. Evaluation Permits must be open to all entities satisfying such criteria. In addition holders of Hydrocarbon Licences shall be able to apply for Evaluation Permits over the areas covered by such Hydrocarbon Licences provided that they meet the requirements of this [Regulation].
- 5.1.2 The holder of an Evaluation Permit shall have the exclusive right within the area covered by the Evaluation Permit to conduct activities aimed at determining the suitability of Geological Formations for use as a Storage Reservoir.
- 5.1.3 Evaluation Permits may be granted for a defined surface area and to a depth to the centre of the Earth as reasonably determined by the [Competent Authority] for a period

of 5 years. Evaluation Permits shall be renewable at the request of the Permit Holder for such further periods as the [Competent Authority] may reasonably determine.

5.1.4 The grant and renewal of Evaluation Permits under Section 5.1.3 may be subject to the fulfilment of minimum reasonable work obligations in relation to the Evaluation of the potential CO₂ Storage Complex.

5.1.5 [Subject to Chapter [7],] the [Competent Authority] must ensure that no conflicting uses of the area over which an Evaluation Permit has been issued are permitted during the period of validity of such Evaluation Permit. However no Evaluation Permit shall be issued in respect of an area covered by a pre-existing Storage Permit.

5.1.6 Until expiry or surrender of the Evaluation Permit the Evaluation Permit holder shall have the sole right to apply for a Storage Permit pursuant to Chapter 6 in respect of any CO₂ Storage Complex identified within the area covered by the Evaluation Permit.

5.2 Applications for Evaluation Permits

5.2.1 Applications to the [Competent Authority] for Evaluation Permits must include the following information:

- (A) name and address of the applicant and, if different, of the potential Operator;
- (B) proof of the technical competence of the applicant or the potential Operator; and
- (C) the defined surface area to be Evaluated;

5.3 Conditions for Evaluation Permits

5.3.1 The [Competent Authority] may only issue an Evaluation Permit if the [Competent Authority] is reasonably satisfied that:

- (A) all relevant requirements of this [Regulation] are met; and
- (B) the Evaluation will be in the hands of a financially sound and technically competent Operator

5.4 Contents of Evaluation Permits

5.4.1 The Evaluation Permits must contain the following:

- (A) name and address of the Operator;
- (B) precise location and delimitation of the Evaluation Permit;
- (C) the term of the Evaluation Permit; and
- (D) the minimum work obligations, if any, required under Section 5.1.4.

6 CHAPTER 6 - STORAGE PERMITS

6.1 Storage Permits

6.1.1 The [Competent Authority] must publish objective non-discriminatory criteria upon which Storage Permits are to be granted. Storage Permits are open to all entities satisfying such criteria and it shall not be necessary for the applicant to hold or to have held an Evaluation Permit in respect of the area covered by the application for the Storage Permit.

- 6.1.2 With effect from the time the application is made, and on the condition that the application is approved by the [Competent Authority], the holder of a Storage Permit shall have the exclusive right to inject a CO₂ Stream into the Storage Reservoir identified in the Storage Permit for the purpose of the long term storage of such CO₂ and the exclusive right to apply for extensions of such Storage Permit.
- 6.1.3 Storage Permits shall be issued for a term of at least 20 years with the right to apply for one or more 10-year extensions, provided always that the term shall extend to cover the period required to complete the Closure of the Storage Reservoir and transfer of responsibility for it pursuant to Section 8.6.
- 6.1.4 There shall only be one Operator for each Storage Reservoir and the [Competent Authority] shall ensure that no conflicting uses of the Storage Reservoir are permitted during the validity of the Storage Permit.

6.2 Applications for Storage Permits

- 6.2.1 Applications to the [Competent Authority] for Storage Permits must include the following information:
 - (A) name and address of the applicant and, if different, of the potential Operator;
 - (B) proof of the technical competence of the applicant or the potential Operator;
 - (C) the characterisation of the Storage Complex and an assessment of the expected security of the Storage Reservoir pursuant to Sections 4.1 and 4.2;
 - (D) the maximum quantity of CO₂ to be injected and stored as well as the prospective composition of CO₂ Streams and injection rates and pressures, the planned total duration of injection, the location of Injection Facilities and the methods to transport the CO₂ to the Injection Facilities;
 - (E) a proposed Monitoring Plan pursuant to Section 8.1.2;
 - (F) a proposed Corrective Measures Plan pursuant to Section 8.4.2;
 - (G) a proposed provisional Closure Plan pursuant to Section 8.5.2;
 - (H) proof of the Financial Security or other equivalent provision as required under Section 8.7; and
 - (I) whether any co-existing Hydrocarbon Licence or Mineral Licence has been granted in respect of some or all of the same area.

6.3 Conditions for Storage Permits

- 6.3.1 The [Competent Authority] may only issue a Storage Permit if the Competent Authority is reasonably satisfied that:
 - (A) all relevant requirements of this [Regulation] are met; and
 - (B) the management and operation of the Storage Reservoir will be in the hands of a financially sound and technically competent Operator.

6.4 Contents of Storage Permits

- 6.4.1 The Storage Permit must contain the following:

- (A) name and address of the Operator;
- (B) precise location and delimitation of the Storage Reservoir and Storage Complex;
- (C) the maximum quantity of CO₂ authorised to be geologically stored, the maximum daily well injection rates and the maximum bottom hole injection pressure;
- (D) the approved Monitoring Plan, the obligation to implement the plan and requirements for updating it pursuant to Section 8.1 as well as reporting requirements pursuant to Section 8.2;
- (E) the requirement to notify the [Competent Authority] in case of a Significant Irregularity or Contamination or Leakage, the approved Corrective Measures Plan and the obligation to implement the Corrective Measures Plan in case of a Significant Irregularity, Contamination or Leakage pursuant to Section 8.4;
- (F) conditions for Closure and the approved provisional Closure Plan pursuant to Section 8.5;
- (G) provisions on changes, review, updating and withdrawal of the Storage Permit pursuant to Section 6.5;
- (H) the requirement to maintain the Financial Security or any other equivalent pursuant to Section 8.7; and
- (I) the term of the Storage Permit and a requirement to transfer responsibility for the Storage Reservoir and the stored CO₂ to the [Competent Authority] upon satisfaction of the criteria set out in Annex III.

6.5 Changes, review, update and withdrawal of Storage Permits

6.5.1 The Operator must inform the [Competent Authority] of any material changes planned in the operation of the Storage Reservoir. The [Competent Authority] will update the Storage Permit or the Storage Permit conditions in accordance with such changes, provided the changes are consistent with the provisions of this [Regulation].

6.5.2 The [Competent Authority] may review and where necessary update the Storage Permit:

- (A) if it has been notified or made aware of a Significant Irregularity, Contamination or Leakage;
- (B) if the reports submitted pursuant to Section 8.2 or the inspections carried out pursuant to Section [8.3] show material non-compliance with Storage Permit conditions; or
- (C) if it is aware of any other material failure by the Operator to meet the Storage Permit conditions;

provided that before making any changes to the Storage Permit the [Competent Authority] shall first consult with the Operator and, in areas of non-compliance with the Storage Permit conditions, give the Operator reasonable time to remedy the non-compliance.

6.5.3 In cases of material non-compliance with the Storage Permit conditions where the Operator has failed to remedy the situation within the period referred to in Section 6.5.2, the [Competent Authority] may serve a written notice on the Operator specifying

the ongoing material non-compliance and a final reasonable period of time within which such non-compliance must be remedied failing which the [Competent Authority] can withdraw the Storage Permit on the expiry of one month's written notice.

6.5.4 After a Storage Permit has been withdrawn pursuant to Section [6.5.3], the [Competent Authority] may either issue a new Storage Permit or Close the Storage Reservoir pursuant to Section 8.5.1. Until a new Storage Permit has been issued or the Storage Reservoir is Closed, the [Competent Authority] may take over the responsibility for the Storage Reservoir and the stored CO₂, including all ensuing legal, financial and other obligations. To the extent possible, the [Competent Authority] shall recover any reasonable and necessary costs incurred from the former Operator including by drawing upon the Financial Security.

7 CHAPTER 7 - RELATIONSHIP WITH HYDROCARBONS AND MINERAL LICENCES

7.1 Hydrocarbons and Mineral Licences and permits in the same area

7.1.1 The Competent Authority may not issue:

- (A) an Evaluation Permit or a Storage Permit in relation to any area over which a [Hydrocarbons Licence or a Mineral License] has been issued to any person except the holder of the relevant [Hydrocarbons Licence or Mineral Licence]; or
- (B) a [Hydrocarbons Licence or Mineral Licence] in relation to any area over which an Evaluation Permit or a Storage Permit has been issued to any person except the holder of the relevant permit.

7.2 Discovery of Hydrocarbons or Mineral Deposits

7.2.1 If the holder of an Evaluation Permit or a Storage Permit discovers Hydrocarbons or a Mineral Deposit during the course of conducting activities in accordance with the relevant permit:

- (A) the permit holder has the exclusive right to apply for a [Hydrocarbons Licence or a Minerals Licence] in relation to the area covered by the relevant permit; and
- (B) the exclusivity period is to end at the earlier of:
 - (1) the [Competent Authority] issuing, or refusing to issue, a [Hydrocarbons Licence or a Minerals Licence] to the permit holder; or
 - (2) [2] years after the Hydrocarbons or Mineral Deposit are first discovered.

7.2.2 If the exclusivity period ends and the Competent Authority has not issued a [Hydrocarbons Licence or a Minerals Licence] to the relevant permit holder, the Competent Authority may, subject always to the provisions of Section 7.1.1(B), issue such [Hydrocarbons Licence or Minerals Licence] to any other person in accordance with *[insert reference to relevant [Hydrocarbons or Minerals Licence] legislation]*.

7.3 Enhanced Hydrocarbon Recovery

7.3.1 Subject to Section [7.2], any person engaging in Enhanced Hydrocarbon Recovery under the terms of a [Hydrocarbons Licence] as at the date of the coming into force of this [Regulation], shall not require a Storage Permit under this [Regulation] to continue to engage in such Enhanced Hydrocarbon Recovery.

7.3.2 Any person relying on the exemption in Section [7.1] shall cease the injection of CO₂ promptly upon the cessation of Hydrocarbon recovery under the relevant [Hydrocarbon Licence] unless prior to such cessation such person has applied for and obtained a Storage Permit under this [Regulation].

8 CHAPTER 8 - OPERATION, CLOSURE AND POST-CLOSURE OBLIGATIONS

8.1 Monitoring

8.1.1 The Operator must manage the Storage Reservoir to minimise the risk of either Leakage or Contamination. Accordingly the Operator must carry out monitoring in order (i) to detect Leakage or Contamination and (ii) to estimate the flux of CO₂ released to the atmosphere or hydrosphere if such a release is detected. Monitoring shall include:

- (A) assessing local reservoir pressure at the injection wells and of the overall reservoir;
- (B) detecting corrosion or degradation of the Injection Facilities;
- (C) comparison between the reported and forecast behaviour of CO₂ in the Storage Complex; and
- (D) assessing the effectiveness of any Corrective Measures taken pursuant to Section 8.4.

8.1.2 The monitoring must be based on a monitoring plan designed by the Operator pursuant to the requirements laid out in Annex II, submitted to and approved by the [Competent Authority] pursuant to Section 6.2.1(E) and 6.4.1(D) (the 'Monitoring Plan'). The Monitoring Plan shall be updated pursuant to the requirements laid down in Annex II and in any case every five years to take account of changes to the assessed risk of Leakage or Contamination according to experience current at that time, technical developments and best practise not entailing excessive cost or requirements of an unreasonable nature. Updated plans must be re-submitted to the [Competent Authority] for approval.

8.2 Reporting

8.2.1 Each year the Operator must submit to the [Competent Authority]:

- (A) results of the monitoring pursuant to Section 8.1 in the reporting period;
- (B) the quantities and composition of the CO₂ Streams delivered in the reporting period;
- (C) proof of the maintenance of the Financial Security pursuant to Section 8.7 and 6.4.1(H); and
- (D) any other information the [Competent Authority] reasonably considers relevant for the purposes of assessing compliance with Storage Permit conditions.

8.3 Inspections

8.3.1 The Competent Authority may conduct routine and non-routine inspections of all Storage Reservoirs within the scope of this [Regulation] for the purposes of checking and promoting compliance with this [Regulation].

- 8.3.2 Inspections may include activities such as visits to the Injection Facilities, assessing the injection and monitoring operations carried out by the Operator, and checking all relevant records kept by the Operator.
- 8.3.3 Routine inspections must be carried out at least every 5 years following at least one calendar month's prior written notice to the Operator.
- 8.3.4 Non-routine inspections may be carried out:
- (A) if the [Competent Authority] has been notified of a Leakage, Contamination or Significant Irregularity;
 - (B) if the reports pursuant to Section 8.2 have shown insufficient compliance with the Storage Permit conditions;
 - (C) to investigate serious environmental complaints; or
 - (D) in other situations where the [Competent Authority] reasonably considers a non-routine inspection is appropriate.
- 8.3.5 Following each inspection, the [Competent Authority] must prepare a report on the results of the inspection. The report shall evaluate compliance with the requirements of the Storage Permit and indicate whether or not further action is necessary. The report must be communicated to the Operator concerned.

8.4 Measures in case of a Significant Irregularity, Leakage or Contamination

- 8.4.1 In the case of a Significant Irregularity, Leakage, or Contamination, the Operator must immediately notify the [Competent Authority] and take the necessary Corrective Measures.
- 8.4.2 The Corrective Measures referred to in Section 8.4.1 must be taken on the basis of a corrective measures plan submitted to and approved by the [Competent Authority] pursuant to Sections 6.2.1(F) and 6.4.1(E) (the 'Corrective Measures Plan');
- 8.4.3 If the Corrective Measures taken by the Operator in accordance with the Corrective Measures Plan referred to in Section 8.4.2 are not effective in the reasonable opinion of the [Competent Authority], the [Competent Authority] may request the Operator to take additional or different Corrective Measures than those laid out in the Corrective Measures Plan which are reasonably expected to significantly reduce or eliminate a Significant Irregularity, Leakage or Contamination.
- 8.4.4 If a Significant Irregularity, Leakage or Contamination occurs that is not covered by the Corrective Measures Plan, the Operator must present a proposed set of additional Corrective Measures in an updated Corrective Measures Plan to the [Competent Authority] as soon as practical. Approval of such an updated Corrective Measures Plan is not to be unreasonably withheld or delayed. Once approved by the [Competent Authority], or approved with such changes as may be reasonable, the Operator shall implement the updated Corrective Measures Plan as soon as practical.
- 8.4.5 If the Operator fails to take the necessary Corrective Measures (including any additional or different Corrective Measures pursuant to Section 8.5.3 and 8.5.4), the [Competent Authority] may take the necessary Corrective Measures itself and recover any reasonable and necessary costs from the Operator including by drawing down on the Financial Security.

8.5 Closure of a Storage Reservoir

- 8.5.1 A Storage Reservoir or part of it must be Closed on the basis of the Closure Plan:

- (A) if the relevant conditions set out in the Closure Plan approved in the Storage Permit have been met and the Operator requests the same; or
- (B) if the [Competent Authority] so decides after the withdrawal of a Storage Permit pursuant to Section 6.5.4.

8.5.2 A provisional Closure Plan must be submitted to and approved by the [Competent Authority] pursuant to Section 6.4.1(F).

8.5.3 Prior to the Closure of a Storage Reservoir pursuant to Sections 8.5.1(A) or 8.5.1(B):

- (A) the provisional Closure Plan must be updated if necessary in view of the actual performance and monitoring of the Storage Complex and current best practice and technical improvements not entailing excessive cost or requirements of unreasonable nature;
- (B) the Operator must prepare a report documenting that there is credible evidence that there is no material risk of Leakage or Contamination, according to the site-specific criteria included in the Storage Permit, as described in Annex III;
- (C) the updated Closure Plan and the report demonstrating no material risk of Leakage or Contamination must be submitted to the [Competent Authority]; and
- (D) the updated Closure Plan must be approved by the [Competent Authority] as the definite Closure Plan, such approval not to be unreasonably withheld or delayed.

8.5.4 When the [Competent Authority] is satisfied that the definite Closure Plan has been fully and competently executed by the Operator, including (i) providing credible evidence that there is no material risk of Leakage or Contamination, (ii) decommissioning of the Injection Facilities in accordance with Annex III and (iii) where necessary the Operator has provided adequate provision for future obligations incidental to the CO₂ operation such as those associated with decommissioning of facilities associated with Hydrocarbon exploitation, the Competent Authority shall declare the Storage Reservoir to be Closed, such declaration not to be unreasonably withheld or delayed.

8.6 Transfer of responsibility

8.6.1 Where a Storage Reservoir has been Closed pursuant to Section 8.5, the responsibility for the Closed Storage Reservoir and the stored CO₂, including all ensuing legal, financial and other obligations, shall be transferred to the [Competent Authority], on its own initiative or upon request from the Operator, such transfer not to be unreasonably withheld or delayed.

8.6.2 After the transfer of responsibility pursuant to Section 8.6.1, monitoring may cease. However, if any Leverages or Contamination are identified, [the Competent Authority] must assess the scale of the problem and implement such Corrective Measures as may be reasonably necessary.

8.6.3 There shall be no recovery of costs incurred from the former Operator after the transfer of responsibility to the [Competent Authority].

8.6.4 Where a Storage Reservoir has been Closed pursuant to Section 8.5.1(B), transfer of responsibility shall be deemed to take place when there is credible evidence that there is no material risk of Leakage or Contamination in accordance with the criteria set out in Annex III.

8.7 Financial security

8.7.1 Financial Security, or any other equivalent reasonably determined by the [Competent Authority], may be required by the [Competent Authority] to be made by the applicant

prior to the commencement of CO₂ injection to ensure that all obligations arising under the Storage Permit issued pursuant to this [Regulation], including Closure provisions, can be met.

8.7.2 The Financial Security or any other equivalent referred to in Section 8.7.1, if required by the Competent Authority, must be kept:

(A) after a Storage Reservoir has been Closed pursuant to Section 8.5.1(A), until the responsibility for the Storage Reservoir is transferred to the [Competent Authority] pursuant to Section 8.6;

(B) after the withdrawal of a Storage Permit pursuant to Section 6.5.3:

(1) until a new Storage Permit has been issued; or

(2) where the Site Reservoir is Closed pursuant to Section 8.5.1(B), until the transfer of responsibility is deemed to take place pursuant to Section 8.6.4.

9 CHAPTER 9 - TRANSFER OF EVALUATION PERMITS AND STORAGE PERMITS

9.1 Entitlement to transfer interest in Exploration Permit or Storage Permit

The holder of:

(A) an Evaluation Permit; or

(B) a Storage Permit

is permitted to transfer the Evaluation Permit or Storage Permit in accordance with these [Regulations].

9.2 Purported transfers contrary to [Regulations] are invalid

9.2.1 Any purported transfer of an Evaluation Permit or a Storage Permit otherwise than in accordance with these [Regulations] shall be invalid and without force and effect.

9.3 Prior written consent of [Competent Authority] required

9.3.1 The holder of an Evaluation Permit or the holder of a Storage Permit shall not transfer an Evaluation Permit or a Storage Permit to any other person without the prior written consent of the [Competent Authority], such consent not to be unreasonably withheld or delayed.

9.4 Transfer and conditions imposed on transfer

9.4.1 The application for transfer of an interest in an Evaluation Permit or Storage Permit must be made in writing to the Competent Authority and must be accompanied by:

(A) the name and address of the transferee;

(B) evidence of the technical competence of the transferee including satisfaction of the relevant criteria referred to in Sections 5.3 and 6.3; and

(C) evidence of Financial Security or other equivalent provision as required under Section 8.7.

9.4.2 The [Competent Authority] may impose such conditions the [Competent Authority] reasonably considers appropriate including conditions relating to technical capability or financial capacity of the transferee on the transfer of the Evaluation Permit or Storage Permit.

10 CHAPTER 10 - REGISTERS

- 10.1 The [Competent Authority] must establish and maintain a register of all permitted Storage Reservoirs and Storage Complexes, including maps of their spatial extent and the current status of each such Storage Reservoir.
- 10.2 The [Competent Authority] must establish and maintain a register containing prescribed information relating to Evaluation Permits and Storage Permits.

ANNEX I

CRITERIA FOR THE CHARACTERISATION AND ASSESSMENT OF STORAGE COMPLEXES REFERRED TO IN CHAPTER 4

The characterisation and assessment of Storage Complexes referred to in Chapter 4 shall be carried out in four steps according to the following criteria. Derogations from one or more of these criteria are permitted so long as the capacity of the characterisation and assessment to enable the determinations pursuant to Chapter 4 is not materially affected.

Step 1: Data collection

Sufficient data shall be accumulated to construct a three-dimensional (3D) dynamic model for prediction of the behaviour of CO₂ within the Storage Complex during injection of CO₂, and for the prediction of long-term behaviour of CO₂ within the Storage Complex after cessation of injection. This data shall cover at least the following intrinsic characteristics of the Storage Complex:

- (a) reservoir geology and geophysics;
- (b) hydrogeology (in particular existence of potable ground water);
- (c) reservoir engineering (including volumetric calculations of pore volume for CO₂ injection and ultimate storage capacity, pressure and temperature conditions, vertical and horizontal permeability, pressure volume behaviour as a function of formation injectivity, cumulative injection rate and duration);
- (d) geochemistry of formation fluids and minerals in the Storage Reservoir;
- (e) geomechanics, including *in-situ* stress and fracture gradients in the Storage Reservoir and the Cap Rock;
- (f) seismicity (assessment of potential for natural and induced earthquakes); and
- (g) presence and condition of natural and man-made pathways which could provide Leakage pathways.

Step 2: Numerical model of the Storage Complex

Using the data collected in Step 1, a three-dimensional (3D) model, or a set of such models, including the candidate Storage Reservoir, Cap Rock and Storage Complex shall be built using appropriate numerical modelling methods. The model(s) shall characterise the Storage Complex in terms of:

- (a) geological structure of the Storage Complex;
- (b) geomechanical and geochemical properties of the Storage Reservoir and Cap Rock;
- (c) presence and flow properties of any faults or fractures;
- (d) capillary or permeability seals as well as porous and permeable horizons within the entire Storage Complex;
- (e) areal and vertical extent of the storage formation sufficient to model expected CO₂ Plume movement;
- (f) pore volume (including porosity distribution); and
- (g) any other relevant characteristics.

The uncertainty associated with each of the parameters used to build the model shall be assessed by developing a range of scenarios for each parameter and calculating the appropriate confidence limits. Any uncertainty associated with the model itself shall also be assessed.

Step 3: Dynamic modelling of the Storage Complex operation and sensitivities

Step 3.1 Security characterisation

Security characterisation shall be based on dynamic modelling, comprising a variety of time-step numerical simulations of CO₂ injection into the Storage Reservoir and long-term behaviour of injected CO₂ within the Storage Complex, using the using the model(s) constructed under Step 2. The following factors shall be considered:

- (a) possible injection rates and CO₂ properties;
- (b) the efficacy of coupled process modelling (*i.e.* the way various single effects in the simulator(s) interact);
- (c) the reservoir modelling methods used (multiple simulators may be required in order to validate certain findings); and
- (d) short and long term simulations (to establish the behaviour and disposition of the injected CO₂ over decades and centuries, including dissolution of CO₂ into water).

The dynamic modelling and other analyses shall provide insight to:

- (e) pressure volume behaviour versus time within the Storage Reservoir;
- (f) areal and vertical extent of CO₂ vs. time;
- (g) the nature of CO₂ flow in the reservoir, including phase behaviour;
- (h) CO₂ trapping mechanisms and rates (including spill points and lateral and vertical seals);
- (i) secondary containment systems in the overall Storage Complex;
- (j) storage capacity and pressure gradients in the Storage Reservoir;
- (k) the risk of fracturing the Storage Reservoir or the Cap Rock;
- (l) the risk of CO₂ Migration through the Cap Rock (*e.g.*, due to exceedance of capillary entry pressure of the Cap Rock or due to degradation of the Cap Rock);
- (m) the risk of Leakage through abandoned or inadequately sealed wells;
- (n) the rate of CO₂ Migration (in open-ended reservoirs);
- (o) fracture flow properties;
- (p) changes in formation(s) fluid chemistry and subsequent reactions (*e.g.* pH change, mineral formation) and inclusion of reactive modelling to assess such effects; and
- (q) displacement of formation fluids.

Step 3.2 Sensitivity characterisation

Multiple simulations shall be undertaken to identify the sensitivity of the assessment to assumptions made about particular parameters and to assess the range of likely outcomes based on actual and expected operational conditions. The simulations shall be based on altering parameters in the numerical model(s). Any significant sensitivity shall be taken into account in the risk assessment.

Step 4: Hazard Characterisation

Hazard characterisation shall be undertaken by analysing the potential for Leakage or Contamination, as established through dynamic modelling and sensitivity characterisation described above. This shall include consideration of *inter alia*:

- (a) potential Leakage pathways;
- (b) potential magnitude (flux rates) of Leakage events for identified Leakage pathways;
- (c) critical parameters affecting potential Leakage (*e.g.*, maximum reservoir pressure, maximum injection rate and sensitivity to various assumptions in the dynamic model(s));
- (d) secondary effects of CO₂ injection, including displaced formation fluids and new substances created by injection of CO₂;
- (e) any other factors which could pose a hazard to human health or the environment (*e.g.*, the Injection Facilities);
- (f) potential Contamination of subsurface resources such as potable water or hydrocarbon accumulations; and
- (g) possible interactions of CO₂ injection with other subsurface activities (*e.g.*, exploration, production and storage of Hydrocarbons or geothermal production).

The hazard characterisation shall cover the full range of potential operating conditions to test the security of the Storage Complex.

Step 5: Risk assessment

The risk assessment shall cover the range of scenarios developed under the hazard characterisation of Step 4 and shall comprise the following:

- (a) *Exposure assessment* – based on the characteristics of the environment and distribution of human population above the Storage Complex, and the potential behaviour and fate of leaking CO₂ from potential pathways identified under Step 4;
- (b) *Effects assessment* – based on the sensitivity of particular species, communities or habitats linked to potential Leakage events identified under Step 4. Where relevant it shall include effects of exposure to elevated CO₂ concentrations in the biosphere (including soils, marine sediments and benthic waters) (asphyxiation or hypercapnia) and reduced pH in those environments as a consequence of leaking CO₂). It shall also include an assessment of the effects of other substances that may be present in leaking CO₂ Streams (either impurities present in the stored CO₂ or new substances formed through storage of CO₂). These effects shall be considered at a range of temporal and spatial scales, and linked to a range of different magnitudes of Leakage events; and
- (c) *Risk characterisation* – This shall comprise an assessment of the safety and integrity of the Storage Complex in the short and long term, including an assessment of the risk of Leakage under the proposed conditions of use, and of the worst-case environment and health impacts. The risk characterisation shall be conducted based on the hazard, exposure and effects assessment. It shall include an assessment of the sources of uncertainty.

ANNEX II

CRITERIA FOR ESTABLISHING AND UPDATING THE MONITORING PLAN REFERRED TO IN SECTION 8.1 AND FOR POST-CLOSURE MONITORING

1. Establishing and updating the Monitoring Plan

The Monitoring Plan referred to in Section 8.1 shall be established and updated with the purpose of meeting the monitoring requirements laid out in Section 8.1 according to the following criteria:

1.1 Establishing the plan

The Monitoring Plan shall provide details of the monitoring to be deployed at the main stages of the project, including baseline, operational and any Closure monitoring. The following shall be specified for each phase:

- (a) parameters monitored;
- (b) monitoring technology employed and justification for technology choice;
- (c) monitoring locations and spatial sampling rationale; and
- (d) frequency of application and temporal sampling rationale.

The parameters to be monitored are identified so as to fulfil the purposes of monitoring. However, the plan shall in any case include continuous or intermittent monitoring of the following items:

- (e) fugitive emissions of CO₂ from the Injection Facilities;
- (f) CO₂ volumetric flow at injection wellheads;
- (g) CO₂ pressure and temperature at injection wellheads (to determine mass flow);
- (h) chemical analysis of the injected material;
- (i) annular pressure and fluid volume in injection wells;
- (j) corrosion monitoring and mechanical integrity testing of injection wells; and
- (k) reservoir temperature and pressure (to determine CO₂ phase behaviour).

The Monitoring Plan shall be based on appropriate best practice at the time of design not entailing excessive cost or requirements of an unreasonable nature. The following options shall be considered and used as appropriate:

- (l) technologies that can detect a Leakage into the atmosphere or hydrosphere;
- (m) technologies that can detect the presence, location and/or Migration paths of CO₂ within the Storage Complex;
- (n) technologies that provide information about pressure-volume behaviour and location of the CO₂ Plume to refine numerical dynamic models established pursuant to Chapter 4 and Annex I; and

- (o) technologies that provide wide areal coverage sufficient to capture information on any previously undetected potential Leakage pathways or Contamination across the areal dimensions of the Storage Complex and beyond, in the event of a Significant Irregularity or Migration of CO₂ out of the Storage Complex.

1.2 Updating the plan

The data collected from the monitoring shall be collated and interpreted. The observed results shall be compared with the behaviour predicted in dynamic simulation of the CO₂ Plume undertaken for the security characterisation described in Step 3 of Annex I.

Where there is a significant deviation between the observed and the predicted behaviour, the relevant dynamic model(s) shall be recalibrated to reflect the observed behaviour. The recalibration shall be based on observations, and where necessary to provide confidence in the recalibration assumptions, additional data shall be obtained.

Steps 2, 3, 4 and 5 of Annex I shall be repeated using the recalibrated predictions so as to generate new hazard scenarios and flux rates and to update the risk assessment.

Where new CO₂, pathways or flux rates are identified, the Monitoring Plan and the Corrective Measures Plan shall be updated accordingly.

2. Post-Injection Monitoring

The Monitoring Plan shall provide for Post-Injection Monitoring after the definite cessation of CO₂ injection, for the purpose of providing credible evidence that there is no material risk of Leakage or Contamination, as described in Annex III. It shall serve in particular to provide information required for the determination of Section 8.6.1.

The data collected from the Post-Injection Monitoring shall be collated and interpreted. The observed results shall be compared with the behaviour predicted in dynamic simulation of the CO₂ Plume undertaken for the security characterisation described in Step 3 of Annex I.

Where there is a significant deviation between the observed and the predicted behaviour of the CO₂ Plume, or there is insufficient evidence that there is no material risk of Leakage or Contamination as described in Annex III, further monitoring, interpretation and modelling shall be conducted at the discretion of the Operator, until the Operator is able to demonstrate security of the stored CO₂.

ANNEX III

CRITERIA FOR CLOSURE OF THE STORAGE RESERVOIR AND TRANSFER OF RESPONSIBILITY REFERRED TO IN SECTIONS 8.5 AND 8.6

A provisional Closure Plan included in the Storage Permit and approved by the [Competent Authority] pursuant to Sections 6.4.1(F) and 8.5.2 shall include:

- (a) site-specific criteria for demonstrating that there is no material risk of Leakage or Contamination; and
- (b) a plan for decommissioning of facilities.

1. Site-specific criteria

The site-specific criteria shall enable the Operator to demonstrate to the [Competent Authority] that there is no material risk of Leakage or Contamination pursuant to Section 8.5.3 by providing evidence within specific tolerance limits that:

- (a) there is no current Leakage that exceeds a level pre-defined in the Storage Permit as having the potential to cause measurable, significant harm to human health or to the natural environment;
- (b) there is no evident Contamination that has not been remediated in a manner approved by the [Competent Authority]; and
- (c) as far as can be reasonably anticipated, the condition of the Storage Complex and the anticipated future behaviour of the stored CO₂, pose no risk of measurable, significant harm to human health and safety or to the environment.

The site-specific criteria for no material risk of Leakage or Contamination shall take into account the geological characteristics of the Storage Complex as determined in the characterisation process described in Annex I. Pursuant to Section 8.5.3, the site-specific criteria shall be updated after the Post-Injection Monitoring to account for the behaviour of the stored CO₂ during and after injection operations relative to the modelled predictions, as described in Annex II.

The specific criteria shall demonstrate that *inter alia*:

- (d) potential leakage pathways have been identified according to the characterisation and risk assessment processes, updated over the course of injection operations as described in Annex II;
- (e) actual (*de minimis*) Leakage sites have been identified, mapped and monitored sufficiently to predict any long-term CO₂ flux at surface;
- (f) remediated leakage sites have been identified, mapped and monitored sufficiently to estimate any measurable, long-term CO₂ flux at surface;
- (g) the key characteristics of the stored CO₂, including the reservoir mass balance, match the predictions of the dynamic reservoir model maintained and updated throughout storage operations, including cessation of injection, as described in Annex II;
- (h) fluid pressure around injection wells has declined after final cessation of CO₂ injection;
- (i) fluid pressure anywhere within the Storage Reservoir does not exceed a specific fraction of the minimum fracture pressure of the Cap Rock, as stipulated in the Storage Permit; and

- (j) Post-Injection Monitoring indicates that the CO₂ Plume is contained within the areal dimensions of the Storage Permit.

2. Decommissioning plan

The provisional Closure Plan submitted pursuant to Sections 6.4.1(F) and 8.5.2 shall explain how the engineered structures potentially materially affecting the security of stored CO₂ will be removed and/or modified to minimise long-term risk of Leakage or Contamination, including plans for:

- (a) all wells penetrating the Storage Reservoir or the CO₂ Plume to be sealed in such away as to prevent Leakage or Contamination for a period of centuries, consistent with [*relevant legislation*];
- (b) all wells within the areal dimensions of the Storage Permit that do not penetrate the Storage Reservoir nor the CO₂ Plume to be regularly monitored by the Operator for evidence of Leakage or Contamination until such time as they are sealed in such away as to prevent Leakage or Contamination for a period of centuries, consistent with [*relevant legislation*]; and
- (c) those parts of the Injection Facilities not required for the long-term secure containment of the stored CO₂ to be removed and disposed in a manner consistent with [*relevant legislation*].