ARTICLE 6.4 MECHANISM

A6.4-SB002-AA-A05

Draft Recommendation

Requirements for the development and assessment of mechanism methodologies pertaining to activities involving removals

Version 01.0

United Nations
Framework Convention on
Climate Change

TABLE OF CONTENTS **Page**

1. Procedural background

1. The Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA), by its decision 3/CMA.3 “Rules, modalities and procedures for the mechanism established by Article 6, paragraph 4, of the Paris Agreement”, requested the Supervisory Body of the mechanism established by Article 6, paragraph 4, of the Paris Agreement (the Supervisory Body), to elaborate and further develop, on the basis of the rules, modalities and procedures of the mechanism, recommendations on activities involving removals, including appropriate monitoring, reporting, accounting for removals and crediting periods, addressing reversals, avoidance of leakage, and avoidance of other negative environmental and social impacts, in addition to the activities referred to in chapter V of the annex (Article 6, paragraph 4, activity cycle), to be considered at its fourth session (November 2022).

2. The Supervisory Body, at its first meeting, agreed that an informal working group on removals comprising its members and alternate members as well as the secretariat staff would work prior to the second meeting of the Supervisory Body to prepare draft recommendations to the CMA, taking into account the inputs provided at this meeting for consideration by the Supervisory Body at its second meeting, with a view to forwarding recommendations to CMA 4.

3. For the purpose of brevity, the term “removal activities” has been used in this note to imply “activities involving removals”.

2. Purpose

4. This document contains draft recommendations on the requirements for the development and assessment of mechanism methodologies pertaining to removal activities under the Article 6.4 mechanism.

3. Key issues and proposed solutions

5. The draft recommendations contained in this document cover the specific issues mentioned in paragraph 6(c) of the decision 3/CMA.3 “Rules, modalities and procedures for the mechanism established by Article 6, paragraph 4, of the Paris Agreement”, namely, appropriate monitoring, reporting, accounting for removals and crediting periods, addressing reversals, avoidance of leakage, and avoidance of other negative environmental and social impacts.

4. Impacts

6. This document will facilitate the consideration, by the Supervisory Body, of the recommendations on the requirements for the development and assessment of mechanism methodologies pertaining to removal activities under the Article 6.4 mechanism.

5. Subsequent work and timelines

7. Further work will be taken up as agreed by the Supervisory Body.

6. Recommendations to the Supervisory Body

8. It is recommended that the Supervisory Body take this document into consideration while developing recommendations requested by the CMA under paragraph 6(c) of decision 3/CMA.3.

1. Requirements for the development and assessment of mechanism methodologies pertaining to activities involving removals

1. Mechanism methodologies pertaining to removal activities shall meet the requirements contained in the sections A to G below which elaborate and further develop the requirement contained in paragraphs 33 to 39 of the annex to decision 3/CMA.3 “Rules, modalities and procedures for the mechanism established by Article 6, paragraph 4, of the Paris Agreement”.

2. Mechanism methodologies pertaining to removal activities shall meet any other requirements that may be agreed by the CMA in future.

3. Mechanism methodologies pertaining to land-based removal activities shall, in addition, comply with the requirements contained in the Appendix I of this document;

4. Mechanism methodologies pertaining to removal activities that take recourse to storage of the removed carbon stocks in geological formations shall, in addition, comply with the requirements contained in the Appendix II of this document;

5. The following definitions apply in relation to land-based removal activities, in addition to the definitions contained in the RMP:

   (a) **Achieved carbon stocks** The verified carbon stocks, net of the activity emissions, leakage, and the baseline removals, that represent the amount of CO2 removed by a removal activity.

   (b) **Holding period** Period in years for which the achieved carbon stocks are continuously held out of the atmosphere.

   (c) **Tonne-years** The product of tonnes of the achieved carbon stocks and the respective holding period, in years, of these tonnes.

   (d) **Time horizon** The time period in years that delineates the temporal boundary within which the impact of a mitigation action or policy is assessed.

   (e) **Permanence period** Simplified and approximate holding period applied across all the achieved carbon stocks, that is long enough to approximately justify crediting of 1 credit per tCO2 of the achieved carbon stocks. Any permanence period of less than the time horizon is a non-conservative approximation that results in overcrediting.

   (f) **Crediting factor** A multiplicative factor applied to 1 tonne of CO2 removed in order to get the number of credits (i.e. A6.4ER). The value of the factor depends upon the time horizon, the holding period of the carbon stocks achieved and the discount rate applied for valuation of future mitigation at the present time. The crediting factors are derived from the equivalence of marginal cumulative radiative forcing created by a 1 tCO2 pulse emission.

   (g) **Tonne-year crediting** Calculation of credits by applying an appropriate crediting factor to the achieved carbon stocks based on their actual holding period.

(h) **Tonne-based crediting** Calculation of credits by applying a crediting factor of 1.0 to the achieved carbon stocks based on an assumption that these carbon stocks will have a holding period equal to the permanence period.

1.1. Monitoring

6. Mechanism methodologies shall require that all removal activities monitor the achieved carbon stocks through their quantification using field measurements, or field measurements in combination with remote-sensing data where applicable.

7. Results of quantification of carbon stocks shall be stated with the associated uncertainties, and these uncertainties shall be within the specified limits.

8. If the uncertainty in estimates exceeds the specified limits, adjustments shall be applied to the estimated values to make these conservative;

9. Estimation of carbon stocks may employ conservative default factors that allow flexibility in monitoring or monitoring with lower costs.

1.2. Reporting

10. Mechanism methodologies shall require that all removal activities prepare monitoring reports after monitoring operations and summarize the outcomes of the monitoring.

11. Monitoring reports shall be transmitted to a designated operational entity (DOE) for verification.

12. Reports shall be submitted soon enough after the quantification of the achieved carbon stocks to allow the DOE to visit the site and conduct sample checks as needed.

13. Monitoring report shall contain all the field data, including remotely sensed data, or if such data is too voluminous, a summary of such data. In the case where the monitoring report contains only a summary of the data, full data shall be made available to the DOE at the time of verification, except for confidential data, if any.

14. Monitoring report shall include, apart from the estimates of the achieved carbon stocks, the records of events or incidents such as fire, pest outbreak, harvests, or seepage, that might have affected the carbon stocks in the intervening period.

15. The monitoring report shall include information on how the environmental and socioeconomic impacts were assessed and addressed by applying robust social and environmental safeguards, as described in section F below.

16. The monitoring report shall include information on how the removal activity is fostering sustainable development, including by applying the tools and approaches that may be developed by the Supervisory Body;

17. Verification, by the DOE, of the information provided under paragraphs (vi) and (vii) above shall be carried out if the host Party concerned requires such a verification;

18. Simplified monitoring and reporting is shall be allowed when the purpose of monitoring is to ensure continued existence of the carbon stocks and not to seek verification of additional carbon stocks.

1.3. Accounting

19. Mechanism methodologies shall require that net removals achieved by a removal activity are equal to carbon stock achieved by the activity minus the baseline carbon stocks, minus emissions attributable to implementation of the activity, minus any leakage emissions.

20. Baselines shall be established by applying an approved methodology;

21. Baselines shall comply with one of the approaches set out in decision 3/CMA.3, annex, paragraph 36;

22. Baselines shall be set with justification for the appropriateness of the choices, including information on how the proposed baseline approach is consistent with decision 3/CMA.3, annex, paragraphs 33 and 34;

23. Baseline scenarios shall be consistent with the applicable legal and regulatory requirements in the host Party country;

24. Where applicable, baselines shall follow the more ambitious level set by host Party at its discretion;

25. Baselines shall re-assessed and, if required, updated:

    (a) At the end of a renewable crediting period;

    (b) At the end of [X] years for activities opting for a fixed crediting period;

26. The activity boundary for the accounting of removals and project emissions shall include in-situ carbon stocks, the ex-situ carbon stocks, the equipment and the material used, and any sources of emissions related to implementation of the activity.

27. Any carbon pools and greenhouse gases may be optionally excluded from the activity boundary if such exclusion results in a conservative estimation of net removals;

28. The net removals achieved by the activity shall be limited to those that are in addition to any removals that are likely to occur in the baseline;

29. A proposed removal activity shall demonstrate additionality according the approved methodology applied;

30. The removals achieved by the activity shall at be equal to or exceed the removals that may be required by the applicable laws in the host Party country. More specifically, if the activity is a standalone activity within an area covered by an activity under jurisdictional approaches to enhance forest carbon stocks, the proposed baseline approach consistent with decision 3/CMA.3, annex, paragraphs 33, 34 and 36 shall be used, unless the host Party decides that a more ambitious jurisdictional baseline shall be applicable.

31. A proposed removal activity shall demonstrate that it faces at least some barrier in its implementation in the absence of the mechanism, and also justify how the mechanism would enable the overcoming of those barriers.

1.4. Crediting period

32. Mechanism methodologies shall require that a removal activity applies a crediting period for the issuance of A6.4ERs that is a maximum of 15 years renewable a maximum of twice;

33. A shorter crediting period shall apply if specified by the host Party pursuant to decision 3/CMA.3, annex, paragraph 27(b);

34. The crediting period shall not start before 2021;

35. The renewal of a crediting period shall be approved after a technical assessment by a DOE to determine necessary updates to the baseline, and the ex-ante estimates of net removals;

36. A renewal of crediting period shall apply the latest updated version of the applicable methodology;

37. The end of the crediting period of a removal activity shall not be the end of obligations of the activity participants to continue periodic monitoring of the carbon stocks against which credits were issued based on tonne-based crediting method until such carbon stocks have been held out of the atmosphere for a period equal to the permanence period selected.

1.5. Avoidance of leakage

38. Mechanism methodologies shall require a removal activity to be designed to avoid or minimize leakage;

39. Leakage that cannot be avoided shall be quantified and deducted from the removals achieved by the activity;

40. If indirect leakage, such as leakage due to market effects, is likely to occur, the effect of such leakage shall be quantified, and a suitable adjustment factor shall be applied to the removals achieved by the activity.

1.6. Avoidance of other negative environmental and social impacts

41. Mechanism methodologies shall require that any negative environmental and social impacts caused by the implementation of a removal activity is identified in the activity design document;

42. Where possible a removal activity shall be so designed that it does not cause any negative environmental and social impacts;

43. A land-based removal activity shall not result in replacement of native species with exotic species;

44. A removal activity shall not be implemented in land areas that are being used for biodiversity conservation and food production, unless the activity has positive effect on achieving these objectives while also achieving removals;

45. A removal activity shall not be implemented in a socio-economic context where it is likely to impact food and water security, local livelihoods and on the rights of indigenous peoples, unless the activity is likely to strengthen these as a result of its implementation.

Appendix 1. Additional requirements to be met by land-based removal activities

1. Monitoring

1. Mechanism methodologies shall require that after the first monitoring report on the basis of which credits have been issued, simplified monitoring be carried out in order to ensure continued existence of the carbon stocks where required. This monitoring record shall include records related to events such as fire, pest outbreak, seepage or any intentional or planned actions that may affect the quantities of carbon stocks stored, such that the monitoring:

    (a) Allows accurate calculation of tonne-years in the case of tonne-year crediting;

    (b) Ensures that carbon stocks do not decrease below the last verified stocks, in the case of tonne-based crediting.

2. Mechanism methodologies shall require that a carbon stock inventory and a monitoring report are prepared:

    (a) In the case of tonne-year crediting: when the activity participants wish to request for issuance of credits;

    (b) In the case of tonne-based crediting: within a period of [5][4][3] years from the last verified carbon stock inventory; and when an event occurs that is likely to have caused reversal of verified carbon stocks.

2. Addressing reversal

3. Reversal of removals occurs when the verified carbon stocks under a removal activity are released back into the atmosphere such that the carbon stocks are decreased below the verified stocks;

4. Mechanism methodologies shall require that:

    (a) In the case of a removal activity that has opted for tonne-year crediting, no reversals occur. The provisions of this section apply only to the removal activities that opt for tonne-based crediting;

    (b) The net carbon stocks achieved by a removal activity shall not be re-emitted into the atmosphere before the end of the permanence period;

    (c) A permanence period of [40][50][60][100] years shall be applied;

    (d) A removal activity may opt for one of the following two approaches to address reversals:

        (i) Tonne-year crediting

            a. Under this approach credits shall be equal to the number of verified tonnes of achieved carbon stocks multiplied by the applicable crediting factor;

b. Under this approach no reversal of carbon stocks can occur;

c. The credits issued shall be deemed permanent and the carbon stocks for which credits were issued may be either preserved for future issuance of credits or may be emitted.

(ii) Tonne-based crediting

a. This has two options:

i. [**Option 1** Under this method, credits issued shall be equal to the number of tonnes of carbon stocks achieved and verified, since the previous verification.]

ii. [**Option 2** Under this method, credits issued shall be equal to the number of tonnes of carbon stocks achieved and verified, since the previous verification, divided by the ratio pp/crp_left, where pp is the permanence period in years and crp_left is the time to the end of the crediting period in years.]

b. The carbon stocks for which credits have been issued shall be monitored and verified once every [3][4][5] years, and in the event of a reversal happening [before years equal to the permanence period from the year of verification have elapsed] [before the end of the crediting period], the reversal shall be compensated by following one of the options below:

Option I: Permanence buffer backed up by host Party guarantee

i. A percentage of credits to be issued to a removal activity is set aside into a permanence buffer of credits at the time of issuance. In the event of a reversal, an equivalent number of credits from the permanence buffer are used to replace the credits affected by the reversal;

ii. The host Party or an entity designated by it, could assume the liability for intentional reversals and the portion of unintentional reversals exceeding the capacity of the permanence buffer.

iii. The percentage of credits to be set aside by a project activity into the permanence buffer would be determined on the basis of the risk rating of the project activity. This percentage could be either fixed ex ante at the time of registration of the project activity, or assessed ex post at the time of verification, as the risk profile of the project activity could change over time.

iv. The credits accumulated in the permanence buffer shall be [retained permanently in the buffer] [shall be returned to the project participants once all the credits issued to a removal activity have fulfilled the permanence requirement].

Option II: Commercial insurance

i. Under this option, project participants shall buy insurance from a third party against potential reversal of credited removals. The third-party insurer shall be accredited by the Supervisory Body. The insurer shall provide a guarantee to the Supervisory Body on behalf of the activity participants to compensate for any reversals of certified carbon removals.

3. Participation requirements

5. A Party to the Paris Agreement may only host an Article 6.4 land-based removal activities in an area covered by an activity under the jurisdictional approaches to enhance forest carbon stocks, if it has submitted an expression of its agreement to the UNFCCC secretariat to allow the implementation of Article 6.4 land-based removal activities in that area and if it has demonstrated that:

   (a) Where the host country conducts monitoring across the jurisdiction, the purpose is to ensure that project leakage and any reversals within the jurisdiction are accounted for and that environmental integrity is maintained at the jurisdictional level, but no credit is issued at the jurisdictional level, although a baseline may be set at the jurisdictional level;

   (b) The activity area credited under the activity under the jurisdictional approaches to enhance forest carbon stocks is non-activity area for the Article 6.4 land-based removal activities. There is no overlap between the activity area credited under the activity under the jurisdictional approaches to enhance forest carbon stocks and the activity area credited as Article 6.4 land-based removal activities and therefore, no double counting or double claim is taking place.

   (c) However further analysis on relationship between activities under the approaches to enhance forest carbon stocks and removal activities under 6.4 mechanism would be required to fully address any potential issues, including the relationship with the requirements under Article 5 of the Paris Agreement.

Appendix 2. Additional requirements to be met by removal activities that take recourse to geological storage of achieved carbon stocks

1. Definitions

1. A “geological storage site” means a paired geological formation, or a series of such formations, consisting of an injection formation of relatively high porosity and permeability into which carbon dioxide can be injected, coupled with an overlying cap rock formation of low porosity and permeability and sufficient thickness which can prevent the upward movement of carbon dioxide from the storage formation.

2. Geological storage of carbon dioxide means its injection into an underground geological storage site for long-term isolation from the atmosphere.

3. The “operational phase” of a geological storage site means the period that begins when carbon dioxide injection commences and ends when carbon dioxide injection permanently ceases.

4. The “closure phase” of a geological storage means the phase that follows the operational phase and is the period that begins when carbon dioxide injection permanently ceases and ends when the geological storage site has been closed.

5. The “closure” of a geological storage site means the completion of the sealing of the geological storage site, including the appropriate plugging of wells relating to the geological storage site;

6. The “post-closure phase” means the period that begins when the geological storage site has been closed.

7. “Seepage” is defined as a transfer of carbon dioxide from beneath the ground surface or seabed ultimately to the atmosphere or ocean.

8. The “site development and management plan” is the documented description of how a geological storage site will be operated and managed.

9. “History matching” means the process of comparing observed results from the monitoring and measurement of a geological storage site with the results of the predictive numerical modelling of the behaviour of carbon dioxide injected into the geological storage site, and the use of the observed results to calibrate and update numerical models and modelling results. It can involve multiple iterations.

10. “Liability” means the legal responsibility arising from the removal activities that take recourse to storage in geological formations or the relevant geological storage site, with the exception of the obligations arising from a net reversal of storage as set out in section 8 addressing net reversal, but including all obligations related to the operation of the storage site (e.g. monitoring, remedial measures, etc.), to compensate for or remedy any significant damages, including damage to the environment, such as ecosystem damage, other material damages or personal injury.

11. “Remedial measures” means actions and measures intended to stop or control any unintended physical leakage or seepage of carbon dioxide, to restore the integrity of a geological storage site, or to restore long-term environmental quality significantly affected by a removal activity that take recourse to storage in geological formations.

12. A “net reversal of storage” of carbon dioxide means that:

    (a) For a verification period during the crediting period, the accumulated verified removal of greenhouse gases (GHGs) emissions that have occurred as a result of a registered mitigation activity under the mechanism are negative (i.e. the seepage from the geological storage site of the removal activities that take recourse to storage in geological formations exceeds the remainder of the removal achieved);

    (b) For a verification period after the end of the last crediting period, seepage has occurred from the geological storage site of the removal activities that take recourse to storage in geological formations.

2. Prevention of seepage/reversal and its possible negative impact

13. Selection and characterization of the geological storage site

    (a) Geological storage sites shall only be used to store carbon dioxide as Article 6.4 activities if, under the proposed conditions of use, there is no significant risk of seepage, no significant environmental or health risks exist, and the geological storage site will comply with all laws and regulations of the host Party.

    (b) The geological storage site is not located in international waters.

    (c) The following shall be evaluated when determining whether geological storage sites shall be used to store carbon dioxide as Article 6.4 activities consistent with paragraph B(a)(i) above:

        (i) All available evidence, such as data, analysis and history matching, indicates that the injected carbon dioxide will be completely and permanently stored such that, under the proposed or actual conditions of use, no significant risk of seepage or risk to human health or the environment exists;

        (ii) Whether the geological storage site is suitable for potable water supply.

    (d) For the purpose of determining whether the requirements set out in paragraph (i) to (iii) above are met, the participants shall take the following steps to characterize the proposed geological storage site:

        (i) Step 1: data and information collection, compilation and evaluation. This step shall involve the collection of sufficient data and information to characterize the geological storage site and determine potential seepage pathways. The collected data and information shall be evaluated in order to make a preliminary assessment of the site’s storage capacity and to assess the viability of monitoring. The data and information shall be evaluated for its quality and, where required, new data shall be collected;

        (ii) Step 2: characterization of the geological storage site architecture and surrounding domains. This step shall involve the assessment of known and inferred structures within the injection formation(s) and cap rock formation(s)

that would act as barriers to, or facilitators of, the migration of injected carbon dioxide. This step shall involve the compilation of (a) numerical three-dimensional static earth model(s) of the geological storage site. The uncertainty associated with key parameters used to build the model shall be assessed. The model shall be used to characterise, inter alia:

a. The structure of the geological containment;

b. All relevant geological properties of the injection formation(s);

c. The cap rock formation(s) and overburden;

d. The fracture system;

e. The areal and vertical extent of the geological storage site (e.g. the injection formation, the cap rock formation, overburden, secondary containment zones and surrounding domains);

f. The storage capacity in the injection formation(s);

g. The fluid distribution and physical properties;

h. Other relevant characteristics.

(iii) Step 3: characterization of dynamic behaviour, sensitivity characterization and risk assessment. This step shall involve an assessment of how the injected carbon dioxide can be expected to behave within the geological storage site architecture and surrounding domains, with a particular focus on the risk of seepage. This step shall utilize numerical dynamic modelling of the injected carbon dioxide using the static model developed in step 2 above to assess coupled processes (i.e. the interaction between each single process in the model), and, where possible, reactive processes (e.g. the interaction of injected carbon dioxide with in situ minerals in the numerical model), and short- and long-term simulations. Such numerical modelling shall be used to provide insight into the pressure and extent of carbon dioxide in the geological storage site over time, the risk of fracturing the cap rock formation(s) and the risk of seepage. Multiple simulations shall be conducted to identify the sensitivity of the assessments to assumptions made. The simulations carried out in this step shall form the basis for risk and safety assessments, detailed in section C paragraphs (a) to (d) below;

(iv) Step 4: establishment of a site development and management plan. Drawing on steps 1–3 above, a site development and management plan shall be established. The plan shall address the proposed conditions of use for the geological storage site and include, inter alia, descriptions of:

a. The preparation of the site;

b. Well construction, such as materials and techniques used, and the location, trajectory and depth of the well;

c. Injection rates and the maximum allowable near-wellbore pressure;

d. Operating and maintenance programmes and protocols;

e. The timing and management of the closure phase of the proposed removal activities that take recourse to storage in geological formations, including site closure and related activities.

(e) A wide range of data and information shall be used in performing the characterization and selection of the geological storage site, including, inter alia:

(i) Geological information, such as descriptions of the overburden and cap rock formation(s) and injection formation(s), locations of mapped faults, subsurface well and wellbore information, permeability and porosity, which are important in determining the injectivity of the injection formation, and the cap rock formation containment capacity, and information about regional tectonics, including the stress field and historical seismic activity;

(ii) Geophysical information, such as the thickness and lateral extent of the storage and cap rock formation(s), pressure, temperature, the existence of faults, and reservoir heterogeneity. Sources of data may include, inter alia, well logs, sonic logs and seismic surveys;

(iii) Geomechanical information, such as the stress state and the rock fracture pressure within the injection formation(s) and the cap rock formation(s). Sources of data include borehole data, such as breakouts inferred from caliper and televiewer logs, minifrac results, information about anisotropy within the reservoir, and mud loss events;

(iv) Geochemical information, such as information on rock and fluid properties and mineralogy. Fluid properties, such as the brine salinity, should also be used to determine dissolution trapping rates;

(v) Hydrogeological information, such as aquifer characteristics and aquifer flow direction and rates within the geological storage site, the overburden and surrounding domains.

3. Risk and safety assessment

14. A comprehensive and thorough risk and safety assessment shall be carried out in order to assess the integrity of the geological storage site and potential impacts on human health and ecosystems in proximity to the proposed Article 6.4 removal activities that take recourse to storage in geological formations. The risk and safety assessment shall also be used to inform environmental and socio-economic impact assessments.

15. The risk and safety assessment shall consider the following:

(a) Specific risks associated with containment failure resulting in emissions of greenhouse gases from above-ground installations and seepage from subsurface installations, and the potential effects on, inter alia:

(i) The contamination of underground sources of drinking water;

(ii) The chemical properties of seawater;

(iii) Human health and ecosystems (e.g. as a result of carbon dioxide accumulations at dangerous levels in non-turbulent air);

(b) The risk of continuous slow seepage from a geological storage site. This type of event can arise due to, inter alia:

(i) Seepage along (an) injection well(s) or abandoned well(s);

(ii) Seepage along a fault or fracture;

(iii) Seepage through the cap rock formation.

16. The risk and safety assessment shall:

(a) Cover the full chain of Article 6.4 removal activities that take recourse to storage in geological formations, including surrounding environments;

(b) Provide assurance of safe operational integrity regarding the containment of carbon dioxide, based on site-specific information about the geological storage site, potential seepage pathways, and secondary effects of storing carbon dioxide in the geological storage site, such as brine migration;

(c) Be used to determine operational data for the application of the site development and management plan, such as to set the appropriate maximums of injection pressure that will not compromise the confining cap rock formation(s) and the overburden of the geological storage site;

(d) Take account of the effects of potential induced seismicity or other geological impacts, as well as any other potential consequences for the environment, including on local ecosystems, property and public health, and global environmental effects on the climate directly attributable to the Article 6.4 removal activities that take recourse to storage in geological formations, including effects due to seepage;

(e) Be used to help prioritize locations and approaches for enhanced monitoring activities;

(f) Provide a basis for remedial measures, including plans for responses that can stop or control any unintended emissions from surface Article 6.4 removal activities that take recourse to storage in geological formations and seepage of carbon dioxide, restore the integrity of a geological storage site, and restore long-term environmental quality significantly affected by a removal activity that take recourse to storage in geological formations. Such measures and plans shall accompany monitoring plans;

(g) Include a communication plan.

17. In order to assess the potential risks of storage of carbon in a geological storage site, the activity participants shall take the following steps:

(a) Step 1: hazard characterization. This shall include an analysis the following:

(i) Potential hazards resulting from the capture, transportation and injection of carbon dioxide;

(ii) Potential seepage pathways from the geological storage site;

(iii) The magnitude of potential seepage for identified potential seepage pathways;

(iv) Critical parameters affecting potential seepage, such as the maximums of injection formation pressure, injection rates and temperature;

(v) The sensitivity to various assumptions made during numerical modelling;

(vi) Any other factors which could pose a hazard to human health and the environment;

(b) Step 2: exposure assessment. This shall be based on the characteristics of surrounding populations and ecosystems, the potential fate and behaviour of any seeped carbon dioxide, and other factors;

(c) Step 3: effects assessment. This shall be based on the sensitivity of species, communities or habitats linked to potential seepage events identified during the hazard characterization and the effects of elevated carbon dioxide concentrations in the atmosphere, biosphere and hydrosphere;

(d) Step 4: risk characterization. This shall comprise an assessment of the safety and integrity of the geological storage site in the short-, medium- and long-term, including an assessment of the risk of seepage under the proposed conditions of use set out in the site development and management plan;

(e) Step 5: contingency plan for large incidents, including seepage. This shall comprise all the necessary plans to be put in place in case of large incidents, including availability of trained personnel, materials and equipment and financial means to mitigate adverse impacts of the incident and teams prepared to act as swiftly as possible.

4. Monitoring of carbon stocks stored in geological formations

18. The monitoring of Article 6.4 removal activities that take recourse to storage in geological formations shall be undertaken to meet the following objectives:

(a) To provide assurance of the environmental integrity and safety of the geological storage site;

(b) To confirm that the injected carbon dioxide is contained within the geological storage site and within the activity boundary;

(c) To ensure that injected carbon dioxide is behaving as predicted in order to minimize the risk of any seepage or other adverse impacts;

(d) To ensure that good site management is taking place, taking account of the proposed conditions of use set out in the site development and management plan;

(e) To detect and estimate the flux rate and total mass of carbon dioxide from any seepage;

(f) To determine whether timely and appropriate remedial measures have been carried out in the event of seepage;

(g) To determine the removal of greenhouse gases (GHGs) that have occurred as a result of the Article 6.4 removal activities that take recourse to storage in geological formations;

(h) To determine the greenhouse gases (GHGs) emissions that have occurred as a result of the Article 6.4 removal activities that take recourse to storage in geological formations;

(i) To determine any negative environmental impact.

19. The monitoring plan shall, in addition to the requirements set out in the guiding principles, include the following:

(a) Reflect the principles and criteria of international good practice for the monitoring of geological storage sites and consider the range of technologies described in the relevant sections of the Intergovernmental Panel on Climate Change (IPCC) 2006 IPCC Guidelines for National Greenhouse Gas Inventories and other good practice guidance;

(b) Transparently specify which parameters and information will be monitored and collected, and the location and frequency of application of different monitoring techniques during the operational phase, closure phase and post-closure phase;

(c) Provide for specific techniques and methods that can:

(i) Detect and estimate the quantity of the carbon dioxide stored in the geological storage site;

(ii) Detect potential seepage via pathways in the cap rock formation(s) and in the overburden and surrounding domains in the geological storage site;

(iii) Estimate the flux rate and total mass of carbon dioxide from any seepage;

(d) Include provisions for history matching, by using the monitoring results to calibrate and update the numerical models that were used to characterize the geological storage site

(e) Provide for measurement of the carbon dioxide stream and composition, including impurities, at various points in the carbon dioxide capture, transportation and storage chain, including at the point(s) of injection into the geological storage site, at an appropriate frequency;

(f) Provide for measurement of the temperature and pressure at the top and bottom of the injection well(s) and observation well(s), at an appropriate frequency;

(g) Provide for the monitoring and measurement of various geological, geochemical and geomechanical parameters, such as fluid pressures, displaced fluid characteristics, fluxes and microseismicity, at an appropriate frequency;

(h) Provide for the monitoring and measurement of relevant parameters in the overburden and surrounding domains of the geological storage site, such as the monitoring of groundwater properties, soil gas measurements and measurements of the surface concentrations of carbon dioxide in the air, which shall be calibrated to detect signs of seepage, at an appropriate frequency;

(i) Provide for the detection of corrosion or degradation of the transport and injection facilities;

(j) Provide for an assessment of the effectiveness of any remedial measures taken in the event of seepage;

(k) The determination of types and amounts of chemical products utilized;

(l) The determination of the types and amounts of chemical products discharged.

20. The activity participants shall, for each verification period, carry out history matching and, where necessary, update the numerical models used to characterize the geological storage site by conducting new simulations using the monitored data and information. The numerical models shall be adjusted in the event of significant deviations between observed and predicted behaviour.

21. Where significant deviations are observed during history matching or when requesting a renewal of the crediting period, the activity participants shall, as appropriate:

(a) Recharacterize the geological storage site, in accordance with paragraphs (i) to (v) of section B(a) above;

(b) Revise the project boundary;

(c) Update the risk and safety assessment, in accordance with paragraphs a. to d. of section C. above;

(d) Update the environmental and socio-economic impact assessments;

(e) Revise the monitoring plan, in order to improve the accuracy and/or completeness of data and information, taking into account observed deviations determined during history matching, changes to the project boundary, changes to the risk and safety assessment, changes to the environmental and socio-economic impact assessments, new scientific knowledge and improvements in the best available technology;

(f) Update the site development and management plan, taking account of the results of the activities described in paragraph d (i–v) above, where appropriate.

5. Environmental and socio-economic impact assessments

22. For removal activities that take recourse to storage in geological formations, as a minimum, the comprehensive environmental and socio-economic impact assessments shall analyse thoroughly and exhaustively air emissions (nitrogen oxides, sulphur oxides, dust, mercury, polycyclic aromatic hydrocarbons, etc.), solid waste generation, and water use associated with technologies it uses.

23. In all cases, in conducting the environmental and socio-economic impact assessments, best available techniques will be applied in order to facilitate a high level of protection for the environment as a whole and for communities.

24. The environmental and socio-economic impact assessments shall include at least a comprehensive analysis of the environmental and socio-economic impacts.

6. Participation requirements

25. The provisions of section IV of the Rules modalities and procedures as well as their elaboration under the guiding principles shall apply mutatis mutandis to an Article 6.4 removal activities that take recourse to storage in geological formations. In addition, the provisions of paragraph b below shall apply to Article 6.4 removal activities that take recourse to storage in geological formations.

26. A Party to the Paris Agreement may only host an Article 6.4 removal activities that recourses to geological storage of achieved carbon stocks, if it has submitted an expression of its agreement to the UNFCCC secretariat to allow the implementation of Article 6.4 removal activities that recourse to geological storage of achieved carbon stocks and provided that it has established laws or regulations which:

    (a) Set procedures that include provisions for the appropriate selection, characterization and development of geological storage sites, recognizing the project requirements for Article 6.4 removal activities that take recourse to storage in geological formations set out in these recommendations;

    (b) Define means by which rights to store carbon dioxide in, and gain access to, subsurface pore space can be conferred to activity participants;

    (c) Provide for timely and effective redress for affected entities, individuals and communities for any significant damages, such as environmental damage, including damage to ecosystems, other material damages or personal injury, caused by the activity, including in the post-closure phase;

    (d) Provide for timely and effective remedial measures to stop or control any unintended seepage of carbon dioxide, to restore the integrity of a geological storage site, and to restore long-term environmental quality significantly affected by an Article 6.4 removal activities that take recourse to storage in geological formations;

    (e) Establish means for addressing liability arrangements for carbon dioxide geological storage sites, taking into account the provisions set out related to liability;

    (f) For a host Party that accepts the obligation to address the environmental and socio-economic impact of a net reversal of storage, establish measures to fulfil such an obligation.

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