

## **SUBMISSION BY THE UNITED STATES OF AMERICA**

### **Introduction**

The United States, as an observer Party to the Kyoto Protocol, welcomes the opportunity to share its views on addressing issues in the modalities and procedures for the inclusion of carbon dioxide capture and storage (CCS) in geological formations as project activities under the clean development mechanism. Although CCS is occurring now on a relatively small scale, CCS technologies have the potential to enable large emitters of CO<sub>2</sub> to significantly reduce greenhouse gas (GHG) emissions. These technologies allow CO<sub>2</sub> to be captured at stationary sources and injected underground for long-term storage in a process called geologic sequestration (GS). Our comments will highlight our experience in developing regulations to ensure the protection of underground sources of drinking water (USDWs) and for GHG monitoring and reporting. The requirements that we describe are focused on protection of USDWs and GHG reporting for facilities that choose to inject CO<sub>2</sub> underground for geologic sequestration, rather than requirements for facilities to undertake CCS activities or control GHGs. However, we hope this submission will provide useful information that will enhance discussions under the CDM related to the safety and effectiveness of CCS.

### **Protection of Drinking Water**

In December 2010, the U.S. Environmental Protection Agency (U.S. EPA) finalized a rule, under authority of the Safe Drinking Water Act, that establishes new federal requirements for the underground injection of CO<sub>2</sub> for the purpose of long-term underground storage, or geologic sequestration, and a new well class – Class VI – to ensure the protection of USDWs from injection related activities. The elements of the rule build upon the existing Underground Injection Control (UIC) Program regulatory framework, with modifications to address the unique nature of CO<sub>2</sub> injection for GS, including:

- Geologic site characterization requirements to ensure that GS wells are appropriately sited.
- Requirements for the construction and operation of the wells that include construction with injectate-compatible materials and automatic shutoff systems to prevent fluid movement into unintended zones.
- Requirements for the development, implementation, and periodic update of a series of project-specific plans to guide the management of GS projects.

- Periodic re-evaluation of the area of review around the injection well to incorporate monitoring and operational data and verify that the CO<sub>2</sub> is moving as predicted within the subsurface.
- Rigorous testing and monitoring of each GS project that includes testing of the mechanical integrity of the injection well, ground water monitoring, and tracking of the location of the injected CO<sub>2</sub> using direct and indirect methods.
- Extended post-injection monitoring and site care to track the location of the injected CO<sub>2</sub> and monitor subsurface pressures until it can be demonstrated that USDWs are no longer endangered.
- Clarified and expanded financial responsibility requirements to ensure that funds will be available for corrective action, well plugging, post-injection site care, closure, and emergency and remedial response.
- A process to address injection depth on a site-specific basis and accommodate injection into various formation types while ensuring that USDWs at all depths are protected.
- Considerations for permitting wells that are transitioning from Class II enhanced recovery to Class VI that clarify the point at which the primary purpose of CO<sub>2</sub> injection transitions from enhanced recovery (i.e., a Class II well) to long-term storage (i.e., Class VI).

The Class VI requirements are designed to promote transparency and national consistency in permitting of GS projects while also allowing flexibility, where appropriate. Many components of the rule provide flexibility by allowing the permitting authority discretion to set certain permit criteria that are appropriate to local geologic settings.

## **Greenhouse Gas Reporting**

The GHG Reporting Program was established under authority of the Clean Air Act and requires reporting of GHG emissions and other relevant information from certain source categories in the United States. The Program provides a comprehensive and transparent approach to reporting, and information obtained through subpart PP and subpart RR will enable tracking of the amount of CO<sub>2</sub> that is captured and sequestered in the United States.

### *Reporting of CO<sub>2</sub> Supply*

On October 30, 2009, U.S. EPA issued a final rule under subpart PP of the GHG Reporting Program that requires the reporting of CO<sub>2</sub> supplied to the U.S. economy. In addition to other

types of CO<sub>2</sub> suppliers, Subpart PP applies to all facilities with production process units that capture and supply CO<sub>2</sub> for commercial applications or that capture and maintain custody of a CO<sub>2</sub> stream to sequester or otherwise inject it underground. These facilities are required to report the amount of CO<sub>2</sub> in a stream captured, and provide information on the downstream CO<sub>2</sub> end use.

### *Reporting of Geologic Sequestration*

On December 1, 2010, U.S. EPA issued a final rule under subpart RR of the GHG Reporting Program that requires facilities that inject CO<sub>2</sub> underground for GS to report GHG data to U.S. EPA annually. Subpart RR covers any well or group of wells that inject a CO<sub>2</sub> stream for long-term containment in subsurface geologic formations, including all wells permitted as Class VI under U.S. EPA's UIC Program. Facilities that conduct enhanced oil and gas recovery are not required to report geologic sequestration under subpart RR unless the owner or operator chooses to opt-in to subpart RR or the facility holds a UIC Class VI permit for the well or group of wells used to enhance oil and gas recovery.

Subpart RR requires facilities that conduct GS to report basic information on CO<sub>2</sub> received for injection, to develop and implement a U.S. EPA-approved site-specific monitoring, reporting and verification (MRV) plan that is best suited for each facility, and to report the amount of CO<sub>2</sub> sequestered using a mass balance approach and annual monitoring activities. This rule is complementary to and builds on U.S. EPA's UIC permit requirements, including recently finalized requirements for Class VI injection wells.

In developing these reporting requirements, U.S. EPA took into account the 2006 IPCC guidelines for national GHG inventories, which directly address accounting for GS and include methodologies for estimating emissions from capture, transport, injection and geologic sequestration of CO<sub>2</sub>.<sup>1</sup> For geologic sequestration specifically, the U.S. EPA requirements are consistent with the IPCC guidelines' Tier 3 methodology<sup>2</sup> for estimating and reporting emissions based on site-specific evaluations of each GS site. For example, the U.S. EPA requires a comprehensive surface emissions monitoring plan (the MRV plan, described in the next section) based on the likelihood, timing, and magnitude of potential surface leakage of injected CO<sub>2</sub> (determined through site characterization and modeling). The reporter's selection of monitoring technologies must be based on the specific geology and conditions at the GS site. In addition, the monitoring plan is expected to evolve as site knowledge increases, as models are validated or updated, and to keep up to date with new monitoring methodologies.

### *Monitoring, Reporting, and Verification (MRV) Plans*

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<sup>1</sup> 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Volume 2—Energy. Chapter 5 Carbon Dioxide Transport, Injection, and Geological Storage, available at: <http://www.ipccnggip.iges.or.jp/public/2006gl/index.htm>.

<sup>2</sup> Tier 3 methods include either detailed emission models or measurements and data at individual plant level where appropriate.

Each facility that conducts GS (must develop and implement a U.S. EPA-approved site-specific MRV plan. We considered it important for all facilities conducting GS to demonstrate that they have met MRV standards. An adequate MRV plan would be tailored to site-specific conditions and be designed for each stage of the GS project. In addition, the MRV plan would allow for modification or adaptation of the plan based on monitoring results.

This site-specific flexible approach was taken for three reasons. First, each facility will have a unique set of geologic, environmental, and operational conditions that are best addressed with site-specific solutions to satisfy each MRV requirement. Second, as projects mature, reporters will collect new information and may choose to improve their conceptual site models and modify their monitoring, modeling, and evaluation techniques. Third, we recognize that the uncertainties and inherent variability in the natural systems will necessitate modifications to the selected methods and approaches over time and in response to unexpected events.

Many of the injection and monitoring technologies that may be applicable for GS are commercially available today and will be more widely demonstrated over the next few years.<sup>3</sup> While technologies for quantifying CO<sub>2</sub> surface leakage from GS sites are continuously being refined, it is generally recognized that, when properly planned and implemented, monitoring methods will be effective at detecting surface leakages. A wide range of techniques for monitoring GS have been used at GS sites as well as for a number of years in other applications, including oil and gas production, enhanced oil and gas recovery, and plant and soil science. These techniques may be used at a GS site to monitor the injected CO<sub>2</sub>, the surrounding rocks and fluids, wells and equipment, and the surface conditions.

The major components of the MRV plan<sup>4</sup> include the delineation of the areas to be monitored for surface leakage of CO<sub>2</sub>, the identification of potential surface leakage pathways for CO<sub>2</sub> in the monitoring area and the likelihood, magnitude, and timing, of CO<sub>2</sub> leakage through these pathways, and a strategy for establishing expected baselines, detecting and quantifying any surface leakage of CO<sub>2</sub>.

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<sup>3</sup> For more information on injection and monitoring technologies, see, e.g., Environmental Protection Agency, General Technical Support Document for Injection and Geologic Sequestration of Carbon Dioxide: Subparts RR and UU, Greenhouse Gas Reporting Program (Nov. 2010), available at <http://www.epa.gov/climatechange/emissions/subpart/rr.html>; J.J. Dooley, C.L. Davidson & R.T. Dahowski, "An Assessment of the Commercial Availability of Carbon Dioxide Capture and Storage Technologies as of June 2009," Joint Global Change Research Institute, Pacific Northwest National Laboratory, PNNL-18520 (2009), available at [http://www.pnl.gov/main/publications/external/technical\\_reports/PNNL-18520.pdf](http://www.pnl.gov/main/publications/external/technical_reports/PNNL-18520.pdf).

<sup>4</sup> For more information, see Environmental Protection Agency, Mandatory Reporting of Greenhouse Gases: Injection and Geologic Sequestration of Carbon Dioxide, Final Rule, 75 Fed. Reg. 75060 (Dec. 1, 2010), available at <http://www.epa.gov/climatechange/emissions/subpart/rr.html>; Environmental Protection Agency, General Technical Support Document for Injection and Geologic Sequestration of Carbon Dioxide: Subparts RR and UU, Greenhouse Gas Reporting Program (Nov. 2010), available at <http://www.epa.gov/climatechange/emissions/subpart/rr.html>.

The monitoring strategy should be designed so that potential leakage pathways are monitored in a comprehensive manner that allows for timely and accurate identification of leaks, including establishing expected baselines so that the reporter can discern whether or not the results of monitoring are attributable to surface leakage of injected CO<sub>2</sub>. The strategy for detecting CO<sub>2</sub> leakage to the surface could include taking measurements on a continuous basis, such as pressure readings in injection and monitoring wells, or continuously reading eddy covariance monitoring. The leakage detection strategy could also include regularly scheduled periodic monitoring events and surveys designed to evaluate conditions at a snapshot in time. Regularly scheduled monitoring events could include periodic sampling of water chemistry, mechanical integrity testing of injection and monitoring wells, or whole-area airborne surveys conducted at regular intervals. Given the uncertainty concerning the nature and characteristics of leaks that will be encountered, U.S. EPA expects that the CO<sub>2</sub> leakage quantification strategy in the MRV plan will provide a list of possible quantification methods and a discussion of when and how those methods might be employed for each surface leakage pathway identified during site characterization.

#### *GHG Reporting Data Elements for Geologic Sequestration*

Facilities that conduct GS must report annually the mass of CO<sub>2</sub> received for injection for the first time into a well at the facility, as well as the source of the CO<sub>2</sub> received. In addition, these facilities must submit an MRV plan to U.S. EPA, implement the U.S. EPA-approved plan, and report annually the following:

- The mass of CO<sub>2</sub> injected into the subsurface.
- The mass of CO<sub>2</sub> produced from oil or gas production wells or from other fluid wells.
- The mass of CO<sub>2</sub> emitted from surface leakage.
- The mass of CO<sub>2</sub> equipment leaks and vented CO<sub>2</sub> emissions from sources between the injection flow meter and the injection wellhead and between the production flow meter and the production wellhead.
- The mass of CO<sub>2</sub> sequestered in subsurface geologic formations, by subtracting total CO<sub>2</sub> emissions from CO<sub>2</sub> injected in the reporting year.
- The cumulative mass of CO<sub>2</sub> reported as sequestered in subsurface geologic formations in all years since the facility became subject to subpart RR.

The reporter would be required to report the annual amount of CO<sub>2</sub> sequestered at a facility using a mass balance equation, in which the sum of CO<sub>2</sub> emissions would be subtracted from the amount of CO<sub>2</sub> injected to equal the amount of CO<sub>2</sub> sequestered. Although not included in this submission, mass balance equations are provided in the Subpart RR regulatory text at 40 CFR 98.443.

## *Annual Monitoring Reports for Geologic Sequestration*

Facilities with a U.S. EPA-approved MRV plan must also submit an annual monitoring report to U.S. EPA which contains the following information:

- A narrative history of the monitoring efforts conducted over the previous calendar year, including a listing of all monitoring equipment that was operated, its period of operation, and any relevant tests or surveys that were conducted.
- A description of any changes to the monitoring program that the reporter concluded were not material changes warranting submission of a revised MRV plan.
- A narrative history of any monitoring anomalies that were detected in the previous calendar year and how they were investigated and resolved.
- A description of any surface leakages of CO<sub>2</sub>, including a discussion of all methodologies and technologies involved in detecting and quantifying the surface leakages and any assumptions and uncertainties involved in calculating the amount of CO<sub>2</sub> emitted.

### **Suggested References**

Environmental Protection Agency, Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO<sub>2</sub>) Geologic Sequestration (GS) Wells, Final Rule, 75 Fed. Reg. 77230 (Dec. 10, 2010), available at [http://water.epa.gov/type/groundwater/uic/wells\\_sequestration.cfm](http://water.epa.gov/type/groundwater/uic/wells_sequestration.cfm).

Environmental Protection Agency, Mandatory Reporting of Greenhouse Gases: Injection and Geologic Sequestration of Carbon Dioxide, Final Rule, 75 Fed. Reg. 75060 (Dec. 1, 2010), available at <http://www.epa.gov/climatechange/emissions/subpart/rr.html>.

Environmental Protection Agency, General Technical Support Document for Injection and Geologic Sequestration of Carbon Dioxide: Subparts RR and UU, Greenhouse Gas Reporting Program (Nov. 2010), available at <http://www.epa.gov/climatechange/emissions/subpart/rr.html>.

Environmental Protection Agency, Mandatory Reporting of Greenhouse Gases, Final Rule, 74 Fed. Reg. 56260 (Oct. 30, 2009), available at <http://www.epa.gov/climatechange/emissions/ghgrulemaking.html>.

Report of the Interagency Task Force on Carbon Capture and Storage (2010), available at [http://www.epa.gov/climatechange/policy/ccs\\_task\\_force.html](http://www.epa.gov/climatechange/policy/ccs_task_force.html).