Specifications

for the Application of the United Nations Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009)

to Injection Projects for the Purpose of Geological Storage

Done in Geneva, 30 September 2016

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Document prepared by the Task Force on Application of UNFC-2009 to Injection Projects

Summary

This document provides the Specifications for the Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) incorporating Specifications for its Application (as set out in ECE Energy Series No. 42, ECE/ENERGY/94), to Injection Projects for the purpose of Geological Storage. The document was prepared by the Task Force on Application of UNFC-2009 to Injection Projects of the United Nations Economic Commission for Europe (UNECE) Expert Group on Resource Classification. Following review by the Expert Group at its sixth session in April 2015, the draft text was issued for public comment from 8 July to 15 September 2015 and subsequently revised based on the feedback received.

The main focus of the document is on classifying Injection Projects related to the geological storage of carbon dioxide. The same principles of project maturity should however also be applicable to other injection projects where a fluid is injected into a subsurface geological formation for storage.

The Specifications were endorsed by the UNECE Committee on Sustainable Energy at its twenty-fifth session, Geneva, 30 September 2016.

Preface

The 2009–2010 work plan of the Expert Group on Resource Classification included an agreement to explore how the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) could be used to classify injection projects (e.g., carbon dioxide (CO_2) storage and natural gas storage). A small Task Force of volunteers was established in early 2011 to work on this issue. Draft Specifications for the Application of UNFC-2009 to Injection Projects were first presented to the Expert Group at its sixth session in 2015 (ECE/ENERGY/GE.3/2015/4). The draft text was issued for public comment from 8 July to 15 September 2015. The Specifications were subsequently revised in response to the comments received. An accompanying document was prepared summarizing the comments received and how the Task Force responded to them (EGRC-7/2016/INF.2). The revised draft Specifications were then submitted to the Expert Group for review at its seventh session (26–29 April 2016). Following review, the Expert Group recommended that the draft Specifications be submitted to the Committee on Sustainable Energy for endorsement.

The initial and main focus of the Specifications is on classifying injection projects related to the geological storage of CO_2, but they could also be applied to other types of injection projects for storage in geological formations, for example natural gas. Geological CO_2 storage in the context of carbon capture and storage (CCS) refers to the containment of CO_2 in deep subsurface geological "reservoirs", with the purpose of isolating the CO_2 emissions from the atmosphere.

The Expert Group on Resource Classification has noted that this work is important for the future development of CCS. A reliable estimate of CO_2 storage capacity is a vital aspect of site selection.

Acknowledgements

The development of these Specifications was undertaken by the Task Force on the Application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) to Injection Projects. The Task Force is a sub-group of the United Nations Economic Commission for Europe (ECE) Expert Group on Resource Classification. The Task Force comprises the following expert volunteers: Karin Ask (Chair), Michelle S. Bentham, Simplicio Caluyong, Benjamin Court, Scott Frailey, Eva Halland, Wolf Heidug, Martin Hubbig and Lesley R. Seldon.

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Contents

I. Introduction

1. The purpose of this document is to enable the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009), incorporating Specifications for its Application (as set out in ECE Energy Series No. 42 and ECE/ENERGY/94), to Injection Projects for the purpose of Geological Storage.

2. The main focus in this document is on classifying Injection Projects related to Geological Storage of carbon dioxide (CO_2). The same principles of project maturity should however also be applicable to other injection projects where a fluid is injected into a subsurface geological formation for storage.

3. UNFC-2009 classifies quantities associated with projects. It was originally developed to classify fossil energy and mineral reserves and resources located on or below the Earth's surface. Resource classification is used in the oil and gas industry as well as the mining industry to assess the commercial attractiveness of different extraction projects. Each project is associated with a certain quantity that can be extracted, given a defined technical solution and a certain investment. Projects can be of different size and have different degree of maturity.

4. For Injection Projects for the purpose of Geological Storage, the resource is the reservoir available for geological storage. The quantity that is classified is the quantity of a given fluid, such as CO_2, that can be stored in this reservoir by implementing an Injection Project.

5. Text that has been kept unaltered from UNFC-2009 incorporating Specifications for its Application is marked in this document with a grey highlighter for clarity.

6. The intended use of this document is in conjunction with UNFC-2009 and its Generic Specifications.

II. UNFC-2009 as applied to Injection Projects

A. Categories and Sub-categories

7. In Part I of UNFC-2009, the categories and sub-categories of the classification system are described as follows:

8. *"UNFC-2009 is a generic principle-based system in which quantities are classified on the basis of the three fundamental criteria of economic and social viability (E), field project status and feasibility (F), and geological knowledge (G), using a numerical coding system. Combinations of these criteria create a three-dimensional system. Categories (e.g. E1, E2, E3) and, in some cases, sub-categories (e.g. E1.1) are defined for each of the three criteria as set out and defined in Annexes I and II.*

9. *The first set of categories (the E axis) designates the degree of favourability of social and economic conditions in establishing the commercial viability of the project, including consideration of market prices and relevant legal, regulatory, environmental and contractual conditions. The second set (the F axis) designates the maturity of studies and commitments necessary to implement mining plans or development projects. These extend from early exploration efforts before a deposit or accumulation has been confirmed to exist through to a project that is extracting and selling a commodity, and reflect standard value chain management principles. The third set of categories (the G axis) designates the level of confidence in the geological knowledge and potential recoverability of the quantities.*

10. *The categories and sub-categories are the building blocks of the system, and are combined in the form of "classes". UNFC-2009 can be visualized in three dimensions, or represented in a practical two-dimensional abbreviated version as shown in Figure 1."*

11. Definitions and supporting explanations for the different categories and sub-categories can be found in Part IV of this document. Minor changes have been made to the Explanations to facilitate the application to Injection Projects for the purpose of Geological Storage or to other forms of Underground Gas Storage, while keeping it as close to the original UNFC-2009 explanatory text as possible.

B. Classes and sub-classes

12. Figure 1 shows UNFC-2009, in its abbreviated version with primary classes and categories, adapted for application to Injection Projects for the purpose of Geological Storage. The classes and categories are the same as for extractive activities.

13. The Total Geological Storage is classified at a given date in terms of the following:

(a) Injected and Stored quantities: Quantities of a fluid that have been injected and are currently stored in the reservoir. Projects at this stage may still require activities such as monitoring of any fluid movements, making sure that there is reasonable confidence that the injected fluid is retained in the reservoir

(b) Lost quantities: Quantities that may be delivered to the injection site but which are lost in the transportation or surface facilities prior to injection. Equivalent to non-sales production.

(c) Commercial and Potentially Commercial Projects: Geological storage associated with a known reservoir where injection for the purpose of geological storage is ongoing or which may be used for storage in the future. The classification is based on technical and commercial studies related to defined injection activities.

(d) Non-Commercial Injection Projects: Additional geological storage associated with a known reservoir that will not be used for storage by any currently defined injection project.

(e) Screening Projects: Geological storage associated with an undiscovered reservoir that may be used for storage in the future provided that the reservoir is confirmed;

(f) Storage not feasible: Reservoir which will not be available for storage or where storage is for some reason not feasible.

14. As for extractive activities, additional generic sub-classes are also defined based on the Injection Projects sub-categories defined in section IV of this document.

15. Classifications other than the ones shown in Figure 2 on page 7 can be generated by choosing appropriate combinations of categories, or by grouping or further subdividing the categories.

III. Injection Projects Definitions

A. Geological Storage

16. The term Geological Storage refers mainly to permanent containment of carbon dioxide (CO_2) in subsurface geological formations, here referred to as reservoirs, with the purpose of isolating CO_2 emissions from the atmosphere. The storage reservoir can be for instance a depleted oil and gas reservoir or a saline aquifer. The application of UNFC-2009

described in this document has been developed primarily with Geological Storage of CO_2 in mind, but can also be applied to other forms of injection projects where fluids are stored in geological formations.

17. Underground storage of hydrogen is sometimes referred to as Geological Hydrogen Storage. As hydrogen storage is likely to be temporary rather than permanent, this is more comparable to Underground Gas Storage as described below.

18. Natural gas is often held in inventory underground. The most commonly used underground facilities are depleted reservoirs in oil and gas fields, aquifers and salt caverns. The main difference between such storage and Geological Storage of CO_2, apart from the fluid itself, is that the natural gas is only temporarily stored and will at some point be withdrawn from the reservoir. The storage reservoir can be used repeatedly for temporary storage and subsequent withdrawal. Several different quantity measures will be associated with such storage. The total quantity that can be stored will be the sum of the quantity that is currently in storage and can be withdrawn (often referred to as working gas), the quantity of permanent inventory gas necessary to maintain sufficient pressure for withdrawal purposes (base gas or "cushion" gas), and the quantity currently available for storage.

19. When an Underground Gas Storage is developed, the technical and economical maturity of the project activities associated with it can be classified according to the principles of UNFC-2009 as outlined in this document. The different quantities associated with the classified projects should always be clearly stated.

20. CO_2, nitrogen or natural gas is sometimes injected into a producing oil field in order to increase the amount of hydrocarbons that can be extracted. The resulting hydrocarbon resources can be classified using UNFC-2009 as it is defined for extractive activities.

Figure 1

Abbreviated version of UNFC-2009 with primary classes and categories adapted for application to injection projects for the purpose of geological storage

UNFC-2009 Classes Defined by Categories as Applied to Injection Projects for the Purpose of Geological Storage					
Total Geological Storage	**Injected and Stored Quantities**				
	Lost Quantities[a]				
		Class	**Categories**		
			E	F	G[b]
	Future storage by commercial injection projects	Commercial Injection Projects[c]	1	1	1, 2, 3
	Future storage in known reservoirs by injection projects	Potentially Commercial Injection Projects[d]	2[e]	2	1, 2, 3
		Non-Commercial Injection Projects[f]	3	2	1, 2, 3
	Storage Not Feasible[g]		3	4	1, 2, 3
	Potential future storage in undiscovered reservoirs by injection projects	Screening Projects	3	3	4
	Storage Not Feasible[g]		3	4	4

[a] Losses and leaks during transportation or in the surface facilities prior to injection.

[b] G categories may be used discretely, or in cumulative (e.g. G1+G2), as is commonly applied for recoverable fluids.

[c] Commercial Projects have been confirmed to be technically, economically and socially feasible. Quantities associated with Commercial Projects are defined in many classification systems as Reserves, but there are some material differences between the specific definitions that are applied within the extractive industries and hence the term is not used here.

[d] Potentially Commercial Projects are expected to be developed in the foreseeable future, in that the quantities are assessed to have reasonable prospects for eventual economic injection, but the technical and/or commercial feasibility has not yet been confirmed. Consequently, not all Potentially Commercial Projects may be developed.

[e] Potentially commercial projects may satisfy the requirements for E1.

[f] Non-commercial projects include those that are at an early stage of evaluation in addition to those that are considered unlikely to become commercially feasible developments within the foreseeable future.

[g] Can include parts of a reservoir where storage is currently not feasible, but where it may become feasible in the future as technological developments occur. Depending on the fluid injected and the applied technology, some or all of these quantities may never be used for storage due to physical and/or chemical constraints.

Figure 2

UNFC-2009 classes and sub-classes defined by sub-categories, adapted for application to injection projects for the purpose of geological storage[a]

UNFC-2009 Classes Defined by Categories and Sub-Categories as Applied to Injection Projects						
Total Geological Storage	**Injected and Stored Quantities**					
	Lost Quantities					
	Class		**Sub-class**	**Categories**		
				E	F	G
	Known Reservoir	Commercial Injection Projects	Active Injection	1	1.1	1, 2, 3
			Approved for Development	1	1.2	1, 2, 3
			Justified for Development	1	1.3	1, 2, 3
		Potentially Commercial Injection Projects	Development Pending	2[b]	2.1	1, 2, 3
			Development on Hold	2	2.2	1, 2, 3
		Non-Commercial Injection Projects	Development Unclarified	3.2	2.2	1, 2, 3
			Development not Viable	3.3	2.3	1, 2, 3
		Storage Not Feasible		3.3	4	1, 2, 3
	Undiscovered Reservoir	Screening Projects	Geological Storage Identified	3.2	3.1[c]	4
			Geological Storage Indicated	3.2	3.2[c]	4
			Geological Storage Inferred	3.2	3.3[c]	4
		Storage Not Feasible		3.3	4	4

[a] Refer also to notes for Figure 1.

[b] Development Pending projects may satisfy the requirements for E1.

[c] Sub-categories have been defined specifically for application to injection projects to facilitate differentiation of screening projects at different stages of evaluation.

21. When geological storage of the injected CO_2 is part of the objective of an increased recovery project, the stored quantities can be classified in the same way, applying UNFC-2009 as described in this document. The geological storage part of the project is likely to be developed in parallel with the hydrocarbon recovery part, and the two activities will in this case have the same level of maturity, but with two different types of quantities associated with it; the quantities that will be extracted and the quantities that will be stored.

22. The Total Geological Storage of a reservoir is the total amounts of a given fluid that could be injected and stored in this reservoir, including amounts that could be dissolved in aquifer water, be trapped by chemical reaction or adsorbed onto the carbon in coal bed methane recovery. How much of the Total Geological Storage initially in place will eventually be utilized for geological storage, will depend on the specifics of the individual projects that are classified.

B. Defining the Project

23. UNFC-2009 classifies quantities associated with projects. The injection project typically includes injection wells, monitoring wells, surface equipment, injection flow lines, and an operations control centre. The project may include pressure relief wells and produced fluid processing equipment. Depending on the location of the custody transfer, a delivery pipeline may be included in the injection project.

24. One or more injection wells may be required to store a projected rate and quantity of fluid. The monitoring well(s) may be within the storage unit and/or above the overlying cap rock or seal. The surface equipment may include injection lines and manifolds (and associated valves), a metre, and a pump or compressor (if needed to increase pipeline delivery pressure to injection wellhead pressure). An operations control centre may be at the injection site and/or remotely and is used to monitor and control injection operations.

25. The project should include estimates of storage quantities and injection rates. The reservoir, or the geologic formation planned to be used for storage and the respective overlying cap rock, should be characterized to meet the project goals. Projections of investments and other costs as well as revenue from storage should be estimated.

26. Once a project has been defined, UNFC-2009 can be used to classify the quantities stored according to the technical and economical maturity of the defined project activities.

C. Quantities Stored

27. In this document, the term Quantity refers to the quantity of a given fluid that could be stored in the reservoir being evaluated, given a defined project activity and a certain investment. CO_2 storage quantities are typically quoted in mass. The quantitative evaluation shall take into account both the geological knowledge of the subsurface at the time of the evaluation, and the engineering considerations relating to the reservoir properties as well as the chosen technical solution and the socio-economic conditions governing the project. The quantity will also depend on the composition of the stored fluid, which should be given with the storage quantity. The quantity stored in one reservoir may be the aggregated quantities from several sources, from one single source or part of the total quantity from one source.

D. Development Plan

28. In order for a project to be approved for development, a Plan for Development of the injection site and its operation must be prepared. The Development Plan typically includes timeline, design elements, and economics for the injection project. It is often part of a larger integrated project including capturing the fluid and transporting it to the injection site. The timeline should include lead time for equipment, drilling and completing wells, and for characterizing the reservoir as well as acquiring necessary injection permits and managements approval. The design elements should include well locations, completion techniques, drilling methods, site facilities (as needed), transportation, and the source and type of injection fluid. Economic evaluations should include source of revenue, as well as capital and operating expenses for the full Project Life Time. The duration of the availability of the injection fluids should be known. A risk assessment should always be part of the development plan.

E. Project Life Time

29. Feasibility of an injection project for the purpose of Geological Storage comprises two components;

(i) The injection of fluid and

(ii) The retention of the injected fluid through one or more trapping mechanisms.

30. An injection project will need to include activities also after the active injection has ceased, such as monitoring of any fluid movements and making sure that there is reasonable confidence that the injected fluid is retained in the reservoir. How this will affect the total life time of the project will depend on the specifics of the project, the reservoir, the injected fluid and the prevailing rules and regulations.

31. When an injection project is classified as technically and economically feasible according to UNFC-2009, the evaluation shall comprise the complete Project Life Time.

F. Economic Viability

32. In UNFC-2009, the phrase "Economically viable" encompasses economic factors (in the narrow sense) plus other relevant "market conditions", and includes consideration of prices, costs, legal/fiscal frameworks, environmental, social and all other non-technical factors that could directly impact the viability of a development project. This definition is highly relevant also for geologic storage projects, where the strictly economic feasibility of a project may depend on government subsidies or other incentives. Classifying a geologic storage project as Economically Viable within UNFC-2009 requires that all relevant non-technical factors have been considered.

G. Storage Permission

33. Geological storage of CO_2, or storage of other fluids in subsurface geological formations, may be subject to different local, national and/or international regulations and requirements. Within the European Union (EU), CO_2 storage sites should not be operated without a Storage Permit. Such permits may be given independently by the EU Member States, and should be issued by an established or designated competent authority. All Storage Permits should also be made available to the Commission. Other regulations may be relevant in other parts of the world.

34. In order for an injection project to be classified as Economically Viable according to UNFC-2009, all required Storage Permits or other relevant permits must be in place, or there must be reasonable expectations that such permits will be in obtained within a reasonable time frame.

IV. Definition of Categories and Sub-Categories with supporting explanations

35. Figures 3 and 4 show the definitions from UNFC-2009, and a revised version of the same definitions as well as supporting explanations adapted for application of UNFC-2009 to injection projects for the purpose of geological storage.

(a) "Extraction and sale" has been replaced with "Injection for the purpose of geological storage";

(b) "Screening phase" includes all projects where the existence of a reservoir available for Geological Storage has not yet been confirmed (undiscovered reservoirs)

Figure 3

Definition of categories and supporting explanations adapted for application of UNFC-2009 to injection projects for the purpose of geological storage

	UNFC-2009	*UNFC-2009 applied to Injection Projects for the purpose of Geological Storage*	
Category	**Definition**	**Definition**	**Supporting Explanation**
E1	*Extraction and sale has been confirmed to be economically viable.*	Injection for the purpose of geological storage has been confirmed to be economically viable [a].	Injection is economic on the basis of current market conditions and realistic assumptions of future market conditions. All necessary approvals/contracts have been confirmed or there are reasonable expectations that all such approvals/contracts will be obtained within a reasonable time frame. Economic viability is not affected by short-term adverse market conditions provided that longer term forecasts remain positive.
E2	*Extraction and sale is expected to become economically viable in the foreseeable future*[b].	Injection for the purpose of geological storage is expected to become economically viable[a] in the foreseeable future[b].	Injection has not yet been confirmed to be economically viable but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic injection and storage in the foreseeable future[b].
E3	*Extraction and sale is not expected to become economically viable in the foreseeable future*[b]*, or the evaluation is at too early a stage to determine economic viability.*	Injection for the purpose of geological storage is not expected to become economically viable[a] in the foreseeable future[b], or the evaluation is at too early a stage to determine economic viability[a].	On the basis of realistic assumptions of future market or other socio-economic conditions, it is currently considered that there are not reasonable prospects for economic injection in the foreseeable future[b]; or, economic viability of injection cannot yet be determined due to insufficient information (e.g. during the screening phase).

[a] The phrase "economically viable" encompasses economic (in the narrow sense) plus other relevant "market conditions", and includes consideration of prices, costs, legal/fiscal framework, environmental, social and all other non-technical factors that could directly impact the viability of a development project.

[b] "Foreseeable future" is a time frame within which an injection project for the purpose of geological storage has reasonable prospects for becoming technically and commercially feasible.

	UNFC-2009	*UNFC-2009 applied to Injection Projects for the purpose of Geological Storage*	
Category	**Definition**	**Definition**	**Supporting Explanation**
F1	*Feasibility of extraction by a defined development project or mining operation has been confirmed.*	Feasibility of an injection project for the purpose of geological storage has been confirmed.	Injection is currently taking place; or, implementation of an injection project is underway; or, sufficiently detailed studies have been completed to demonstrate the feasibility of geological storage by implementing a defined injection project.
F2	*Feasibility of extraction by a defined development project or mining operation is subject to further evaluation.*	Feasibility of an injection project for the purpose of geological storage is subject to further evaluation.	Preliminary studies demonstrate the existence of a Reservoir in such form, quality and quantity that the feasibility of geological storage by a defined injection project can be evaluated. Further data acquisition and/or studies may be required to confirm the feasibility of injection for the purpose of geological storage.
F3	*Feasibility of extraction by a defined development project or mining operation cannot be evaluated due to limited technical data.*	Feasibility of an injection project for the purpose of geological storage cannot be evaluated due to limited technical data.	Very preliminary studies (screening phase), which may be based on a defined injection project, indicate the need for further data acquisition and/or further geological studies in order to confirm the existence of a reservoir in such form, quality and quantity that the feasibility of injection for the purpose of geological storage can be evaluated.
F4	*No development project or mining operation has been identified.*	No injection project for the purpose of geological storage has been identified.	Reservoir which may be suitable for injection for the purpose of geological storage but which will not be utilised by any currently defined injection project.
G1	*Quantities associated with a known deposit that can be estimated with a high level of confidence.*	Quantities associated with a known reservoir that can be estimated with a high level of confidence.	The G-axis represents the level of confidence in the estimated quantities of a fluid that can be stored in the reservoir through a defined injection project. The quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the reservoir. The estimates are categorised as G1, G2 and/or G3 as appropriate. The quantities that can be stored should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	*Quantities associated with a known deposit that can be estimated with a moderate level of confidence.*	Quantities associated with a known reservoir that can be estimated with a moderate level of confidence.	
G3	*Quantities associated with a known deposit that can be estimated with a low level of confidence.*	Quantities associated with a known reservoir that can be estimated with a low level of confidence.	
G4	*Estimated quantities associated with a potential deposit, based on primary or indirect evidence.*	Estimated quantities associated with a potential reservoir, based on primary or indirect evidence.	Undiscovered storage quantities that are estimated during the screening phase. Normally subject to a substantial range of uncertainty as well as a major risk that no injection project may be implemented.

[c]A defined injection project comprises both the active injection phase and the retention phase, i.e. the full Project Life Time until there is reasonable confidence that the injected fluid is retained in the reservoir or has been extracted.

36. The UNFC-2009 Sub-Categories and definitions have been revised as shown in Figure 4 for application to Injection projects for the purpose of Geological Storage.

Figure 4
UNFC-2009 sub-categories with definitions adapted for application to Injection Projects for the purpose of Geological Storage

Category	*Sub-Category*	*Sub-Category Definition*
E1	E1.1	Injection for the purpose of geological storage is economic on the basis of current market conditions and realistic assumptions of future market conditions.
	E1.2	Injection for the purpose of geological storage is not economic on the basis of current market conditions and realistic assumptions of future market conditions, but is made viable through government subsidies and/or other considerations.
E2		*No sub-categories defined*
E3	E3.1	Injection losses. Quantities that may be delivered to the injection site but which are lost in the transportation of surface facilities prior to injection. Equivalent to non-sales production.
	E3.2	Economic viability of injection for the purpose of geological storage cannot yet be determined due to insufficient information (e.g. during the exploration/screening phase).
	E3.3	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic injection for the purpose of geological storage in the foreseeable future.
F1	F1.1	Injection for the purpose of geological storage is currently taking place.
	F1.2	Capital funds have been committed and implementation of an injection project for the purpose of geological storage is underway.
	F1.3	Sufficiently detailed studies have been completed to demonstrate the feasibility of an injection project for the purpose of geological storage.
F2	F2.1	Project activities are on-going to justify injection for the purpose of geological storage in the foreseeable future.
	F2.2	Project activities are on hold and/or where justification as a commercial injection project for the purpose of geological storage may be subject to significant delay.
	F2.3	There are no current plans to develop or to acquire additional data at the time due to limited potential.

V. Generic Specifications

37. In these generic specifications, the following words have specific meanings:

- "Shall is used where a provision is mandatory
- "Should" is used where a provisions is preferred; and
- "May" is used where alternatives are equally acceptable.

38. When a specification is equally valid for injection projects and extraction projects, the original text from the Generic Specification for the Application of UNFC-2009 has been kept unaltered. In other cases, the text has been modified to better suit the purpose of classifying Injection projects for the purpose of Geological Storage.

39. Where a generic specification is defined below, this sets a minimum standard for reporting under UNFC-2009. However, if a specification for the same issue exists in an Aligned System, and it fully meets the requirements of the generic specification defined below, that specification may be adopted. (Currently, no other system for classifying Injection Projects has been aligned with UNFC-2009.)

A. Use of numerical codes

40. While the defined Classes and Sub-classes shown in Figures 2 and 3 of Part I of UNFC-2009 may be used as supplementary terminology, the relevant Numerical Code(s) shall always be reported in conjunction with the estimated quantity. For example, these may be documented in the form 111, 111+112, or 1.1;1.2;1, as appropriate.

41. Note that some Sub-categories are defined below that are in addition to those provided in Annex II of UNFC-2009. These optional Sub-categories have been identified as potentially useful in certain situations and have been defined herein in order to ensure consistency in their application. Nothing in this document shall preclude the possible use of additional Sub-classes in the future that may be deemed to be useful in particular cases, especially where such Sub-classes facilitate the linkage to other systems and which may be defined in Bridging Documents.

B. Bridging document

42. Application of UNFC-2009 to extraction projects requires reference to a Bridging Document for the relevant commodity-specific specifications. The Bridging Document that was used as the basis for the evaluation shall be disclosed in conjunction with the reported quantities. There is currently no other universally accepted classification system for injection projects for the purpose of geological storage, for which a Bridging Document can be prepared. UNFC-2009 can still be applied to injection projects as described in this document.

C. Effective date

43. Reported quantities are estimates of remaining quantities as at the Effective Date of the evaluation. The Effective Date shall be clearly stated in conjunction with the reported quantities. The evaluation should take into account all data and information available to the evaluator prior to the Effective Date. If information becomes available subsequent to the Effective Date, but prior to reporting, that could have significantly changed the estimated quantities as at the Effective Date, the likely effect of this information shall be disclosed.

D. Commodity or product type

44. For extraction projects, estimated quantities should be reported separately for each commodity or significant product type that will be sold, used, transferred or disposed of separately. When UNFC-2009 is applied to injection projects, only one fluid is normally expected to be stored in the same reservoir. When this fluid comes from more than one source, it may be relevant to report quantities separately for separate sources.

45. If UNFC-2009 is applied to Underground Gas Storage projects, it may be relevant to report different quantities such as total storage, working gas and base gas separately.

E. Basis for estimate

46. Reported quantities may be those quantities attributable to the injection project as a whole, or may reflect the proportion of those quantities that is attributable to the reporting entity's economic interest in the injection project. The reporting basis shall be clearly stated in conjunction with the reported quantities.

F. Reference point

47. The Reference Point is a defined location within an injection operation at which the reported quantities are measured or estimated. The Reference Point may be the custody transfer point from a pipeline operator to a storage site operator, or the last metered quantity prior to injection. The Reference Point shall be disclosed in conjunction with the reported quantities. Where the Reference Point is not the point where custody is transferred to the storage site (or the entity's downstream operations), and such quantities are classified as E1, the information necessary to derive estimated quantities shall also be provided.

G. Classification of projects based on level of maturity

48. Where it is considered appropriate or helpful to sub-classify projects to reflect different levels of project maturity, based on the current status of the project, the optional Sub-classes shown in Figure 3 of UNFC-2009 (Part I) may be adopted for reporting purposes. Additional guidance on the distinction between the Sub-classes of UNFC-2009 is provided in Annex V of Part II of the same document. Sub-category definitions for application to injection projects for the purpose of geologic storage are provided in Part III of this document.

H. Distinction between E1, E2 and E3

49. The distinction between quantities that are classified on the Economic axis as E1, E2 or E3 is based on the phrase "reasonable prospects for economic injection for the purpose of geological storage in the foreseeable future". The definition of "foreseeable future" can vary depending on the stored fluid.

50. The Economic axis Categories encompass all non-technical issues that could directly impact the viability of a project, including commodity prices, operating costs, legal/fiscal framework, environmental regulations and known environmental or social impediments or barriers. Any one of these issues could prevent a new project from proceeding (and hence quantities would be classified as E2 or E3, as appropriate), or it could lead to the suspension or termination of injection activities in an existing operation. Where injection activities are suspended, but there are "reasonable prospects for economic injection and

storage in the foreseeable future", remaining technically available storage quantities shall be reclassified from E1 to E2. Where "reasonable prospects for economic injection and storage in the foreseeable future" cannot be demonstrated, remaining storage shall be reclassified from E1 to E3.

I. Confidence levels for G1, G2 and G3

51. The level of confidence for quantities that are classified on the Geological axis as G1, G2 and G3 is defined as "high", "medium" and "low", respectively. These are not specified more precisely at a generic level because there are fundamental differences between the approaches that are appropriate for fluids stored, as discussed in the Supporting Explanation to the definitions of these Categories above.

J. Distinction between Quantities Stored and Total Geological Storage

52. Other than quantities that are classified on the Feasibility axis as F4 (Storage Not Feasible), all reported quantities shall be limited to those quantities that can potentially be injected on the basis of existing technology or technology currently under development, and are associated with actual or possible future injection projects. In the absence of any consideration of potential economic injection, for instance during a screening phase, all reported quantities shall be classified as F4.

K. Aggregation of quantities

53. Estimated quantities associated with injection projects and geological storage operations that are classified in different Categories on the Economic or Feasibility axis shall not be aggregated with each other without proper justification and disclosure of the methodology adopted. In all cases, the specific Classes that have been aggregated shall be disclosed in conjunction with the reported quantity (e.g. 111+112+221+222) and a footnote added to highlight the fact that there is a risk that Projects that are not classified as E1F1 (Commercial Projects) may not eventually achieve commercial operation.

54. Where estimated quantities have been aggregated from multiple projects, consideration should be given to sub-dividing the aggregated totals by reservoir and by location.

L. Economic assumptions

55. In accordance with the definitions of E1, E2 and E3, economic assumptions shall be based on current market conditions and realistic assumptions of future market conditions. Except where constrained by regulation, assumptions of future market conditions should reflect the view of either:

(a) The organization responsible for the evaluation;

(b) The view of a competent person or independent evaluator; or,

(c) An externally published independent view, which is considered to be a reasonable forecast of future market conditions. The basis for the assumptions (as opposed to the actual forecast) shall be disclosed.

M. Evaluator qualifications

56. Evaluators must possess an appropriate level of expertise and relevant experience in the estimation of quantities associated with the type of reservoir and injection project under evaluation.

N. Units and conversion factors

57. In order to facilitate global comparability of storage estimates, it is recommended that the Système International d'Unités (SI units) is used for reporting of resource quantities. However, it is recognized that there are traditional measurement units that are widely used and accepted for certain commodities; where such units are used for reporting purposes, conversion factors to SI units shall be provided. Similarly, where quantities are converted from one unit to another, the conversion factors applied shall be disclosed.

O. Documentation

58. Estimated quantities shall be documented in sufficient detail that would allow an independent evaluator or auditor to clearly understand the basis for estimation of the reported quantities and their classification.

P. Expansion of G4 to account for uncertainty

59. In some situations, it may be helpful to express a range of uncertainty for quantities that are classified on the Geological axis as G4, e.g. Screening Projects. In such cases, the following specification shall apply:

(a) G4.1: low estimate of the quantities;

(b) G4.2: incremental amount to G4.1 such that G4.1+G4.2 equates to a best estimate of the quantities;

(c) G4.3: incremental amount to G4.1+G4.2 such that G4.1+G4.2+G4.3 equates to a high estimate of the quantities.

60. Category G4, when used alone, shall reflect the best estimate and is equal to G4.1+G4.2.

Q. Optional labels for estimates

61. Where it is considered appropriate or helpful to use labels in addition to the numerical codes for a range of estimates for a specific Injection Project, the terms "Low Estimate", "Best Estimate" and "High Estimate" may be used to correspond to quantities that are classified on the Geological axis as G1, G1+G2 and G1+G2+G3 respectively.

R. Classification of quantities associated with Screening Projects

62. In some situations, it may be helpful to sub-classify Screening Projects on the basis of their level of maturity. In such cases, the following specification shall apply:

(a) F3.1: where site-specific geological studies and screening activities have identified the potential for an individual reservoir with sufficient confidence to warrant

drilling or testing that is designed to confirm the existence of that reservoir in such form, quality and quantity that the feasibility of injection and geological storage can be evaluated;

(b) F3.2: where local geological studies and screening activities indicate the potential for one or more reservoirs in a specific part of a geological province, but requires more data acquisition and/or evaluation in order to have sufficient confidence to warrant drilling or testing that is designed to confirm the existence of a reservoir in such form, quality and quantity that the feasibility of injection and geological storage can be evaluated;

(c) F3.3: at the earliest stage of exploration activities, where favourable conditions for the potential discovery of storage reservoirs in a geological province may be inferred from regional geological studies.

S. Classification of additional quantities available for geological storage

63. In some situations, it may be helpful to sub-classify projects where storage is currently not feasible (F4) on the basis of the current state of technological developments. In such cases, the following specification shall apply:

(a) F4.1: the technology necessary to store some or all of the these quantities is currently under active development, following successful pilot studies on other reservoirs, but has yet to be demonstrated to be technically feasible for the style and nature of reservoir in question;

(b) F4.2: the technology necessary to store some or all of the these quantities is currently being researched, but no successful pilot studies have yet been completed;

(c) F4.3: the technology necessary to store some or all of these quantities is not currently under research or development.

T. Quantities delivered for injection and storage that may not be stored

64. The Sub-categories of E3 permit a distinction to be made between those quantities that may be forecasted to be available for injection in the future, but which may not be stored due to for instance losses or leaks in the transportation or surface facilities (E3.1), and those for which there are no reasonable prospects for economic injection and geological storage in the foreseeable future (E3.3). These are defined in Figure 4. Historical losses and leaks in active injection projects are referred to as “Lost quantities” (Figures 1 and 2) are also included to ensure that the classification can embrace all quantities delivered for storage both historically and in the future.

Annex

Glossary of Terms

Term	*Definition*
Aligned System	A classification system that has been aligned with UNFC-2009 as demonstrated by the existence of a Bridging Document that has been endorsed by the Expert Group on Resource Classification.
Bridging Document	A document that explains the relationship between UNFC-2009 and another classification system, including instructions and guidelines on how to classify estimates generated by application of that system using the UNFC-2009 Numerical Codes.
Category	Primary basis for classification using each of the three fundamental Criteria of economic and social viability (related Categories being E1, E2, and E3), field project status and feasibility (related Categories being F1, F2, F3 and F4), and geological knowledge (related Categories being G1, G2, G3 and G4). Definitions of Categories are provided in Annex I to UNFC-2009.
Class(es)	Primary level of resource classification resulting from the combination of a Category from each of the three Criteria (axes).
Complementary Texts	Additional texts to provide mandatory requirements (i.e. Specifications) and further guidance regarding the application of UNFC-2009. (This Specifications Document is an example of a complementary text.)
CRIRSCO Template	The CRIRSCO Template of 2013 is the system developed by the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) for solid minerals and, for the purposes of this Specifications Document, includes the reporting codes and standards that are aligned with it.
Criteria	UNFC-2009 utilizes three fundamental Criteria for reserve and resource classification: economic and social viability; field project status and feasibility; and, geological knowledge. These Criteria are each subdivided into Categories and Sub-categories, which are then combined in the form of Classes or Sub-classes.
Evaluator	Person, or persons, performing resource estimation and/or classification.
Exploration Projects	A Project that is associated with one or more Potential Deposits (as defined below).
Generic Specifications	Specifications (as documented in this Specifications Document) that apply to the classification of quantities of any commodity using UNFC-2009.
Known Deposit	A deposit that has been demonstrated to exist by direct evidence. More detailed specifications can be found in relevant commodity-specific Aligned Systems.

Term	*Definition*
Known Reservoir	A reservoir that has been demonstrated to exist by direct evidence.
Mapping Document	The output of a comparison between another resource classification system and UNFC-2009, or between that system and existing Aligned Systems, which highlights the similarities and differences between the systems. A Mapping Document can provide the basis for assessing the potential for the other system to become an Aligned System through the development of a Bridging Document.
Numerical Code	Numerical designation of each Class or Sub-class of resource quantity as defined by UNFC-2009. Numerical Codes are always quoted in the same sequence (i.e. E;F;G).
Porosity	The ratio of the aggregated volume of interstices in a rock to its total volume. Usually stated as a percentage.
Potential Deposit	A deposit that has not yet been demonstrated to exist by direct evidence (e.g. drilling and/or sampling), but is assessed as potentially existing based primarily on indirect evidence (e.g. surface or airborne geophysical measurements). More detailed specifications can be found in relevant commodity-specific Aligned Systems.
Potential Reservoir	A reservoir that has not yet been demonstrated to exist by direct evidence (e.g. drilling and/or sampling), but is assessed as potentially existing based primarily on indirect evidence (e.g. surface or airborne geophysical measurements).
PRMS	Petroleum Resources Management System of 2007 (PRMS), which was approved by the Society of Petroleum Engineers (SPE) Board in March 2007 and endorsed by the World Petroleum Council (WPC), the American Association of Petroleum Geologists (AAPG), the Society of Petroleum Evaluation Engineers (SPEE) and the Society of Exploration Geophysicists (SEG).
Project	A Project is a defined development or mining operation which provides the basis for economic evaluation and decision-making. In the early stages of evaluation, including exploration, the Project might be defined only in conceptual terms, whereas more mature Projects will be defined in significant detail. Where no development or mining operation can currently be defined for all or part of a deposit, based on existing technology or technology currently under development, all quantities associated with that deposit (or part thereof) are classified in Category F4.
Reservoir	A subsurface body of rock with sufficient porosity and permeability to store and transmit fluids and characterized by a hydraulically connected pressure system.

Term	*Definition*
Specifications	Additional details (mandatory rules) as to how a resource classification system is to be applied, supplementing the framework definitions of that system. Generic Specifications provided for UNFC-2009 in this Specifications Document ensure clarity and comparability and are complementary to the commodity-specific requirements included in Aligned Systems, as set out in the relevant Bridging Document.
Specifications Document	Specifications for the application of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009).
Sub-categories	Optional subdivision of Categories for each of the fundamental Criteria of economic and social viability, field project status and feasibility, and geological knowledge. Definitions of Sub-categories are provided in Annex II to UNFC-2009.
Sub-classes	Optional subdivision of resource classification based on project maturity principles resulting from the combination of Subcategories. Project maturity Sub-classes are discussed further in Annex V of the UNFC-2009 Specifications Document.
Système International d'Unités	Internationally recognized system of measurement and the modern form of the metric system. Prefixes and units are created and unit definitions are modified through international agreement as the technology of measurement progresses, and as the precision of measurements improves. Abbreviated to SI.
UNFC-2009	United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009.