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# Mapping of the United Nations Framework Classification for Fossil Energy and Mineral Resources

Report of the Economic Commission for Europe Task Force on Mapping

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## PREFACE

In July 2007, the Ad Hoc Group of Experts on Harmonization of Fossil Energy and Mineral Resources Terminology charged a special Task Force to prepare a mapping of the United Nations Framework Classification for Fossil Energy and Mineral Resources (UNFC) with the classification systems of: the Society of Petroleum Engineers/World Petroleum Council/American Association of Petroleum Geologists/Society of Petroleum Evaluation Engineers (SPE-PRMS); the Committee for Mineral Reserves International Reporting Standards (the CRIRSCO Template); and, the Russian Federation. The Task Force's mandate also included consideration of possible changes to the UNFC that would facilitate the mapping between these systems.

Although this document represents the final report of the Mapping Task Force, it should be seen as an interim step in an on-going process. In particular, the mapping work was completed in the context of proposed changes to some of the definitions of the UNFC and, as these changes have yet to be adopted, it is therefore provisional in that sense. Further, it is recognised that as more detailed mapping work is undertaken, it may be necessary to make some adjustments to the mapping between systems.

The views presented in the report are solely those of the Task Force members in their capacity as individual professional experts. The report does not purport to represent the views of the employers of the Task Force members nor the views of any of the organizations that they represent or are associated with. Specifically, it should be noted that the report has not been formally endorsed by any of the organizations whose classification systems were included in the mapping exercise.

The Task Force was led by Ms. Mücella Ersöy and Mr. Per Blystad, with Mr. Niall Weatherstone, Mr. Ferdi Camisani-Calzolari, Mr. John Etherington, Mr. Kirill Kavun, Mr. James Ross, and Mr. Andrej Subelj as members.



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## ACRONYMS AND ABBREVIATIONS

AAPG	American Association of Petroleum Geologists
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
IASB	International Accounting Standards Board
LOM	Life-of-Mine
PRMS	SPE/WPC/AAPG/SPEE Petroleum Resources Management System
QRE	Qualified Reserves Evaluator
ROM	Run-of-Mine
SPE	Society of Petroleum Engineers
SPEE	Society of Petroleum Evaluation Engineers
SRO	Self-Regulating Organization
UNFC	United Nations Framework Classification for Fossil Energy and Mineral Resources
USGS	United States Geological Survey
WPC	World Petroleum Council

## Introduction

The United Nations Framework Classification for Fossil Energy and Mineral Resources (UNFC) is a universally applicable scheme for classifying petroleum and solid minerals (including energy minerals) reserves and resources. The Classification is designed to allow the incorporation of currently existing terms and definitions into this framework and thus to make them comparable and compatible. This approach has been simplified through the use of a three-digit code clearly indicating the essential characteristics of energy and mineral commodities in market economies.

The Ad Hoc Group of Experts on Harmonization of Fossil Energy and Mineral Resources Terminology has always recognized the need for supplementary guidelines to assist users in interpreting the UNFC beyond the definitions, but has refrained from developing these in order to retain flexibility to align with other systems. The Ad Hoc Group of Experts requested the Society of Petroleum Engineers (SPE), on behalf of the petroleum industry, and the Committee for Mineral Reserves International Reporting Standards (CRIRSCO), on behalf of the solid minerals industry, to compare their respective systems and the UNFC with a view to harmonizing terminology and providing the required guidelines.

In July 2007, the Ad Hoc Group of Experts charged a special Task Force to prepare a draft mapping of the SPE, CRIRSCO, Russian Federation and UNFC systems. The Task Force was led by Ms. Mücella Ersöy and Mr. Per Blystad with Mr. Niall Weatherstone, Mr. Ferdi Camisani-Calzolari, Mr. John Etherington, Mr. Kirill Kavun, Mr. James Ross, and Mr. Andrej Subelj as members. The mandate stated:

*The team is to complete the mapping of the various classifications and definitions to the UNFC. Specifically, this will be the CRIRSCO Template, New Russian Classification and SPE PRMS terminologies. The results of this initial effort can then be leveraged to support mapping of other national and international classification systems to the UNFC.*

*In doing this work, you are invited to consider the changes that will be required to bring the classifications and definitions together for wide acceptance and global adoption with United Nations support. This should include changes to the UNFC for minerals and for petroleum to align these on a project status based framework. It should also include recommended changes to the three underlying classifications for further consideration. It is important to recognize that it is costly to change any of the systems. It may therefore be wise, in the first instance, to exploit flexibility inherent in the current systems in the form of specifications and guidelines that may affect practices within the current systems. Substantive changes to classifications and definitions would probably be best handled in the context of an International Financial Reporting Standard for extractive activities in order to avoid impacting existing reporting standards.*

SPE and CRIRSCO had previously engaged in a similar exercise at the request of the International Accounting Standards Board (IASB) resulting in a detailed mapping between the CRIRSCO Template and the SPE/WPC/AAPG/SPEE Petroleum Resources Management System (PRMS). The Task Force agreed to build on this initiative to preserve linkage to the IASB project.

The primary conclusion of the mapping effort was that changes to the current UNFC were necessary to facilitate harmonization between solid minerals and petroleum. The table in Section I compares the UNFC 2004 definitions for minerals and petroleum to the proposed generic description for each category and sub-category.



Adjustments to the CRIRSCO Template and the SPE PRMS have not been considered in this review, but it may well be that adjustments may further facilitate the development of a common global terminology.

It is envisaged that the mapping based on these proposed generic UNFC definitions could form the basis of a harmonized system that would allow users to classify commodity quantities and report them within various systems and, using the mapping modules, also present results using UNFC codification. Further, these mapping modules could serve as a “template” such that other national, industrial, and institutional level systems could be similarly mapped into UNFC codes and thus promote international communication and global assessments.

A draft report was presented at the fourth session of the Ad Hoc Group of Experts in Geneva, 17-19 October 2007. The report was discussed and initial feedback was received. It was decided to provide an extended opportunity for comments on the draft report until 31 January 2008. An initial deadline of 29 February was agreed for completion of a final report.

Based on the feedback received from members of the Ad Hoc Group of Experts, it was decided to schedule an interim workshop to discuss options for changes and their potential impact on existing systems that used or were based on the 2004 UNFC document. Representatives from eleven countries met in Geneva on 27-28 February 2008. These discussions were extremely useful and results are merged with the prior feedback into this final report.

Sections II and III provide a detailed discussion on the status of mapping exercises conducted to date among CRIRSCO Template - SPE PRMS - UNFC (proposed) and the Russian Federation and UNFC (2004) respectively.

Section IV summarizes the major feedback issues and the recommendations of the Task Force on possible approaches to resolving these issues.

# I. PROPOSED CHANGES TO CATEGORY AND SUB-CATEGORY DEFINITIONS

The Task Force noted that its mandate included the consideration of changes to the UNFC that would be required to bring the classifications and definitions together for wide acceptance and global adoption with United Nations support.

The Task Force recognized that the mapping of UNFC to other classifications would be easier if the UNFC definitions were simplified, which also would be more appropriate for an umbrella classification. Further, the Task Force recognized that a major strength of the UNFC is its 3D numerical codification which helps to avoid issues related to language. It was therefore considered unnecessary to establish labels for each category. Labels would need to be translated into other languages and problems with the actual meaning of the labels have previously been raised (e.g. Intrinsically Economic and Exceptional Economic).

The Task Force recommends that for clarity, the labels for categories and sub-categories be removed. This should also remove confusion that could arise as a consequence of assigning different labels to the categories and sub-categories for minerals and petroleum within the UNFC.

In addition to two different sets of labels, there are also two sets of definitions within the current version of the UNFC (i.e. one definition for solid minerals and one for petroleum). The Task Force decided to develop generic principle-based definitions for each of the categories and sub-categories and recommends that the differences in application between solid minerals and petroleum be addressed in the form of additional commodity-specific guidelines. These generic definitions have been designed to be as simple as possible, capturing the key principles from the existing (2004) system, but excluding detailed and/or commodity-specific information that could be better captured in the guidelines.

The Task Force agreed that the definitions should be kept at a level appropriate for global communication (“high level”), in order to maintain continuity with the current definitions and to ensure maximum potential for alignment with other systems. The Task Force considers that it is the principles that are important at this level, not the specific details. The Task Force has proposed a simplification of the current definitions, to the extent possible, to a point where they incorporate the necessary principles for all commodities, without material deviation from their current meaning, and exclude detailed and/or commodity-specific information that could be captured in commodity-specific guidelines. The Task Force has used these proposed new definitions in mapping of the CRIRSCO Template and the SPE-PRMS to the UNFC.

It was noted that the concept of commerciality brings together all relevant aspects of project evaluation, including technical feasibility, economic viability, legal considerations, fiscal terms, environmental regulations, etc. It is achieved at the juxtaposition of the E and the F axes, rather than solely on one or the other. However, in order to ensure that the requirement for commerciality is met for relevant combinations of categories, the F axis was deemed to be the appropriate location to recognize full satisfaction of all commercial criteria including technical considerations, while the E axis was defined to be inclusive of all “Market Conditions”, including prices, costs, legal/fiscal framework, environmental, social and all other non-technical factors that have a direct impact on economic viability.

The table compares the prior UNFC 2004 definitions for minerals and petroleum to the proposed generic description for each category and sub-category.

## 2004 UNFC definitions and proposed changes

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
<b>E1</b>	Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a pre-feasibility study, feasibility study or mining report, in order of increasing accuracy, that justify extraction under the technological, economic, environmental and other relevant commercial conditions realistically assumed at the time of the determination.	Production is justified under the technological, economic, environmental and other relevant commercial conditions realistically assumed or specified at the time of the estimation.	Extraction and sale is economically viable.  Refer to definitions of E1.1 and E1.2.
<b>E1.1</b>	Extraction is justified under competitive market conditions. Thus, the average value of the commodity mined per year must be such as to satisfy the required return on investment.	Production is justified under normal economic conditions. Assumptions regarding future economic conditions may be constrained by regulation.	Extraction and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions. <sup>11</sup> Economic viability is not affected by short-term adverse market conditions provided that longer-term forecasts remain positive.
<b>E1.2</b>	Exceptional (conditional) economic quantities are at present not economic to extract under normal economic conditions. Their extraction is made possible through government subsidies and/or other considerations.	Exceptional economic quantities are at present not economic to produce under normal economic conditions. Their production is made possible through government subsidies and/or other considerations.	Extraction and sale 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.

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<sup>1</sup> Market conditions are defined to include prices, costs, legal/fiscal framework, environmental, social and other non-technical factors that directly impact economic viability.

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
<b>E2</b>	Quantities, reported in tonnes/volume with grade/quality, demonstrated by means of a pre-feasibility study, feasibility study or mining report, in order of increasing accuracy, not justifying extraction under the technological, economic, environmental and other relevant commercial conditions realistically assumed at the time of the determination, but possibly so in the future.	Production is not justified under the technological, economic, environmental and other relevant commercial conditions realistically assumed at the time of the estimation, but which may become justified in the future.	Extraction and sale has not yet been confirmed to be economically viable.  Refer to definitions of E2.1 and E2.2.
<b>E2.1</b>	Marginal economic quantities are quantities that at the time of determination are not economic, but border on being so. They may become economic in the foreseeable future as a result of changes in technological, economic, environmental and/or other relevant commercial conditions.	Marginal economic quantities are quantities that at the time of determination are not economic, but border on being so. They may become economic in the foreseeable future as a result of changes in technological, economic, environmental and/or other relevant commercial conditions.	Extraction and sale has not yet been confirmed to be economic but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic extraction in the foreseeable future.
<b>E2.2</b>	Sub-marginal economic quantities are quantities that would require a substantially higher commodity price or a major cost-reducing advance in technology to render them economic.	Sub-marginal economic quantities are quantities that would require a substantially higher commodity price or a major cost-reducing advance in technology to render them economic.	Extraction and sale is not economic on the basis of realistic assumptions of future market conditions, and eventual economic extraction would require a substantial improvement in market conditions.
<b>E3</b>	Quantities, reported in tonnes/volume with grade/quality, estimated by means of a geological study to be of intrinsic economic interest. Since the geological study includes only a preliminary evaluation of economic viability, no distinction can be made between economic and potentially economic. These resources are therefore said to	Quantities that are of undetermined economic viability or are of no economic interest (unrecoverable).	Extraction and sale is not economic or economic viability has not yet been determined.  Refer to definitions of E3.1, E3.2 and E3.3.

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
	lie in the range of economic to potentially economic. Generally only in situ quantity figures are reported.		
<b>E3.1</b>	Not defined.	Quantities that will be produced but not sold.	Extraction without sale.
<b>E3.2</b>	Not defined.	Economic viability undetermined.	Economic viability of extraction has not yet been determined.
<b>E3.3</b>	Not defined.	Additional quantities remaining in-place, i.e. the quantities initially in-place less the produced and remaining recoverable quantities.	Currently considered to have no potential for eventual economic extraction.
<b>F1</b>	<p>Mining report and/or feasibility study has demonstrated extraction of the reported quantities to be justified.</p> <p>Cost data must be reasonably accurate, and no further investigations should be necessary to make the investment decision. The information basis associated with this level of accuracy comprises the reserve figures based on the results of detailed exploration, technological pilot tests, and capital and operating cost calculations such as quotations of equipment suppliers.</p>	Development and/or production plans have demonstrated production of the reported quantities to be justified.	<p>A technically and commercially feasible development project has been confirmed.</p> <p>Refer to definitions of F1.1, F1.2 and F1.3.</p>
<b>F1.1</b>	A Mining Report is understood as the current documentation of the state of development and	The development project is completed and the facilities are	Extraction is currently taking place.

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
	<p>exploitation of a deposit during its economic life, including current mining plans. The operator of the mine generally makes it. The study takes into consideration the quantity and quality of the minerals extracted during the reporting time, changes in categories of economic viability due to changes in prices and costs, development of relevant technology, newly imposed environmental or other regulations, and data on exploration conducted concurrently with mining.</p> <p>It presents the current status of the deposit, providing a detailed and accurate, up-to-date statement on the reserves and the remaining resources.</p>	<p>producing.</p>	
<b>F1.2</b>	<p>Not defined.</p>	<p>Development projects for recovery of a commodity are committed when firm commitments have been made for the expenditures and activities needed to bring a discovered accumulation to the production stage.</p> <p>Undeveloped projects are committed only when it can be clearly demonstrated that there is intent to develop them and bring them to production. Intent may be demonstrated with funding / financial plans, declarations of commerciality, regulatory approvals and satisfaction of other conditions that would otherwise prevent the project from being developed and brought to production.</p> <p>These commitments should be unconditional, except for timing that may be dependent on the development of prior committed projects. An example of this would be where production is dedicated to</p>	<p>All necessary approvals have been obtained, capital funds have been committed, and implementation of the development project is under way.</p>

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
		a long-term sales contract and will only be developed as and when the capacity is required to satisfy the contract.	
<b>F1.3</b>	A feasibility study assesses in detail the technical soundness and economic viability of a mining project, and serves as the basis for the investment decision and as a bankable document for project financing. The study constitutes an audit of all geological, engineering, environmental, legal and economic information accumulated on the project. Generally, a separate environmental impact study is required.	Development plans have demonstrated production of the reported quantities to be justified, but commitments to carry out the development works have not yet been made.	Implementation of the development project is commercially justified and there are reasonable expectations that all necessary approvals/contracts will be obtained.
<b>F2</b>	<p>A pre-feasibility study provides a preliminary assessment of the economic viability of a deposit and forms the basis for justifying further investigations (detailed exploration and feasibility study). It usually follows a successful exploration campaign, and summarizes all geological, engineering, environmental, legal and economic information accumulated to date on the project.</p> <p>The pre-feasibility study addresses the items listed under the feasibility study, although not in as much detail.</p>	Development and production of recoverable quantities have not been justified, due to conditions that may or may not be fulfilled.	<p>A potential development project has been identified, but technical and commercial feasibility has not yet been confirmed.</p> <p>Refer to definitions of F2.1, F2.2 and F2.3.</p>
<b>F2.1</b>	Not defined.	Activities are ongoing to justify development and production in the foreseeable future.	Project activities are ongoing to justify development in the foreseeable future.

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
<b>F2.2</b>	Not defined.	Activities to justify development and production are unclarified or temporarily suspended.	Project activities are on hold and/or where justification as a commercial development may be subject to significant delay.
<b>F2.3</b>	Not defined.	Investigations have indicated that development and production will not be technically justified.	There are no current plans to develop or to acquire additional data at the time due to limited potential.
<b>F3</b>	<p>A Geological Study is an initial evaluation of economic viability. This is obtained by applying meaningful cut-off values for grade, thickness, depth, and costs estimated from comparable mining operations.</p> <p>Economic viability categories, however, cannot in general be defined from the Geological Study because of the lack of detail necessary for an Economic viability evaluation. The resource quantities estimated may indicate that the deposit is of intrinsic economic interest, i.e. in the range of economic to potentially economic.</p> <p>A Geological Study is generally carried out in the following four main stages: reconnaissance, prospecting, general exploration and detailed exploration (as defined below). The purpose of the geological study is to identify mineralization, establish continuity, quantity, and quality of a mineral deposit, and thereby define an investment opportunity.</p>	Project evaluation is incomplete or lacks sufficient definition to establish feasibility. This includes projects aiming to identify the presence of petroleum accumulation(s) or projects to improve recovery.	Project evaluation is at too early a stage to determine technical and commercial feasibility.
<b>F4</b>	Not defined.	Not defined.	Remaining in-place quantities that are currently considered to be technically unrecoverable.



Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
<b>G1</b>	Detailed exploration involves the detailed three-dimensional delineation of a known deposit achieved through sampling, such as from outcrops, trenches, boreholes, shafts and tunnels. Sampling grids are closely spaced such that size, shape, structure, grade, and other relevant characteristics of the deposit are established with a high degree of accuracy. Processing tests involving bulk sampling may be required. A decision on whether to conduct a feasibility study can be made from the information provided by detailed exploration.	Quantities that are estimated to be recoverable from a known (drilled) accumulation, or part of a known accumulation, where sufficient technical data are available to establish the geological and reservoir production performance characteristics with a high level of confidence.  Quantities in this category that are associated with a development project (i.e. F1) may be subdivided to reflect their development and producing status.	Quantities associated with a known deposit that can be estimated with a high level of confidence.
<b>G2</b>	General Exploration involves the initial delineation of an identified deposit. Methods used include surface mapping, widely spaced sampling, trenching and drilling for preliminary evaluation of mineral quantity and quality (including mineralogical tests on laboratory scale if required), and limited interpolation based on indirect methods of investigation. The objective is to establish the main geological features of a deposit, giving a reasonable indication of continuity and providing an initial estimate of size, shape, structure and grade. The degree of accuracy should be sufficient for deciding whether a pre-feasibility study and detailed exploration are warranted.	Quantities that are estimated to be recoverable from a known (drilled) accumulation, or part of a known accumulation, where sufficient technical data are available to establish the geological and reservoir production performance characteristics with a reasonable level of confidence.	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.
<b>G3</b>	Prospecting is the systematic process of searching for a mineral deposit by	Quantities that are estimated to be recoverable from a known (drilled)	Quantities associated with a known deposit that can be estimated with a

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
	<p>narrowing down areas of promising enhanced mineral potential. The methods utilized are outcrop identification, geological mapping, and indirect methods such as geophysical and geochemical studies. Limited trenching, drilling, and sampling may be carried out. The objective is to identify a deposit that will be the target for further exploration. Estimates of quantities are inferred, based on interpretation of geological, geophysical and geochemical results.</p>	<p>accumulation, or part of a known accumulation, where sufficient technical data are available to establish the geological and reservoir production performance characteristics with a low level of confidence.</p>	<p>low level of confidence.</p>
<b>G4</b>	<p>A Reconnaissance study identifies areas of enhanced mineral potential on a regional scale based primarily on results of regional geological studies, regional geological mapping, airborne and indirect methods, preliminary field inspection, as well as geological inference and extrapolation. The objective is to identify mineralized areas worthy of further investigation towards deposit identification. Estimates of quantities should only be made if sufficient data are available and when an analogy with known deposits of similar geological character is possible, and then only within an order of magnitude.</p> <p>In the case of uranium, reconnaissance studies identify speculative resources, defined as in situ resources. This is uranium that is thought to exist, mostly on the basis of indirect evidence and geological extrapolations, in deposits discoverable with existing exploration techniques. The location of deposits envisaged in this category could generally be</p>	<p>Quantities that are estimated to be recoverable from an un-drilled accumulation, on the basis of inferred geological and reservoir production performance characteristics.</p>	<p>Estimated quantities associated with a potential deposit, based primarily on indirect evidence.</p>

Cat.	2004 Coal, uranium and other solid minerals	2004 Petroleum	Proposal for revised UNFC definitions
	specified only as being somewhere within a given region or geological trend.		

## II. MAPPING OF THE UNITED NATIONS FRAMEWORK CLASSIFICATION FOR FOSSIL ENERGY AND MINERAL RESOURCES WITH THE COMMITTEE FOR MINERAL RESERVES INTERNATIONAL REPORTING STANDARDS TEMPLATE AND THE SOCIETY OF PETROLEUM ENGINEERS PETROLEUM RESOURCES MANAGEMENT SYSTEM CLASSIFICATIONS

The United Nations Framework Classification (UNFC) is designed to provide a standardized system for creating an inventory of naturally occurring petroleum and solid minerals reserves and resources contained on or within the earth's crust. A key aspect of such a system is that it must align with established and widely-used classifications in order to have broad application, e.g. as a high-level umbrella system. Such a system also requires sufficient guidelines to ensure consistency in the allocation of quantities within this framework.

The mapping of the UNFC to (i) the International Template as maintained by the Committee for Mineral Reserves International Reporting Standards (CRIRSCO), and (ii) the Petroleum Resources Management System (PRMS) maintained by the Society of Petroleum Engineers (SPE), was seen as a test of this alignment, and included the opportunity to recommend changes to the UNFC if improved alignment could be achieved.

In undertaking this mapping work, a critical input was the relationship between the CRIRSCO Template and SPE-PRMS, as these had previously been mapped to each other as part of a Convergence Study provided to the International Accounting Standards Board. The existing alignment between these two systems was of significant help in guiding the Task Force towards the proposed changes to the UNFC category and sub-category definitions as set out in Section I. The level of alignment achieved between the CRIRSCO Template, SPE-PRMS and the proposed UNFC generic definitions can be seen in the comparison of definitions shown in Annex I.

It was recognized that these systems provide for quite different levels of granularity with SPE-PRMS reflecting the potential for a much more detailed level of reporting than the CRIRSCO Template. This is simply a function of the intended use of these systems; CRIRSCO is focused on public disclosures while PRMS is designed to support internal project management. However, for this reason, the Task Force has tried to strike a balance between the level of sub-division in the UNFC that may be appropriate or useful at a generic level and more detailed sub-divisions that are assigned specifically for the mapping to these more granular systems. It is intended that users of a particular system would apply the level of detail appropriate for that system by using the option of further category sub-division. Such further sub-divisions should be consistent with, but need not be part of, the UNFC.

While the proposed UNFC definitions for categories and sub-categories shown in the table are applicable to the full range of commodities, it is clear that the variations in evaluation methods and classification detail will require guidelines that are more commodity specific. The Task Force recognizes that for purposes of providing these guidelines, quantities can be broadly divided into solid minerals and petroleum.

A fundamental benefit of accepting the proposed revisions to the UNFC category/sub-category definitions is that this then provides sufficient alignment between the UNFC, the CRIRSCO Template and SPE-PRMS that it becomes viable for the existing detailed guidelines developed and maintained by CRIRSCO and SPE to be adopted as the standard reference guidelines for the UNFC. The Task Force sees this potential integration between systems as being extremely beneficial to the harmonization of terminology at a global level, and far preferable to new guidelines being developed specifically for the UNFC.

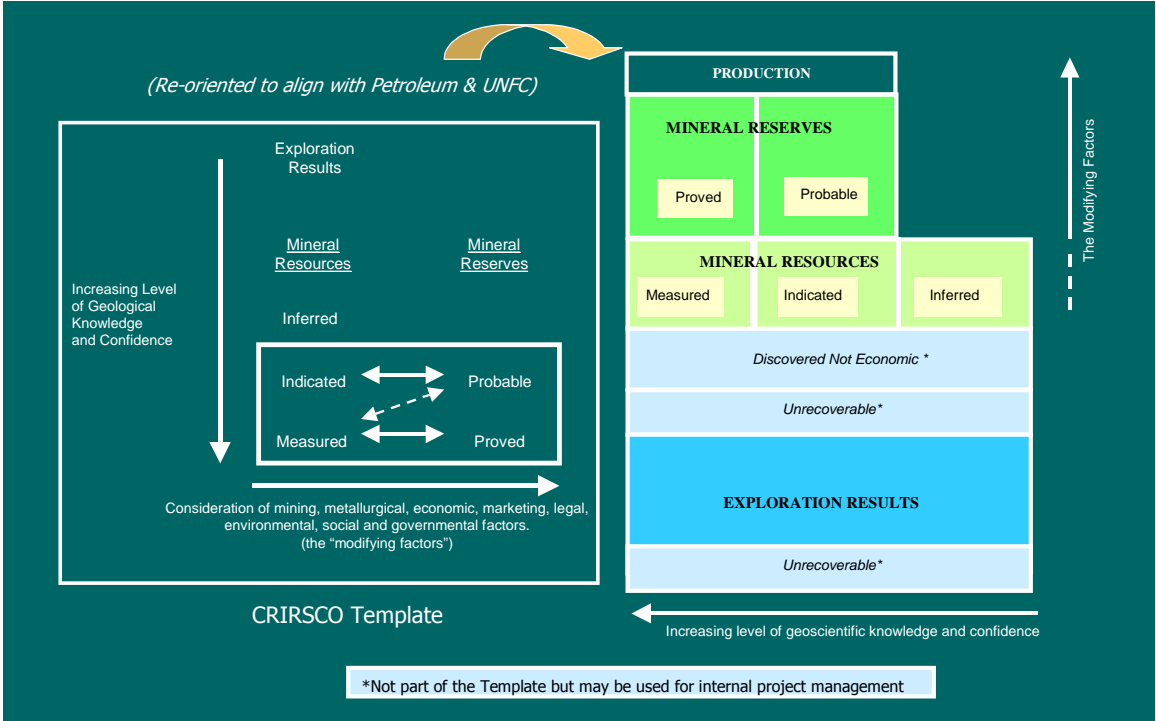
Annex II provides additional detailed comparison of the CRIRSCO and SPE-PRMS definitions. Annex III compares terminology as used in minerals and petroleum evaluations within these systems.

### A. Mapping of UNFC and CRIRSCO Template for Solid Minerals

The CRIRSCO Template of 2006 (hereinafter referred to as the “Template”) is the most recently developed international technical standard for the reporting of Exploration Results, Mineral Resources and Mineral Reserves. It is in turn based on a number of national or regional reporting standards that are compatible with each other and the Template, and whose authors contributed to the development of the Template that represents current international best practice.

Figure 1 compares the Template’s traditional display re-oriented to align with petroleum’s two-dimensional classification matrix (see Section II B).

Figure 1  
CRIRSCO Template for solid minerals



In the solid minerals system:

Where exploration activities have taken place but are insufficiently advanced to estimate a Mineral Resource quantity, the generic term of Exploration Results is applied. Exploration Results are insufficient to determine the volume and quality of mineralization and should not be confused with Mineral Resources.

Where geological studies have been carried out and an estimate of the quantity of mineralization is possible (volume, tonnes, grade etc) then classification takes place on the horizontal, geological, axis on the basis of the level of detail of the studies and the degree of confidence in the geological model.

Mineral Resources are in situ estimates of mineralization prior to conversion to Mineral Reserves (i.e. with no adjustments for mining dilution or losses), although preliminary consideration is given to likely mining and processing techniques, economic cut off grades and so on. Mineral Reserves are generally quoted as the product of mining activities (tonnage and grade or quality) i.e. the quantities delivered to the processing plant. Where further processing is required to produce a saleable product, recovery or yield factors should be provided if the results are to be published.

Conversion of Mineral Resources to Mineral Reserves requires technical studies of at least pre-feasibility level to demonstrate that all of the Modifying Factors<sup>2</sup> have been addressed and the results are positive. The Modifying Factors are broadly similar to the “contingencies” described for petroleum in Section II B.

Where adequately detailed geological studies have been carried out but preliminary assessment of the Modifying Factors indicates that the project is not currently viable, Mineral Resources are not converted to Mineral Reserves but may be held in an inventory of “discovered not economic” (a term not used in the Template) to be reviewed in future should conditions change.

Note that this diagram shows classes recognized for public disclosure in the Template in yellow shading. Additional classes beyond those defined in the Template but suitable for internal project management are shown in blue background. Classes may be adjusted in the future to accommodate other categories or sub-categories found useful, for example by governments.

## **1. CRIRSCO Template mapped to proposed UNFC at a high level**

Figure 2 shows the classification categories of the Template and their high level equivalents under the UNFC codification system (based on the proposed revised UNFC definitions).

## **2. Mapping based on project maturity status**

The petroleum industry (see Section II B) relies heavily on project maturity status as a form of classification on the vertical axis. While the increasing detail of studies from exploration through geological to feasibility studies is implicit in the Template, project maturity is not used as an explicit form of classification. Nevertheless, the project evaluation process undertaken in a minerals project is very similar to that of a

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<sup>2</sup> The Modifying Factors comprise mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors.

project in petroleum. Figure 3 compares the most commonly used terminology for minerals project development stages with the UNFC and SPE-PRMS equivalents.

Figure 4 illustrates an expanded mapping of these systems keyed to UNFC E, F, and G categories and sub-categories (see also Annex I). Combinations of sub-categories create classes that uniquely capture the detail in a solid minerals assessment. Note again that the sections highlighted in blue are not part of the CRIRSCO template for public disclosure but may be used for internal project management and/or to illustrate alignment with petroleum classification in Section II B.

Figure 2  
High level mapping of UNFC to CRIRSCO Template

Fundamental Characterization	Solid Mineral Classes	UNFC E axis	UNFC F axis	UNFC G axis		
				Proved	Probable	NA
DISCOVERED AND MINEABLE	MINERAL RESERVES	1	1	1	2	
				Measured	Indicated	Inferred
DISCOVERED AND NOT COMMERCIALY RECOVERABLE	MINERAL RESOURCES	2.1	2	1	2	3
	Discovered Not Economic	2.2	2	1	2	3
	Unrecoverable	3	4	1	2	3
				Zone of Mineralization		
UNDISCOVERED	Exploration Results	3	3	4		
	Unrecoverable	3	4			

\*Not part of the Template but may be used for internal project management

Figure 3  
High level mapping of UNFC to CRIRSCO Template

UNFC F-axis		PRMS Sub-Classes		Template Classes	Mineral Project Development Stage
Category	Sub-category				
F1	F1.1	F1.1	On Production	Mineral Reserves	On Production (1)
	F1.2	F1.2	Approved for Development		Project Implementation
	F1.3	F1.3	Justified for Development		Feasibility Study (2)
F2	F2.1	F2.1	Development Pending	Mineral Resources	Pre-Feasibility Study (3)
	F2.2	F2.2	Development Unclassified or on Hold		Order of Magnitude Studies (4)
	F2.3	F2.3	Development not Viable		(5, 6)
F4		F4.1	Discovered Unrecoverable		
F3		F3.1	Prospect	Exploration Results	Conceptual Studies (7)
		F3.2	Lead		
		F3.3	Play		
F4		F4.2	Undiscovered Unrecoverable		(8)

\*Not part of the Template but may be used for internal project management

\*Sub-categories are commodity specific and not part of UNFC generic

Notes:

<sup>a</sup> On or in production is equivalent across all three systems.

<sup>b</sup> Project approval is usually made at senior management level and corresponds to the end of a feasibility study which is sufficiently detailed to provide an accurate assessment of the technical and economic viability of the project. Economic projects are those where cash flow schedules generate a positive net present value under a defined discount rate; the same definition applies to petroleum and mineral projects. After approval, the project will move into the implementation stage. Minerals companies may report reserves as developed or undeveloped if regulators require it. This detail would be dealt with in guidelines to the classification.

<sup>c</sup> Pre-feasibility studies will be sufficiently detailed to enable a decision to abandon or defer the project or move to the feasibility stage. Reserves are usually (but not always) publicly declared following a pre-feasibility study provided the study has adequately addressed the modifying factors and no significant impediments to development have been identified. While a pre-feasibility study may indicate that a project is justified for development, approval for development would normally require completion of feasibility. Timing to physical implementation is not considered as critical as in petroleum projects, with long lead times to production being common. However, studies would be refreshed periodically to ensure that reserves remain viable.

<sup>d</sup> Mineral Resources have realistic prospects of eventual economic extraction, which is taken to mean under realistic assumptions of future prices, recovery and other inputs. To reach the equivalent of development pending, pre-feasibility studies will usually be complete or in progress, while order of magnitude studies will be sufficient to make the decision



whether to continue to pre-feasibility. “Unclarified or on hold” would generally mean that studies were in progress or inconclusive although preliminary economic indications remain favourable.

<sup>e</sup> Order of Magnitude studies based on advanced exploration will generally be adequate to determine if the project is likely to be viable and whether it should move to pre-feasibility. Projects that are not viable under currently assumed conditions may be placed in a mineral inventory pending future re-evaluation.

<sup>f</sup> Material that is deemed to be permanently unrecoverable, for example in rock pillars left behind to support major infrastructure such as shafts, will be removed from resources entirely. Estimated quantities may be retained in a mineral inventory pending any change of status and to maintain the mass balance of the overall in situ mineralization.

<sup>g</sup> Predicted but undiscovered petroleum in the PRMS classification (Prospective Resources) is equivalent to early indications of mineralization classified as Exploration Results under the Template. Exploration Results may be publicly reported but not as estimates of tonnes and grade due to the inadequate available data. Any estimates of potential tonnage and grade will be speculative and may be based on analogous geological settings. These may be useful for internal planning and prioritization of exploration effort but are not relevant to the CRIRSCO classification which is focused on the public release of information. Because of the lack of available data, studies that may be carried out to form a preliminary view on project viability, or to guide future exploration, are likely to be only conceptual in nature.

Figure 4  
Detailed mapping of UNFC to CRIRSCO Template

Fundamental Characterization	Solid Mineral Classes	Mineral Project Development Stage	UNFC E axis	UNFC F axis	UNFC G axis		
					Proved Measured	Probable Indicated	----- Inferred
DISCOVERED AND COMMERCIALY RECOVERABLE	MINERAL RESERVES	On Production (1)	1	1.1	1	2	
		Project Implementation	1	1.2	1	2	
		Feasibility Study (2)	1	1.3	1	2	
DISCOVERED AND NOT COMMERCIALY RECOVERABLE	MINERAL RESOURCES	Pre-Feasibility Study (3)	1 or 2.1	2.1	1	2	3
		Order of Magnitude Studies (4)	3.2 or 2.1	2.2	1	2	3
	Discovered Not Economic	(5,6)	2.2	2.3	1	2	3
	Unrecoverable		3.3	4.1	1	2	3
UNDISCOVERED	EXPLORATION RESULTS	Conceptual Studies (7)	3.2	3.3	4		
	Unrecoverable	(6)	3.3	4.2	4		

### 3. CRIRSCO Template

The International Reporting Template is maintained by CRIRSCO on their website at: <http://www.crirSCO.com>. Combined with the above mapping, these guidelines could be applied to evaluations with results reported using the UNFC system, provided that the recommended changes to the UNFC definitions are adopted.

#### B. Mapping of UNFC and SPE-PRMS for Petroleum

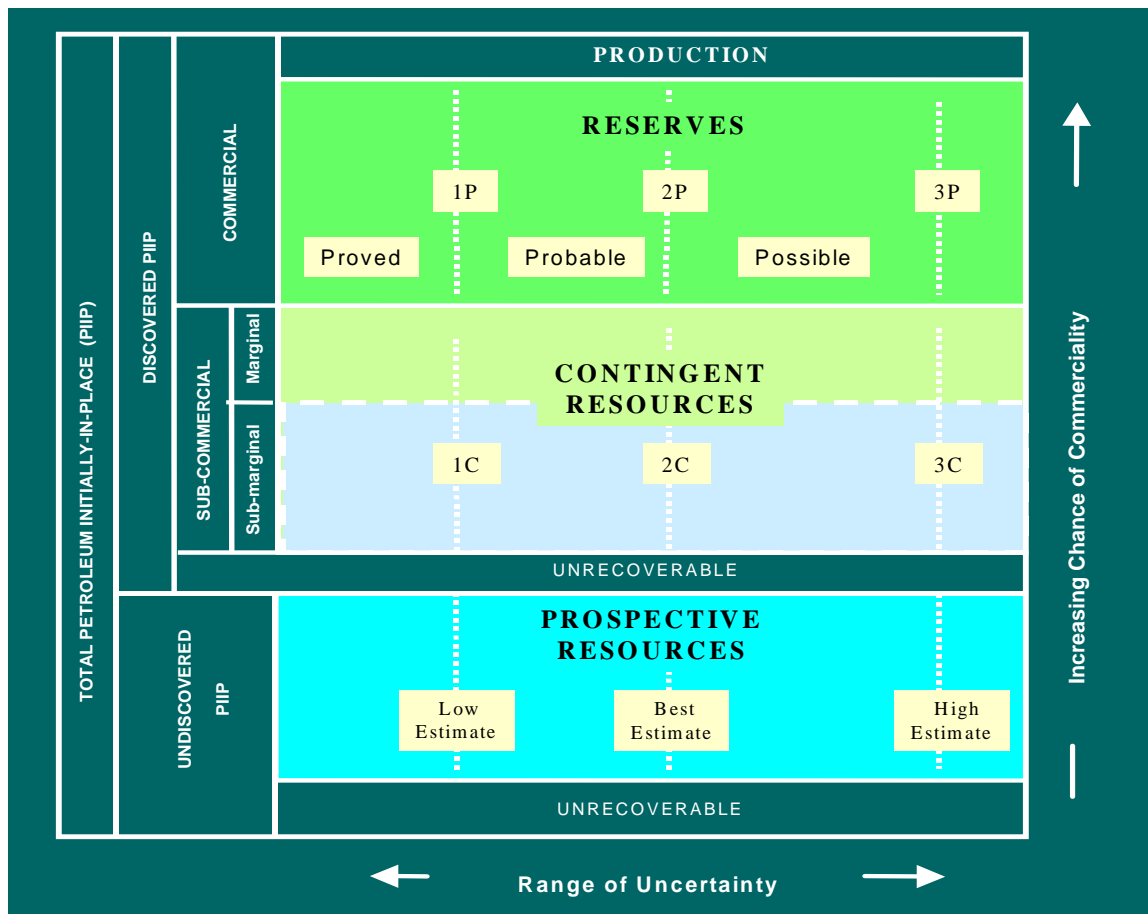
The SPE/WPC/AAPG/SPEE Petroleum Resources Management of 2007 (hereinafter referred to as “PRMS”) is the most recently developed international technical standard for petroleum evaluations.

Figure 5 illustrates the PRMS two-dimensional classification matrices. In PRMS:

- (a) Quantities are classified on the vertical axis according to a combination of the development project’s economic viability and evaluation maturity expressed as chance of commerciality.
- (b) Quantities are categorized on the horizontal axis based on certainty of estimated sales quantities derived from each project. Estimates of sales quantities reflect a combination of the uncertainty of hydrocarbons initially in- place and the recovery efficiency of the applied development programme.
- (c) Multiple projects may be applied to an accumulation with the ultimate recovery being the combination of the quantities recovered by each project.
- (d) All quantities are as measured at defined transfer points; these are the upstream petroleum “sales products” (crude oil, condensate, natural gas, natural gas liquids) delivered for distribution or further downstream refining.
- (e) Quantities may only be classified as Reserves if the associated project is commercial, that is, both economic and committed for development. Reserves classification implies that there are no significant contingencies that would preclude implementation and there should be documented intent to initiate development of such projects within a reasonable time frame (timing may vary according to specific circumstances).
- (f) Contingent Resources have an associated chance of success that may be expressed qualitatively through assignment to maturity-based sub-classes or quantitatively through assigning a percentage chance of development through to Reserves status.
- (g) Quantities classified as Contingent Resources are sub-classified as Marginal and Sub-marginal based principally on project economics but may also be influenced by other commercial contingencies (contingencies are broadly equivalent to CRIRSCO’s “Modifying Factors”).
- (h) Quantities associated with “Marginal” Contingent Resources projects are in a discovered accumulation but cannot be classified as Reserves since commitment to develop has not been demonstrated because of one or more of the following reasons:
  - (i) Project is economic but priorities cause significant deferment of development.
  - (ii) One or more necessary conditions prevent development (e.g. regulatory issues).

- (iii) Economic development is contingent on positive changes in conditions (price, technology, etc.) that can be reasonably forecast.
  - (iv) Initial results indicate an economic project but additional information is required to make a final evaluation.
- (i) Quantities associated with “Sub-marginal” Contingent Resources projects are in a discovered accumulation but:
- (i) Initial results indicate that the project is sub-economic but additional information is required to make a final evaluation.
  - (ii) No technically and/or economically viable development plan can be defined without invoking very significant, but feasible, improvements in future conditions.
- (j) Where no feasible recovery project is proposed, those remaining in-place quantities assigned to a discovered, or predicted in an undiscovered, accumulation are classified as “Unrecoverable”.
- (k) Quantities within the Prospective Resources class are interpreted to be recovered from undiscovered accumulations by a defined preliminary development programme but there is a significant associated risk of project failure, that is, no discovery may be confirmed. In the event that a discovery is confirmed, the project moves to Contingent Resources but is still subject to chance of commercial development.

Figure 5  
PRMS classification



## 1. Mapping of SPE-PRMS to UNFC and Solid Minerals

The commerciality axis in PRMS implicitly combines economic and project maturity status information. Sub-classification options within PRMS are available to disaggregate commerciality into its components and can be used as the basis for mapping between the PRMS, UNFC, and Solid Minerals classification systems. Figure 6 provides a high level mapping based primarily on project economic status (based on the proposed revised UNFC definitions). Compared to the Classification for Solid Minerals (Figure 2):

- (a) Petroleum Marginal Contingent Resources are the class equivalent of Mineral Resources.
- (b) Sub-Marginal Contingent Resources represent an internal inventory of currently uneconomic projects to be periodically reviewed for development potential and is similar to “Discovered Not Economic” in the minerals system.
- (c) Prospective Resources are the class equivalent of Exploration Results.

PRMS defines incremental uncertainty categories of Proved and Probable Reserves mapped to Proved and Probable Mineral Reserves categories. In the petroleum system, possible quantities are included in high

estimates of in-place and project recovery efficiency; in the minerals industry, geologic control is considered insufficient to define Possible Mineral Reserves and these high estimates would be included within Inferred Mineral Resources. While PRMS does not define incremental uncertainty terminology for Contingent Resources, the terms C1/C2/C3 as used herein are considered to align with Proved, Probable and Possible regarding confidence levels. Then, C1/C2/C3 Marginal Contingent Resources Reserves are generally equivalent to Measured/Indicated/Inferred Mineral Resources in terms of uncertainty; however, the quantities estimated under PRMS are those that can be recovered and sold under a defined development project, while Mineral Resources are defined in terms of in situ tonnage and grade prior to final mine design.

Figure 6  
High level mapping of PRMS and UNFC classifications

Fundamental Characterization	PRMS Resources Classes		UNFC E axis	UNFC F axis	UNFC G axis		
					Proved	Probable	Possible
DISCOVERED AND COMMERCIALY RECOVERABLE	RESERVES		1	1	1	2	3
					C1	C2	C3
DISCOVERED AND NOT COMMERCIALY RECOVERABLE	CONTINGENT RESOURCES	Marginal	2.1	2	1	2	3
		Sub-Marginal	2.2				
	Unrecoverable		3	4			
					Estimate of Potential		
UNDISCOVERED	PROSPECTIVE RESOURCES		3	3	4.1	4.2	4.3
	Unrecoverable			4			

Figure 7 provides more detailed mapping to UNFC including sub-categorization based primarily on project status (PRMS sub-classes). As shown in Figure 3, these sub-classes are not defined in the CRIRSCO template; however, similar stages of development may be identified in minerals projects.

For Reserves to be attributed, projects are required to meet the evaluator’s normal economic hurdles based on reasonable assumptions of forecast conditions (E1.1), but can include situations where there are adverse short-term market conditions provided that longer-term forecasts remain positive. E1.2 describes projects that are sustained by government or other subsidies.

Projects classified as Marginal Contingent Resources may be technically and economically feasible (E1.1) but awaiting resolution of other contingencies (e.g. environmental permits) or may require realistically forecast positive improvements in conditions (E2.1). Sub-marginal Contingent Resources require significant, but feasible, improvements in conditions (E2.2). Where project evaluations of discovered accumulations are not sufficiently complete to define ultimate commerciality, the economic status is “undetermined” (E3.2). Non-sales quantities (lease fuel, flare and losses) are assigned to E3.1 and may be associated with projects at all stages of maturity.

Figure 7  
Detailed mapping of PRMS and UNFC classifications

Fundamental Characterization	PRMS Resources Classes	PRMS Sub-Classes	UNFC E axis	UNFC F axis	UNFC G axis		
					1P/1C low est	2P/2C best est	3P/3C high est
DISCOVERED AND COMMERCIALY RECOVERABLE	RESERVES	On Production	1.1 or 1.2	1.1	1	1+2	1+2+3
		Approved for Development	1.1 or 1.2	1.2	1	1+2	1+2+3
		Justified for Development	1.1 or 1.2	1.3	1	1+2	1+2+3
DISCOVERED AND NOT COMMERCIALY RECOVERABLE	CONTINGENT RESOURCES	Development Pending	1 or 2.1	2.1	1	1+2	1+2+3
		Development Unclarified or on Hold	3.2 or 2.1	2.2	1	1+2	1+2+3
		Development not Viable	2.2	2.3	1	1+2	1+2+3
	Unrecoverable		3.3	4.1	1	1+2	1+2+3
UNDISCOVERED	PROSPECTIVE RESOURCES	Prospect	3.2	3.1	4.1	4.1+4.2	4.1+4.2+4.3
		Lead	3.2	3.2	4.1	4.1+4.2	4.1+4.2+4.3
		Play	3.2	3.3	4.1	4.1+4.2	4.1+4.2+4.3
	Unrecoverable		3.3	4.2	4.1	4.1+4.2	4.1+4.2+4.3

While detailed development plans may be envisaged for undiscovered accumulations complete with production/sales profiles, cash flow schedules and economic analyses, given the associated risk of failure, the economic status remains undetermined (E3.2). Unrecoverable quantities, discovered or undiscovered, estimated to remain in-place after the completion of all development projects, are designated as E3.3.

Petroleum projects may be further sub-classified by their maturity being a qualitative indicator of decreasing chance of commerciality and such sub-classes are defined in the F-axis. Reserves sub-classes are: On Production (1.1), Approved for Development (1.2), and Justified for Development (1.3). Contingent Resources sub-classes are Development Pending (2.1), Development Unclarified or On Hold (2.2), and Development Not Viable (2.3). While the latter discoveries have no current development plans, they are retained in inventory pending major, unforeseen, but feasible improvements in conditions. Unrecoverable Discovered quantities are codified as F4.1.

Projects in undiscovered accumulations are also sub-classified based on exploration project maturity as Prospects, Leads or Plays; these are assigned to commodity-specific sub-categories of F3.1, F3.2 and F3.3. Associated quantities that are predicted to exist in-place but are not considered recoverable under any technically feasible development plan are classified as Unrecoverable (F4.2).

Petroleum project evaluations may use combinations of deterministic and probabilistic methods with resulting sales quantities expressed in both incremental and cumulative terms. Figure 6 maps certainty categories in terms of PRMS cumulative scenarios: 1P/2P/3P for Reserves where 1P = Proved (G1), 2P = Proved plus Probable (G1+G2), and 3P = Proved plus Probable plus Possible (G1+G2+G3). Equivalent

cumulative scenarios for Contingent Resources are 1C/2C/3C and for Prospective Resources are low/best/high estimates.

When the range of uncertainty is represented by a probability distribution, a low, best, and high estimate will be provided such that:

- (a) There should be at least a 90 per cent probability (P90) that the quantities actually recovered will equal or exceed the low estimate.
- (b) There should be at least a 50 per cent probability (P50) that the quantities actually recovered will equal or exceed the best estimate.
- (c) There should be at least a 10 per cent probability (P10) that the quantities actually recovered will equal or exceed the high estimate.

For quantities that are forecast to be recovered from undiscovered accumulations (F3), typically low, best and high estimates are developed as part of the evaluation and the associated quantities may be defined using the commodity-specific sub-categories of G4.1, G4.2 and G4.3 as G4.1, G4.1+G4.2, and G4.1+G4.2+G4.3 scenarios. In probabilistic assessments, these estimates are aligned with the P90/P50/P10 from distribution of predicted sales volumes. Where only a single deterministic best estimate is developed, it is deemed to be G4.1+G4.2. Where such estimates refer to remaining in-place quantities, the economic status is E3.3. All estimates are conditional on chance of discovery; conditional results may be expressed as a risked best estimate or risked mean.

Those quantities classified as Reserves may be further allocated to Developed (Producing and Non-Producing) and Undeveloped according to funding and operational status of related wells and facilities. Such allocations are represented by assigning quantities to commodity-specific sub-categories on the feasibility axis as in Figure 8.

Figure 8  
UNFC codification for developed and undeveloped reserves

Fundamental Characterization	PRMS Class	PRMS Sub-Classes	UNFC F axis			UNFC G axis		
			Developed		Undeveloped	1P	2P	3P
			Producing	Non-Producing				
DISCOVERED AND COMMERCIALY RECOVERABLE	RESERVES	On Production	1.1.1.1	1.1.1.2	1.1.2	1	1+2	1+2+3
		Approved for Development	NA	1.2.1.2	1.2.2	1	1+2	1+2+3
		Justified for Development	NA	NA	1.3.2	1	1+2	1+2+3

## 2. SPE/WPC/AAPG/SPEE Petroleum Resources Management System

This document is maintained by the Society of Petroleum Engineers (SPE) on its website <http://www.spe.org/spe-app/spe/industry/reserves/index.htm>. Combined with the above mapping, these guidelines could be applied to evaluations with results reported using the UNFC system, provided that the recommended changes to the UNFC definitions are adopted.

# III. MAPPING OF THE NEW RUSSIAN FEDERATION CLASSIFICATION SYSTEM TO THE UNITED NATIONS FRAMEWORK CLASSIFICATION

Mapping of the new Russian Classification system to the UNFC is part of the mandate for the Task Force on Mapping. As discussed below, there are two parallel systems in use in the Russian Federation. A mapping of these systems to the current (2004) UNFC was developed and provided by Russian experts. The Task Force wishes to express its gratitude for this work.

It is recognized that in developing this mapping based on the proposed revised UNFC, the Russian experts have not had the opportunity to compare this work in detail with their mapping to the current version of the UNFC. If the proposed changes to the UNFC definitions are adopted, it may be necessary to re-confirm the validity of the mapping shown here, based on a more detailed review by the Russian experts.

When mapping the new Russian Federation (RF) Classification System to the current UNFC (2004) with the results adjusted to the format recommended by the Task Force on Mapping, the following specific features have been revealed by the Russian experts.

(a) All classes and categories of the RF Classification can be allocated by three fundamental criteria of the UNFC mapping module, thus reflecting the different economic viability of reserves/resources taken into account in public reporting.

(b) The terms “reserves” and “resources” have different meanings in the RF Classification and the UNFC and do not correspond to each other. Russian C1 and C2 “reserves” are not necessarily “reserves” as referred to in Western classifications. Further, RF “predicted (reconnaissance) resources” (P2 and P3) are not recognized as “resources” in Western Minerals classifications (CRIRSCO Template), but are recognized as “resources” in Western Petroleum Classifications (SPE PRMS). In the Russian Federation, “reserves” can be both “economic” and “sub-economic” as well as explored in detailed and preliminarily evaluated (C2). At the same time there is a lot in common in descriptive characteristics of individual (“parallel”) reserve/resource categories. These can be compared and equalized on the basis of a certain measure of commonality.

(c) The mapping scheme for individual categories of the RF Classification and UNFC seems to be as follows: High geological confidence level “measured” resources and “proved” reserves obtained on their basis may be equalized to RF categories of A+B+C1; reasonable level of geological confidence “indicated” resources and “probable” reserves obtained on their basis may correspond to RF C1 or C2 categories; low confidence level “inferred” resources may be compared with RF preliminarily evaluated C2 or prognostic P1 categories, the latter being referred to as “Reconnaissance Resources” not further categorized in the UNFC current (2004). According to the same scheme, this subdivision also includes RF P2 and P3 undiscovered (prognostic) resource categories.

(d) For mineral deposits belonging to high geological complexity groups (in compliance with the RF Classification), assignment of “resources” to “reserves” is possible as well as the use of C1 and C2 categories in design engineering.



(e) In the Russian Federation, estimation of undiscovered (prognostic) resources classified by degree of justification of recognition and probability of confirmation is regarded as one of the main results and performance indices of exploration activities. Their quantification is carried out using analogies. Compiling of inventories and reporting of undiscovered resources by categories is not provided for in the current UNFC (2004). For this reason, in the process of mapping all prognostic resources defined in the Russian Federation by criteria of geological knowledge (P1, P2 and P3) are to be assigned to the UNFC “Reconnaissance Resources” class. However, it is noted that the Task Force on Mapping proposes that, at the commodity level of petroleum, subcategories be established that capture the different levels of prognostic resources.

(f) Unrecoverable resources are not taken into account by the RF Classification. Such type of estimates may be used for internal long-term planning and project management. By implication resources remaining in-place correspond to losses of solid minerals. They may have a conditional commercial value. The estimation of In-Balance economic reserves is supposed to include determination of their tonnages in situ as well as their recoverable quantities with account taken of mining losses and dilution, i.e. by the quantity of marketable mineral product produced and sold. A rather confident forecast and taking losses and dilution into consideration can be effected at the stages of design and bringing the mining unit into production.

(g) Referred to In-Balance economic reserves in the RF Classification and the UNFC are those which at the moment of evaluation prove to be economically efficient for recovery according to the results of technical/economic investigations.

(h) The most crucial and meaningful part of calculating “economic” (“In-Balance”) reserves according to the UNFC and the Russian Classification is their estimation by results of feasibility or at least pre-feasibility studies based on reasonably admissible factors influencing economic efficiency of extraction of mineral resources from the subsoil.

(i) If the recovery of mineral resources from the subsoil proves to be economically unjustified at the moment of evaluation, but is promising to be such in the foreseeable future, these quantities in compliance with the RF Classification are referred to as Out-Of-Balance (subclass “1”). If the non-commerciality is related to the specific location of the deposit, or to social or environmental conditions etc., the resources are also assigned to Out-Of- Balance (subclass “2”). This subclass of the RF classification may be mapped to the class of “Discovered Not Economic Resources” of UNFC.

The Task Force on Mapping has redrafted the tables received from the Russian experts in order to (a) compare directly with the tables used in the preceding sections of this report to illustrate the mapping of the UNFC to the CRIRSCO Template and the SPE-PRMS, and (b) reflect the proposed revised definitions for the UNFC, as set out in section I of this report.

For the benefit of readers not familiar with the Russian classification, the Task Force on Mapping has developed a brief description of the Russian classification system.

## A. Russian Federation classification

The Russian Federation’s State Commission on Mineral Reserves maintains classification systems for solid minerals (RF-M-2006) and petroleum (RF-P-2005) reserves and resources. While maintained separately and using slightly different terminology, the underlying classification principles are aligned between the solid minerals and petroleum systems. All Russian Federation classifications are based on:

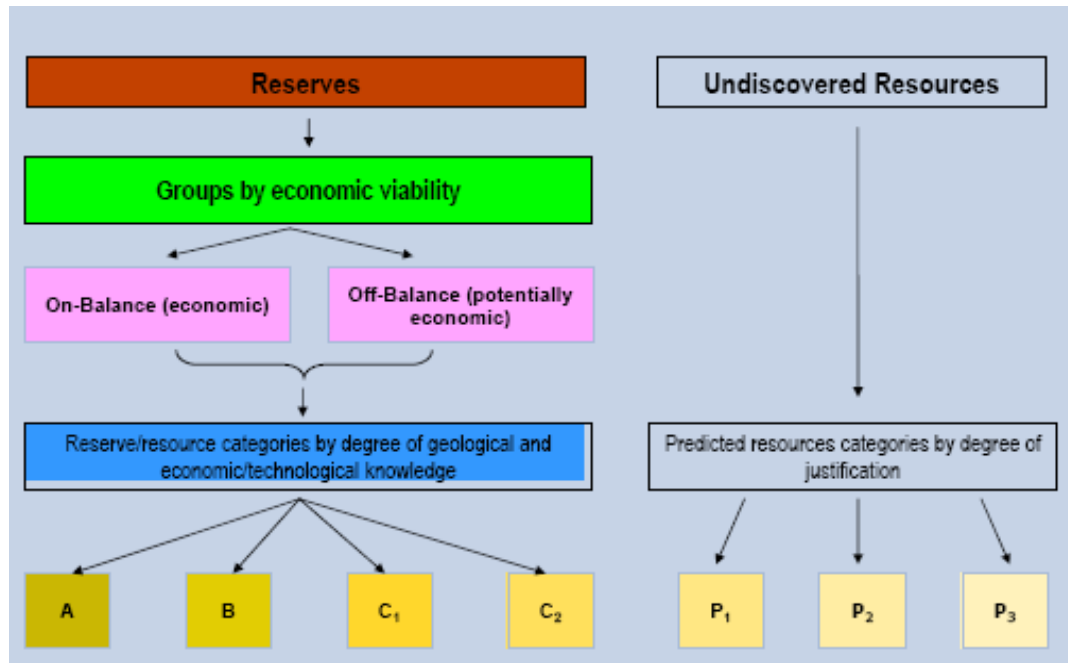
- (a) Economic efficiency
- (b) Degree of commercial development
- (c) Degree of geological study

## B. Russian Federation classification for solid minerals (RF-M-2006)

Figure 9 illustrates the current Russian classification system for minerals. Given sufficient geological information, identified areas of mineralization are initially divided into “Reserves” and Undiscovered Resources. “Reserves” in RF-M-2006 encompasses not only those in situ deposits explored in detail and judged to be economic (On-Balance - economic) but also prospective portions of the subsoil preliminarily evaluated as economic and/or which may become economically viable for extraction in the future (Off-Balance – potentially economic). When related to the CRIRSCO system, On-Balance (economic) reserves are equivalent to Mineral Reserves. Off-balance (potentially economic) reserves are equivalent to Mineral Resources.

Depending on the complexity of the geological structure of a deposit, the operational status of a project and the degree of uncertainty of information about the object in question, “reserves” of different confidence code levels can be defined.

Figure 9  
Russian Federation minerals classification system (2006)



## 1. Mapping of UNFC to Russian Federation Classification for Solid Minerals

Figure 10 illustrates a high level mapping of RF-M-2006 based on the proposed UNFC definitions. This table demonstrates that the fundamental characterization of reserves/resources in the Russian classification and the UNFC (economic, potentially economic and undiscovered) reflect different economic contents of individual classes (see column 2). In RF-M-2006, as distinct from UNFC and the CRIRSCO template, “reserves” may include not only quantities explored in detail and proved to be economically efficient, but also prospective portions of the subsoil preliminarily evaluated as economically viable as well as resources not economic at the time of the estimation but which may become justified for economic extraction in the future. Depending on the complexity of the geological structure of a deposit, the operational status of a project and the degree of uncertainty in the information about the object in question, “reserves” of different confidence levels (categories) can be obtained and defined by the appropriate UNFC codes.

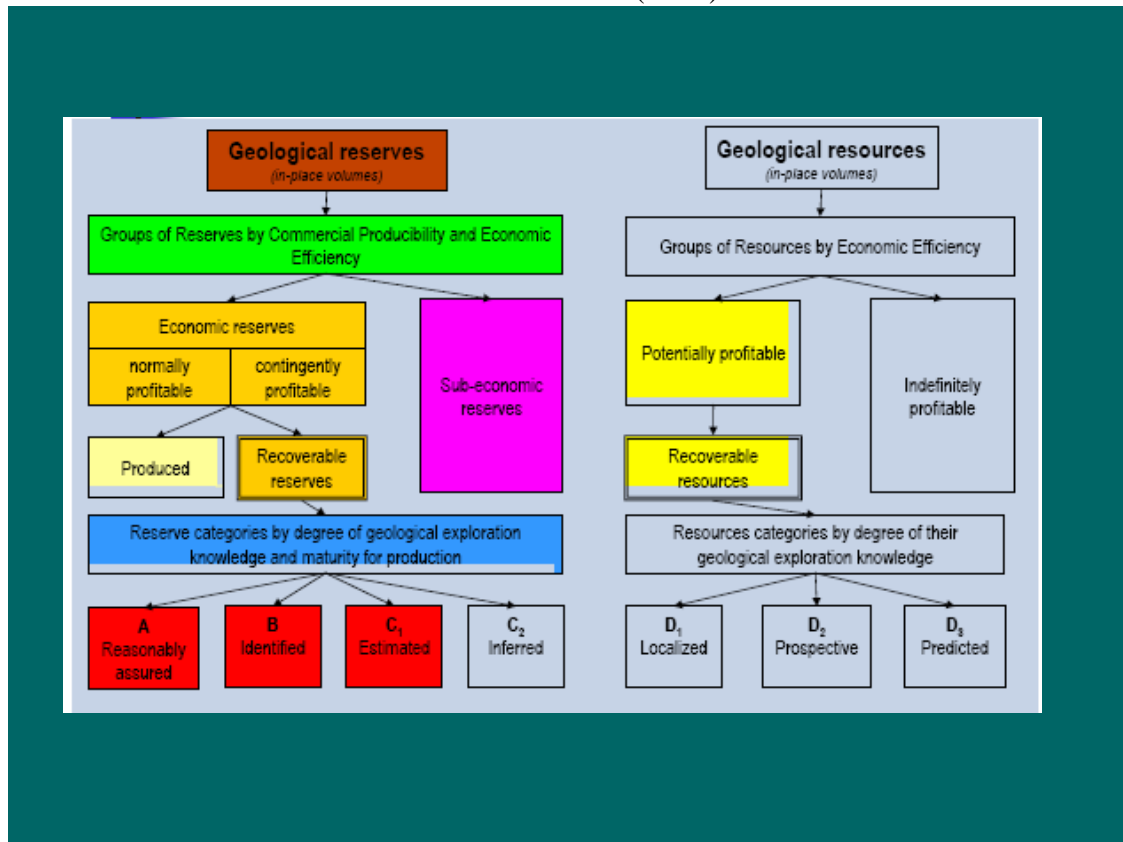
The multiplicity of geological deposit types, and the methods and techniques applied in their exploration and evaluation may be responsible for ambiguous mapping in the results and codification of the classification systems being mapped. Mismatching of the numbers of subdivisions identified along the appropriate axes in different classifications may lead to the necessity of aggregating data by subcategories or their separate reporting beyond the framework of respective classifications.

Figure 10  
Preliminary mapping of Russian Federation Minerals Classification (2006) to UNFC

Russian Federation Mineral Classification (RF-M-2006)								
Fundamental Characterization	Groups By Economic Efficiency	Operational Project Status & Level of Technical-economic Evaluation	Categorized by Level of Geological Assurance	UNFC E axis	UNFC F axis	UNFC G axis		
Economic (In-balance)	RESERVES	Not provided for in RF classification		1 <sup>1</sup>	1.1	1	2	3
		Not provided for in RF classification					1	2
		Detailed Exploration Feasibility Study	A, B, C <sub>1</sub> , C <sub>2</sub> Explored/Evaluated		1.3	1	2	
		General Evaluation Pre-Feasibility Study	C <sub>1</sub> , C <sub>2</sub> Evaluated	2	2		2	
Potentially Economic (Out-of balance)	RESERVES (in UNFC – Resources)	Detailed Exploration Feasibility Study	A, B, C <sub>1</sub> , C <sub>2</sub> Explored/Evaluated	2.1	1.3	1	2	3
				2.2	1.3	1	2	3
		General Evaluation Pre-Feasibility Study	C <sub>1</sub> , C <sub>2</sub> Evaluated	2	2		2	
		Not provided for in RF classification		3	3 & 4	1	2	3
Undiscovered	RESOURCES	Prospecting Opportunity Studies	C <sub>2</sub> , P1, P2 Preliminarily Evaluated & Predicted	3	3			3
		Regional Geological Studies Geological Report	P2, P3 Predicted (order of magnitude for P3)	3	3	4		

1 Subcategories E1.1 (Normal Economic) and E1.2 (Exceptional Economic) not provided for in RF classification

Figure 11  
Russian Federation Classification for Petroleum (2005)



### C. Russian Federation Classification for Petroleum (RF-P-2005)

The Russian Classification for Petroleum (Figure 11) was revised in November 2005 and all those reporting to the Ministry of Natural Resources are required to conform to the new system by January 2009.

“Geological Reserves” refers to quantities of oil, gas, and condensate and contained associated components in-place confined to discovered accumulations studied by drilling. When appropriate development plans are applied, accumulations are subdivided into:

- (a) Normally Profitable: those that can be economically produced at the time of the evaluation, and have no contingencies to prevent production and sales.
- (b) Contingently Profitable: those that cannot be commercially developed without reasonable improvements in conditions.
- (c) Sub-economic: those where production, at the time of the estimation, is impractical or technically unfeasible.

Recoverable reserves are only estimated for Normally and Contingently Profitable “reserves”. In-place quantities are estimated for Sub-economic “reserves”.

The recoverable quantities are categorized by a combination of the degree of geological knowledge and the depth of development as follows:

- (a) Category A: (reasonably assured) are those quantities under development by a grid of production wells drilled according to a development plan.
- (b) Category B: (identified) includes that portion of the reservoirs adjacent to (within the influence of) productive wells.
- (c) Category C<sub>1</sub>: (estimated) includes reserves of (i) non-drilled parts of a reservoir adjacent to reserves of Categories A+B within the possible extraction cone area, (ii) non-tested wells area of the reservoir if its yield was proved by testing/production from other wells (analogs).
- (d) Category C<sub>2</sub>: (inferred) reserves include: (i) parts of beyond C<sub>1</sub> provided adequate geological and geophysical information support horizon continuity, (ii) horizons whose productivity has not been proven by flow tests but is based on well logs, (iii) non-drilled fault blocks in reservoirs whose production has been successfully demonstrated but are inferred to be productive based on analogy.

Undiscovered features that have a defined chance of discovery are categorized as:

- (a) Category D1 (localized): Petroleum quantities in potentially productive formations confined to identified traps prepared for drilling. The shape, size and mode of occurrence of inferred petroleum accumulations are determined by geological and geophysical investigations, thickness and reservoir characteristics. The assumed composition and properties of the oil and gas are based on analogy with explored deposits.
- (b) Category D2: (prospective) include petroleum in litho-stratigraphic complexes and horizons whose potential has been proven for larger regional structures.
- (c) Category D3: (predicted) includes petroleum potential in large litho-stratigraphic complexes where no commercial discoveries have yet been made.

## **1. Mapping of UNFC to Russian Federation Classification for Petroleum**

Figure 12 documents the preliminary mapping of the Russian Federation classification for petroleum using the proposed UNFC definitions, based on equivalencies interpreted on the three major axes.

The apparent lack of alignment in the associated G-axis descriptions of level of confidence in the Economic Reserves class is related to a differing assessment approach. UNFC is a project-based system; once a project is categorized by its maturity, the estimates of recoverable quantities are defined as full range based on in-place and recovery efficiency uncertainty scenarios. The Russian Federation’s system is reservoir-based and would first subdivide a reservoir by geological confidence and use this as the basis for assigning project maturity. Category A reserves are only associated with producing wells. Thus for areas of the reservoir assigned to C<sub>2</sub> based on in-place uncertainty, it would not be logical to include the high confidence associated with a producing well.

Figure 12  
Preliminary mapping of Russian Federation Classification for Petroleum to UNFC

Fundamental Characterization	Groups By Economic Efficiency	Categorized by Project Maturity	Categorized by Level of Geological Assurance	UNFC E axis	UNFC F axis	UNFC G axis		
Geological (In-Place) Reserves	ECONOMIC RESERVES	On Production	A	1	1.1	1		
		Committed Development Project	B+C <sub>1</sub>		1.2		2	
		Uncommitted Development Project	C <sub>2</sub>		1.3			3
	Sub-Economic Reserves			2				
	Unrecoverable Reserves			4.1				
Geological (In-Place) Resources	Potentially Economic	Localized Recoverable	D <sub>1</sub>	3	3	4		
		Prospective Resources	D <sub>2</sub>					
		Undiscovered Resources	D <sub>3</sub>					
	Intrinsically Economic Resources							

## IV. DISCUSSION OF FEEDBACK

Following the release of the draft report of the Task Force on 9 October 2007, and the discussions at the fourth session of the Ad Hoc Group of Experts on Harmonization of Fossil Energy and Mineral Resources Terminology, on 17-19 October 2007, it was agreed to give the Ad Hoc Group of Experts time to comment on the report before its finalization. Particular attention was given to obtaining feedback from those organizations that were users of the current (2004) UNFC in order to gauge the potential impact of the proposed changes on their existing classifications.

Comments were received from organizations and individual members located in: Austria, Canada, China, Germany, Hungary, India, Poland, Russian Federation, Ukraine, United Kingdom, and United States of America.

Of those that provided feedback, China, Hungary, India, Poland and Ukraine indicated that they applied the UNFC or used mineral systems that were based on the UNFC.

Key feedback issues have been summarized in the following sections. Where a final recommendation has been developed, it is highlighted in ***bold italics***.

## A. Defining reserves and resources

The problem of clarity in defining the terms “reserves” and “resources” results in significant confusion. Although the terms are widely used in both the petroleum and minerals industries, they are subject to different definitions, interpretations, and applications. The current (2004) UNFC includes definitions of Classes using these terms, but the terms themselves were not given separate definitions, except for proved reserves, beyond the definitions of categories that identified them.

In PRMS the term “resources” is used generically and *is intended to encompass all quantities of petroleum naturally occurring on or within the earth’s crust, discovered and undiscovered, (recoverable and unrecoverable) plus those quantities already produced*. Further, it includes all types of petroleum whether currently considered “conventional” or “unconventional”. Contingent Resources and Prospective Resources are specific terms that are applied to all recoverable quantities that are not either “reserves” or “production”.

In the CRIRSCO Template, there is no definition of the term “resources”. The term “Mineral Resources” refers to *in situ quantities that have reasonable prospects for eventual economic extraction*. The term Exploration Results is considered equivalent to PRMS’ Prospective Resources, but CRIRSCO never uses the term resources associated with these Exploration Results. Both PRMS and CRIRSCO apply the term “reserves” only to commercially recoverable quantities.

The Russian Federation uses the term “In-place Resources” or “Geological Resources” to refer to deposits in the exploration phase that are “undiscovered”. It uses the term “In-place Reserves” or “Geological Reserves” to refer to discovered reservoir/deposits whether they are commercially developable or not.

The Task Force considered two options:

- (a) A revised UNFC text is developed that incorporates specific definitions of “reserves” and “resources” (modified or unmodified). Essentially, this approach recommends that the UNFC “set the standard” for these terms.
- (b) Some members consider that option (a) is impractical due to the widespread use of the terms that already exists and hence the difficulty in achieving global consensus. Their proposal is that the revised UNFC text avoid reliance on these terms and define Classes (where necessary) using simple non-technical terminology. This could serve to enhance global communications at the level of the umbrella system without compromising the very specific (and carefully defined) usage of the two terms at the detailed level of systems such as the CRIRSCO Template, the SPE-PRMS and the RF classification.

***Option (b) is recommended.***

Some members of the Task Force recommend that, in the UNFC text referring generically to “all quantities”, the phrase “reserves and resources” should be used. Other members do not support this specific recommendation.



## B. Clarifying in-place versus recoverable quantities

This issue was identified as a particularly important one for the UNFC to address in order to avoid confusion in communications.

Although there is generally an excellent correspondence between the CRIRSCO Template and SPE-PRMS in terms of the fundamental principles, there is one area in particular where the two industries deviate from each other in terms of the reported quantities for Mineral and Contingent Resources. This difference relates to the reporting of in situ quantities versus recoverable quantities, a problem that is further compounded by the fact that an in-place estimate in petroleum is generally not equivalent to an in situ estimate for Mineral Resources as defined by CRIRSCO. In addition, the UNFC is designed to provide a “mass balance” of quantities estimated to be initially in-place by classifying both expected future production and those quantities that are expected to be left in the ground. This “mass balance” is incorporated into SPE-PRMS through the classification of “Unrecoverable” quantities, but is not applied within the CRIRSCO Template.

Although Mineral Resources are estimated quantities “in the ground” they are limited to those parts of a deposit that “have reasonable prospects for eventual economic extraction”. Mineral Resources do not include parts of a deposit that are considered to be technically unrecoverable (not mineable for geological reasons), nor do they include those parts of the deposit that are below a cut-off grade and which would not (currently) be expected to be economically extractable. Hence, it is expected that the quantities defined as Mineral Resources will eventually be mined and could therefore be considered as “potentially economically recoverable”. Actual mined quantities may deviate from these quantities to some degree, but the impact varies by commodity and cannot be estimated until a reasonably detailed mine plan is available.

Although not part of the CRIRSCO Template, the mining industry also refers to “Mineral Inventory” (particularly in the coal sector). In contrast to Mineral Resources, Mineral Inventory is estimated without applying any economic (cut-off grade) constraints. The additional quantities that would be included in Mineral Inventory but not in Mineral Resources would therefore be those that are considered to be technically recoverable, but which currently do not have reasonable prospects for eventual economic extraction; these are defined as “Discovered not Economic” in section II of this report.

Thus, conceptually, Mineral Resources is that portion of in situ Mineral Inventory that is deemed eventually economically extractable and Mineral Reserves is that portion of Mineral Resources that will be recovered under a defined mine plan. While conceptually correct, it is not common for minerals evaluators to estimate in situ quantities (tonnage and grade) beyond those classified as Mineral Resources. Only Minerals Reserves are reported in terms of recoverable (“as mined”) quantities.

In petroleum, when Contingent Resources (as defined in SPE-PRMS) are estimated, a development plan is defined, at least conceptually, but as it has not yet been finalized (because of technical immaturity and/or commercial contingencies) these quantities could also be said to reflect only what is “technically recoverable”. The sub-class of Development Not Viable captures those quantities that are technically recoverable, but which (currently) do not have potential for economic recovery.

As supported by the mapping of the CRIRSCO Template and SPE-PRMS, there is a general correspondence between Mineral Resources and the more mature sub-classes of Contingent Resources. In addition, Mineral Inventory (as defined above) would seem to be roughly equivalent to all three Contingent Resource sub-classes combined (i.e. including Development Not Viable).

It is an underlying principle in PRMS that all quantities are reported in terms of petroleum products in their condition as marketed (“sales quantities”). While initially-in-place estimates are generated as the basis (in most cases) for estimating recoverable quantities, this can only be derived from reports by summing those quantities reported as recoverable with the residual defined as Unrecoverable.

There is alignment between minerals and petroleum in quantities reported as “reserves” (UNFC- F1 category); in both cases, these are recoverable sales (and non-sales if applicable) quantities. However, there is not complete alignment in other categories. Quantities reported as discovered/not commercial (F2) in minerals are not those quantities that are recoverable, but in the case of Mineral Resources are in situ potentially economically recoverable. In situ materials that do not meet Mineral Resources criteria and labelled as “Discovered Not Economic” are typically not estimated and reported. Quantities reported as discovered/not commercial (F2) in petroleum are all recoverable with the exception of F2.4 which is the residual of the initially-in-place that is not recovered by defined development programmes.

Two options have been considered, but no firm agreement has been reached as to which would be the simplest and clearest for users. The options are:

(a) To create a new Category (F4) that refers to those residual quantities located “in the ground” in accumulations/deposits for which no technically feasible development plan has been defined. In PRMS this would represent initially-in-place minus all reported recoverable quantities. As there is no equivalent to initially-in-place in the Template, and no estimates of tonnage and grade are made beyond Mineral Resources, the F4 Category would not be used.

The key advantage of this approach is that it recognizes the equivalence between Contingent Resources and Mineral Resources in terms of representing potentially recoverable quantities, and hence facilitates both being assigned to F2 and/or its sub-categories without requiring any changes to the definitions as set out in the draft Task Force report. In addition, it provides the option (but not requirement) for both petroleum and solid minerals to express quantities as in-place or (potentially) recoverable. The proposed F2.4 sub-category is not required in this option as Unrecoverable (i.e. additional quantities remaining in-place) would be uniquely defined by E3.3/F4.

However, there remains the potential for confusion in clearly identifying the basis for quantity estimates categorized as F2 (and F3) in some commodities and extraction programmes where the technically recoverable (but in situ) estimates and projections of commercially recoverable quantities are quite different.

(b) To differentiate remaining in-place (and in situ) estimates from recoverable quantities by appending an alpha character on the G-axis (e.g. G1P is high confidence in-place and G1R is high confidence recoverable (or assume R is the default and only append P for in-place (or vice versa))).

The advantage of this approach is that it allows the proposed E and F-axis definitions to remain intact. The G-axis remains an indicator of estimate uncertainty whether applied to in situ, recoverable, or remaining-in-place quantities. There is the option, but not requirement, to utilize sub-categories to report estimates of recoverable quantities.

This option would create complexity in a purely numeric designation (language independent to avoid English alphabet letters) as originally envisaged by UNFC.

***The Task Force recommends utilizing option (a) above.*** Some members have identified several caveats as set out below, but it should be noted that the following comments do not represent the views of all members of the Task Force:

*There may be circumstances where quantities reported as F2 in a minerals evaluation may not align with the sum of recoverable volumes reported in a petroleum evaluation under F2.1 to F2.3.*

*Petroleum evaluators should ensure that they fully assess potential recoverable volumes under F2.3 by applying all technically feasible development projects regardless of economic viability.*

*Notwithstanding (b), a portion of the quantities reported as Unrecoverable by petroleum evaluators may include quantities that will become recoverable in the future as technology advances.*

*Since estimates in mineral evaluations are typically confined to Mineral Resources and there is no estimate of original discovered in-place quantities, there will rarely be an accounting of additional minerals inventory or unrecoverable.*

*If minerals evaluators choose to speculate on recoverable quantities for inventories (but not public disclosures), such estimates should be sub-categorized as F2.1 – F2.3.*

### C. Accommodating national inventory approaches

The UNFC is intended to meet the diverse needs of international energy studies and policy formulations, national resource inventories, company business portfolios and financial reporting. Both PRMS and CRIRSCO are primarily viewed as systems designed to support reserves and resources management and reporting in commercial ventures, although the project-based principles of PRMS were originally developed by a national agency and have been successfully applied by them for some 15 years. Evaluators charged with maintaining national inventories of reserves and resources to support centralized long term planning may need to take a different approach in order to document the full potential of an area.

Such national inventories typically begin at the basin or play level. Proved plays are those that have been drilled/sampled to the extent that a significant accumulation has been discovered but there may not yet be any commercial development. Unproved plays are those that, based on geological analysis, could yield discoveries in the future, but there is a risk that the play will not be confirmed by discoveries. Using statistical analysis techniques, evaluators can forecast distributions of original in-place quantities, the portion of the play that will yield discoveries, the portions that will ultimately (perhaps > 50 years) be commercially developed (in addition to existing commercial and sub-commercial projects) assuming some pace of leasing and economics, and a recoverable part of the original in-place quantities. Conversions from in-place to recoverable are often based on historical analogues, possibly with some projection of new technologies.

Conceptually, this basin analysis approach can be integrated within the UNFC system where most of these projections would fall within the F2 and F3 domain. Even in the discovered/not yet developed sector, national Governments may wish to catalogue quantities that can be potentially developed if leased and funded. These may be assessed as economic (E1), but since development would be contingent on leasing, funding and the confirmation of a specific commercial development project, they would be classed as F2.

Whether the development projects are funded from the private or government sectors, or not yet funded, it remains the case that no recoverable quantities can be estimated in the absence of at least a conceptual development project. The term “project” takes on a slightly different character with different levels of maturity, but all the principles are the same.

Communications are further complicated by the fact that some national agencies refer to the total quantities as “projected reserves”, whereas the CRIRSCO and SPE systems carefully define and use the key term of “reserves” only for commercially recoverable quantities associated with a specific mine or development project (see Section IV A regarding use of terminology).

***It is felt that these types of analyses can be accommodated in the UNFC, but careful mapping is required in order to ensure an appropriate level of consistency.***

#### D. Attributing Mineral Reserves based on pre-feasibility studies

Historically, some minerals evaluators have considered that a feasibility study was required to attribute Mineral Reserves. However, even under the current (2004) UNFC, Probable Mineral Reserves could be assigned on the basis of a pre-feasibility study. The difference between the current UNFC (2004) and the proposed new definitions is that all “reserves” would now fit into F1 rather than be split between F1 and F2, thus providing alignment between the UNFC, the CRIRSCO Template and SPE-PRMS.

In addition, under CRIRSCO guidelines:

*Pre-feasibility studies will be sufficiently detailed to enable a decision to abandon or defer the project or move to the feasibility stage. Reserves are usually (but not always) publicly declared following a pre-feasibility study provided the study has adequately addressed the modifying factors and no significant impediments to development have been identified.*

Although the Template does not separate Mineral Reserves on a project status basis, CRIRSCO could, if required, assign projects based on feasibility studies to F1.1 (if extraction is underway) and F1.2 (if development is underway), but those projects for which reserves can legitimately be publicly declared following a pre-feasibility study (or a feasibility study, where appropriate) would be classed as F1.3 to denote a lower level of detail.

***The proposed UNFC generic definitions do not use the terms feasibility or pre-feasibility study, because:***

- (a) They are too specific in relation to the critical distinction that is between reserves and contingent/mineral resources; and,***
- (b) They are commodity-specific, having no meaning in most of the petroleum sector.***

The overall intent of the guidelines is to ensure that, provided studies are sufficiently complete for a company to be able to demonstrate a technically and commercially viable development project, then reserves may be attributed. F1.3 aligns with petroleum’s criteria for projects that are “Justified for Development”.

#### E. Stage of exploration versus level of confidence in estimates

While stated in several different ways, there is general discomfort among some current users of the UNFC with respect to the proposed new definitions for the G-axis categories, for example:

*G1 Quantities associated with a known deposit that can be estimated with a high level of confidence.*

Versus the prior 2004 UNFC definition:

G1 Detailed Exploration:

*Detailed exploration involves the detailed three-dimensional delineation of a known deposit achieved through sampling, such as from outcrops, trenches, boreholes, shafts and tunnels. Sampling grids are closely spaced such that size, shape, structure, grade, and other relevant characteristics of the deposit are established with a high degree of accuracy. Processing tests involving bulk sampling may be required. A decision on whether to conduct a feasibility study can be made from the information provided by detailed exploration.*

Combined with the other categories (G2: General Exploration, G3: Prospecting, G4: Reconnaissance Study) and associated wording, it is apparent that the terms were denoting both the stage of exploration and the level of confidence in the estimated quantities. The UNFC-2004 F-axis categories were more focused on the mining studies (feasibility report, etc.). Under the Task Force proposal and in order to facilitate alignment with petroleum, the F-axis would become a more explicit project maturity indicator (which includes both engineering and geosciences degree of study in an assessment of the potential for commercialization of a development project) and the G-axis is limited to an indication of the level of confidence in both the in-situ quantities (tonnage and grade) and the expected recovery efficiency of the development plan being applied.

The key criterion for each of the 2004 definitions (e.g. “high degree of accuracy” for G1) is maintained in the proposed definitions, as can be seen by reference to the table in section I.

The CRIRSCO definitions are more aligned with petroleum in terms of level of confidence, although for minerals the emphasis remains on geological studies as they relate to estimates of in situ quantities that could have potential for economic extraction.

It is noted that minerals and petroleum have very different views of recovery efficiency, due to the fact that in mining it is feasible to recover most if not all of the in situ estimate, whereas in petroleum recovery reflects the ability to get it to move through the rock formation to the producing wells, and recovery efficiency can be a very small proportion of the in-place estimate if the rock and/or fluid characteristics are not favourable.

***The proposed UNFC definitions provide G categories that are designed to accommodate both petroleum and solid minerals. While the words are different, this should not prevent alignment with assessments under UNFC-2004 mineral guidelines.***

## F. Mixing of incremental and scenario terms

In the minerals sector, quantities are always assessed in discrete “tranches”. This is completely understandable, since the commodity does not move in the sub-surface and therefore can be defined as a specific volume in three dimensions. This is referred to as the incremental approach, in that Indicated Resources are incremental (additional) to Measured Resources, for example. In petroleum, this logic has serious problems associated with it and it is becoming the dominant approach to consider scenarios as the basis for characterizing uncertainty in estimates of petroleum quantities. In this approach, typically three

scenarios, reflecting low, best and high estimates, are generated. If the development project satisfies the requirements for reserves, these three scenarios would be defined as Proved (1P), Proved plus Probable (2P) and Proved plus Probable plus Possible (3P). These estimates can then be disaggregated to provide Probable and Possible reserves, but the scenario terms have become widely accepted and are more meaningful for petroleum evaluators.

Thus, while a probable reserve under CRIRSCO is considered directly equivalent to a probable reserve under PRMS, and hence both would be coded as 112 under the proposed UNFC definitions, in the petroleum sector the wide use of 2P reserves would have to be coded as 111+112. While this creates somewhat complex tables in Annex II, it recognizes the dual approach.

## G. Maintaining simplicity in the 3D matrix approach

Several responders expressed concern as regards complicating the initial simple 3x3x4 matrix with multiple levels of sub-categories (e.g. F1.1.1.1). These have been generated as a consequence of the mapping work, and particularly with respect to PRMS, which is a system that provides a very high degree of granularity. These additional sub-categories are not defined at the generic level of the UNFC as they are considered to be commodity-specific and are not necessarily applied on a global basis. However, they are included within the mapping sections in order to (a) illustrate the relationship between the systems and (b) explicitly assign the codes to the respective definitions in order to preclude alternative applications of the same codes.

In defining classes for any revised UNFC, great care will be required to ensure that the relevant sub-categories are always clearly documented, as the high level categories may not always provide sufficient discrimination to be useful on their own.

## H. Developed and Undeveloped Reserves

In PRMS, those quantities classified as Reserves may be further allocated to Developed (Producing and Non-Producing) and Undeveloped, according to the funding and operational status of related wells and facilities. Thus, an individual project could have quantities in all of these Reserve status sub-divisions. Further, undeveloped quantities may exist in all three project maturity sub-classes of Reserves and, for each Reserve status sub-division, there is a range of uncertainty. Thus, even Developed Producing Reserves may have a Possible category based on low certainty of upside recovery.

***The Task Force recommends that such allocations be represented by assigning quantities to commodity-specific sub-categories on the F-Axis.***

While not part of the CRIRSCO Template, Developed and Undeveloped allocations are applied by some minerals companies to satisfy specific regulatory and accounting reporting requirements; sometimes it is an allocation of quantities based on the funding and operational status of the extraction programme (including facilities) being applied, whereas in other cases it is used as a project maturity indicator (i.e. the mine is developed or undeveloped).

## I. Sales and non-sales production

It is recognized that not all quantities produced/extracted will ultimately be sold in the commercial market. This term was originally introduced in UNFC to allow for quantities produced in barter economies. In petroleum, the extracted material may be consumed (lease fuel), lost (e.g. flared gas), or simply re-injected.

Petroleum tracks both raw wellhead production and sales quantities (after surface processing, lease fuel use and losses) and all reserves and resources should be quoted in terms of sales quantities at a defined transfer point. E3.1 is used to capture those remaining quantities projected to be non-sales in the development plan.

Minerals use the term Run-of-Mine to define the raw extraction in terms of tonnes and grade and this forms the basis of Mineral Reserves estimates. If there are any losses prior to on-site processing, they may be noted but are typically not significant or tracked separately. Such losses end up in tailings which may be re-worked in the future. Even if there is stockpiling, it has already been captured in Run-of-Mine production and reserves. The impact of on-site processing prior to transfer/sale (mineral processing recovery factor) is reported separately from the tonnage and grade that are reported as Mineral Reserves. ***Thus there may be no Non-sales quantities reported for Mineral Reserves.***

## J. Impact on prior applications of UNFC

The UNFC has already been adopted (or adapted) as a national system and applied to solid minerals by a number of countries including China, India, Indonesia and Ukraine. The Task Force recognized that its recommended changes could lead to some complications for existing users.

Overall, it was felt that the benefits of establishing a fully-harmonized generic classification system outweighed the disadvantages associated with change. If the proposals of the Task Force are accepted then, in order to maintain global consistency, a re-evaluation of the existing classifications would be appropriate. It is noted that any such re-evaluation should not require any re-assessment of quantities as such, but a check on the impact of the changes to the category/sub-category definitions in terms of possibly modifying the codification of the quantities in some cases. ***It is accepted that these national systems may need to be re-mapped if the UNFC is updated and the codification adjusted where required.***

## V. CONCLUSIONS AND RECOMMENDATIONS

The Mapping Task Force has reached several key conclusions and makes some specific recommendations for due consideration by the Ad Hoc Group of Experts on Harmonization of Fossil Energy and Mineral Resources Terminology.

(a) The existing category and sub-category definitions of the 2004 UNFC led to some inconsistencies when considered in the context of mapping to the CRIRSCO Template and SPE-PRMS. A key issue was the fact that a probable petroleum reserve and a probable mineral reserve mapped to different Classes in the UNFC, despite the CRIRSCO-SPE mapping work indicating a general correspondence between them. Fixing this particular issue was achieved through the use of generic definitions that reflected the general principles rather than narrow commodity-specific constraints.

(b) In order to provide an appropriate high-level system, the Task Force has also simplified all the current category and sub-category definitions, to the extent possible, to a point where they incorporate the necessary principles for all commodities, but without material deviation from their current meaning. As part of this process, the Task Force has excluded detailed and/or commodity-specific information that could be captured in commodity-specific guidelines. The Task Force also recommends removal of the text labels that were attached to the definitions in the 2004 version. These were considered unnecessary and potentially misleading.

(c) It is recommended that the proposed changes to the UNFC definitions be accepted by the Ad Hoc Group of Experts on Harmonization of Fossil Energy and Mineral Resources Terminology and a revised UNFC document be generated as soon as possible to reflect those changes.

(d) The mapping of the CRIRSCO Template and the SPE-PRMS systems against the revised definitions illustrates the high level of harmonization that has been achieved. Further, given this level of harmonization, it is envisaged that the existing guidelines for the two systems could be applied to the UNFC with little, if any, modification

(e) The mapping of the Russian Federation classification system to the proposed new UNFC definitions is considered to be only preliminary at this stage. Further discussions and interaction with the Russian experts is necessary to finalize the mapping work.

It is hoped that additional national classification systems will be mapped to a revised UNFC as soon as feasible. The onus for the mapping effort would lie with the agency that applies the classification system, but should be supported by the Ad Hoc Group of Experts. Such mappings should be formatted in a way similar to Annex II with sufficient detail to establish equivalency to UNFC categories and classes. Further indications of alignment with the CRIRSCO Template (for solid minerals) and PRMS (for petroleum) should form part of the mapping report. Any significant areas where such alignment is not feasible should be noted and the reasons for lack of alignment should be documented.

(f) It is recommended that a “working group” be established with similar membership to that of the Task Force on Mapping with a mandate to provide advice and guidance to any such mapping effort, with particular emphasis on maintaining a standardized format for the mapping document and ensuring consistency with the existing mapped systems.



## Annex I

# UNITED NATIONS FRAMEWORK CLASSIFICATION/COMMITTEE FOR MINERAL RESERVES INTERNATIONAL REPORTING STANDARDS/PETROLEUM RESOURCES MANAGEMENT SYSTEM CATEGORY DEFINITIONS

The proposed UNFC category and sub-category definitions shown here are generically applicable to both solid minerals and petroleum. Additional sub-categories beyond those shown here may be utilised for the purposes of addressing the greater granularity available in some commodity-specific systems.

Estimated quantities of a commodity are defined only by Classes, which are discrete combinations of categories or sub-categories from each of the three criteria: E, F and G. It is not meaningful, therefore, to consider quantities in the context of only one or two of these three criteria. However, it is useful to compare each of the definitions with the specific wording of systems being “mapped” to the UNFC.

The following table documents excellent alignment between the proposed UNFC definitions and the relevant aspects of the definitions and guidelines that are contained in the International Template for the Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves (the Template) maintained by the Committee for Minerals Reserves International Reporting Standards (CRIRSCO) and the Petroleum Resources Management System (PRMS) for classification and reporting of petroleum maintained by the Society of Petroleum Engineers (SPE). Annex II of this report provides more in-depth discussion of the “mapping” carried out between the Template and PRMS respectively and the proposed revised UNFC.

<b>Cat.</b>	<b>UNFC Definitions</b>	<b>CRIRSCO Template</b>	<b>SPE-PRMS</b>
<b>E1</b>	Extraction and sale is economically viable.  Refer to definitions of E1.1 and E1.2.	See mapping of sub-categories.	See mapping of sub-categories.

Cat.	UNFC Definitions	CRIRSCO Template	SPE-PRMS
E1.1	<p>Extraction and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions.<sup>1</sup> Economic viability is not affected by short-term adverse market conditions provided that longer-term forecasts remain positive.</p>	<p><b>Mineral Reserve:</b></p> <p><i>Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified.</i></p> <p><i>The term ‘economically mineable’ implies that extraction of the Mineral Reserve has been demonstrated to be viable under reasonable financial assumptions.</i></p> <p><b>Reclassification of Mineral Reserves to Mineral Resources:</b></p> <p><i>It is not intended that re-classification from Mineral Reserves to Mineral Resources or vice versa should be applied as a result of changes expected to be of a short term or temporary nature, or where company management has made a deliberate decision to operate on a non-economic basis. Examples of such situations might be commodity price fluctuations expected to be of short duration, mine emergency of a non-permanent nature, transport strike etc.</i></p>	<p><b>Determination of Commerciality (in part):</b></p> <p><i>A reasonable assessment of the future economics of such development projects meeting defined investment and operating criteria; a reasonable expectation that there will be a market for all or at least the expected sales quantities of production required to justify development; evidence that legal, contractual, environmental and other social and economic concerns will allow for the actual implementation of the recovery project being evaluated.</i></p> <p><b>Economic Limit:</b></p> <p><i>Interim negative project net cash flows may be accommodated in short periods of low product prices or major operational problems, provided that the longer-term forecasts must still indicate positive economics.</i></p>
E1.2	<p>Extraction and sale 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.</p>	<p>Not explicitly defined and therefore not reported separately.</p>	<p>Not explicitly defined and therefore not reported separately.</p>

Cat.	UNFC Definitions	CRIRSCO Template	SPE-PRMS
<b>E2</b>	<p>Extraction and sale has not yet been confirmed to be economically viable.</p> <p>Refer to definitions of E2.1 and E2.2.</p>	See mapping of sub-categories.	See mapping of sub-categories.
<b>E2.1</b>	<p>Extraction and sale has not yet been confirmed to be economic but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic extraction in the foreseeable future.</p>	<p><b>Mineral Resource:</b></p> <p><i>A concentration or occurrence of material of economic interest in or on the Earth’s crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction.</i></p>	<p><b>Economic Status:</b></p> <p><i>Marginal Contingent Resources are those quantities associated with technically feasible projects that are either currently economic or projected to be economic under reasonably forecasted improvements in commercial conditions but are not committed for development because of one or more contingencies.</i></p>
<b>E2.2</b>	<p>Extraction and sale is not economic on the basis of realistic assumptions of future market conditions, and eventual economic extraction would require a substantial improvement in market conditions.</p>	<p>Not explicitly defined since:</p> <p><i>Portions of a mineral deposit that do not have reasonable prospects for eventual economic extraction must not be included in a Mineral Resource.</i></p> <p>Currently this material, informally defined as “Discovered Not Economic” may not be publicly reported, however as with petroleum it may form part of an inventory of discovered mineralisation pending major changes in commercial conditions.</p>	<p><b>Economic Status:</b></p> <p><i>Sub-Marginal Contingent Resources are those quantities associated with discoveries for which analysis indicates that technically feasible development projects would not be economic and/or other contingencies would not be satisfied under current or reasonably forecasted improvements in commercial conditions. These projects nonetheless should be retained in the inventory of discovered resources pending unforeseen major changes in commercial conditions.</i></p>
<b>E3</b>	<p>Extraction and sale is not economic or economic viability has not yet been determined.</p> <p>Refer to definitions of E3.1, E3.2 and E3.3.</p>	See mapping of sub-categories.	See mapping of sub-categories.
<b>E3.1</b>	Extraction without sale.	Not explicitly defined.	<b>Economic Status:</b>

Cat.	UNFC Definitions	CRIRSCO Template	SPE-PRMS
			<i>Non-sales (lease fuel, flare, and losses) may be separately identified and documented in addition to sales quantities for both production and recoverable resource estimates.</i>
<b>E3.2</b>	Economic viability of extraction has not yet been determined.	<b>Exploration Results:</b>  <i>This is common in the early stages of exploration when the quantity of data available is generally not sufficient to allow any reasonable estimates of tonnage and grade to be made.</i>	<b>Economic Status:</b>  <i>Where evaluations are incomplete such that it is premature to clearly define ultimate chance of commerciality, it is acceptable to note that project economic status is “undetermined.”</i>
<b>E3.3</b>	Currently considered to have no potential for eventual economic extraction.	Not explicitly defined.  Aligns with the petroleum term “Unrecoverable”.	<b>Unrecoverable:</b>  <i>That portion of Discovered or Undiscovered Petroleum Initially-in-Place quantities which are estimated, as of a given date, not to be recoverable.</i>
<b>F1</b>	A technically and commercially feasible development project has been confirmed.  Refer to definitions of F1.1, F1.2 and F1.3.	See mapping of sub-categories.	See mapping of sub-categories.
<b>F1.1</b>	Extraction is currently taking place.	<b>Mineral Reserve:</b>  <i>Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified.</i>	<b>On Production:</b>  <i>The project is currently producing and selling petroleum to market.</i>
<b>F1.2</b>	All necessary approvals have been obtained, capital funds have been committed, and implementation of the development project is under way.	<i>Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified.</i>	<b>Approved for Development:</b>  <i>All necessary approvals have been obtained, capital funds have been committed, and implementation of the development project is under way.</i>
<b>F1.3</b>	Implementation of the development project is commercially justified and there are reasonable expectations that all	<i>The term ‘Mineral Reserves’ need not necessarily signify that extraction facilities are in place or</i>	<b>Justified for Development:</b>  <i>Implementation of the development project is justified on the basis of reasonable forecast</i>

Cat.	UNFC Definitions	CRIRSCO Template	SPE-PRMS
	<p>necessary approvals/contracts will be obtained.</p>	<p><i>operative, or that all necessary approvals or sales contracts have been received. It does signify that there are reasonable expectations of such approvals or contracts.</i></p> <p>Note: F1.1, F1.2 and F1.3 are used to provide project status sub-categories and are not explicitly distinguished in the CRIRSCO Template.</p>	<p><i>commercial conditions at the time of reporting, and there are reasonable expectations that all necessary approvals/contracts will be obtained.</i></p>
F2	<p>A potential development project has been identified, but technical and commercial feasibility has not yet been confirmed.</p> <p>Refer to definitions of F2.1, F2.2 and F2.3.</p>	<p>See mapping of sub-categories.</p>	<p>See mapping of sub-categories.</p>
F2.1	<p>Project activities are ongoing to justify development in the foreseeable future.</p>	<p><b>Mineral Resource:</b></p> <p><i>A concentration or occurrence of material of economic interest in or on the Earth's crust in such form, quality and quantity that there are reasonable prospects for eventual economic extraction.</i></p> <p><i>The term 'reasonable prospects for eventual economic extraction' implies a judgement (albeit preliminary) by the Competent Person in respect of the technical and economic factors likely to influence the prospect of economic extraction, including the approximate mining parameters. In other words, a Mineral Resource is not an inventory of all mineralisation drilled or sampled, regardless of cut-off grade, likely mining dimensions, location or continuity. It is a realistic inventory of mineralisation which, under</i></p>	<p><b>Development Pending:</b></p> <p><i>A discovered accumulation where project activities are ongoing to justify commercial development in the foreseeable future.</i></p>

Cat.	UNFC Definitions	CRIRSCO Template	SPE-PRMS
<b>F2.2</b>	Project activities are on hold and/or where justification as a commercial development may be subject to significant delay.	<p><i>assumed and justifiable technical and economic conditions, might, in whole or in part, become economically extractable.</i></p> <p><i>Interpretation of the word ‘eventual’ in this context may vary depending on the commodity or mineral involved. For example, for some coal, iron ore, bauxite and other bulk minerals or commodities, it may be reasonable to envisage ‘eventual economic extraction’ as covering time periods in excess of 50 years. However for many gold deposits, application of the concept would normally be restricted to perhaps 10 to 15 years, and frequently to much shorter periods of time.</i></p> <p>Note: F2.1 and F2.2 are used to provide project status sub-categories and are not explicitly distinguished in the CRIRSCO Template.</p>	<p><b>Development Unclarified or On Hold:</b></p> <p><i>A discovered accumulation where project activities are on hold and/or where justification as a commercial development may be subject to significant delay.</i></p>
<b>F2.3</b>	There are no current plans to develop or to acquire additional data at the time due to limited potential.	<p>Not explicitly defined since:</p> <p><i>Portions of a mineral deposit that do not have reasonable prospects for eventual economic extraction must not be included in a Mineral Resource.</i></p> <p>Aligns with the informally defined term “Discovered Not Economic”.</p>	<p><b>Development Not Viable:</b></p> <p><i>A discovered accumulation for which there are no current plans to develop or to acquire additional data at the time due to limited production potential.</i></p>
<b>F3</b>	Project evaluation is at too early a stage to determine technical and commercial feasibility.	<p><b>Exploration Results:</b></p> <p><i>This is common in the early stages of exploration when the quantity of data available is generally not sufficient to allow any reasonable estimates of tonnage and grade to be made.</i></p>	<p><b>Prospective Resources:</b></p> <p><i>It is recognised that the development programs will be of significantly less detail and depend more heavily on analog developments in the early phases of exploration.</i></p>

Cat.	UNFC Definitions	CRIRSCO Template	SPE-PRMS
F4	Remaining in-place quantities that are currently considered to be technically unrecoverable.	Not explicitly defined.  Aligns with the petroleum term “Unrecoverable”.	<b>Unrecoverable:</b>  <i>That portion of Discovered or Undiscovered Petroleum Initially-in-Place quantities which are estimated, as of a given date, not to be recoverable.</i>
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	<b>Measured Mineral Resource:</b>  <i>That part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence.</i>	<b>Low Estimate:</b>  <i>This is considered to be a conservative estimate of the quantity that will actually be recovered from the accumulation by a project. If probabilistic methods are used, there should be at least a 90% probability (P90) that the quantities actually recovered will equal or exceed the low estimate.</i>  Note: In SPE-PRMS, this estimate is usually quoted as a 1P or 1C scenario, which aligns with G1.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.	<b>Indicated Mineral Resource:</b>  <i>That part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence.</i>	<b>Best Estimate:</b>  <i>This is considered to be the best estimate of the quantity that will actually be recovered from the accumulation by the project. It is the most realistic assessment of recoverable quantities if only a single result were reported. If probabilistic methods are used, there should be at least a 50% probability (P50) that the quantities actually recovered will equal or exceed the best estimate.</i>  Note: In SPE-PRMS, this estimate is usually quoted as a 2P or 2C scenario, which aligns with G1+G2.

Cat.	UNFC Definitions	CRIRSCO Template	SPE-PRMS
<b>G3</b>	Quantities associated with a known deposit that can be estimated with a low level of confidence.	<p><b>Inferred Mineral Resource:</b></p> <p><i>That part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence.</i></p>	<p><b>High Estimate:</b></p> <p><i>This is considered to be an optimistic estimate of the quantity that will actually be recovered from an accumulation by a project. If probabilistic methods are used, there should be at least a 10% probability (P10) that the quantities actually recovered will equal or exceed the high estimate.</i></p> <p>Note: In SPE-PRMS, this estimate is usually quoted as a 3P or 3C scenario, which aligns with G1+G2+G3.</p>
<b>G4</b>	Estimated quantities associated with a potential deposit, based primarily on indirect evidence.	<p><b>Exploration Results:</b></p> <p><i>Include data and information generated by exploration programmes that may be of use to investors but which may not be part of a formal declaration of Mineral Resources or Mineral Reserves. This is common in the early stages of exploration when the quantity of data available is generally not sufficient to allow any reasonable estimates of tonnage and grade to be made. Examples include discovery outcrops, single drill hole intercepts or the results of geophysical surveys.</i></p>	<p><b>Prospective Resources:</b></p> <p><i>Those quantities of petroleum which are estimated, as of a given date, to be potentially recoverable from undiscovered accumulations.</i></p> <p>Note: SPE-PRMS recommends the reporting of Low, Best and High estimates for Prospective Resources conditional on chance of discovery.</p>



## Annex II

# MAPPING OF PETROLEUM (PETROLEUM RESOURCES MANAGEMENT SYSTEM) AND MINERALS (COMMITTEE FOR MINERAL RESERVES INTERNATIONAL REPORTING STANDARDS) RESERVES AND RESOURCES DEFINITIONS

SPE/WPC/AAPG/SPEE 2007 PRMS	CRIRSCO 2006 Template	Comments
<p><b>Reserves</b> – those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions. Reserves must satisfy four criteria: they must be discovered, recoverable, commercial, and remaining based on the development project(s) applied. Reserves are further subdivided in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by their development and production status. To be included in the Reserves class, a project must be sufficiently defined to establish its commercial viability. There must be a reasonable expectation that all required internal and external approvals will be forthcoming, and there is evidence of firm intention to proceed with development within a reasonable time frame.</p> <p>A reasonable time frame for the</p>	<p>A “<b>Mineral Reserve</b>” is the economically mineable part of a Measured and/or Indicated Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined. Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors (the Modifying Factors). These assessments demonstrate at the time of reporting that extraction could reasonably be justified. Mineral Reserves are subdivided in order of increasing confidence into Probable Mineral Reserves and Proved Mineral Reserves.</p>	<p>Mineral and Petroleum reserves are essentially the same in that they have been discovered; remain available for extraction (i.e. not already extracted), and they are recoverable, meaning that the technology is available and validated to extract the useful mineral from the ground and by subsequent processing, where necessary, yield a marketable product. The difference between ‘economically mineable’ and ‘commercial’ is one of timing and intent, with the petroleum guidelines requiring firm commitment to initiate development within a “reasonable” timeframe (e.g. 5 years); minerals guidelines do not explicitly set a time constraint.</p> <p>To be designated as economic or commercial, and thus reserves, projects in both industries must satisfy a series of conditions regarding their technical, economic and legal status, for example, obtaining, or having a reasonable expectation of obtaining, environmental and other permits. In mining these are called the</p>

SPE/WPC/AAPG/SPEE 2007 PRMS	CRIRSCO 2006 Template	Comments
<p>initiation of development depends on the specific circumstances and varies according to the scope of the project. While five years is recommended as a benchmark, a longer time frame could be applied where, for example, development of economic projects are deferred at the option of the producer for, among other things, market-related reasons, or to meet contractual or strategic objectives. In all cases, the justification for classification as Reserves should be clearly documented.</p> <p>To be included in the Reserves class, there must be a high confidence in the commercial producibility of the reservoir as supported by actual production or formation tests. In certain cases, Reserves may be assigned on the basis of well logs and/or core analysis that indicate that the subject reservoir is hydrocarbon bearing and is analogous to reservoirs in the same area that are producing or have demonstrated the ability to produce on formation tests.</p>		<p>Modifying Factors, in petroleum these are called contingencies.</p> <p>Mineral Reserves are derived from Mineral Resources: Mineral Resources minus losses (e.g. pillars) + dilution (e.g. material below cut-off grade) = Mineral Reserves. Mineral Reserves are typically estimated in terms of tonnage of ore delivered from the mine with an associated grade being the concentration of the economic product (e.g. copper) which can be recovered after smelting/refining. Disclosures of Mineral Reserves must include a discussion of the Modifying Factors and in particular recovery factors that can be applied to reserves to obtain Sales Quantities. Best practice is to include Sales Quantities in the reserve statement.</p> <p>Petroleum is typically delivered as a more refined product (e.g. dry methane gas with very minor non-hydrocarbons), and this delivery specification becomes the basis of Reserves.</p>
<p><b>Proved Reserves</b> – those quantities of petroleum, which by analysis of geoscientific and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known reservoirs and under defined economic conditions, operating methods, and government regulations.</p> <p>If deterministic methods are used, the term reasonable certainty is intended to express a high degree of confidence that the quantities will be</p>	<p>A “<b>Proved Mineral Reserve</b>” is the economically mineable part of a Measured Mineral Resource. It includes diluting materials and allowances for losses, which may occur when the material is mined. Studies to at least pre-feasibility level will have been carried out, including consideration of, and modification by, realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors (the Modifying Factors). These studies demonstrate</p>	<p>Proved Mineral Reserves can only be derived from Measured Mineral Resources, which represent material in the ground with the highest degree of geological confidence. Petroleum Proved Reserves represent the recoverable volumes of greatest geological and engineering (recovery efficiency) certainty.</p> <p>Minerals are generally solid and must be explored (drilled) in greater detail to determine available quantities and grades on a local basis, whereas conventional oil and</p>

SPE/WPC/AAPG/SPEE 2007 PRMS	CRIRSCO 2006 Template	Comments
<p>recovered. If probabilistic methods are used, there should be at least a 90% probability that the quantities actually recovered will equal or exceed the estimate.</p>	<p>at the time of reporting that extraction is justified.</p>	<p>gas are mobile and will flow towards an extraction well and thus require less dense sampling. Mineral Reserves estimators tend to rely on deterministic methods more than probabilistic (see Appendix B). Notwithstanding this difference in assessment methods, when all of the Modifying Factors or contingencies have been satisfied, the resulting Proved and Probable Reserves represent essentially same level of confidence in both industries.</p>
<p><b>Probable Reserves</b> – those additional Reserves which analysis of geoscientific and engineering data indicate are less likely to be recovered than Proved Reserves but more certain to be recovered than Possible Reserves.</p> <p>It is equally likely that actual remaining quantities recovered will be greater than or less than the sum of the estimated Proved plus Probable Reserves (2P). In this context, when probabilistic methods are used, there should be at least a 50% probability that the actual quantities recovered will equal or exceed the 2P estimate.</p>	<p>A “<b>Probable Mineral Reserve</b>” is the economically mineable part of an Indicated, and in some circumstances, a Measured Mineral Resource, where the Modifying Factors (see below) are uncertain. It includes diluting materials and allowances for losses which may occur when the material is mined. Studies to at least pre-feasibility level will have been carried out, including consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors (the Modifying Factors). The results of the studies demonstrate at the time of reporting that extraction could reasonably be justified.</p>	<p>Probable Mineral Reserves are derived from Indicated Mineral Resources, which are generally geologically well defined but to a lesser degree than Measured. This lower level of confidence; which mining describes as ‘reasonable’ as opposed to high, cannot be changed when the material is converted to a Mineral Reserve. Petroleum Probable Reserves similarly have a lower level of confidence than Proved due primarily to technical uncertainties (in-place quantities and recovery efficiency) but may also be influenced by commercial issues.</p> <p>In both industries the sum of Proved plus Probable is considered the evaluator’s best estimate of the remaining recoverable quantities using the information available at the time the estimate is made.</p>
<p><b>Possible Reserves</b> – those additional reserves which analysis of geoscientific and engineering data indicate are less likely to be recoverable than Probable Reserves.</p> <p>The total quantities ultimately recovered from the project have a</p>	<p>There is no direct equivalent of Possible Reserves in the CRIRSCO classification.</p>	<p>The Minerals industry does not have a category of Possible Reserves. This follows from the notes above on the confidence of the underlying geological information. The nearest equivalent to Possible Reserves is Inferred Resources, where the geological certainty is inadequate to</p>

<b>SPE/WPC/AAPG/SPEE 2007 PRMS</b>	<b>CRIRSCO 2006 Template</b>	<b>Comments</b>
<p>low probability to exceed the sum of Proved plus Probable plus Possible (3P) which is equivalent to the high estimate scenario. When probabilistic methods are used, there should be at least a 10% probability that the actual quantities recovered will equal or exceed the 3P estimate.</p>		<p>apply the Modifying Factors and arrive at a meaningful reserve estimate. In Petroleum, 3P Reserves are the upside potential of quantities recovered by a defined project that satisfies Reserves class criteria, in particular economic, recoverable and commercial at the time of estimation.</p>
<p><b>Contingent Resources</b> – Those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects, but which are not currently considered to be commercially recoverable due to one or more contingencies.</p> <p>Contingent Resources may include, for example, projects for which there are currently no viable markets, or where commercial recovery is dependent on technology under development, or where evaluation of the accumulation is insufficient to clearly assess commerciality. Contingent Resources are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by their economic status.</p>		<p>Mineral Resources are essentially similar to Marginal Contingent Resources (see below) in that they are waiting for something to happen before they can be converted into reserves. This may simply mean that studies of the Modifying Factors have not been undertaken or completed, or it may mean that economic conditions have to change to some extent to enable the conversion to take place. In general there will be a realistic expectation that these conditions will eventually be met.</p> <p>Petroleum Contingent Resources include all discovered quantities but are subsequently subdivided according to commercial status (marginal, sub-marginal) and project maturity. There is no CRIRSCO Template equivalent to Sub-marginal Contingent Resources, although companies often maintain internal non-reportable mineral inventories of material for which the conversion to reserves is currently deemed unlikely.</p>
<p><b>Marginal Contingent Resources</b> – Those quantities associated with technically feasible projects that are either currently economic or projected to be economic under reasonably forecasted improvements</p>	<p>A “<b>Mineral Resource</b>” is a concentration or occurrence of material of economic interest in or on the Earth’s crust in such form, quality and quantity that there are reasonable prospects for eventual</p>	<p>Mineral Resources are estimates of the tonnage and grade of mineralization in the ground before mining and processing adjustments are made. Petroleum resources are always considered as saleable</p>

SPE/WPC/AAPG/SPEE 2007 PRMS	CRIRSCO 2006 Template	Comments
<p>in commercial conditions but are not committed for development because of one or more contingencies.</p>	<p>economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, estimated or interpreted from specific geological evidence, sampling and knowledge. Mineral Resources are subdivided, in order of increasing geological confidence into Inferred, Indicated and Measured categories.</p>	<p>product, i.e. what is sold to customers after extraction from the ground and any processing to make a product or products. Apart from this distinction, the concepts are similar, with Contingent Resources being a precursor to Reserves dependent, or contingent, upon addressing the factors required for the conversion to take place.</p> <p>Contingent Resources are subdivided into Marginal and Sub-Marginal. Marginal implies that the material has, in minerals terminology, “reasonable prospects for eventual economic extraction”.</p>
<p><b>Sub-Marginal Contingent Resources</b> – Those quantities associated with discoveries for which analysis indicates that technically feasible development projects would not be economic and/or other contingencies would not be satisfied under current or reasonably forecasted improvements in commercial conditions. These projects nonetheless should be retained in the inventory of discovered resources pending unforeseen major changes in commercial conditions.</p>	<p>No formalized direct equivalent class, or sub-class, is defined by CRIRSCO. Informally these are referred to as “Discovered Not Economic”.</p>	<p>CRIRSCO’s classification does not include provision for the public reporting of mineralization that does not have reasonable prospects for eventual economic extraction, even though it may be discovered. In order to become economic, a significant shift might be needed in the price, or new technology may be needed to viably process the material. In such cases where there is little likelihood of this happening in the foreseeable future, then the material is maintained in an internal inventory of opportunities but not publicly disclosed.</p>
<p><b>C1</b> – Category criteria are identical to those of Proved Reserves conditional on meeting Reserves class criteria.</p> <p>If deterministic methods are used, there should be a high degree of confidence that the C1 quantities will be recovered. If probabilistic methods are used, there should be at least a 90% probability that the</p>	<p>A “<b>Measured Mineral Resource</b>” is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a high level of confidence. It is based on detailed and reliable exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches,</p>	<p>Measured Mineral Resources meet the criteria of a high degree of confidence in the geologic characteristics of the mineralization, with the continuity of both ore-body geometry and grade being demonstrated by detailed exploration.</p> <p>Both Measured Mineral Resources and C1 Contingent Resources</p>

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<p>quantities actually recovered will equal or exceed the 1C estimate.</p>	<p>pits, workings and drill holes. The locations are spaced closely enough to confirm geological and grade continuity.</p>	<p>require conditions to be favourable before conversion to Proved Reserves. In the case of minerals these are the successful application of the Modifying Factors (including adjustments for losses and dilution); in the case of C1 resources, it is satisfying the contingencies.</p>
<p><b>C2</b> – Category criteria are identical to those of Probable Reserves conditional on meeting Reserves class criteria.</p> <p>It is equally likely that actual remaining quantities recovered will be greater than or less than the 2C estimate. In this context, when probabilistic methods are used, there should be at least a 50% probability that the actual quantities recovered will equal or exceed the 2C estimate.</p>	<p>An “<b>Indicated Mineral Resource</b>” is that part of a Mineral Resource for which tonnage, densities, shape, physical characteristics, grade and mineral content can be estimated with a reasonable level of confidence. It is based on exploration, sampling and testing information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes. The locations are too widely or inappropriately spaced to confirm geological and/or grade continuity but are spaced closely enough for continuity to be assumed.</p>	<p>In the terminology used by CRIRSCO, Indicated Mineral Resources can be converted to Probable Mineral Reserves conditional on meeting Reserves class criteria, which means successful application of the Modifying Factors (including adjustments for losses and dilution).</p> <p>The contingencies that must be satisfied to convert Petroleum’s C2 Contingent Resources to Probable Reserves are broadly similar to the Mineral’s Modifying Factors.</p>
<p><b>C3</b> – Category criteria are identical to those of Possible Reserves conditional on meeting Reserves class criteria.</p> <p>The total quantities ultimately recovered from the project have a low probability to exceed the 3C estimate which is equivalent to the high estimate scenario. When probabilistic methods are used, there should be at least a 10% probability that the actual quantities recovered will equal or exceed the 3C estimate.</p>	<p>An “<b>Inferred Mineral Resource</b>” is that part of a Mineral Resource for which tonnage, grade and mineral content can be estimated with a low level of confidence. It is inferred from geological evidence, sampling and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which is limited or of uncertain quality and reliability.</p>	<p>The Petroleum class C3 is based on the upside potential of an identified reservoir, where additional oil or gas may be recovered. The likelihood of this happening is given a low but quantifiable probability. This is essentially the same as an Inferred Mineral Resource although the relationship of Inferred to the next confidence level of Indicated is different.</p> <p>Inferred Mineral Resources generally represent the first point at which data are adequate to describe a mineralised volume, tonnage and grade. In order to become a reserve, Inferred Resources must first be upgraded to Indicated Resources by</p>

SPE/WPC/AAPG/SPEE 2007 PRMS	CRIRSCO 2006 Template	Comments
		<p>more sampling (drilling). This is because the ore body geometry, grade and continuity of Inferred Mineral Resources is inadequate to permit application of the Modifying Factors.</p> <p>However, Petroleum C3 Contingent Resources can be converted to Possible Reserves when a project satisfies the contingent conditions and the level of confidence remains low, consistent with the lack of input data.</p>
<p><b>Prospective Resources</b> – Those quantities of petroleum which are estimated, as of a given date, to be potentially recoverable from undiscovered accumulations.</p> <p>Potential accumulations are evaluated according to their chance of discovery and, assuming a discovery, the estimated quantities that would be recoverable under defined development projects. It is recognized that the development programs will be of significantly less detail and depend more heavily on analog developments in the earlier phases of exploration.</p>	<p>Exploration Results include data and information generated by exploration programmes that may be of use to investors but which may not be part of a formal declaration of Minerals Resources or Mineral Reserves.</p> <p>It should be made clear in public reports that contain Minerals Exploration results that it is inappropriate to use such information to derive estimates of tonnage and grade.</p>	<p>Mineral Exploration Results generally consist of ‘points’ of data; for example mineralized intersection in an isolated drill hole or a sample taken from a surface rock exposure. The information may be encouraging but is insufficient to enable a geological model to be constructed or for a resource volume (tonnage) and grade to be estimated. Exploration Results are the nearest equivalent in the CRIRSCO classification to the petroleum industry’s “undiscovered accumulations”.</p> <p>The petroleum industry goes beyond what minerals would normally do (at least in public) in assessing the likelihood of discovery and the potential recoverable quantities conditional on discovery and development. These forecasts by petroleum companies, in common with any made by minerals companies, are likely to guide further exploration rather than form a fundamental part of the business valuation.</p>

## Annex III

### Comparison of terms used in petroleum and minerals evaluations

The following compares terms commonly used in reserves and resources assessment and reporting by the petroleum and minerals industry.

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
Accumulation	An individual body of naturally occurring petroleum in a reservoir. (also called a deposit)		See Mineralization
Aggregation	The process of summing reservoir (or project) level estimates of resource quantities to higher levels or combinations such as field, country or company totals. Arithmetic summation of incremental categories may yield different results from probabilistic aggregation of distributions. Reserves in different categories and/or classes should not be aggregated without due consideration of their associated confidence levels and the varying degrees of technical and commercial risk involved in their classification.		Mineral Reserves and Resources are reported on a mine-by-mine basis. If aggregated, categories would be arithmetically summed by category. Mineral Resources are separately stated from Mineral Reserves. In some jurisdictions, Inferred Mineral Resources must be stated separately (and not added to) Measured + Indicated Mineral Resources.



TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
Beneficiation		Physical and/or chemical separation of constituents of interest from a larger mass of material. Examples include screening, flotation, magnetic separation, leaching, washing, roasting etc.	Equivalent in petroleum would be processing to remove non-hydrocarbons.
Beneficiation Plant		Treatment facility that removes gangue and waste rock from run-of-mine ore, to produce a saleable product or a concentrate that will be purified in a smelter/refinery.	Except for some coal and industrial minerals projects, most mines have beneficiation plants.
Best Estimate	With respect to resource categorization, this is considered to be the best estimate of the quantity that will actually be recovered from the accumulation by the project. It is the most realistic assessment of recoverable quantities if only a single result were reported. If probabilistic methods are used, there should be at least a 50% probability (P50) that the quantities actually recovered will equal or exceed the best estimate.		While the term is not commonly used in the mineral industry, there is a similar concept that the sum of Proved and Probable Mineral Reserves represents the best estimate of the remaining recoverable run-of-mine quantities from a mining project based on the data available to make the estimate and Life-of-Mine plan.
Commercial	When a project is commercial, this implies that the essential social, environmental and economic conditions are met, including political, legal, regulatory and contractual conditions. In addition a project is commercial if the degree of commitment is such that the accumulation is expected to be developed and placed on production within a reasonable time frame.		Generally equivalent to “economic” in minerals. Concept in the minerals industry would be a combination of meeting economic hurdles and satisfying other Modifying Factors. Commitment (intent to mine) is not required to declare Mineral Reserves, although there is an expectation that a company could make a commitment to develop a mine if it wished to do so.

TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
Contingencies	The economic, marketing, legal, environmental, social, and governmental factors forecast to exist and impact the project during the time period being evaluated.		Generally the petroleum industry’s contingencies are equivalent to the mineral industry’s “Modifying Factors”.
Conventional Resources	Conventional resources exist in discrete petroleum accumulations related to localized geological structural features and/or stratigraphic conditions, typically with each accumulation bounded by a down-dip contact with an aquifer, and which is significantly affected by hydrodynamic influences such as buoyancy of petroleum in water.		There is no equivalent terminology used in the minerals industry.
Current Economic Conditions	Establishment of current economic conditions should include relevant historical petroleum prices and associated costs and may involve a defined averaging period. The SPE guidelines recommend that a one-year historical average of costs and prices should be used as the default basis of “constant case” resources estimates and associated project cash flows. Regulatory agencies may apply alternative definitions.		As utilized in reporting of Mineral Reserves under SEC Industry Guide 7, SEC staff opinion has defined current conditions as based on a three-year historical average. In other jurisdictions, appropriate economic conditions are determined by the Competent Person and may involve forward-looking assumptions on process, costs and exchange rates.
Cut off Grade		The lowest grade, or quality, of mineralized material that qualifies as economically mineable and available in a given deposit. May be defined on the basis of economic evaluation, or on physical or chemical attributes that define an acceptable product specification. The cut-off grade may vary with the time period or location within the mineral deposit.	As part of the evaluation process, petroleum teams may also apply cut offs in terms of gross reservoir thickness, net to gross ratio, porosity/permeability, hydrocarbon saturation, etc. to isolate zones that can be commercially developed.

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
Competent Person		Must have at least five years experience in deposit type or applicable related deposit type and be a member of a professional self-regulating organization with a code of ethics and disciplinary powers.	Petroleum uses the term Qualified Reserves Evaluator (QRE) (refer to SPE “Standards Pertaining to the Estimating and Auditing of Oil and Gas Reserve Information”). A Competent Person must be a member of a Self-Regulating Organization (SRO); while this is not a requirement for a QRE, many evaluators are licensed by government agencies.
Deterministic Estimate	The method of estimation of Reserves or Resources is called deterministic if a discrete estimate(s) is made based on known geoscientific, engineering, and economic data.		Similar concept in minerals evaluations.
Developed	Developed Reserves are expected quantities to be recovered from existing wells and facilities.		Petroleum facility capital costs are depreciated based on Developed Reserves. Some mining companies categorize reserves as Undeveloped, Partly Developed, or Fully Developed for internal planning purposes (e.g. Zambian Copperbelt).
Development Plan	The design specifications, timing and cost estimates of the development project including, but not limited to, well locations, completion techniques, drilling methods, processing facilities, transportation and marketing.		Also termed Plan of Development (POD). Generally equivalent to a pre-feasibility or feasibility study in the minerals industry.
Dilution		Those portions of ore below cut off grade and waste rock that are included in run-of-mine tonnage that can not be segregated because of irregularities in	The term is not used in petroleum for reserves estimates; the closest analogy would be the water-cut in raw production. Note

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
		contacts (planned dilution) or through failure to follow ore control limits or stope boundaries during extraction (unplanned dilution).	that a similar term “diluent” refers to condensate or other light hydrocarbons used to dilute heavy oil to decrease viscosity for pipeline transport.
Economic	In relation to petroleum Reserves and Resources, economic refers to the situation where the income from an operation exceeds the expenses involved in, or attributable to, that operation.		In both industries, at a minimum, exploitation of reserves must result in positive cash flow; for new projects NPV, IRR, payback period etc. hurdles must be met.
Economically Mineable		Extraction of the Mineral Reserve has been demonstrated to be viable under reasonably assumed financial assumptions.	
Economic Limit	Economic limit is defined as the production rate beyond which the net operating cash flows (after royalties or share of production owing to others) from a project, which may be an individual well, lease, or entire field, are negative.		In the minerals industry broadly equivalent to end of Life-of-Mine plan to exploit Mineral Reserves.
Entitlement	That portion of future production (and thus resources) legally accruing to a lessee or contractor under the terms of the development and production contract with a lessor.		Similar concept used in minerals industry.
Evaluation	The geoscientific, engineering, and associated studies, including economic analyses, conducted on a petroleum exploration, development or producing project resulting in estimates of the quantities that can be recovered and sold and the associated cash flow under defined forward conditions.		Generally equivalent to a pre-feasibility or feasibility study in the minerals industry.

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
Feasibility study		A feasibility study is a comprehensive study of a mineral deposit in which all geological, engineering, legal, operating, economic, social, environmental and other relevant factors are considered in sufficient detail that it could reasonably serve as the basis for a final decision by a financial institution to finance the development of the deposit for mineral production.	In petroleum, this is generally referred to as a development plan and associated evaluation where the detail is appropriate to the project maturity.
Field	An area consisting of a single reservoir or multiple reservoirs all grouped on, or related to, the same individual geological structural feature and/or stratigraphic condition. There may be two or more reservoirs in a field that are separated vertically by intervening impermeable rock, laterally by local geologic barriers, or both. The term may be defined differently by individual regulatory authorities.		Generally equivalent to a mine. One or multiple projects may be applied to a field or area of mineralization to recover quantities of economic interest.
Forecast Case	Modifier applied to project resources estimates and associated cash flow when such estimates are based on those conditions (including costs and product price schedules) forecast by the evaluator to reasonably exist throughout the life of the project. Inflation or deflation adjustments are made to costs and revenues over the evaluation period.		In most jurisdictions, appropriate economic conditions in minerals evaluations are determined by the Competent Person and typically involve forward-looking assumptions on prices, costs and exchange rates.
Gangue		Material that is intimately mixed with minerals of commercial interest.	In most cases, gangue is removed in beneficiation plants after mining.
Grade		Any physical or chemical	In mining this is typically

TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
		measurement of the characteristics of the material of interest in samples or product. Note that the term quality has special meaning for diamonds and other gemstones. (Also termed quality, assay or analysis value).	expressed as an estimated concentration of valued product (e.g. % Cu, g/t Au, cts/t diamonds) in the reported tonnage. Petroleum quantities are reported assuming 100% grade (according to sales product specifications).
High Level of Confidence		In the minerals industry high level of confidence is restricted to Measured Resources/Proved Reserves. The Competent Person is encouraged to discuss and to quantify risk to the extent possible.	“High level of confidence” as used in the CRIRSCO guidelines is considered to (broadly) equate with “Reasonable certainty” as used in the petroleum industry.
Life-of-Mine (LOM) Plan		A plan showing the spatial location of development (underground access), ore and waste (open-pit stripping) production increments (typically annual). The plan should include a description of all the human resources and equipment resources required and cash flow statements demonstrating the project or operation to be economic. Typically the plan will be accompanied by design criteria in terms of applicable Modifying Factors and a risk analysis including measures to be taken to mitigate risk. Pre-feasibility and feasibility studies will include life-of-mine plans. The Life-of-Mine planned tonnages and grades should constitute the Mineral Reserve.	Generally equivalent to petroleum’s Plan of Development – see Development Plan.  In some jurisdictions, Inferred Mineral Resources may be included in Life-of-Mine plans, but these Inferred Resources may not be included in Mineral Reserves.
Losses		That ore that meets economic cut offs but is not recovered in run-of-mine tonnage due to mine	If the pillars can be recovered through subsequent mining, they

TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
		design versus irregularities in mineralization; may include pillars in underground mines, and allowances for incomplete extraction of material within ore control limits or stope boundaries.	<p>may remain classed as Mineral Resources.</p> <p>In petroleum losses typically refers to oil or gas that is produced but subsequently lost in surface processing (see Non-sales Quantities).</p>
Measurement	The process of establishing quantity (volume or mass) and quality of petroleum products delivered to a reference point under conditions defined by delivery contract or regulatory authorities.		Equivalent in mining industry to tonnage and grade estimation.
Mine		An industrial facility at which minerals are removed from the ground. Includes a means of access to the minerals in situ.	<p>May exploit single or multiple ore bodies or deposits of mineralization. Usually accompanied by treatment plants, although a single treatment plant may serve more than one mine, and a mine may deliver production to more than one treatment plant. Broadly equivalent to field in petroleum industry.</p>
Minerals		Minerals (sometimes referred to as solid minerals) are naturally occurring materials in or on the earth's crust that include metallic ores, other industrial minerals (non-metallic minerals, aggregates), gemstones, uranium, and fossilized organic material (coal).	<p>In this context, Mineral Resources and Mineral Reserves are valuable commodities that can be extracted from the earth's crust, processed if necessary, and sold.</p> <p>Oil shale and oil (bitumen) sands are sometimes treated as minerals and sometimes treated as petroleum depending on the jurisdiction in which they occur.</p>

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
Mineralization		Any single mineral or combination of minerals occurring in a mass, or deposit, of economic interest. The term is intended to cover all forms in which mineralization might occur, whether by class of deposit, mode of occurrence, genesis or composition.	The term does not imply any measure of volume or tonnage, grade or quality and is thus not part of a Mineral Resource under the CRIRSCO Template. In petroleum, the equivalent term may be a prospect or lead.
Mining		All activities related to extraction of metals, minerals and gemstones from the earth, whether surface or underground, and by any method (e.g. quarries, open cast, open cut, solution mining, dredging etc.); also referred to as quarrying.	In petroleum would be referred to as a development project consisting of wells and related facilities, or mines in case of oil shale or oil sands project if applicable.
Modifying Factors		The term 'Modifying Factors' is defined to include mining, metallurgical, economic, marketing, legal, environmental, social and governmental considerations.	Generally equivalent to the term "Contingencies" in petroleum evaluations.
Non-sales Quantities	Those quantities that have been, or are expected to be produced but not sold. This may include quantities that either have been or are expected to be used in the production process, such as fuel gas, plus those quantities that are removed or lost during the production process.		Generally equivalent to metallurgical losses in the minerals industry.
Ore		Mixture of minerals containing valuable commodity and gangue or waste; must meet cut off grade for Mineral Reserves.	Also equivalent to run-of-mine material that will be beneficiated or sold (industrial minerals, coal).
Petroleum	Petroleum is defined as a naturally occurring mixture consisting of hydrocarbons in the gaseous, liquid, or solid phase.		Petroleum may also contain non-hydrocarbon compounds, common examples of which are



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			carbon dioxide, nitrogen, hydrogen sulphide, or sulphur. In rare cases non-hydrocarbon content could be greater than 50%.
Petroleum Initially-in-Place	Petroleum Initially-in-Place is the total quantity of petroleum that is estimated to exist originally in naturally occurring reservoirs. Crude Oil-in-place, Natural Gas-in-place and Natural Bitumen-in-place, are defined in the same manner. (Also referred as Total Resource Base or Hydrocarbon Endowment).		Minerals equivalent would be the Resource Base of USGS. However Resource Base is a superset of the CRIRSCO reporting Template, i.e. it includes mineralization for which there are no reasonable prospects for eventual extraction.
Pre-feasibility study		A pre-feasibility study is a comprehensive study of the viability of a mineral project that has advanced to a stage where the mining method, in the case of underground mining, or the pit configuration, in the case of an open pit, has been established, where an effective method of mineral processing has been determined, and includes a financial analysis based on reasonable assumptions of technical, engineering, legal, operating and economic factors and evaluation of other relevant factors which are sufficient for a Competent Person, acting reasonably, to determine if all or part of the Mineral resource may be classified as a Mineral Reserve.	In petroleum, this is generally referred to as a development plan (or Plan of Development) where the detail is appropriate for the project maturity.
Probabilistic Estimate	The method of estimation of Resources is called probabilistic when the known geoscientific, engineering, and economic data are used to	Not formally recognized by CRIRSCO	Can be applied at the local scale in minerals to estimate the frequency distribution of tonnage and grade within a

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
	generate a continuous range of estimates and their associated probabilities.		local area. Tonnages and grades above cut off can be accumulated to estimate Mineral Resources and Reserves. The tonnages present at specified probability thresholds are not estimated.
Production	Production is the cumulative quantity of petroleum that has been actually recovered over a defined time period. While all recoverable resource estimates and production are reported in terms of the sales product specifications, raw production quantities (sales and non-sales, including non-hydrocarbons) are also measured to support engineering analyses requiring reservoir voidage calculations.		Equivalent to Sales Quantities in the minerals industry being the quantity and quality (if applicable) of valuable mineral commodity sold to the customer.
Project	Represents the link between the petroleum accumulation and the decision-making process, including budget allocation. A project may, for example, constitute the development of a single reservoir or field, or an incremental development in a producing field, or the integrated development of a group of several fields and associated facilities with a common ownership. In general, an individual project will represent a specific maturity level at which a decision is made on whether or not to proceed (i.e. spend money), and there should be an associated range of estimated recoverable resources for that project.	A mine or group of mines, treatment plants and associated infrastructure for which pre-feasibility and feasibility studies are prepared including integrated life-of-mine plans, and for which a decision is made to raise and spend capital for development.	Generally equivalent concept.
Product tonnage and grade determination		Weight and chemical analysis of product delivered to the customer.	Equivalent to production measurement as used in petroleum industry.

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
Property	A volume of the earth's crust wherein a corporate entity or individual has contractual rights to extract, process, and market a defined portion of specified in-place minerals (including petroleum). Defined in general as an area but may have depth and/or stratigraphic constraints. May also be termed a lease, concession, or license.		Similar concept applies in minerals industry. In some jurisdictions, extensions of dipping ore bodies in depth may be included, even if outside the surface boundaries, called the doctrine of extralateral rights.
Range of Uncertainty	The range of uncertainty of the recoverable and/or potentially recoverable volumes may be represented by either deterministic scenarios or by a probability distribution.		Similar concept in minerals provided as a sensitivity analysis; appropriate range analysis set by Competent Person.
Reasonable Certainty	If deterministic methods for estimating recoverable resource quantities are used, then reasonable certainty is intended to express a high degree of confidence that the estimated quantities will be recovered.		CRIRSCO uses the term "high level of confidence". The term "reasonable certainty" is not used in the minerals industry, "High level of confidence" is considered to (broadly) equate with "Reasonable certainty" in the petroleum industry.
Reasonable Level of Confidence		In the minerals industry reasonable degree of confidence is restricted to Indicated Resources/Probable Reserves. The Competent Person is encouraged to discuss and to quantify risk to the extent possible.	In minerals, a reasonable level of confidence would typically indicate a 50% or higher probability on a local scale. On a global (project) scale the probability would be higher. In petroleum this would broadly equate to the confidence level for Probable Reserves and C2 Contingent Resources.
Reasonable Expectation	Indicates a high degree of confidence (low risk of failure) that the project will proceed with commercial development or the referenced event		These terms relate to Reserves. In both industries there must be a high degree of confidence that the

TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
	will occur. There must be a reasonable expectation that all required internal and external approvals will be forthcoming, and there is evidence of firm intention to proceed with development within a “reasonable time frame.”		project could proceed through to producing status.
Extraction could be Reasonably Justified		Appropriate assessments and studies have been carried out, and include consideration of and modification by realistically assumed mining, metallurgical, economic, marketing, legal, environmental, social and governmental factors. These assessments demonstrate at the time of reporting that extraction could reasonably be justified.	
Reasonable prospects for eventual economic extraction		Must take into account time period, which is commodity dependent. Although not prescribed, “reasonable” would typically imply greater than 50 % chance.	Applies to Mineral Resources and Marginal Contingent Resources (petroleum).
Recovery Efficiency	A numeric expression of that portion of in-place quantities of petroleum estimated to be recoverable by specific processes or projects, most often represented as a percentage.		Same concept applies for both mining and petroleum industries; in the minerals industry has a more general meaning which implies a comparison between material present at the beginning or end of a process, such as mining, treatment by a specified plant, etc. Does not imply conversion of in situ resources to saleable product unless specified or customary, e.g. Yield in the coal industry represents percentage of Run-of-mine
Recovery (Yield)		The percentage of material of initial interest that is extracted during mining and/or processing. A measure of mining or processing efficiency.	

TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
			coal converted to saleable products at a wash plant.
Reference Point	A defined location within a petroleum extraction and processing operation where quantities of produced product are measured under defined conditions prior to custody transfer (or consumption). Also called Point of Sale or Custody Transfer Point.		Referred to as Point of Sale or Transfer in the minerals industry.
Reservoir	A subsurface rock formation containing an individual and separate natural accumulation of moveable petroleum that is confined by impermeable rocks/formations and is characterized by a single-pressure system.		A field is composed of one or more reservoirs. A mine may be composed of one or more mineralized zones (generally less continuous than a reservoir).
Resources Categories	Subdivisions of estimates of resources to be recovered by a project(s) to indicate the associated degrees of uncertainty. Categories reflect uncertainties in the total petroleum remaining within the accumulation (in-place resources), that portion of the in-place petroleum that can be recovered by applying a defined development project or projects, and variations in the conditions that may impact commercial development (e.g., market availability, contractual changes, etc.).		In mining, generally defined by incremental terms: Proved, Probable Mineral Reserves or Measured, Indicated, Inferred Mineral Resources. In petroleum may be defined by incremental terms (Proved, Probable, Possible Reserves; C1, C2, C3 Contingent Resources) or cumulative terms (1P, 2P, 2P reserves; 1C, 2C, 3C Contingent Resources).
Resources Classes	Subdivisions of Resources that indicate the relative maturity of the development projects being applied to yield the recoverable quantity estimates. Project maturity may be indicated qualitatively by allocation to classes and sub-classes and/or quantitatively by associating a project's estimated chance of reaching		In the minerals industry there are three classes (more often referred to as categories): Mineral Reserves, Mineral Resources, and Exploration Results (for which estimation of tonnages and grades is not possible). The

<b>TERM</b>	<b>SPE (Petroleum) Definition</b>	<b>CRIRSCO (Minerals) Definition</b>	<b>Comments</b>
	producing status.		CRIRSCO Template does not explicitly classify on project maturity although this is implied by the project development process (exploration, pre-feasibility, feasibility).
Risk	The probability of loss or failure. As “risk” is generally associated with the negative outcome, the term “chance” is preferred for general usage to describe the probability of a discrete event occurring.		In the minerals industry, could include probabilities for upside and downside cases.
Royalty	Royalty refers to payments that are due to the host government or mineral owner (lessor) in return for depletion of the reservoirs and the producer (lessee/contractor) for having access to the petroleum resources. Many agreements allow for the producer to lift the royalty volumes, sell them on behalf of the royalty owner, and pay the proceeds to the owner. Some agreements provide for the royalty to be taken only in kind by the royalty owner.		Equivalent term used in mineral industry. May be in form of net profits interest or based on a percentage of sales proceeds (net smelter return is term often used, even though material may not be smelted). Less commonly may be in terms of value per ton or percentage of gross value of recovered product before deductions for treatment and other charges.
Run-of-Mine (ROM)		Mixture of valuable minerals and waste (gangue) at the shaft collar or pit rim. The tonnage may be more or less than the (in situ) Mineral Resources depleted; the grade will generally be less than the grade of (in situ) Mineral Resources depleted.	Equivalent term in petroleum would be raw wellhead production before separation or processing.

TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
Sales Quantities	The quantity of petroleum product delivered at the custody transfer (reference point) with specifications and measurement conditions as defined in the sales contract and/or by regulatory authorities. All recoverable resources are estimated in terms of the product sales quantity measurements.		Can be used similarly to petroleum by some portions of mineral industry, e.g. Coal and industrial minerals. For metallics, Mineral Resources are estimated as in-situ quantities, and Mineral Reserves are estimated as tonnage, grade and contained metal delivered to a beneficiation plant (run-of-mine).
Sub-Commercial	A project is Sub-commercial if the degree of commitment is such that the accumulation is not expected to be developed and placed on production within a reasonable time frame. While five years is recommended as a benchmark, a longer time frame could be applied where, for example, development of economic projects are deferred at the option of the producer for, among other things, market-related reasons, or to meet contractual or strategic objectives. Discovered sub-commercial projects are classified as Contingent Resources.		Not formally used in mineral industry. Longer time frames than five years are typical in the Mineral Industry, and projects would not necessarily be removed from reserves if start dates are uncertain or more than five years in the future.
Tonnage		An expression of the amount of material of interest irrespective of the units of measurement (which should be stated when figures are reported)	The quantity or volume of material of interest (rock volume containing ore). The closest analogy in petroleum is gross reservoir volume used in resource calculations but is not usually reported.
Uncertainty	The range of possible outcomes in a series of estimates. For recoverable resource assessments, the range of uncertainty reflects a reasonable range of estimated potentially recoverable quantities for an individual accumulation or a project. May be		In the minerals industry the meaning is similar, but the range of uncertainty is typically expressed qualitatively, or if quantitatively restricted to production increments.

TERM	SPE (Petroleum) Definition	CRIRSCO (Minerals) Definition	Comments
	expressed qualitatively or quantitatively.		
Unconventional Resources	Unconventional resources exist in petroleum accumulations that are pervasive throughout a large area and that are not significantly affected by hydrodynamic influences (also called “continuous-type deposits”). Examples include coal bed methane, basin-centred gas, shale gas, gas hydrate, natural bitumen (tar sands), and oil shale deposits. (also termed “Non-Conventional” Resources and “Continuous Deposits”)		There is no equivalent terminology used in the minerals industry.
Undeveloped Reserves	Undeveloped Reserves are quantities expected to be recovered through future investments:		Developed/Undeveloped modifiers typically not reported, by mining industry but may be used for internal planning.
Waste		Material below cut-off grade; where must be mined to access ore, is segregated from ore as much as practical.	Some waste will become incorporated in run-of-mine material, and is then called dilution.
Working Interest	Gross Working Interest is a company’s equity interest in a project before reduction for royalties or production share owed to others under the applicable fiscal terms. Net Working Interest is after reduction for royalties or share of production owing to others.		Similar concept used in the minerals industry and referred to as “Equity Participation of Portion/Share”. May not be reduced by royalties because these are typically small and treated as costs. Typically Mineral Reserves are reported on a 100% basis, and that percentage attributable to the company is separately noted.