1. United Nations Framework Classification for Resources Update 2019 (ECE/ENERGY/125 and ECE Energy Series 61), which replaces the United Nations Framework Classification for Fossil Energy and Mineral Resources 2009 incorporating Specifications for its Application (ECE/ENERGY/94 and ECE Energy Series 42). ~~Page 4 of 29~~

1. Introduction

The United Nations Framework Classification for Resources (UNFC)1. is a project-based classification and management system applicable to all energy and mineral resource projects including petroleum, solid minerals, renewable energy, anthropogenic resource projects as well as underground storage projects, including CO2 storage.

UNFC is a voluntary system used by countries, companies or individuals for the sustainable management and reporting of energy and mineral resources. UNFC is developed by the United Nations Economic Commission for Europe (UNECE) with more than 70 years of experience in resource management in Europe and specifically in resource classification for more than 25 years. UNFC has been recommended for worldwide use by the United Nations Economic and Social Council (ECOSOC).

With the adoption of the 2030 Agenda for Sustainable Development (2030 Agenda) in 2015, sustainable management has become the fundamental basis for the balanced future development of the planet s resources. All the Sustainable Development Goals (SDGs) require energy and raw materials for their timely realization. Establishing a complete picture of the current and future supply base of energy and minerals is thus necessary for effective and sustainable resource management and policy development. Accurate and consistent estimates of energy and raw material resources are important for the classification and management of resources. However, the estimates need to be viewed as part of a larger framework of scientific and socio-economic information, and together they provide the foundation for meaningful assessments and decision making under different contexts. UNFC presumes assessments are undertaken by professionals with relevant qualifications and experience applying rational, justifiable and ethical decision making.

UNFC is a generic principle-based system in which quantities are classified by the three fundamental criteria of: a) social, environmental and economic viability (E-axis), b) technical feasibility (F-axis), and c) confidence in estimates of the potential recoverability of the quantities (G-axis). SEE PAGE 4 OF PDF FOR GRAPHIC.

2. United Nations Framework Classification for Fossil Energy and Mineral Resources 2009

UNFC uses a numerical and language independent coding scheme. Combinations of these criteria create a three-dimensional system with the axes representing E, F and G. It has been designed to meet, to the extent possible, the needs of applications pertaining to: a) strategic policy formulation based on energy

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and raw material studies; b) resources management functions; c) corporate business processes; and d) budget allocation. UNFC has adopted a three-tier application framework with principles and definitions at the first level. This is followed by second level generic and sectoral specifications, which constitutes the rules of application. Additional guidance or instructions for using UNFC is provided as the third level. The purpose of this document is to be used in conjunction with UNFC and to enable its second level application for petroleum projects. It should not be used as a stand-alone document. The UNFC-20092. (replaced by the updated UNFC in 2019) has also been bridged to the Petroleum Resources Management System (PRMS 2007), the Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation of 2013, and National Standard of the People's Republic of China - . PRMS 2007 was updated in 2018. PRMS is designed to provide a common reference for the international petroleum industry, including many national reporting and regulatory disclosure agencies. Many of the principles, definitions and guidelines in the PRMS, the Russian and Chinese systems are common to the UNFC, but their application should not limit the full granularity or use of the UNFC system. UNFC has a unique clarity in capturing technical feasibility, social and environmental issues that may have an impact on the project life cycle. Additional useful industry reference material can also be sourced from the Canadian Oil and Gas Evaluation Handbook (COGEH).

1.1. Petroleum Products

In the context of this document Petroleum products include, but is not limited to, any of the following: In respect of liquid products, any of the following:

light crude oil; medium crude oil; heavy crude oil; bitumen; natural gas liquids (NGL); synthetic crude oil; or any other unconventional oil e.g. shale oil, oil shale, etc. In respect of gaseous products, any of the following:

conventional natural gas; unconventional natural gas e.g. shale gas, coal bed methane (CBM also referred to as coal seam gas CSG), gas hydrates, synthetic gas etc.

1.2. Petroleum Project

A project is the basis of any resource evaluation and is the defined activity or set of activities for the future management of resource recovery operations that is linked to the decision-making process. A petroleum project provides the basis for estimating the recoverable petroleum resource and the associated technical, socio-environmental economic evaluation.

A petroleum source is an accumulation of petroleum that is estimated to be available or potentially available for viable production by the application of a development project/s. From a petroleum source, one or more petroleum products may be produced for sale.

An individual project represents a level of investment maturity and facilitates the decision on whether to proceed to the next level of project maturation. All projects require an associated development plan commensurate with the level of maturity. Viable projects require an approved, feasible and socio-environmental-economically viable field development plan. For potentially viable, non-viable or

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Commented [RJE3]: Suggest delete “etc.” or be comprehensive.

Commented [RJE4]: Any value in referencing associated products, like CO2/helium, that may be sold? I suggest the user be referred to the appropriate UNFC guidance, if so.

Commented [RJE5]: This reference to environmental/social/economic viability is not consistently used throughout the document. Suggest standardize.

prospective projects a development plan is still required but may be preliminary or conceptual. For these projects the probability of viable development shall be documented.

Commented [RJE6]: Refer to section 5.2 for additional discussion.

1.3. Effective Date

Estimates and classification of petroleum resource projects are evaluated as at a given date (effective date) using all the available data. All petroleum resource evaluation reports shall clearly state the effective date.

2. Ethical standards

Resource estimation can be the subject of unintentional or motivational bias. To ensure petroleum resources are evaluated/audited in an unbiased manner certain ethical standards should be observed including compliance with highest standards of professionalism and personal conduct in performance of required duties.

This includes, but is not necessarily limited to:

2.1.1. Independence

Declare any conflict of interest

Disclosure of any outcome-related compensation plan

Maintain the freedom to report any irregularities to an independent governance body

2.1.2. Objectivity

Consider all available data (including poor or unexpected results)

Use realistic and supportable technical and commercial assumptions

Maintain compliance with appropriate resource evaluation definitions and guidelines

Adequate technical, commercial and ethical training opportunities for personnel involved in resource estimation and maintain currency

Avoid manipulation of data to support a pre-conceived idea

Document all assumptions and results

Peer review work and discuss differences of opinion

Report results transparently and responsibly

2.1.3. Confidentiality

Comply with any confidential agreements such as non-disclosure agreements

2.1.4. Additional guidelines:

Maintain records of all data and analyses in a secure place for an appropriate period as required by internal controls and compliance with regulatory authorities

Conduct all work within health and safety guidelines in place

3. Classification

Classification is uniquely defined by the combination of three criteria from the categories or sub-categories defined within the UNFC 2019 system. There are five major classes (Sections 3.1-3.6) that can be identified using the E, F and G criteria (refer UNFC 2019). In addition, several sub-classes can be identified within each class. Section 3.6 provides additional guidance for production that is consumed in operations and G-axis

3.1. Viable Projects (E1, F1, G1, 2, 3)

Current or future recovery by commercially viable petroleum operations. Viable projects have been confirmed to be environmentally, socially, economically and technically feasible.

On production is used where the project is producing, and supplying one or more petroleum products to market, at the effective date of the evaluation.

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Approved for development requires that all approvals/permits/contracts are in place, and capital funds have been committed.

Justified for development requires there shall be a reasonable expectation (high confidence) that all necessary approvals/contracts for the project to proceed to development will be forthcoming within a reasonable timeframe. Typically, the acceptable time frame is five years, but a longer timeframe may be considered if enough justification is provided.

Estimates associated with viable projects are defined in many classification systems as Reserves, but there are some material differences between the specific definitions that are applied within different industries. The term is not used in PRSG.

3.2. Potentially Viable Projects (E2, F2, G1, 2, 3)

Where future recovery by petroleum operations has been identified as potentially viable but where development is pending or on-hold. The project may be stalled due to environmental-socio-economic viability and/or technical feasibility of the project has yet to be confirmed.

Development pending is limited to those projects that are actively subject to project-specific activities, such as the acquisition of additional data (e.g. appraisal drilling) or the completion of feasibility studies and associated economic analyses designed to confirm the viability including the determination of optimum development scenarios or plans. Also, the status may include projects that have non-technical contingencies, provided these contingencies are currently being actively pursued by the developers and are expected to be resolved positively in the foreseeable future.

Development on hold is used where a project is considered to have at least a reasonable chance of achieving viability (i.e. there are reasonable prospects for eventual viable development), but where there are currently major non-technical contingencies (e.g. environmental or social issues) that need to be resolved before the project can move towards development.

Not all potentially viable projects will progress to the development phase.

3.3. Non-Viable Projects (E3, F2, G1, 2, 3)

Projects that fall in the non-viable category include where development is uncertain or currently assessed as not viable in the foreseeable future

Development unclarified is appropriate for projects that are in the early stages of technical and commercial evaluation (e.g. a recent new discovery), and/or where significant further data acquisition is required, in order to make a meaningful assessment of the potential for a viable development (i.e. there is currently insufficient basis for concluding that there are reasonable prospects for eventual viability).

Development not viable is used where a technically feasible project can be identified, but it has been assessed as having insufficient potential to warrant any further data acquisition activities or any direct efforts to remove impairments to development. Projects in this subclass should only be maintained for a short period and subsequently be reclassified as F4, unless conditions improve. Moreover, projects that would require unreasonable assumptions to achieve viability should be reclassified as F4.

3.4 Prospective Projects (E3, F3, G4)

These are projects where potential future development and recovery is dependent on successful exploration activities. Currently, there is insufficient information on the source to assess the project environmental-socio-economic viability and technical feasibility. A prospective project is associated with an accumulation that has not yet been demonstrated to exist by direct evidence (e.g. drilling) but has been assessed primarily on indirect evidence (e.g. surface or airborne geophysical measurements).

In some situations, it may be helpful to sub-classify prospective projects based on their level of maturity. In such cases, the following specification shall apply: [Note: This classification devolved from the mining industry. The petroleum industry routinely quantifies prospective resources (undrilled prospects) as to G1, G2, G3 therefore the G4 category is superfluous. Often different types of exploration data (offset wells, 2D or 3D seismic data, gravity and\or magnetic data, geochemical data, etc.) combined with field size distribution information can create robust stochastic quantification of prospects.   This is just one of the reasons that the UNFC finds difficulty in application to petroleum contracts in exploration areas.]

F3.1: where site-specific studies have identified a potential resource source and product (s) with enough confidence to warrant further testing;

F3.2: where local studies indicate the potential for one or more resource source in a specific part of an area, but requires more data acquisition and/or evaluation in order to have enough confidence to warrant further testing;

F3.3: at the earliest stage of studies, where favourable conditions for the potential discovery of a resource source in an area may be inferred from regional studies.

3.5. Remaining products not developed from identified projects (E3, F4, G1, 2, 3)

Unrecoverable or additional quantities remaining associated with a known deposit that will not be recovered by any currently defined technically feasible project.

In some situations, it may be helpful to sub-classify remaining products not developed from identified projects based on the current state of technological developments. In such cases, the following specification shall apply:

F4.1: the technology necessary to produce some or all these quantities are currently under active development, following successful pilot studies on other resource sources, but has yet to be demonstrated to be technically feasible for the project;

F4.2: the technology necessary to produce some or all these quantities are currently being researched, but no successful pilot studies have yet been completed;

F4.3: the technology is not currently under research or development.

3.6. Remaining products not developed from Prospective projects (E3, F4, G4)

These projects may become developable in the future as technological or environmental-socio-economic conditions change. Some or all of these estimates may never be developed due to physical and/or environmental-socio-economic reasons. This classification may be used to indicate the source locked-in potential.

3.7. Future Production and G-Axis Methods

Future production that is either unused or Consumed in Operations (CiO) is categorized as E3.1.

Commented [RJE8]: Suggest clarify "unused". Is this flare and losses, for example?

G-axis categories may be used discretely (i.e. G1, G2 and G3) or in cumulative scenario form (i.e. G1, G1+G2, G1+G2+G3)

4. Socio-Environmental-Economic Viability (E-Axis)

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The socio-environmental-economic axis (E-Axis) categories encompass all non-technical issues that could directly impact the development viability of a project, including product pricing, capital and operating costs, legal/fiscal framework/regulations and environmental or social impediments. E-axis categorization explicitly includes environmental and social aspects that may be relevant to the project. Environmental and social issues are an integral part of the assessment of the viability of the project and may be used as a traffic light for the project to proceed based on relevant social and environmental metrics. Non-compliance with relevant environmental and social criteria may also lead to suspension of an existing project or deferment of a planned project. Positive maturity of E axis classification for environmental and social factors can have a major impact on project initiation.

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4.1. Viability Considerations

The socio-environmental-economic status differentiates viable projects from potentially viable, non-viable or prospective projects. A project is viable when it satisfies all the relevant criteria of the E, F and G axes that are required for it to proceed. The criteria that should be considered in determining socio-economic viability includes:

- A reasonable evaluation that the development project will have positive economics and meet defined investment and operating criteria (see section 3.2 Cash Flow Evaluation);

- Evidence to support technical feasibility (F-axis);
- Evidence to support a reasonable and attainable timeframe to development;
- A reasonable expectation that there is a market for the forecast sales quantities of production required to justify development;
- A reasonable expectation that the necessary production, transportation facilities and access to infrastructure are available or are forthcoming;
- Evidence that the regulatory, environmental, societal and political conditions will allow for the actual implementation of the development project being assessed; and
- Evidence that all required internal and external approvals are in place or will be forthcoming. Evidence of this may include items such as government and regulatory approvals, signed contracts, budget approvals, and approvals for expenditures, etc.
- There is a high confidence (guide of more than 90% probability) in the project proceeding to development.

4.2. Cash-Flow Evaluation

Cash flows are required to assess the economic viability of a project. They are based on the estimate of future petroleum sales production (G1+G2 production forecast as the best case) over a time period and the associated net cash flow assessment. For prospective projects a relevant analogue can be used as the basis for the assessment. The cash flow analysis shall be done on a net entitlement basis. Factors that shall be considered when carrying out cash flow assessment are as follows:

Commented [RJE10]: Should associated non-petroleum product sales revenue be included in the calculations?

- All cash flow evaluations shall be undertaken at the reference point and at an effective date.
- Only use future costs for development, recovery and production, including abandonment, decommissioning and restoration (ADR) costs. Prior incurred, or sunk costs, are typically not included but could be used as a guide when assigning future costs. All future and sunk costs should be included in an overall project value assessment.
- Evaluations should be prepared using realistic forecasts of future price and cost assumptions parameters and expected revenues. Certain regulatory agencies and accounting procedures may require that price is publicly disclosed or that constant prices and costs be used, which may not represent expected market value (including those required to meet environmental obligations).
- Future production and revenue related taxes and royalties to be paid.
- The application of an appropriate discount rate applicable to the reporting entity investment requirement.
- Viable project life is limited to the period of economic interest or truncated at the earliest occurrence of either technical, licence/regulatory or economic limit.
- Accounting depreciation, depletion and amortization calculations are not included in a cash flow because they are non-cash items.

Split conditions are defined as the use of different commercial assumptions for categorizing quantities and are not permitted. In UNFC, this means that all economic assumptions associated with a given project shall be the same to assess G1 (low case), G1+G2 (best case) and G1+G2+G3 (high case). Such assumptions include oil price, sales contracts status, and operating and capital costs associated with the project. This means that the project development and economic assumptions should be the same for all categories. If a development includes variable project scope e.g. differing well count or increased facility capacity resulting from an upside scenario, this is assessed separately as an independent incremental project. This incremental project will have its own associated E & F category and confidence in estimates (G1, G2 & G3)

Commented [RJE11]: Suggest check this. These are not necessarily incremental additions, but a complete change in scope. Suggest care be taken in using “incremental”.

4.3. Economic Criteria

A project is economic when the anticipated monetary revenues equal or exceed the costs by a margin that satisfies financing requirements, taking risks and opportunities into account. The project provides a positive return on investment, often measured in monetary criterion, such as having a positive net present value (NPV) at an agreed discount factor.

Commented [RJE12]: Why is this not just revenues exceed costs? The implied modifiers appear to be commercial items, and not economic criteria.

4.3.1. Future Net Revenue

Future net revenue means a forecast of revenue, estimated using forecast prices and costs or constant prices and costs, arising from the anticipated development and production of a potentially viable project or viable project net of the associated royalties, operating costs, development costs and ADR costs. Corporate general and administrative (G&A) expenses and financing costs are not deducted. Net present values of future net revenue shall be calculated using an agreed discount rate. Typically, the discount rate used for comparative analysis for projects is 10%.

In examining the economic viability of potentially viable, non-viable or prospective projects, the same fiscal conditions should be applied as in the estimation of viable projects e.g., reasonable forecast conditions. These projects are then classified into E2 or E3. E2 is where there is an expectation that the project will become economically viable in the foreseeable future. E3 is where extraction and sale are not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability.

All economic assumptions shall be documented and justified.

4.4. Economic Limit

An economic limit is reached when revenue from the sale of produced oil and gas no longer exceeds operating costs. In the determination of a project s economic limit, development is assumed, and the future production may be tested at an undiscounted rate. In this analysis, the production is economically producible when the net revenue exceeds the cost of operation (excluding ADR). Future conditions shall be realistic forecasts. For the purposes of testing the economic limit projects of the same classification and utilising the same reference point may be included together.

The final rate of an individual well may be determined by the economic limit or it may be determined by the physical lifting limit of the fluids in the wellbore. The physical limit of pressure to which the reservoir can be depleted shall also be considered.

[There should be language clarifying the economic “project” such that an individual well may be allowed to fall below an economic limit if the entire project is still profitable]

4.5. Resources Entitlement and Recognition

Net entitlement is that portion of future production (and thus resources) legally accruing to an entity under the terms of the mineral lease or concession agreement.

The ability for an entity to recognize resource entitlements is subject to satisfying certain key elements. These include (a) having an economic interest through the mineral lease or concession agreement (i.e., right to proceeds from sales); (b) exposure to market and technical risk; and (c) the opportunity for reward through participation in exploration, appraisal, and development activities.

Evaluators shall ensure that, to their knowledge, the recoverable resource entitlements from all participating entities sum to the total recoverable resources.

For publicly traded companies, securities regulators may set criteria regarding the classes and categories that can be disclosed. For national interests, the reporting of 100% quantities without concession agreement constraints is typically specified.

4.6. Royalty

Royalty is an entitlement interest in a resources project where the royalty owner does not participate in any of the capital or operating costs required to produce the oil or gas. A royalty is commonly retained by resources lessor when granting rights to the producer. A royalty is paid in either cash or kind (depending on the lease) based on a fraction of the production.

Royalty shall be deducted from the lessee's revenue in any economic evaluation.

4.7. Production-Sharing Contract

A more common fiscal system in many countries is a Production Sharing Contract (PSC) between an international operating company (or group of companies) and the Host Government, which may be represented by its Energy Ministry or National Oil Company (NOC). A foreign operating company or companies is termed the "contractor". A PSC is also often referred to as an Exploration and Production Sharing Agreement (EPSA or PSA).

A PSC entitles the contractor to receive only a specified portion of production in kind at an agreed point of delivery (net entitlement). Ownership of the production is retained by the host government. The contractor can recognize this net entitlement as part of their project inventory.

4.8. Social Criteria

Social factors are not defined in UNFC or in any of the resource-specific guidelines. A practical application of social criteria would be the resulting impact on humans and society, from a project, such as:

- Effects on the local population stemming from environmental changes Changes in social systems and structures (e.g. ownership claims, traditional land usage, land and other value changes, changes in local population community structures, etc.)
- Additional social factors consider the presence of communities with indigenous people, existence of urban and rural localities, the values of the marginalization index and the index of human development.

This impact is commonly thought as being negative but can be positive. For example, job creation, additional income for stakeholders and advances in technology.

A matrix can be used to classify the social impact of petroleum projects. The impact can be categorised as Low (Unlikely), Best (Likely) or High (Most Likely). Specifically, a multivariate geospatial analysis can be used to identify and evaluate social factors relevant to local conditions. Examples of this analysis can be found in the Application of the United Nations Framework Classification for Resources Case Studies (ECE Energy Series 58).

4.9. Environmental Criteria

Environmental factors are not defined in UNFC or in any of the resource-specific guidelines.

A practical application of environmental criteria would be the physical, chemical, and biological impact on, or changes to the project area and surroundings, due to a project (e.g. contamination in soils or water, disruption of wildlife habits and migration characters, etc.)

Additional environmental factors include the existence of safeguard zones, protected natural areas, wetland sites, species of flora and fauna protected by legislation and the presence of critical land use in the area.

As with social criteria, a matrix can be used to classify the likely environmental impacts on petroleum projects. This impact is commonly thought as being negative but can be positive.

4.10. Additional guidelines

Resolution of relevant social and environmental issues is often referred to as obtaining license classification criterion. Classification should be based on the specific and individual contingencies that apply to a project at the time of an evaluation.

SLO can take the form of formal approvals or addressing informal objections by organizations or individuals that would not be directly affected by a petroleum project. These issues would typically be dealt with by discussion and negotiation between interested parties, which could trigger further activity within a formal legal or regulatory setting. This does not mean all issue specific project, issues are resolved so the project can proceed, even if there are still concerns.

There is no standard process for assessing social and environmental contingencies, but the following steps are recommended:

- Identify any relevant social and environmental contingencies.
- Estimate the probability that relevant socio-environmental issues will be resolved and maintained over the life cycle of the project. This resolution will depend on the specifics of an asset or project and the legal, regulatory and social environment in which it is proposed to be carried out. Although qualitative and subjective, the assumed resolution should be based as much as possible on a documented analysis. In many cases, there will be a history of similar project developments that can be used as analogues.
- Consider the status of the efforts being made to resolve socio-environmental issues. The level of effort and engagement required will depend on the project.
- Provide appropriate explanation in a report.

5. Technical Feasibility (F-axis)

5.1. General overview & principles

The feasibility of extraction for a development project is evaluated and represented by the F-axis. This includes maturity of the petroleum recovery technology, development plan and producer ability and commitment necessary for the project execution.

In general, the feasibility of the project development is categorized into four major subcategories:

- F1 - Defined development project with confirmed technical feasibility of extraction.
- F2 - Defined development project with technical feasibility of extraction to be confirmed (requires further evaluation or approval) or a not viable defined project.
- F3 - Conceptual development project to which the technical feasibility of extraction cannot be fully evaluated, given the limited data.
- F4 - Absence of a development project (defined or conceptual) to evaluate.

It should be noted that the feasibility of extraction and the F-axis are defined considering only the maturity status of the development projects. All projects are evaluated in terms of the robustness and maturity of the future development project (which may be conceptual) at the effective date.

This approach facilitates a single evaluation framework to categorize the likelihood of project production at all stages of exploration, appraisal and development.

5.2. Consideration of Risk

All petroleum projects prior to development have an associated chance (probability or risk) of viability, which is equivalent to the chance of commerciality (Pc) being the product of the chance of productive reservoir discovery (Pg) and the chance of development (Pd). The Pd includes the demonstration of a viable recovery technology.

There is generally a well-accepted methodology for assessing Pg. Petroleum system risk factors such as source, migration, reservoir, seal and trap are typically combined in order to generate a Pg. For Pd the technical and social-environmental-economic factors that need to be demonstrated before a project viability can be considered. These include subsurface (resource quality and continuity), applicability of the recovery technology, surface (well locations and infrastructure), project execution (financing and capability), economics, approvals (government and regulatory) and timing. Dependency between factors should be considered. These factors can be used in a methodology that combines them in a matrix or scorecard.

Commented [RJE13]: Should a reference be given on where to get more information?

The assessment of the Pg and Pd should reflect the local project subsurface, surface and development risks and uncertainties. Where data quality and/or quantity is limited, or there are numerous socio-economic or environmental contingencies, Pc would reduce.

All petroleum project evaluations shall include an associated Pc.

5.3. Viability Assessment

Commented [RJE14]: Is the following currently the standard/recommendation at AAPG?

The objective of the viability assessment for prospective projects is to use the inputs to Pg and Pd to derive a range of outcomes and associated probabilities in value terms to inform future project decisions. The un-truncated resource distribution encompasses economically viable and non-viable outcome scenarios and should form the basis of the range of uncertainty. However, as the viability of the project is most often a function of the size of the discovery, economic analysis is often undertaken on scenarios where the discovery size exceeds the viability threshold. In this approach, the un-truncated distribution is truncated to form a new, viable success (truncated) distribution. For viable resource outcomes the recommended approach is to apply deterministic conceptual development scenarios to selected outcomes on the truncated resource distribution. This analysis can then be used to calculate key metrics such as Expected Monetary Value (EMV). The Pc for an untruncated distribution would be different to the Pc for a truncated distribution. As outcomes from single Prospective Projects are so uncertain, more meaningful analyses are often obtained from compounding analyses from a portfolio of opportunities.

5.4. Technology Feasibility

The classification of technology feasibility of a recovery process can be broken down into:

- Established technologies have proven to be technically and economically viable in the reservoir under evaluation or there is sufficient direct evidence to justify technically and economically viability from a proven analogous reservoir. This is a requirement for viable Projects.
- Technology under development is where field testing is underway to establish the economic viability of the recovery process in the reservoir under evaluation. Technically viability has already been established either directly in the reservoir or there is sufficient direct evidence to justify technically viability from a proven analogous reservoir. A requirement for potentially viable, non-viable or prospective projects.
- Experimental technology is where field testing is underway to establish the technical viability of a recovery process or applicability in the reservoir under evaluation. No recoverable resources may be assigned.

5.5. Development Plan Status

The project feasibility status is evaluated in terms of the maturity of the development plan, from no defined projects to demonstrated project viability and commitment.

The before mentioned maturity range can be evaluated qualitatively as:

- Null Maturity (F4)- For project evaluations in which there are no defined projects.
- Low Maturity (F3) - For an early stage of project evaluation where development plan is conceptual and exploration studies underway before the confirmation of a known resource.
- Medium Maturity (F2) - For evaluations in which a resource has been confirmed as potentially viable but requires further data acquisition, field testing to adequately evaluate the feasibility of extraction, producer intent is pending or where it has been demonstrated that extraction is not viable.

- High Maturity (F1) - For project evaluations where sufficient data has been obtained and studies and/or field testing have demonstrated the viability of economic extraction, and that, at the effective date, development is planned or being executed. This qualification is shown in Table 1. SEE PAGE 16 OF PDF FOR TABLE 1

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Project Classes Categories Project Maturity Development Plan Viable Projects F1 HIGH Development Potentially Viable Projects F2 MEDIUM Pre-development Non-Viable Projects F2 Pre-development Prospective Projects F3 LOW Conceptual Remaining Products F4 NULL None Table 1. F-axis categories according to Project classes (viability)

5.6. Project maturity subcategories

For greater clarity and granularity in project maturity definition, in addition to the categories mentioned before (F1, F2, F3 and F4), the UNFC defines subcategories that are visualized in Table 2. SEE PAGE 17 OF PDF FOR TABLE 2

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Categories Project Maturity

Resource Source Status

Subcategories

Commercial Extraction Viability

Project Status

F1 High Maturity

Discovered

F1.1

Confirmed - Established technology

On extraction F1.2 Development approved F1.3 Developemnt justified

F2 Medium Maturity

Discovered

F2.1 Imminent Confirmation

Feasibility in the foreseeable future development pending

F2.2

To be confirmed Technology under development

On hold (viable projects) or unclarified feasibility (non viable projects)

F2.3

Not confirmed/ Not viable Technology under development

No feasibility

F3 Low Maturity Undiscovered F3.1, F3.2, F3.3

Not confirmed technology under development

Prospective Projects

F4 Null Maturity Remaining Products F4.1, F4.2, F4.3

Not evaluated or experimental

Not developed from prospective resources

Table 2.F-axis subcategories according to project classes (maturity)

For a project to mature from a prospective to known, the resource shall provide proof of discovery. In this context, discovery refers to proof of producible hydrocarbons sufficient to evaluate the potential for viable recovery in a reasonable and attainable timeframe. Demonstration typically requires drilling and testing unless a strong geographically proximal analogy can be claimed. Further, extrapolation of discovery should be supported by evidence of continuity and/or repeatability. Development pending projects (F2.1) may satisfy the requirements for E1.

Commented [RJE15]: Suggest there should be no modifier requiring 'geographically proximal". If planned to be retained, this needs further clarification on what constitutes proximal.

Where a project has been demonstrated as not viable this should be clearly documented. Projects in this classification for extended periods require the evaluator to explain why the project should not be re-classified as F4.

Commented [RJE16]: This timeframe should be defined.

5.7. Prospective Projects

It is possible to sub-categorize prospective projects (F3 category), in terms of the level of maturity to provide more detail when required. In such cases, the subcategories should be used in accordance with Table 3: SEE PAGE 18 OF PDF FOR TABLE 3

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Category Subcategory Specifications

F3

F3.1

Site-specific studies Potential resource source identification (individual) Confidence to further testing

F3.2

Local studies Potential resource sources in a specific part of an area Requires additional data to ensure further testing

F3.3

Earliest stage of studies (Regional studies) Favorable conditions identification for the potential discovery of a resource source in an area Table 3. Prospective

5.8. Additional guidelines

For the specific case of remining products not developed (or unrecoverable), it is possible to sub-categorize them in terms of the status of technological developments. In such cases, the subcategories should be used in accordance with Table 4: SEE PAGE 18 OF PDF FOR TABLE 4

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Category Subcategories Specifications

F4

F4.1

Necessary technology under active development Successful pilot studies on other resource sources Preliminary success not extrapolated to the resource source analyzed F4.2 Necessary technology currently being analyzed No successful pilot studies on any resource source F4.3 No research or analysis on the necessary technology

6. Confidence in Estimates (G-axis)

6.1. General overview & principles The confidence in estimates is represented on the G-axis. This axis corresponds to the uncertainty inherent to any petroleum development project production estimates. As such, the G-axis is fundamentally different from the E and F axes, which are focused on the technical feasibility and environmental-social-economic viability of the development project. The key principles for the G-axis are:

- Full range of outcomes - while any project will be associated with one single class or sub class (E and F categories), the G-axis represents the range of project outcomes assessed at defined technical and forecast economic conditions based on the data available at the effective date. A corresponding G1, G1+G2 & G1+G2+G3 should be provided for any given project and represent the associated low, best and high cases. For viable or potentially viable projects the range of uncertainty represents the outcomes that would be economically recoverable. It is only acceptable not to provide a range of outcomes for a given project if the values have been computed in a system with a lower granularity and transferred to UNFC using the relevant bridging process. As of today, only the Russian and the Chinese evaluation bridging documents are operational and may lead to this situation.

- Uncertainty Vs Maturity - the uncertainty and the range of outcomes for a given project is represented by the range between G1 (low), G1+G2 (best) and G1+G2+G3 (high). The higher the uncertainty, the bigger the range. While the G-axis remains independent from the E & F axes, a correlation may be expected between the project maturity (E & F) and the range along the G-axis: generally, with more data and confirmation of viability, the narrower the uncertainty range.

SEE PAGE 19 OF PDF FOR GRAPHIC

6.2. Estimation Procedures

A petroleum accumulation source may contain one or many UNFC projects. The sum of all categories associated with all justifiable UNFC development projects as well as any cumulative production + unrecoverable volumes (F4) will always be equal to the volume-originally-in-place (VOIP) for the Low, Best and High cases (material balance). With:

Low Case = G1

Best case = G1+G2

High case = G1+G2+G3

6.3. Analytical procedures

The estimation of recoverable quantities associated with a given project can be evaluated using (i) volumetric, (ii) analogy and (iii) performance-based procedures. These can be used individually or in combination.

6.3.1. Volumetric analysis

This procedure allows the evaluator to compute the VOIP and then estimate that portion that will be recovered by a specific development project. The volumetric estimate may be based on either probabilistic or deterministic methods. Recovery can be estimated based on analogous field performance and/or modelling/simulation studies. Volumetric estimates can be applied at all stages of development. In a mature field volumetric estimates remain key to investigating if the field may be underdeveloped, or sub-optimally produced.

6.3.2. Analogues

This is used to quantify the amount of resources recoverable when direct measurement information is limited. The estimation is computed by comparing the subject reservoir with another comparable reservoir, which is at a more advanced stage of development. The analogous reservoir is expected to demonstrate key parameters comparable with the subject reservoir. This would include, but not be limited to:

- Depositional and structural environment,
- Petrophysical properties (e.g. net pay, permeability, porosity, saturation, etc),
- Fluid properties, viscosity,

- Reservoir conditions (e.g. depth, temperature, pressure, aquifer),
- Drive mechanisms,
- Development plan (e.g. well spacing, well type, completion methods, artificial lift, facility constraints, costs),

Generally, an analogous reservoir is defined as a reservoir which, in the aggregate, is no more favourable than the subject reservoir. It is the responsibility of the evaluator to document all relevant explanations as to why the analogue is valid.

6.3.3. Performance-based Estimates

Analysis is largely based on actual data acquired during the production of the reservoir. The data is used to calibrate the models used for production forecasting. The analysis will only be valid when enough data are available. Such methods include:

- Decline curve analysis, and type curve analysis. Use of this method assumes that the reservoir is in a semi-steady state. The user should be careful to account for all additional factors that may affect production performance e.g. change in operating conditions, potential interference between existing wells and new projects. In early stages of depletion, there may be significant uncertainty in factors that impact the ultimate production potential and economic limit.
- Material balance involves the analysis of pressure behaviour as reservoir fluids are withdrawn. The results will be highly dependent on the data quality, model calibration, as well as the complexity of the reservoir (drive, baffles or barrier, etc).
- History-matched dynamic modelling remains the most powerful and versatile methodology, allowing the investigation of the current reservoir status, as well as any potential development project. Due care shall be exercised as models become highly complex and calibration is required.

Ideally, several analytical procedures, volumes based, and performance-based, should be checked against one another to ensure reasonableness and consistency in the range of outcomes provided.

6.4. Resources Assessment Methods

Regardless of the analytical procedure used, one should always provide a full range of uncertainty associated with the recoverable resources. The two key methods for evaluation are the deterministic method or probabilistic methods1. Other methods being mostly an adaptation of these two.

6.4.1. Deterministic method

The low (G1), best (G1+G2) and high (G1+G2+G3) outcomes from the project are estimated by taking a discrete value or an array of values for each input parameter to produce a discrete result. For the low (G1), best (G1+G2) and high (G1+G2+G3) case estimates, the deterministic inputs are selected to reflect the level of confidence. A single outcome of recoverable quantities is derived for each deterministic scenario.

6.4.2. Probabilistic method:

The low (G1), best (G1+G2) and high (G1+G2+G3) outcomes from each asset or development project are provided by the full distribution of potential in-place or recoverable quantities. This result is computed through random sampling (e.g., using stochastic geological modelling or Monte Carlo simulation) of each sub-distribution representing the full range of possible values for each input parameter. While this is often used at early stage to compute the range of volumes in place such method may (1 Derived from the definitions provided in PRMS 2018) be useful to understand quickly the impact of key parameters on a specific project. Where probabilistic methods are used the G1 represents the P90, the G1+G2 the P50 and the G1+G2+G3 the P10.

Resource assessments often integrate methods to better define the uncertainty. In all cases, due consideration should be given to possible dependencies between input parameters.

Irrespective of the approach, the basis of the assessment and assumptions shall be documented.

6.5. Aggregation

Project resource quantities can either be aggregated arithmetically or statistically.

A simple arithmetic aggregation will often result in the sum of low cases being conservative and the sum of high cases optimistic. A simple arithmetic summation should be used to aggregate results from the field to a higher level (field, block, basin, country) as required for public disclosure. This usually results in a P90 which is higher than an arithmetic sum and a P10 which is lower than an arithmetic sum.

Statistical aggregation may be undertaken for the purposes of internal reporting and corporate asset management strategy (portfolio analysis). Care should be taken to account for any project dependencies.

Quantities in different classes and sub-classes cannot be aggregated without considering the varying degrees of technical uncertainty and risk.

7. Prospective Projects

7.1. General overview & principles

A prospective project is a project that is associated with one or more potential deposits i.e. a deposit that has not yet been demonstrated to exist by direct evidence (e.g. drilling and/or testing/sampling) but is assessed as potentially existing based primarily on indirect evidence (e.g. surface or airborne geophysical measurements). The associated quantities of petroleum are estimated, at the effective date, to be that portion of the in-place volumes to be potentially recoverable by the application of a future development project/s. Not all prospective projects will result in discovering known deposits. A prospective project should always be accompanied by a documented Pg and Pd.

7.2. Resource Assessment

The objective of the resource assessment for prospective projects is to provide a realistic technical assessment of the range of possible outcomes with associated probabilities for resource size. This typically involves assessing the geologic and reservoir uncertainties in the form of a probability distribution. A combination of geology, geophysics and petrophysics are used to estimate the potential in-place resources. The recoverable resource is then estimated using local reservoir engineering understanding to assess the recovery potential based on a conceptual development project. The range of uncertainty that accompanies a Prospective Project should be the full untruncated distribution of outcomes. Analogues are often used for prospective projects where there is limited data.

7.3. Categories

The associated UNFC categories for Prospective Projects are:

- E3: Economic viability of extraction cannot yet be determined due to insufficient information. The Pd should be documented based on realistic assumptions of future market conditions
- F3: Feasibility of extraction by a defined development project cannot be evaluated due to limited technical data. Very preliminary studies based on a defined (conceptual) development project should be used as an input to inform the likely Pd
- G4: Estimated quantities associated with a potential deposit, based primarily on indirect evidence. Quantities that are estimated during the exploration phase are subject to a substantial range of uncertainty as well as a major risk that no development project may subsequently be implemented to extract the estimated quantities. Where a single estimate is provided, it should be the expected outcome but, where possible, a full range of uncertainty should be documented e.g. in the form of a probability distribution. In estimating Pg, the evaluator shall consider the likelihood and continuity of reservoir productivity

: [Note: This classification devolved from the mining industry. The petroleum industry routinely quantifies prospective resources (undrilled prospects) as to G1, G2, G3 therefore the G4 category is superfluous. Often different types of exploration data (offset wells, 2D or 3D seismic data, gravity and\or magnetic data, geochemical data, etc.) combined with field size distribution information can create robust stochastic quantification of prospects. This is just one of the reasons that the UNFC finds difficulty in application to petroleum contracts in exploration areas.]

8. Unconventional Resources

Classification and categorization as defined in the UNFC can be applied to both conventional and unconventional petroleum accumulations.

Unconventional resources are generally pervasive throughout a large area and are not significantly affected by hydrodynamic influences. Usually there is no obvious structural ~~or~~ - stratigraphic trap, or hydrodynamic influence. Examples includes CBM, low permeability deposits such as tight gas (including shale gas) and tight oil (including shale oil), gas hydrates and natural bitumen. Typically, unconventional resources require specific technological intervention.

Unconventional resources typically require additional sampling and different evaluation techniques to define the range of uncertainty and development plan than conventional resources. Variations in reservoir quality can occur over short distances and therefore extrapolation of productivity beyond a well test should not be assumed unless there is good technical evidence to demonstrate otherwise. Where this cannot be demonstrated that portion of the resource should remain undiscovered. Further, pilot projects may be needed to confirm discovery and potential viability.

Development of unconventional resources often requires drilling many wells over large areas to effectively extract the petroleum. Capital expenditure may remain high over the life of the project but due to the repetitive nature of executing the development performance and cost improvements may occur.

Many unconventional projects are assessed using the deterministic "incremental" approach, which is based on estimates for discrete portions of the project, where each estimate is based on the best estimate of potential recoverability. This approach is not considered the most relevant to accurately represent the degree of confidence and should be used with caution and only in conjunction with the previously described deterministic scenario or probabilistic method.

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9. Abandonment, Decommissioning and Restoration (ADR)

ADR includes all the activities and associated costs necessary to successfully conclude and return a project site to a safe and environmentally compliant condition after cessation of activity. ADR includes:

- Activities carried out for the definitive closure of all the wells, equipment and facilities used throughout the project's life, including wellbore plugging, and surface facilities dismantling and removal.
- Remediation activities carried out with the objective of returning to its previous state the sites used in the project's life, where any environmental damage that has arisen is resolved or where the site is returned to an environmentally safe condition.

ADR of petroleum facilities shall be considered in any investment and operational decision making for all development projects. Planning of abandonment activities shall consider the time required to obtain all the internal and external permits and authorizations (regulation) necessary for the activities to be carried out within the period of license entitlement. Timely and effective planning of all the activities necessary to properly carry out abandonment is required to safe and environmentally compliant conditions. The removal of structures, equipment, facilities, materials and waste, should always be conducted with due care for safety and the environment.

Remediation of the sites used throughout the project's life shall be planned considering the possible future uses thereof, in order not only to restore them to their initial conditions, but also to facilitate sustainable development.

ADR costs should be considered in the development project's costs unless specifically excluded by contractual terms. A project's cumulative net cash flow shall exceed the abandonment liability to be considered economically viable. However, for the purposes of calculating the economic limit of production this may be truncated where the maximum cumulative cash flow is achieved before consideration of abandonment. The creation and filling of special funds/trusts for ADR, during the productive life is recommended, so that the economics of the project will not have a detrimental impact near or upon completion. The entity responsible for a development project resource evaluation should ensure that documentation is provided to ensure that funds are available to cover ADR costs.

10. Annex 1:Definitions and Associated Terms

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Refer also UNFC Annex 1 Glossary of Terms

Bitumen

Bitumen means the naturally occurring viscous mixture, consisting mainly of pentanes and heavier hydrocarbons, with a viscosity greater than 10000 mPa's (cP) measured at the mixtures original temperature in the reservoir and at atmospheric pressure on a gas-free basis.

Category

The primary basis for resource categorization based on three fundamental criteria of economic, environmental and social viability (E1, E2 and E3), field project status and feasibility (F1, F2, F3 and F4) and level of knowledge and confidence in potentially recoverable quantities (G1, G2, G3 and G4).

Coal bed Methane (CBM)

CBM (or coal seam gas - CSG) means natural gas, primarily methane, contained in coal deposits.

Conventional natural gas

Conventional natural gas means natural gas contained in and produced from pore space in an accumulation for which the primary trapping mechanism is related to hydrodynamic forces and localised or depositional geological features.

Entity

An Entity is a corporation, joint venture, partnership, trust, individual, principality, agency, or other person engaged directly or indirectly in (i) the exploration for, or production of, oil and gas; (ii) the acquisition of properties or interests therein for the purpose of conducting such exploration or production; or (iii) the ownership of properties or interests therein with respect to which such exploration or production is being, or will be, conducted.

Foreseeable Future (see also Reasonable Timeframe):

This term is used to distinguish between the E2 and E3 classifications as to the period of time that a Project can make a reasonable projection of the occurrence of future market conditions or events that determine the economic viability or other factors of a Project. For the purposes of the Petroleum Specification, this would typically be five years, but may be extended where there is specific justification. For example, if a necessary condition or event necessary for economic viability is not projected to occur within five years, the Project is deemed not to be economically viable in the Foreseeable Future.

Gas hydrates

Gas hydrates means naturally occurring crystalline substances composed of water and gas, in an ice lattice structure.

Heavy crude oil

Heavy crude oil means crude oil with a density greater than 10 degrees API gravity and less than or equal to 22.3 degrees API gravity.

Hydrocarbon

Hydrocarbon means a compound consisting of hydrogen and carbon atoms, which, when naturally occurring, may also contain other elements such as sulphur and trace heavy metals.

Light crude oil

Light crude oil means crude oil with a density greater than 31.1 degrees API gravity

Medium crude oil

Medium crude oil means crude oil with a density that is greater than 22.3 degrees API gravity and less than 31,1 degrees API gravity.

Natural gas

Natural gas means a naturally occurring mixture of hydrocarbon gases and non-hydrocarbon gases.

Natural gas liquids

Natural gas liquids (NGLs) means those hydrocarbon components that can be recovered from natural gas as a liquid including, but not limited to, ethane, propane, butanes, pentanes plus, condensate and may contain non-hydrocarbons.

Petroleum source

A discovered hydrocarbon accumulation in the earth's subsurface can be the source for petroleum production if developed as a project under defined conditions.

Property

A volume of the earth's crust wherein a corporate entity or individual has contractual rights to produce, process, and market a defined portion of specified petroleum-in-place. Defined in general as an area but may have depth and/or stratigraphic constraints. May also be termed a lease, concession, or license.

Reasonable Expectations: This term is used within the E1 classification and concerns the likelihood of obtaining necessary regulatory approvals, permits and contracts necessary to implement the Project.

For the condition of Reasonable Expectations to apply in the case of governmental and other regulatory approvals and/or permits, the application or submission shall have been made to the authority in question, together with all the substantive supporting information. The entity shall have specific justification to expect that the application will be approved in line with the requirements of the Project and will be approved within a period that is typical for applications of that type in the jurisdiction concerned. The condition of Reasonable Expectations can also apply in circumstances when the application is still to be made or to be fully completed. This is provided the entity has a demonstrated

track record of obtaining approvals for similar applications under the same jurisdiction and the application will be approved within a period that is typical for such applications.

For the condition of Reasonable Expectations to apply to commercial/financing contracts or agreements, negotiations shall be underway, with the specific justification that agreement will be achieved within a time period that would be typical for such contracts or agreements and within any previously sanctioned boundary conditions (e.g., authority to negotiate, joint venture agreements). The conditions of Reasonable Expectations can also apply in the circumstance when negotiations have not commenced, provided that the entity has a demonstrated track record of negotiating similar contracts/agreements to like terms and conditions with the same counterparty(s).

Reasonable Forecast:

Expected future commercial conditions e.g. price outlook, inflation, exchange rate etc

Reasonable Time Frame (see also Foreseeable Future):

This term concerns the time frame within which all approvals, permits and contracts necessary to implement the Project are to be obtained. This should be the time generally accepted as the typical period required to complete the task or activity under normal or typical circumstances. Five years is recommended as a benchmark, but a longer time frame could be applied where, for example, the development of an otherwise economic project is deferred at the option of the owner for market-related reasons, or to meet contractual obligations. In these circumstances, the justification shall be provided.

Reference Point

The Reference Point is the defined location for a petroleum project where sales quantities are measured and assessed prior to custody transfer.

Reporting Entity

The entity submitting the resource report. (Could also be reporting issuer): (a) A "reporting issuer" as defined in securities legislation; or (b In a jurisdiction in which the term is not defined in securities legislation, an issuer of securities that is required to file financial statements with the securities regulatory authority.

Reporting Units

Shall use S.I. units only.

TOE (Tonnes of Oil Equivalent)

Unit representing energy generated by burning one metric ton (1000 kilograms or 2204.68 pounds) or 7.33 barrels of oil equivalent, and equivalent to the energy obtained from 1270 cubic meters of natural gas or 1.4 metric tons of coal, that is, 41.868 gigajoules (GJ), 39.68 million Btu (MMBtu), or 11.63 megawatt hours (MWh).

Synthetic crude oil

Synthetic crude oil means a mixture of liquid hydrocarbons derived by upgrading bitumen, kerogen from oil shales, coal or from gas-to-liquid (GTL) conversion and may contain sulphur or other nonhydrocarbon compounds.

Synthetic gas

Synthetic gas means a gaseous fluid:

- generated as a result of the application of an in-situ transformation process to coal or other hydrocarbon-bearing rock type; and

- comprised not less than 10% by volume of methane.

11. Annex2: Competent Person - Petroleum Specific Functional Competencies/Requirements

11.1. General overview & principles

The following should be read in conjunction with the Guidance Note on Competent Person Requirements and Options for Resources Reporting as published on the UNECE website.

Where the Petroleum Specifications are used for reporting to stock exchanges or investors, it is recommended that the commissioning body adopt the following Competent Persons definition to establish appropriate quality assurance mechanisms, qualification criteria and/or disclosure obligations.

Estimation and classification of petroleum resources is very commonly a team effort, involving several technical and commercial disciplines. However, it is recommended that only one competent person sign as responsible for the content and context of the petroleum resource report (report) and supporting documentation. The competent person shall ensure that the report is factual, complete and not misleading or deceptive. The report shall disclose the name of the competent person, including their qualifications, experience, professional affiliation and state whether the competent person is an employee of the entity preparing the report.

11.2. Qualifications

The competent person shall possess an appropriate level of expertise and relevant experience in the estimation and classification of petroleum resources associated with the type under investigation. Typically, this may include:

- a bachelors or advanced degree in petroleum engineering, geology, geophysics or other relevant engineering or physical science
- minimum ten years practical experience in the relevant petroleum technical discipline, with at least five years of such experience being in the evaluation and classification of petroleum resources, including an understanding of the relevant commercial and regulatory requirements
- is a member in good standing of a professional organization or licensing body of engineers, geologists or other geoscientists whose professional practice includes petroleum resources evaluations and/or audits. The professional organization shall have disciplinary powers, including the power to suspend or expel a member.

Relevant national, industry or reporting regulations may require a competent person to have specific qualifications and experience. In addition, regulatory bodies may mandate a competent person, as defined by regulation, with respect to public reporting.