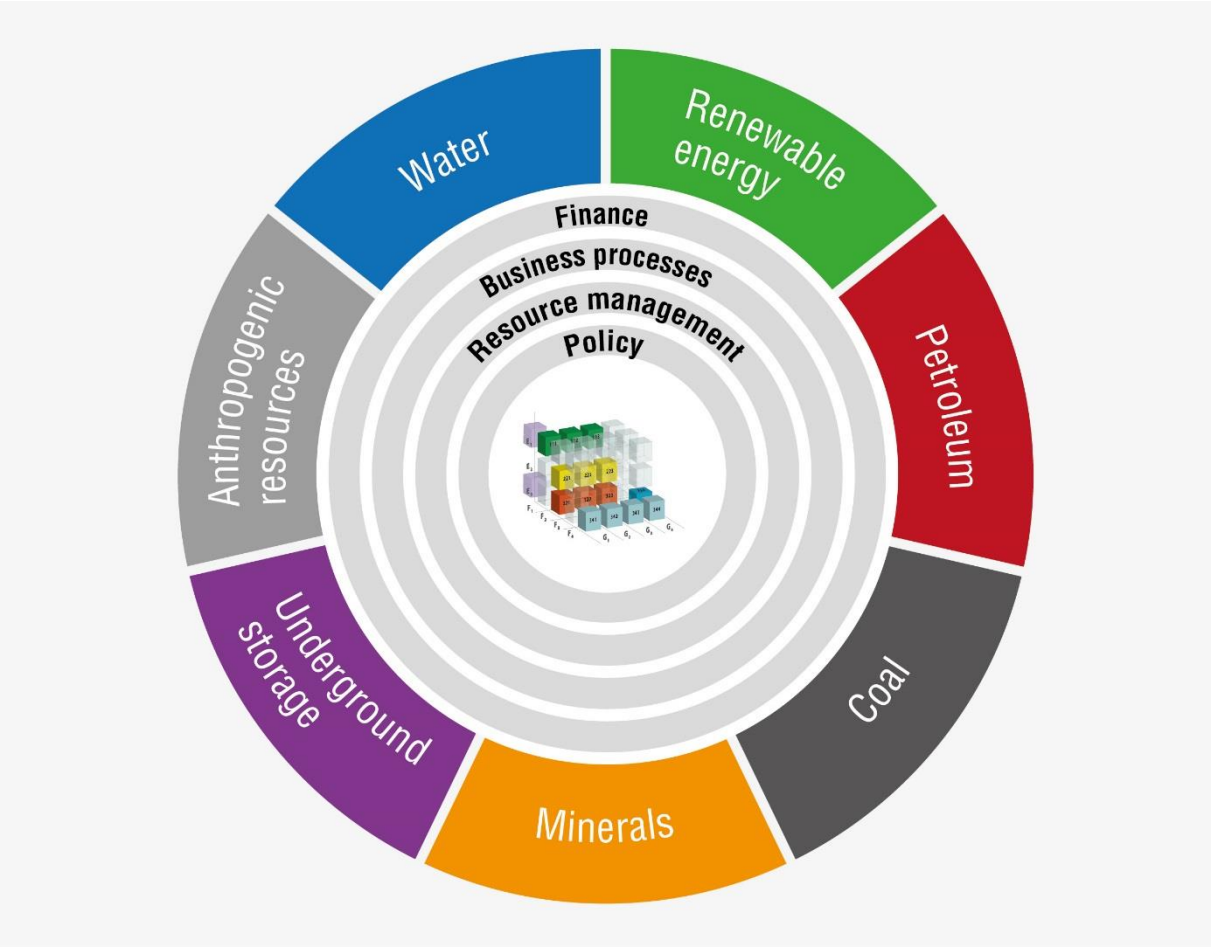
A GUIDANCE FOR THE APPLICATION OF THE UNFC-2009 FOR MINERAL RESOURCES IN FINLAND, NORWAY AND SWEDEN



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1 EXECUTIVE SUMMARY

This Guidance for the Application of the UNFC-2009 for Mineral Resources in Finland, Norway and Sweden helps preparers to produce UNFC-2009 inventories and support users by clarifying how the UNFC-2009 can be used to facilitate policy and strategy formulation, Government resources management, industry business processes and capital allocation, the four principal areas of application of the UNFC.

Guidance is provided with respect to the categorization of projects relative to their economic and social contingencies as an important help for structuring the industrial ecosystem to be both efficient and in harmony with other social and economic priorities.

Guidance is also provided with respect to the categorization of projects relative to the industrial capabilities they call on in the various phases (F-categories).

Finally guidance is provided with respect to the categorization of quantities and their uncertainties (G-Categories)

By addressing the issue of appropriation, the guidance clarifies the difference between a project inventory and the inventories of individual asset owners of the parts belonging to them. The full complexities of appropriation is however not exhaustively covered.

Valuation is an essential tool to use in classification. Brief, but non-exhaustive guidance is provided on valuation of enduring extractive activities.

Advice is provided with respect to the all-important issue of accounting of change by pointing to the power of Design Structure Matrix Methods initially developed to facilitate large engineering projects.

Then guidance is provided with respect to the four principal applications of the UNFC before addressing the issues of disclosure and quality assurance.

The guidance may stimulate minerals exploration, simplify licensing procedures, and classify the current status and potential impediments (contingencies) that restrict asset development at a project level. By using the full UNFC-2009 inventory in conjuncture with the underlying project information, the classification provides a system that can be used for data collection, standardization, aggregation and cross-comparison, thus facilitating the management of extractive activities across multiple temporal and spatial scales.

CONTENTS

2 INTRODUCTION

This document provides guidance on the use of the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) (1) for Finland, Norway and Sweden. It aims to facilitate:

- Resource policy and strategy formulation
- Government resource management
- Industry business process management
- Capital allocation

These are the applications for which the UNFC-2009 has been designed.

The guidance does not intend to change the UNFC-2009. If there is a conflict between this guidance and the UNFC-2009 (including its generic specifications), the UNFC-2009 shall prevail.

It is a prerequisite for the understanding of the guidance to have read, or have ready access to the UNFC-2009 (1) shown in principle in Figure 2.1.

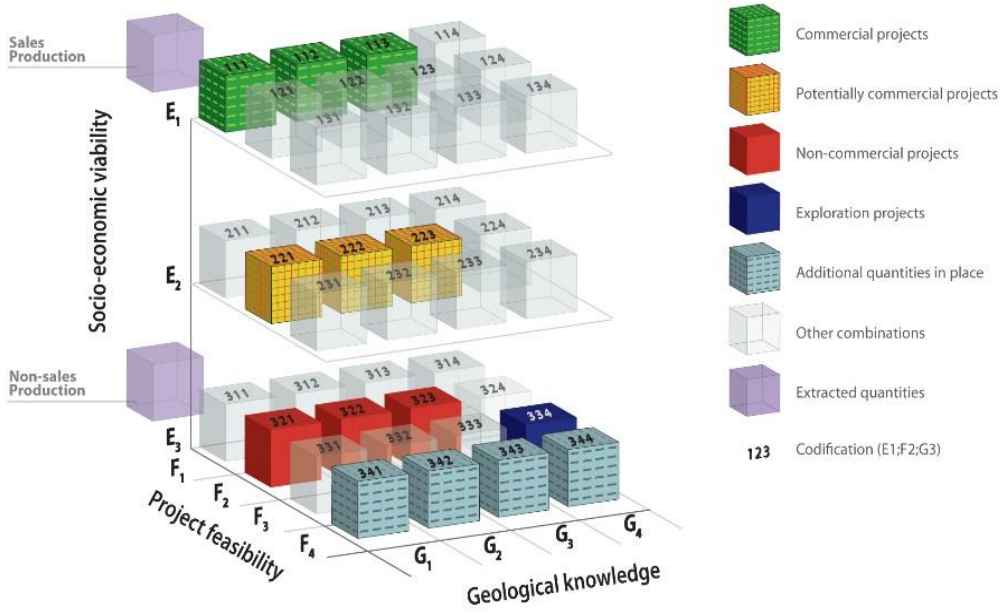

Figure 2.1 UNFC-2009.

The guidance also does not change the various regulatory requirements set by Governments or accounting standard setters for reporting on extractive activities. Guidance is however provided on how to construct a UNFC inventory so that an inventory that complies with the regulated reporting requirements most commonly used in Finland, Norway and Sweden can be generated from it.

This guidance has been drafted in discussions between the Geological Surveys of Finland (GTK), Norway (NGU) and Sweden (SGU), the Swedish Association of Mines, Minerals and Metal Producers (SveMin),

Norwegian Mineral Industry and Petronavit a.s. Liaison has been kept with and inspiration taken from the excellent efforts of the Directorate of Mining of Norway, The Norwegian Petroleum Directorate, The Finnish Mining Association, Statoil and the many rich and excellent contributions provided by The Division of Sustainable Energy of UNECE and the members of the UNECE Expert Group on Resource Classification including its Technical Advisory Group. These latter organizations have however not participated in the drafting of the guidance.

The team that has drafted the guidance has consisted of:

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2.1 DEFINITIONS

Asset

By asset we mean a legal right to perform extractive activities to which there is attached value accruing to the asset owner(s). This value will initially be in the form of information and later also in the form of permits, plants, equipment and extraction capacity and will be affected by the rules of appropriation to stakeholders.

Competent Person

A Competent Person is one who has the ability to put skills, knowledge and experience into practice in order to perform activities or a job in an effective and efficient manner for resource assessment, classification, management and reporting.

Stakeholder

Stakeholders are those parties that may affect the decisions involved in moving a project from the inception and early exploration phase through development, extraction and abandonment of an asset. They are all potential users of the UNFC-2009 (1).

Government is always an important stakeholder and sometimes the initial holder of the assets. Government stakeholders may include Parliament, depending on the importance of the asset decisions. It does include the Cabinet of Ministers. The Ministry of Finance and the ministry holding the relevant extractive activity portfolio will normally be operating the legal and fiscal framework conditions under which the activities take place, and will control the regulatory bodies. Other ministries may be stakeholders on a routine basis, e.g. the ministries of environment, local affairs and foreign policy.

The regulatory *bodies* will be stakeholders. The same applies to local governments, the courts with competency for granting legal rights to assets and/or operations on them.

Asset owners with sufficient voting power to affect decisions will always be stakeholders.

International professional bodies, industry associations and standard setting organizations are stakeholders to the extent they set binding or non-binding best-practice standards for data collection and aggregation.

There are *"outside" public stakeholders* with formal influence on decisions, including landowners with property rights and land users with legal rights to determine the land use.

Public interest bodies with informal influence through political processes or other public activities are not considered stakeholders here. The bodies they influence may be stakeholders.

Value at source

Value at source is the value that the commodities represent for the stakeholders taking a decision to extract at the point of extraction, after correcting market values for all costs, taxes, contractual charges etc. This is the value that determines whether and to which extent there is a business case for extraction that justifies the allocation of capital.

3 CATEGORIZING- AND CLASSIFYING PROJECTS

The UNFC classifies projects based on two sets of basic categories:

1. The degree of favorability of social and economic conditions in establishing the commercial viability of the project – the E-categories.
2. The maturity of studies and commitments necessary to implement development projects or extractive activities – the F-categories. These extend from early exploration efforts before a mineral deposit or an accumulation has been confirmed to exist through to the project that is extracting and selling a commodity. The maturity assumes a standard value chain that distinguishes the various modes of operation.

A third set designates the level of confidence in the geological knowledge and potential recoverability of the quantities – the G categories. They relate to quantification and the related uncertainties inherent in the sampling and estimation methods.

These categories are numbered, with 1 being best. They combine to form classes identified by Arabic numerals as seen by the boxes in Figure 2.1, where the box E1,F1,G1, (or 1,1,1 for short) is equivalent to "proved reserves", i.e. there are no contingencies in the economic and social domain blocking the implementation of the project, the project has advanced to a stage where implementation or extraction can take place, and the quantities have been determined to a degree of certainty that is high enough to attest that they will be reached or exceeded.

The categories with subdivisions and recommended attributes are described below.

3.1 E-CATEGORIES

The E-categories and existing UNFC subdivisions are shown in Annex II p.12 of the UNFC definitions (1).

Categories E1 and E3 are defined with subcategories and are self-explanatory. Category E2 is defined as "Extraction and sale is expected to become economically viable in the foreseeable future", where the phrase "economically viable" encompasses economic (in the narrow sense) plus other relevant "market

conditions", and includes consideration of prices, costs, legal/fiscal framework, environmental, social and all other non-technical factors that could directly impact the viability of a development project.

The category reflecting the least degree of favorability should be chosen unless the ensemble of issues indicates that the likelihood of favorable considerations is lower than any of the individual categories indicates. Then a category reflecting lower favorability than any of the individual categories assigned may be used.

In order to serve the four purposes mentioned in the introduction, it is recommended to attach three attributes to E2[1]:

Attribute b (written E2b): *Issues are yet to be resolved, but there is high probability of their resolution evidenced by an active attempt to resolve all impediments (contingencies) with a high probability of success, based on the characteristics of the project, previous history of similar projects in the area, or other strong indications of success, within the foreseeable future.*

Attribute c (written E2c): *Issues are yet to be resolved, but:*

- *There is an active attempt to resolve all impediments (contingencies) but with no more than a medium probability of success; or,*
- *There is no active effort to resolve impediments, but based on the characteristics of the project and previous history of similar projects in the area, success is likely within the foreseeable future.*

Attribute d (written E2d): *Issues that cannot be influenced by stakeholders are expected to be resolved in the foreseeable future.*

The manner in which these attributes are applied is governed by the need for information for the decision process to determine whether a project is or can be made acceptable from a socio-economic point of view.

The following considerations apply:

1. Value at source
2. Access to resources
3. Competition for land use
    a. Environmental contingencies
    b. Landowner interests
    c. Local authority interests

3.1.1 Value at source

Category E2b can be used if the value of the sales product at source is nearly satisfactory to proceed with the project. Processes are underway to improve it by seeking higher product prices, lower costs or modification of the fiscal and contractual frameworks. Stakeholders with powers to block the projects are seen to benefit from enhancing the value at source.

Category E2c can be used when stakeholders hold powers to enhance the value at source sufficiently for the project to proceed but will be negatively impacted by the enhancement, and/or if there is no activity to resolve the issue.

[1] Attributes "b" and "c" correspond to the proposed subdivisions E2.1 and E2.2 in the Draft guidance on accommodating environmental and social considerations in the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (13)

Category E2d can be used when the value at source is dependent on conditions outside the control of the stakeholders, e.g. global commodity markets, imposition of global or regional environmental costs. There must be reasonable grounds to assume that the conditions outside the control of stakeholders will change to produce an acceptable value at source in the foreseeable future.

3.1.2 Access to resources

A licensor may rate the likelihood of whether it will grant a specific extraction project access to resources. If approval is likely, the licensor will assign category E2b to the project and if not, E2c or E3.2

An applicant for a license may be less certain that he will be awarded the license. He may then assign category E2c or E3.2 to a category that the licensor will categorize as E2b.

The same logic will apply to the extension of licenses after their term expires.

3.1.3 Land use issues

There are a number of project contingencies related to the use and protection of land. These differ between Finland, Norway and Sweden.

Land use is an area of conflicting interests that puts the government resource management to the test. The information in the UNFC-2009 classification enhances the transparency, which is of great importance to governmental resource management.

According to the environmental legislation in Finland, Norway and Sweden, land shall be used for the purposes for which it is best suited. Land use types are designated according to their nature and location, their contribution to fulfilling existing societal needs, and general long-term sustainable development objectives. One instrument for planning land use that is applied (in slightly different ways) in Finland, Norway and Sweden is to designate certain areas as being of national interest for a certain purpose. Land containing deposits of "valuable materials and minerals" can be one of the specified national interest. Areas containing mineral deposits of national interest are often also designated to be of national interest for other (often competing and mutually exclusive) purposes such as reindeer herding, environmental protection, cultural value, or outdoor recreation. If co-existence of the conflicting interests is impossible, one of the interests must be given precedence. It is important for all parties that this is resolved before substantial investments are made. The project information in the UNFC-2009 classification can be applied in land use planning to avoid unreasonable decisions which might hinder justified, effective and sustainable exploration of mineral resources. It can avoid large expenditures not only by project participants but also by Government through the fiscal system on projects that cannot be realized.

3.1.3.1 Contingencies related to environmental protection

Mining in protected areas may or may not occur.

Category E2b can be used if the plans appear acceptable and an active process is underway to allow mining.

Category E2c can be used if mining is possible, but somewhat less likely. This can be when mining needs to take place in national parks, Natura 2000 areas, areas under landscape protection and where a change of legislation, or an administrative action by the cabinet of ministers or other distant authority (weighing the mining plans against alternative use of the land), and where the stakeholders hold little influence and consider the outcome uncertain.

Similar considerations apply to air and water emissions, where the degree of environmental impact plays a role.

3.1.3.2 Contingencies related to landowner interests

Mineral legislations distinguish between state governed and landowner minerals. Geologically, the minerals will either be entirely landowner minerals, state governed minerals or a combination of state and landowner minerals as the state minerals may occur in mineral assemblages that include landowner minerals.

Landowners will always be involved in the process of securing physical access to the mining site and sometimes the infrastructure. This holds true also for the use of land over which indigenous peoples (Sámi and Skolt populations) have rights. These lands cover a high proportion of the prospective mineral areas in Finland, Norway and Sweden.

If there is a process to resolve differences and align interests with a good chance of success, then category E2b should be used.

If the landowner issues are complex or there is strong misalignment between the interests of the landowners/indigenous peoples and those of explorers or miners, or the social resistance to mining is strong among landowners/indigenous peoples, then category E2c should be used.

3.1.3.3 Local community interests

Irrespective of the contingencies mentioned above, the exploration and mining activities will need to be considered by the local authorities with respect to land use on par with any other construction and land use activity in accordance with the zoning legislation.

If there is a positive process with a reasonable chance of success in approving the construction and land use issues, then category E2b should be used.

If the local community holds legal competence to approve or not the activities, but there is no or very weak alignment of interests between the local community and the mining interests and there is no process ongoing to resolve the differences, then category E2c should be used.

3.2 F-CATEGORIES

The F-categories follow the mode of operation of extractive activities and coincide to a high degree with the manner in which these are addressed in the mineral legislation and in capital value processes used in industry as illustrated in Figure 3.4.1.

Many extractive activities are large engineering processes consisting of linked projects rather than single well-defined projects. They may span decades over which important defining factors change, including but not limited to legal and regulatory framework conditions, markets, labor conditions, environmental limitations, technology, geological knowledge, and the composition of product streams. In order to manage these processes well, attributes may be used to distinguish between an initial project and subsequent modifications of the project to improve the extraction. Such attributes were introduced by the Norwegian Petroleum Directorate (NPD) in 2001 in the NPD Petroleum resource classification system (2) and proved to be useful for resource management purposes. In the mineral sector there are quantities stored as non-sales production in addition to quantities remaining in place after termination of the initial project that constitute a potential for additional projects.

Two attributes are recommended (2):

Attribute "f": First development project for a deposit. A project is identified with the attribute "f" (for first) when it is the first development project for one or more deposits. The attribute is used with categories F1.2, F1.3, F2.1 and F2.2. Projects with additional resources in new deposits in discoveries may

also be assigned the "f" attribute when inclusion of the resources will increase the minerals volumes in place in the deposit.

Attribute "a": Project to optimize the recovery from a deposit. A project is identified with the attribute "a" (for additional) when the project lead to improved sales of quantities in place or of the quantities categorized as non-sales quantities by a project with an attribute "f". Attribute "a" is used with categories F1.2, F1.3, F2.1, F2.2 and F3. The "a" attribute is also used to identify projects that can extend production through increased value at source.

The "f" and "a" attributes are normally not used with category F1 where feasibility of extraction by a defined mining operation has been confirmed. The projects identified with "a" attributes are normally important real options to be invested in or not, and are managed as such. Once a decision to develop is taken, the option has been exercised and focus is on the integrated project. Separate accounts to distinguish the part of a project that originates from the first decision from the parts that originates from subsequent ones is not required.

The project options may be independent or dependent of other projects. They may also be mutually exclusive. These relationships are important for business process management. They must be properly accounted for in aggregation to assess the resultant overall uncertainty and to avoid double counting.

In cases where the processing of material initially stored as non-sales production is not integrated with the initial project, a separate project should be identified using the store of non-sales production as the "in-place" resource.

3.3 G-CATEGORIES

The G categories reflect the uncertainties in the quantities assessed.

The recoverable quantities are estimated as those quantities that will cross the classification reference points for sales and non-sales quantities in the future. They will need to be coherent i.e. exactly the same in type (as defined where possible by controlled vocabularies and product classification standards), quantity, quality, price and time as the quantities reported to enter the economy in general statistics.

Quantities can be described either deterministically or probabilistically. The UNFC-2009 description is generic, see Table 3.3.1.

The generic expressions can be made quantitative by deterministic or probabilistic estimation.

1. Deterministic Estimate[2]

The term "deterministic estimate" is an estimated quantity based on a single value for each parameter (from the geosciences, engineering, or economic data) in the reserves calculation that is used in the reserves estimation procedure. An advantage of the deterministic estimate is that there will generally be a physical representation of a project with direct and indirect observations underlying it. A disadvantage is that the probability of occurrence of this realization may be unknown, making it difficult if not impossible to aggregate the estimates of a group of projects.

2. Probabilistic Estimate

A "probabilistic estimate" is an estimate that is obtained when the full range of values that could reasonably occur from each unknown parameter (from the geosciences and engineering data as well as

[2] The language describing deterministic and probabilistic estimates is inspired by SEC's considerations (12).

the socio-economic parameters) is used to generate a full range of possible outcomes and their associated probabilities of occurrence. Probabilistic estimates makes it possible to assess the value of flexibility in an engineering system architecture. They are however not suitable for detailed engineering design work that requires a spacial description of the resource. Values for the probability of exceeding the estimate allow a probability density function to be estimated. This, facilitates aggregations to obtain estimates of the total quantity and the aggregated uncertainty for a group of projects.

Category	Definition	Supporting Explanation
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence	For in situ (in-place) quantities, and for recoverable estimates of fossil energy and mineral resources that are extracted as solids, quantities are typically categorised discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorised as G1, G2 and/or G3 as appropriate. For recoverable estimates of fossil energy and mineral resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorised on the basis of three scenarios of outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence	
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence	
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 or mining operation 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 on uncertainty in the size of the potential deposit should be documented (e.g. in the form of a probability distribution). In addition, it is recommended that the chance (probability) that the potential deposit will become a deposit of any commercial significance is also documented

Table 3.3.1 Summary of the G-category descriptions.

Cumulative probability density functions are commonly used in the petroleum sector and indexed as follows:

G1: There is a 90% probability that the quantity quoted will be exceeded.

G1+G2: This represents the mean, i.e. the expected value of the distribution[3].

[3] In the petroleum sector, P50 is often used, reflecting that the probability of not reaching the specified quantity is equal to the probability of exceeding it. In asymmetric probability distributions, P50 will differ from the mean,

G1+G2+G3: There is a 10% probability that the quoted quantity will be exceeded.

The manner in which quantities are estimated by preparers depends on the needs of the users. While many users can relate to the E and F categories or aggregates of them, the methods for estimating quantities varies, depending inter alia on the premises set by the users. Preparers may therefore wish to prepare all the required estimates once they go through the underlying project information for speed and efficiency. They should identify which sets of premises they have used and may consider using attributes on the G-categories to do so, e.g. $G1_{Government}$, $G1_{JORC}$, $G1_{SEC}$, $G1_{Management}$, $G1_{Partner\ A}$. Over time and as UNFC becomes more widely applied, the number of alternative estimates required may hopefully be reduced, but they are not likely to be eliminated completely.

The above guidance on showing values conforming to other classifications or specific regulations is not part of the UNFC. The guidance is provided to help with the work processes of preparers who need to produce alternative reports. A practical example of what this may involve is taken from the petroleum industry where the US Securities and Exchange Commission requires that recoverable quantities are calculated using the average product prices of the first day of the preceding twelve months. While this is a fair rule aiming at dampening random price volatility while producing comparable results from listers, governments, management and partners may choose to look the other way – towards a set of future observed or assumed prices for better investment decisions. This guidance advises preparers to produce all sets of numbers required in the same work process.

Government specialists, academia, industry, consultants and the professional organizations, in particular the families of organizations behind the CRIRSCO template and the SPE PRMS are relied upon to set the commodity specific professional estimation procedures for quantifying the various commodities under the geologic and extraction settings in which they occur. This represents a challenge that can be met by drawing on the success of earlier initiatives of gathering information and experts of relevant organizations and entities to research the critical issues. The traditional competent or qualified person system is designed to instill quality in the estimation of quantities, while other expertise is required for the classification.

3.4 PROJECT CLASSIFICATION

The E- and F- categories define the project class. The G-categories define the resource quantities in that class. Figure 3.4.1 illustrates the similarity between the F-categories and the decision gates defined by legislation requiring permits, and the decision gates commonly used in industry when shifting from one mode of operation to the next, often deploying new capabilities and supply chain industries.

The UNFC rules and specifications do not encourage aggregation of quantities in different classes. Quantities reported for different projects always include implicit or explicit assumptions, which the preparers are advised to communicate to their best ability, and users are advised to acknowledge. If aggregation is required, then preparers and users should discuss whether and how to assign a probability of success to projects that are not in class E1F1 (where the probability of success is 1.0). The project quantities should be discounted in accordance with the probability of success when estimating the aggregated quantities.

The E-categories are of special importance to the mining sector. They are summarized in Table 3.4.1.

and will, in contrast to the sum of the mean values not sum to the P50, let alone the mean quantity for a group of projects. This is not a critical difference in most cases, considering the errors normally encountered in the subjective estimations of probabilities underlying the estimates.

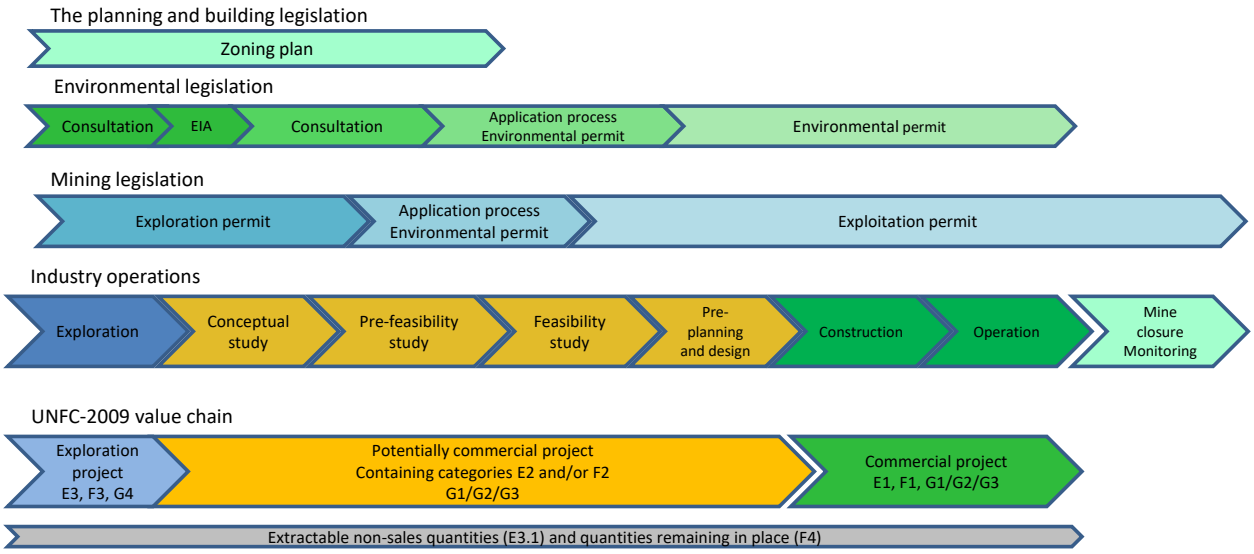

Figure 3.4.1 Schematic of mining-related project life cycles in government and industry processes (conceptual).

E3: Extraction and sale is not expected to become socio-economically viable in the foreseeable future, or evaluation is at too early a stage to determine commercial viability. *No application for regulatory approval and/or legal right to produce and sell has been submitted. The fiscal framework is not determined and contractual conditions do not yet exist.*	**E2: Extraction and sale is expected to become socio-economically viable in the foreseeable future.** *An application for regulatory approval and/or legal right to produce and sell has been submitted but is not yet approved. Fiscal framework and contractual conditions are negotiated but not yet finalized.*	**E1: Extraction and sale has been confirmed to be socio-economically viable.** *A project is assessed as E1 if all necessary permits and legal requirements are approved or in place or will be in a foreseeable future.*
E3.1: Quantities that are forecast to be extracted, but which will not be available for sale.E3.2: Socio-economic viability of extraction cannot yet be determined due to insufficient information (e.g. during the exploration phase), *or* Independent of whether *or not there is an active effort to resolve impediments, the outcome is unknown or unclarified.*	E2.b: Issues are yet to be resolved, but there is high probability of their resolution evidenced by an active attempt to resolve all impediments (contingencies) with a high probability of success, based on the characteristics of the project, previous history of similar projects in the area, or other strong indications of success, within the foreseeable future. E2.c: Issues are yet to be resolved, but: There is an active attempt to resolve all impediments (contingencies) but with no more than a medium probability of success; or; There is no active effort to resolve impediments, but based on the characteristics of the project and previous history of similar projects in the area, success is likely within the foreseeable future.	E1.1: Extraction and sale is socio-economically viable on the basis of current market conditions and realistic assumptions of future market conditions. E1.2: Extraction and sale is not socio-economically viable 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.
E3.3: It is currently considered that there are no reasonable prospects for socio-economic viability in the foreseeable future. *Whether or not there is an active effort to resolve impediments, the probability of success is no greater then medium*.	E2d: Issues that cannot be influenced by stakeholders that are expected to be resolved in the foreseeable future.	

Table 3.4.1 Overview of the use of E-categories

4 APPROPRIATION

UNFC-2009 is a system for the classification of projects and does not address the issues of appropriation i.e. who owns the extractive quantities. This is generally a question of how the cash flows are shared, and depends on the fiscal and contractual conditions. This must be handled outside the classification, but in conjunction with for instance partners' financial reports.

Appropriation arises at the project level in circumstances where a commodity from one project is transferred to another project and then recovered for sale and non-sale proposes. The principle used by NPD in these cases is stated as follows in their definition of Resource Class 1 (the equivalent of E1F1.1):

"Volumes (i.e. quantities) that have been purchased and are expected to be sold at a later date shall not be included. Petroleum that was received free of charge, or as compensation from another party and that is expected to be sold at a later date, shall be included in this classification."

When purchased quantities are being produced together with those extracted from the quantities initially in place (the indigenous quantities), then there is a need for an accounting procedure to calculate the remaining project quantities. The most reasonable convention is Last In First Out (LIFO). This reflects that the purchased quantities are acquired and stored, while the indigenous quantities are uncertain resources to be extracted. LIFO will in practice assign the uncertainty to the indigenous quantities.

5 VALUATION

Valuation may help determine the appropriate category to use for a project. Project values may be observed from accounts in the case of past projects, from transactions, or from forecasts of future cash flows. Of these, valuation based on forecasts is the most complex, but also the most common. Forecasts are often based on financial accounting methods that integrate historical price developments and current market trends; however they can also be supported by systems analysis methodologies such as dynamic Material Flow Analysis.

The net present value (NPV) of future cash flows is a common measure of value. It can be written using continuous variables:

$$NPV = \int_{t=0}^{\infty} (1 + r_c)^{-t} . v(t)dt \qquad (1)$$

Where:

r_c is the continuously compounded discount factor[4]; and

v(t) is the rate of expected cash flow over time t.

[4] There is a one-to-one relation between the continuously compounded discount factor and discount factors compounded over at fixed time periods, say annually. The formula for the NPV when discounted over fixed periods is:

$NPV = \sum_1^t \frac{V(t)}{(1+r)^t}$

Where NPV is the net present value of forecasted cash flows;
t is the time period (say year);
V(t) is the value element (cost or revenue) in period t;
r is the discount factor per period t.

Assuming that the project is of average risk and that project owners are financed by institutions constituting a well-diversified capital market – or at least can choose to be, the appropriate discount factor at which NPV is maximized for these institutions include a risk premium similar to that applying to the financial market as a whole (stock market plus bond market). In this formulation, the cash flows should reflect the actual risk and opportunities arising from the uncertainties associated with the project (3) by taking their values directly into the v(t), the cash flow in period t. The appropriate risk premium on the discount factor may be chosen to be higher for projects near break-even.

Contingent projects can then be valued as follows:

$NPV_p = NPV_s \times P_s + NPV_f \times (1-P_s)$

Where:

NPV_p is the project value.

NPV_s is the success value, i.e. the value given that the contingency is removed.

P_s is the probability that the contingency will be removed and the project will succeed.

NPV_f the failure value, i.e. the value given that the contingency will eliminate the project. It will generally be the negative value of the costs up to the abandonment of the project.

$(1-P_s)$ is the probability that the project will fail.

If the value NPV_p of the contingent project is satisfactory relative to for instance the net present value that alternative use of funds will yield, it is reasonable to assume that activities to remove the contingencies will proceed and the project can remain with the original category. If the NPV_p is not positive enough, then the project may have been assigned too high a category and should be considered for degrading.

6 ACCOUNTING

The UNFC is complete in the sense that material balance is preserved when the classification is applied to the extraction of non-renewable quantities. The quantities initially in place will equal the sum of the quantities:

- Extracted and sold
- Extracted and not sold
- To be extracted and sold in the future
- To be extracted and not sold in the future
- Not extracted due to project abandonment or non-realization
- Remaining in place after extraction

Each partner will have changes in their portfolios of inventories reflecting acquisitions, divestments, mergers, and change in contractual terms and conditions etc. Accounting of these changes caused by changes in appropriation and/or participating interests are not addressed here.

Quantities to be extracted or to remain in-place are classified by the E- and F-categories. They will change class and quantity from one period to the next as a result of operations, project maturation and new

observations and insight. The account can be constructed drawing on the logic of Design Structure Matrix Methods (DSM) (4) applied in large engineering projects.

The quantities to be tracked for each product are:

1. Sales production at the sales reference point
2. Non-sales production and the non-sales reference point
3. Expected value if not G1+G2
4. Probability of realization of the project
5. G1
6. G2
7. G3

   For exploration projects:

8. G4 or
9. G4.1
10. G4.2
11. G4.3
12. Chance of discovery of a minimum economic quantity
13. Minimum economic quantity
14. Additional G-category quantities required, see section 3.3

Figure 6-1 illustrates how the DSM account works. A single project is shown. The account can also be constructed for a portfolio of projects. For simplicity, single numbers are used for the ensemble of quantities mentioned above.

The initial quantities at the beginning of the accounting period are shown in the column to the left of the matrix. Their values are carried over from the previous accounting period. Their input to classes by the end of the period is shown in the rows of the matrix (the input rows). The quantities in the various classes at the end of the period then appears in the columns of the matrix (the output columns) and their aggregated values in the row above the matrix. The column on the far left reflect the changes in estimates during the period. Classes are identical in rows and columns and are referred to by numbers for convenience.

In the example shown, the project holds initially 100 units of sales quantities (resources in the CRIRSCO terminology)[5] in class E1F2.1 and is therefore a potentially commercial (contingent) project. It also hold 10 units of non-sales quantities (class E3.1F2.1) and 200 units of quantities that will not be extracted (class E3.3F4). At the end of the period the project has been upgraded to a commercial project and extraction has started. The class in row 5 in the figure has now delivered 10 units of sales and 95 units to class 3, the commercial class (E1F1.1). The class 3 quantities are recognized as reserves in the CRIRSCO terminology. No quantities remain in the initial class 5 as seen by the zero entered on the diagonal. Of the non-sales production in class 6 (E3.1F2.1), 1 unit has been extracted (but not sold). A solution has been found to sell 1 unit so it has become commercial and is delivered to class 3 (E1.F1.1) and 4 remain as future non-sales production but now with the same F category as the commercial project and is found in class 4 (E3.1F1.1). Again no quantities remain in class 6. Finally, the quantities remaining in place have been reduced by an increase in recovery. Of these 20 have been become commercial and are found in class 3 (E1F1.1) and 190 are on the diagonal in class 7 (E3.3F4). Altogether we see from the last column on the right that the estimates of initial quantities in place have been increased by 15 units, 5 from class 5 and 10 from class 7. The account at the end of the period is now found in the columns (the output columns).

[5] Reference 1 contains the bridging document that relates UNFC to the CRIRSCO template.

The net result is shown in the aggregated row of final quantities at the top of the matrix. This row will then be carried over to the next period and appear in the column of initial quantities.

By constructing the matrix with the best classes at the top, the matrix will show upgrades by the numbers below the diagonal and downgrades by numbers above it.

					Output columns							
					Sales	Non-sales	Commercial	F1 Extractable non-sales	Potentially commercial	F2 Extractable non-sales	Remaining in place	Total quantity change
				Final quantity	10	1	116	4	0	0	190	
							E1F1.1	E3.1F1.1	E1F2.1	E3.1F2.1	E3.3F4	
		Class	**Initial quantity**	**class no**	1	2	3	4	5	6	7	
Input rows		Sales		1								
		Non-sales		2								
	Commercial	E1F1.1		3								
	F1 Extractable non-sales	E3.1F1.1		4								
	Potentially commercial	E1F2.1	100	5	10		95		0			5
	F2 Extractable non-sales	E3.1F2.1	10	6		1	1	4		0		0
	Remaining in place	E3.3F4	200	7			20				190	10

Figure 6-1 Presentation of UNFC accounts using a Design Structure Matrix methodology

In order to provide numbers by class at the end of the period, it is necessary to aggregate the quantities in the columns (the output columns). Except for the measured quantities at the reference points (sales and non-sales production) these are uncertain quantities. To aggregate them "correctly" requires an estimate of their probability density functions, their dependencies and correlations as well as consideration of the purpose and use that will made of the aggregated numbers. This subject is not covered in this guideline.

An estimate of mean (expected) values of the probability density functions is useful. This will normally allow a simple arithmetic aggregation of the inventory. Depending on how the estimation of quantities is done, the expected value may be the sum of the G1 and G2 quantities of the projects.

For public reporting purposes it is sometimes required to aggregate quantities in each class by simple summation. The sum of the G1 estimates normally means summing up the low estimates on the individual probability density functions. As the portfolios grow, the G1 sums become gradually irrelevant as they will fall below and outside the range of expected outcomes for the portfolio as a whole (the probability that all projects go wrong becomes negligible).

7 APPLICATION

The preparation of UNFC -2009 inventories is governed by the needs for its application. Figure 7.1.1 summarizes the four principal needs that the UNFC is designed to meet and the sectors it will apply to.

7.1 RESOURCE POLICY FORMULATION

Resource policy formulation will generally need reliable numbers at high levels of aggregation. This demands a precise definition of what the underlying physical quantities represent, as well as high quality in the estimates of expected values. The law of large numbers will have reduced the operational uncertainties and minimized the range around the expected value. The quantities in the UNFC-2009 classes can be used as indicators for measuring sectoral improvement potentials through wise policy decisions. Policy formulation and strategic decision-making demand numbers to illustrate the effects of alternative policies, and to outline possible choices and development pathways. It refers not only to the quantification of supply and demand and price elasticity, but also to resource depletion and environmental impact mitigation. In other words the dependencies and correlations between extractable quantities, general cost levels and general commodity prices need to be estimated and documented at the underlying project level.

The manner in which UNFC-2009 currently is evolving makes it an essential tool for the formulation of resource policies and national strategies in the coming period of major reforms spurred by the UN Sustainable Development Goals and Paris Climate Accord of 2015. This stems from its basic design and from its recent expansion from applying to fossil energy and mineral resources to energy and mineral resources including injection projects, and soon probably also projects for the classification of anthropogenic resources and water projects.

Strategies and policies are built to create future benefits and instill robustness against adverse effects of unforeseen events over which there is little control. Their formulation is greatly assisted by using the UNFC-2009 numbers.

Numbers of relevance for judging opportunities associated with increased commodity prices or reduced general cost levels are identified by category E2d. Numbers of relevance for judging the risks associated with decreased commodity prices or increased cost levels are not as visible. They would need to be developed from the underlying project information that the UNFC-2009 summarizes.

UNFC numbers are also relevant for other needs in strategy formulation, as outlined below.

Figure 7.1-1 Applications of the UNFC-2009

The Swedish minerals strategy (5) identifies five strategic objectives that are considered to be of particular importance in order to reach the strategy's vision.

1. A mining and minerals industry in harmony with the environment, cultural values and other business activities.
2. Dialogue and cooperation to promote innovation and growth.
3. Favorable framework conditions and infrastructure for competitiveness and growth.
4. An innovative mining and minerals industry with an excellent knowledge base.
5. An internationally renowned, active and attractive mining and minerals sector

In nearly all of them, the UNFC-2009 numbers matter.

Mineral strategies and policies in Finland (6) and Norway (7) conform to the same overall objectives and principles as the Swedish one.

7.2 GOVERNMENT RESOURCE MANAGEMENT

Government resource management consists inter alia of:

- Setting the legal, fiscal and regulatory framework. This work requires careful analysis of the E-categories of quantities to improve the conditions for efficient and responsible resource exploitation.
- Managing the sequence and tempo of extractive activities in an effort to protect and enhance the value at source. This requires not only the full UNFC-2009 inventory, but also the underlying project information. An example of the latter can be seen in the format of the reports that the Norwegian Government requests from the petroleum sector (8).
- Maximizing the societal benefit of resource use by integrating it with the planning, preparation and making full use of the national infrastructures.
- Environmental management, for which category E3.1 – future non-sales quantities - is essential. The non-sales quantities, also often termed mine residuals are considered as potential resources, provided means can be found to turn them into useful products. Without such efforts they may remain environmental burdens.
- Identifying and anticipating potentials that government actions can turn into value.
- Managing industrial and labor relations.
- Revenue and asset management.
- Knowledge building by exploration work that provides national capital through the accumulation of quality information on the resource potentials.
- Adopting a long-term perspective that supports activities to secure future sustainable raw material supply.
- Managing valuable soft infrastructures – education, social investments etc.

7.3 INDUSTRIAL BUSINESS PROCESS MANAGEMENT

For industrial business process management, the demand for information is similar to that for Government resource management. However, it is generally less aggregated and requires additional project information, particularly for contingent resources.

Industries need in general to keep close track of options for future developments, how they interact physically to create synergies, how they fit industrial capabilities (i.e. competence and capacity), how they impact financial capacities and credit ratings, and how they impact share prices through key performance

indicators used by analysts such as annual production and sales, reserves replacement ratios etc. These options will be reflected in internal accounts, as projects that may be independent, dependent, correlated or mutually exclusive. While the classification holds these projects with their extractable quantities, it is important to recognize that they are projects with underlying project descriptions that hold information in addition to the extractable quantities, which is indispensable for managing the industrial business processes. Depending on how options are managed, they may change character at too high a frequency for broad communication. Some of the information may be commercially sensitive and kept confidential.

Developing a mine is a time consuming process with very high development costs. Using the full UNFC-2009 inventory supports business strategy development by providing data that can be used for analyzing the supply chain context with methods such as Material Flow Analysis, Life Cycle Analysis, and demand-supply scenario modeling. For mining companies, or companies that are trying to develop new mining projects, UNFC-2009 can be used as a communication tool that helps to capitalize on progress made in the fields of waste reduction, increased resource efficiency, community engagement, and reporting transparency. All of these are key challenges in the sustainability debate and closely related to the public acceptance of mining, a key success factor for the industry. Moreover, the use of UNFC-2009 contributes to demonstrate compliance with international best practice on a project level, by this likely increasing overall asset value.

7.4 CAPITAL ALLOCATION

External funding of mining projects (and exploration) requires transparency of project information, including identified uncertainties and potential risks. UNFC-2009 enables a compiled presentation of the overall status of a planned mining project that indicates the areas with potential risks.

The UNFC-2009 is built to support the allocation of financial resources. In its efforts to produce an International Financial Reporting Standard for Extractive Activities, the International Financial Accounting Board is in need of a classification that covers all extractive activities. UNFC-2009 is a general classification system rather than a commodity-specific reporting code, and thereby stands alone to meet this need. The traditional procedure adopted for public reporting is meant to provide an indication of future revenues. It discloses estimates of total future sales quantities from committed projects (proved reserves) and to some extent more uncertain estimates (proved plus probable reserves), without detailed information on costs, risks, or levels of appropriation of the cash flow to the entity being financed. Investors generally require detailed and reliable information for making capital allocations. While UNFC-2009 will in general only hold information on resource quantities, it can be used to reference the underlying project information, which provides the necessary level of detail. Capital is often allocated to asset holders and not projects. For this it is necessary to address appropriation, which is not a subject of this document. The owners of UNFC-2009 information are free to decide whether to disclose this information within the limitations set by regulation.

7.5 REGIONAL AND GLOBAL PERSPECTIVES

The UNFC-2009 system can greatly facilitate the communication of projects related to national resource management to decision makers and other stakeholders in a globally harmonized, uniform and easily understandable manner.

The UNFC-2009 classification efforts aim to achieve a well-managed global resource base. It contributes to improving the integration of highly fragmented data inventories, increasing data consistency and accuracy. Data availability, accessibility and harmonization are the main challenges for building comprehensive resource inventories. The use UNFC-2009 serves as a common data standard that

facilitates data aggregation across different levels, in addition to providing a basis for linking distributed resource inventories to compatible information infrastructures. It is a model that is taking into account the social, as well as economic and environmental sustainability. Thus it communicates with the UN Sustainable Development Goals (SDGs). A well-managed global resource base contributes to a number of individual SDGs, such as reducing poverty, economic growth, sustainable industry, innovations and infrastructure, sustainable cities, sustainable consumption and production, climate change as well as peaceful and including societies and global partnership where the industrial activities, performed under the Government framework conditions play an essential role.

8 DISCLOSURE

Disclosure of information on initial and extractable quantities is made at the discretion of the owner of the information, subject to laws, regulations and contractual commitments.

Government reporting requirements may specify information for public disclosure and information that will remain confidential, at least for some time.

Listed companies will need to report as required by the security regulators. Most petroleum companies are listed on the New York Stock Exchange and will need report in compliance with the US Securities and Exchange Commission (SEC) rules and the Financial Accounting Board Standards (FASB). Mining companies are often reporting according to Canadian National Instrument 43-101 or one or more of the internationally recognized mineral standards acceptable to the European Securities and Market Authority (ESMA) shown in Appendix I.

Information will normally be shared internally among stakeholders for decision or collaboration purposes. In many cases, cross-institutional collaboration is a prerequisite for resolving barriers to mining, especially in the socio-political context. Voluntary data disclosure may greatly benefit the process of resolving contingencies on a project level. It facilitates public-private partnerships and supports stakeholder engagement that enables progress along the F and E axes.

More extensive information than what is legislated in the financial reporting codes may need to be disclosed in conjunction with acquisitions, divestments and mergers.

Finally information may find its way into the public domain in regular public communication.

We welcome the development of a reporting system that draws the numbers from a central inventory and tracks the disclosures made by the information owner in an effort to keep the conversations about the resources as factual as possible.

9 QUALITY ASSURANCE

The responsibility of reporting of quantities according to the UNFC-2009 inventories rests with the organization or entity reporting the quantities.

Disclosure requirements, including the use of a Competent Person may be governed by a body, regulator or authority in appropriate jurisdictions. The regulating authority may at the national level be a Ministry or a Commission mandated by the Government for this task. For financial reporting, the Stock Exchange Commission or a banking sector regulator may govern these requirements. An individual body such as a

company may establish its own governance process answerable to an independent Board of Directors, trustees or other stakeholders.

The reporting organization or entity may set up an internal control system to ensure that the estimates are of sufficient quality to support the internal decisions in addition to the reporting requirements they are developed for.

An organization or entity will in general have asset teams that develop and maintain project descriptions including the resource estimates. An internal control system may encompass all the critical assessments made by the asset teams, including resource estimates.

The internal control system may include internal requirements with respect to:

- How information is collected and safeguarded.
- How records are stored and archived.
- How resource and other estimates are compiled and checked.
- How resource accounts are monitored over time.
- How the project information, including resource estimates are communicated.

It should also include an audit function, to be performed by a body independent of the asset that also may be charged with aggregating information from several assets and producing aggregated reports.

This audit function can be fulfilled by an internal body that reports directly to the body in the organization carrying the responsibility for external reporting, usually the Board of Directors. It can also be, or contain input from, an independent third party.

A third party audit may:

- Audit the internal control system, and/or
- Assess the functioning of the system by select reviews, or
- Produce an independent assessment of the assets and how they are accounted for in UNFC-2009 inventories.

The requirements for internal and external evaluators' qualifications follow the UNFC-2009 guidance on the subject (9) (10). This includes the use of licensed Competent Persons when this is required by the users.

10 APPENDIX I - INTERNATIONALLY RECOGNISED MINERAL STANDARDS ACCEPTABLE TO THE EUROPEAN SECURITIES AND MARKET AUTHORITY (11)

For the purposes of meeting the exemption in paragraph 133(ii) above[6], predecessors of these following reporting standards (Mining Reporting and Oil and Gas Reporting) are acceptable.

Mining Reporting

- The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves published by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council of Australia, as amended ('JORC');

- The South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves published by the South African Mineral Resource Committee under the joint auspices of the Southern African Institute of Mining and Metallurgy and the Geological Society of South Africa, as amended ('SAMREC');

- The various standards and guidelines published and maintained by the Canadian Institute of Mining, Metallurgy and Petroleum ('CIM Guidelines'), as amended;

- A Guide for Reporting Mineral Exploration Information, Mineral Resources and Mineral Reserves prepared by the US Society for Mining, Metallurgy and Exploration, as amended ('SME');

- The Pan European Resources Code jointly published by the UK Institute of Materials, Minerals, and Mining, the European Federation of Geologists, the Geological Society, and the Institute of Geologists of Ireland, as amended ('PERC');

- Certification Code for Exploration Prospects, Mineral Resources and Ore Reserves as published by the Instituto de Ingenieros de Minas de Chile, as amended; or

- Russian Code for the Public Reporting of Exploration Results, Mineral Resources and Mineral Reserves prepared by the National Association for Subsoil Examination (NAEN) and the Society of Russian Experts on Subsoil Use (OERN) (The 'NAEN Code')

Oil and Gas Reporting

- The Petroleum Resources Management System jointly published by the Society of Petroleum Engineers, the World Petroleum Council, the American Association of Petroleum Geologists and the Society of Petroleum Evaluation Engineers, as amended;

- Canadian Oil and Gas Evaluation Handbook prepared jointly by The Society of Petroleum Evaluation Engineers and the Canadian Institute of Mining, Metallurgy & Petroleum ("COGE Handbook") and resources and reserves definitions contained in National Instrument 51-101 Standards of Disclosure for Oil and Gas Activities; or

- Norwegian Petroleum Directorate classification system for resources and reserves.

[6] The appendix is copied from reference 8.

Valuation

- The Code for Technical Assessment and Valuation of Mineral and Petroleum Assets and Securities for Independent Expert Reports, prepared by a joint committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and the Mineral Industry Consultants Association, as amended ('VALMIN');

- The South African Code for the Reporting of Mineral Asset Valuation, prepared by the South African Mineral Valuation Committee under the joint auspices of the Southern African Institute of Mining and Metallurgy and the Geological Society of South Africa, as amended ('SAMVAL');

- Standards and Guidelines for Valuation of Mineral Properties endorsed by the Canadian Institute of Mining, Metallurgy and Petroleum, as amended ('CIMVAL')

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12 ACRONYMS AND ABBREVIATIONS

CIM	Canadian Institute of Mining Metallurgy and Petroleum
CIMVAL	Standards and Guidance for Valuation of Mineral Properties endorsed by the Canadian Institute of Mining, Metallurgy and Petroleum, as amended
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
DSM	Design Structure Matrix
E-axis	A collective term for E-categories
E-categories	E1, E2 and E3 designate the criteria of economic and social viability. E1 = highest degree of viability. Sub-categories occur (e.g. E1.1)
ESMA	European Securities and Market Authority
FASB	Financial Accounting Standards Board
F-axis	A collective term for F-categories
F-categories	F1, F2, F3, F4 designate the criteria of field project status and feasibility. F1= the most mature project status. Sub-categories occur (e.g. F1.1)

G-axis	A collective term for G-categories
G-categories	G1, G2, G3 and G4 designate the level of confidence in the geological knowledge and potential recoverability of the quantities. G1 = highest degree of confidence. Sub-categories occur (e.g. G4.1)
JORC	Australasian Joint Ore Reserves Committee
LIFO	Last in first out
NAEN	Self-Regulating Organization "National Association for Subsoil Audit" includes corporate members and an association of individual specialists (OERN) Coordinates and financially supports the OERN activity for the Russian Code development
NAEN code	The Russian Code for public reporting of exploration results, reserves and resources of solid minerals (The NAEN Code)
NPD	Norwegian Petroleum Directorate
NPV	Net present value
PERC	Pan-European Reserves and Resources Reporting Committee
PRMS	SPE/WPCAAPG/SPEE Petroleum Resources Management System of 2007 which has been endorsed by SPE, WPC, AAPG, SPEE and SEG (acronyms also have to be explained)
SAMREC	The South African Code for the Reporting of Exploration Results, Mineral Resources and Mineral Reserves published by the South African Mineral Resource Committee under the joint auspices of the Southern African Institute of Mining and Metallurgy and the Geological Society of South Africa, as amended
SAMVAL	The South African Code for the Reporting of Mineral Asset Valuation, prepared by the South African Mineral Valuation Committee under the joint auspices of the Southern African Institute of Mining and Metallurgy and the Geological Society of South Africa, as amended
SEC	US Securities and Exchange Commission
SDG	Sustainable Development Goals of the United Nations 2030 Agenda for Sustainable Development
SME	Society for Mining, Metallurgy and Exploration, Inc.
SPE	Society of Petroleum Engineers
UN	United Nations
UNECE	United Nations Economic Commission for Europe
UNFC	United Nations Framework Classification for Fossil Energy and Mineral Resources
UNFC-2009	United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009
VALMIN	The Code for Technical Assessment and Valuation of Mineral and Petroleum Assets and Securities for Independent Expert Reports, prepared by a joint committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and the Mineral Industry Consultants Association, as amended.