Society of Petroleum Engineers

Oil and Gas Reserves Committee (OGRC)

"Mapping" Subcommittee
Final Report – December 2005

Comparison of Selected Reserves and Resource Classifications and Associated Definitions

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- UK Statement of Recommended Practices (SORP-2001)
- Canadian Security Administrators (CSA -2002)
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- Norwegian Petroleum Directorate (NPD–2001)
- United States Geological Survey (USGS-1980)
- United Nations Framework Classification (UNFC-2004)

Executive Summary

In October 2005, the "Mapping" subcommittee of the SPE Oil and Gas Reserves Committee (OGRC) completed a study of reserve/resource classification systems published by the following eight international "agencies":

1. US Security and Exchange Commission (SEC - 1978)
2. UK Statement of Recommended Practices (SORP -2001)
3. Canadian Security Administrators (CSA -2002)
4. Russian Ministry of Natural Resources (RF-2005)
5. China Petroleum Reserves Office (PRO – 2005)
6. Norwegian Petroleum Directorate (NPD – 2001)
7. United States Geological Survey (USGS - 1980)
8. United Nations Framework Classification (UNFC- 2004)

The overall structure of, and reserves definitions within, each system were compared to the 1997 SPE/WPC reserves definitions, the 2000 SPE/WPC/AAPG classification, the 2001 supplemental guidelines, and the 2004 glossary (hereafter referred to as the "SPE definitions").

Although the terminology varies, there is a high degree of commonality:

- All systems define major resource categories that can be mapped directly to the SPE categories: undiscovered (prospective resources), discovered unrecoverable, discovered sub-commercial (contingent resources) and discovered commercial (reserves).

- Most classifications recognize three deterministic scenarios with decreasing technical certainty: a low estimate, best estimate and high estimate. While probabilistic assessments are not commonly applied, it is generally accepted that the equivalent estimates on a cumulative probability distribution would be greater than or equal to P90, P50 and P10 respectively. For discovered and commercial volume estimates, the discrete (incremental) volumes within these bounds are generally referred to as proved, probable and possible reserves. The Russian, UNFC and USGS recognize similar certainty classes but use alternative terminology.

The regulatory agencies typically define a subset of the total classification for disclosure to investors and further impose specific rules around technical and commercial certainty. The SEC guidance is the most restrictive while the Canadian and UK regulations allow disclosures more closely aligned with assessments used for internal resource management.

The UNFC uniquely provides a high-level classification system that can be applied to all extractive industries including energy minerals (petroleum, coal and uranium).

Based on analysis of each agency's classification system, the subcommittee collated the following potential "best practices" for review by the OGRC subcommittee charged to recommend revisions to current SPE reserves and resource definitions:

- Utilize a consistent set of criteria to segregate discovered from undiscovered without reference to ultimate commerciality. All such discovered volumes should be initially categorized as contingent resources.

- Estimates of recoverable quantities must clearly identify the development project(s) applied to a specific accumulation (reservoir) and its in-place hydrocarbons. The "project-reservoir" intersect becomes the resource entity for which an uncertainty distribution of recoverable quantities is defined. The project maturity/chance of reaching production status is used to segregate reserves from contingent resources.

- To maintain consistency, the same class confidence hurdles (P90/P50/P10) should be applied to estimates whether assessed using deterministic or probabilistic methods Although the assessment should support either arithmetic summation or probabilistic aggregation, the guidelines should clearly identify that these certainty guidelines apply to the project-reservoir entity.

- From a business perspective, the inclusion of additional deterministic technical and commercial criteria for reserves classes (proved, probable, possible) or discrete estimates (1P, 2P, 3P) may have value in providing increased consistency in assessments. However, these should be provided as guidelines and not imbedded in the class definitions. The definitions should be broad enough to accommodate such criteria as imposed by regulatory agencies.

- Apply developed/undeveloped status to all reserves classes. Reserves that remain undeveloped beyond a reasonable period demonstrate lack of commitment and should be reclassified as contingent resources.

- The definitions should encompass all hydrocarbons whether conventional or unconventional (gas, liquid or solid phases) irrespective of the extraction method and processing applied.

- The total system should provide for accounting of all components to support mass balance; that is, the sum of produced, recoverable, production/processing losses and unrecoverable quantities should equal the estimated initially-in-place hydrocarbons. The guidelines should provide the option, subject to regulatory rules, of including hydrocarbons to be consumed as fuel in production and processing as reserves and contingent resources.

Documentation regarding reserves and resources is best presented in a more structured manner consisting of:

Overall Resource Classification – chart and resource category definitions
Reserves Definitions – high level, principle-based
Application Guidelines – detailed guidance, subject to periodic revisions
Application Examples – illustrations of both common and exceptional issues

The format used by the Petroleum Society of the Canadian Institute of Mining, Metallurgy and Petroleum in their 2002 definitions provides a useful template.

Introduction

The goal of resource classifications is to provide a common framework for estimating quantities of oil and gas, both discovered and undiscovered, associated with reservoirs, properties and projects. The classification should cover volumes originally in-place, technically and/or commercially recoverable, on production or already produced. Ideally, subsets of a single classification system could be used by regulatory agencies, government departments, and internally by the operating companies.

In 2000, the Society of Petroleum Engineers (SPE) jointly with the World Petroleum Council (WPC) and the American Association of Petroleum Geologists (AAPG) published a Reserve and Resource Classification to address the requirement for an international standard. The underlying Reserves Definitions were unchanged from those published by the SPE/WPC in 1997. Additionally, in 2001 the SPE/WPC/AAPG jointly published "Guidelines for the Evaluation of Petroleum Reserves and Resources" as clarifications for the application of the 2001 and 1997 documents. Further clarification was provided in the Glossary of 2005, in particular by the definition of the term commercial, and thereby reserves. The total information contained in these four documents is referred to hereafter as the current "SPE definitions".

At the September 2004 Annual Technical Conference and Exhibition, the leadership of the SPE and the OGRC jointly developed a "grand vision" that reads:

" To have a set of reserves & resource definitions (and an associated set of estimating guidelines, which are current best practices) universally adopted by the oil industry, international financial organization and regulatory reporting bodies".

In order to achieve this "vision", the OGRC discussed several key options to "clarify and/or revise existing SPE Reserves and Resource Definitions". In December 2004, two subcommittees were established to progress this project:

- the **Definitions Subcommittee** was charged with reviewing the current SPE "definitions" documents in detail to identify internal inconsistencies and ambiguities, identify key issues not addressed, examine improved presentation formats, and ultimately draft a revised set of documents.

- the **Mapping Subcommittee** was charged with examining key alternative classification and definitions that are, or have the potential to be, broadly applied to reserves and resources reporting and prepare a detailed comparison of each to the current SPE definitions.

This document contains the results of the Mapping Subcommittee's findings. The survey of each agency provides the OGRC with a useful summary of major classifications currently being applied. The focus of this report is to identify those features that deserve further study by the Definitions Subcommittee in their task to clarify/revise the existing SPE definitions.

The Mapping Subcommittee consisted of: John Etherington (Consultant – Canada), Torbjorn Pollen (Statoil - Norway) and Luca Zuccolo (ENI- Italy) and was chaired by John Etherington.

Classifications/Definitions Studied

The subcommittee reviewed and compared eight sets of classifications and definitions as published by the following agencies:

1. US Security and Exchange Commission (SEC-1978)
2. UK Statement of Recommended Practices (SORP-2001)
3. Canadian Security Administrators (CSA -2002)
4. Russian Ministry of Natural Resources (RF-2005)
5. China Petroleum Reserves Office (PRO-2005)
6. Norwegian Petroleum Directorate (NPD–2001)
7. United States Geological Survey (USGS-1980)
8. United Nations Framework Classification (UNFC-2004)

While there are several other major classifications/definitions that may be examined in the future, these eight represent an appropriately diverse mix used in securities regulations, government reporting, and/or for companies' internal resource/asset management. The eight agencies selected can be categorized as follows with additional reference to the depth of associated documentation (see figure 1):

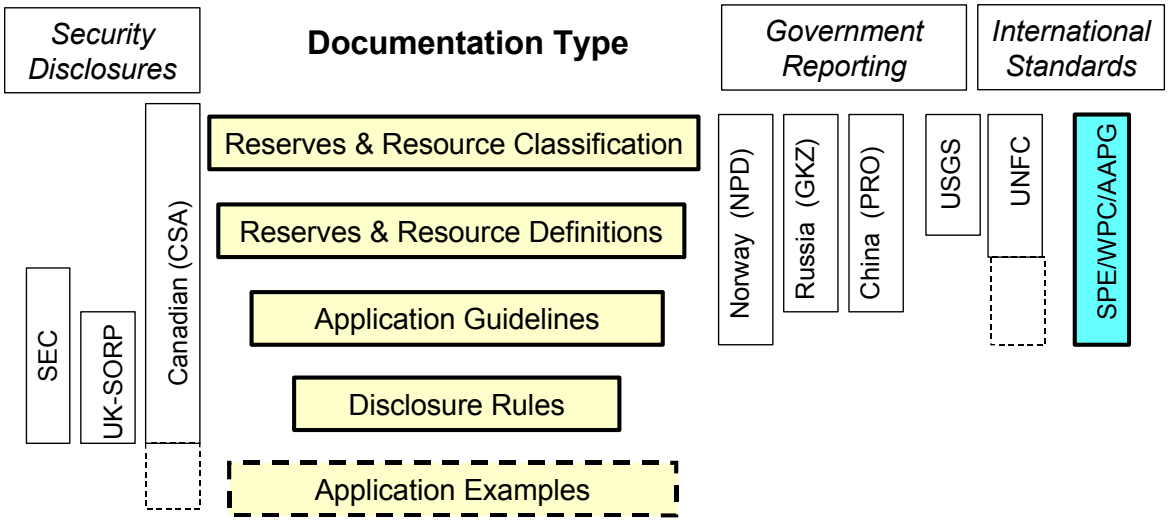


Figure 1: Categorization of Agencies Surveyed

- Securities Disclosures: SEC, Canadian (CSA), UK SORP.
  These agencies define rules for defining proved and/or 2P reserves estimates to be disclosed to security investors for publicly traded oil and gas companies. The primary objective is to provide consistent volume and associated value assessments such that investors may compare financial performance. The estimation guidelines are imbedded in their financial accounting regulations. Typically no overall reserve and resource classification context is supplied and the application guidelines take on the format of "rules". Canada's approach is unique in that the security regulations reference a full classification, definitions and detailed assessment guidelines that are maintained by professional societies, not by the regulatory agency.

- Government and industry reporting: Norway, the Russian Federation, China, USGS. These agencies attempt to capture the full resource base in order to project future production potential for the country and are not primarily concerned to show recoverable volumes and values accruing to individual companies. Governments need this information regarding production and reserves to implement and modify legislation and policy (fiscal terms, licensing incentives, etc.) on resource development to manage energy supply. In the case of Norway, the government's classification is also used internally by the Norwegian companies to manage their oil and gas portfolios *(for those listed on U.S. stock exchanges, they must also estimate proved reserves under SEC guidelines)*. The USGS conducts "future potential of the world" studies based on geological-based assessment units that cut across political boundaries to support long-range global energy supply analyses.

- Technical Standards: United Nations Framework Classification (UNFC), SPE. The SPE and UNFC definitions are presented as independent standards to promote international consistency in total resource assessment processes and terminology. The SPE classification and definitions are the current de facto standard and most oil and gas companies have adapted it into their internal systems. The UNFC incorporates the SPE standards for petroleum within an overall classification system applicable to all the energy minerals (including coal and uranium). The UNFC is endorsed by the UN Economic and Social Council, a top level body in the UN, equivalent to the Security Council, but for economic and social affairs. SPE and UNFC committees are currently coordinating to ensure their classifications are synchronous and have a common set of application guidelines.

Given the diversity of oil and gas accumulations and development projects, there can be significant interpretation latitude, not only in the estimation of recoverable quantities, but also in their logical classification. Thus, to promote consistency in application, it is beneficial to have a comprehensive set of application examples that cover the key issues. None of the agencies currently have such examples. The professional societies that maintain the Canadian technical guidelines are in the process of publishing an extensive set of such examples showing the recommended interpretations for each.

Method of Study

The subcommittee made extensive use of websites and published papers to gather information on the reserves and resources classifications and associated definitions utilized by the identified agencies. The committee established a contact person within the Canadian, Russian, Chinese, USGS and UNFC agencies to act as an advisor and to validate comparisons to their definitions. For the SEC, UK-SORP and Norwegian agencies, the committee sought advice from SPE members experienced in applying these systems.

The selected definitions are published by international organizations such as the United Nations or are part of reporting requirements defined by government agencies. In some cases the definitions are extracted from regulatory reporting requirement documents including legislation to prescribe company disclosures to securities investors of oil and gas reserves and associated financial data.

In order to achieve consistency for analyses, a standard template was developed to document the classification/definitions of each agency surveyed and consists of:

- Overview of the Agency issuing the classification.
- A summary description of the classification.
- A comparison to the SPE/WPC/AAPG 2000 (SPE) classification with a discussion of key differences.
- A table detailing a comparison to the SPE reserves definitions.

In order to consolidate the definitions into a manageable-sized table, it was necessary to summarize lengthy sections of text. This often involved rewording sections and eliminating other sections. A complete documentation of each agency's classification is included in Appendix A. An abbreviated summary of the classifications and a comparison to the SPE system is included herein under the heading "**Summary Comparisons by issuing Agency"**.

It must be emphasized that the SPE does not claim that the classification and definitions as documented in this study represent the authoritative version of these agencies' guidelines; users should obtain official copies of the guidelines directly from the issuing agencies. Readers are referred to the agencies' publications (in many cases these are available on websites) that are the official source of technical and commercial criteria.

Based on their review of these classifications, the subcommittee identified the underlying key principals of a hydrocarbon classification scheme and critically evaluated the varying approaches herein under the heading **"Findings and Analysis"**. The focus was on identifying those features that, if adopted and adapted, have the potential to strengthen a revised SPE reserves and resource classification and associated definitions.

Summary Comparisons by Issuing Agency

Overview of Category and Class "Mapping"

Based on reviews of the agencies' documentation and discussions with experts in each classification, the subcommittee constructed a series of correlation tables to identify categories and classes that are generally equivalent but use different terminology.

Table 1 correlates the major status categories. All the major classifications define 3 major categories: undiscovered, discovered sub-commercial and discovered commercial.

	SPE 2001	SEC 1978	UK-SORP 2001	CSA 2002	RF 2005	PRO 2005	NPD 2001	USGS 1980	UNFC 2003
In-Place									
Total Petroleum Initially-In-Place	Total PIIP			Total PIIP	Total PIIP	Total PIIP	**	Total PIIP	Total PIIP
Discovered Petroleum Initially-In-Place	Discovered PIIP			Discovered PIIP	Geological Reserves	Geological Reserves	**	Discovered PIIP	Discovered PIIP
Undiscovered Petroleum Initially-In-Place	Undiscovered PIIP			Undiscovered PIIP	Geological Resources	Undiscovered PIIP	**	Undiscovered PIIP	Undiscovered PIIP
Recoverable									
Discovered + Undiscovered	Resources			Resources			Recoverable Resources		Remaining Recoverable
Produced	Production	Production	Production	Production	Produced Reserves	Production	Historical Production	Cumulative Production	Produced
Discovered	Discovered	Discovered	Discovered	Discovered	Recoverable Reserves	Recoverable Reserves	**	Identified Resources	
Discovered Commercial	Reserves	Reserves	Reserves	Reserves	Economic - Normally Profitable Reserves	Economical Initially Recoverable Reserves*	Reserves	(Economic) Reserves	Reserves
Discovered Sub-commercial	Contingent Resources			Contingent Resources	Contingently Profitable & Subeconomic Reserves	*	Contingent Resources	Marginal Reserves	Contingent Resources
Discovered Unrecoverable	(Discovered) Unrecoverable			(Discovered) Unrecoverable	Unrecoverable Reserves	Residual Unrecoverable Volumes	**	Demonstrated Subeconomic Resources	Unrecoverable
Undiscovered	Prospective Resources			Prospective Resources	Recoverable Resources	Recoverable Resources	Undiscovered Resources	Undiscovered Resources	Prospective Resources
Undiscovered Unrecoverable	(Undiscovered) Unrecoverable			(Undiscovered) Unrecoverable	Unrecoverable Resources	Residual Unrecoverable Volumes	**		Unrecoverable

* Chinese classification is EUR-based - includes production. Contingent Resources equivalent is technically recoverable minus economically recoverable
** The NPD classification is for recoverable quantities only based on development projects.

Table 1: Correlation of Status Categories

There is general consensus to apply the term "reserves" or "economic reserves" to the discovered commercial category. The term "geological reserves" is applied to discovered in-place volumes in China and Russia. The undiscovered category is variously referred to as prospective, recoverable or undiscovered resources; the common denominator is the term "resources" as opposed to reserves. "Resources" is also commonly used as a general term for all discovered and undiscovered volumes. The discovered sub-commercial category is variously termed contingent resources or contingent (or marginal) reserves. The regulatory agencies typically define a subset of the total reserves and resources for public disclosures; the SEC and UK-SORP rules cover only a portion of reserves while the Canadian (CSA) guidelines allow the option to also report contingent and/or prospective resources. The Norwegian Petroleum

Directorate's classification does not include in-place categories; it applies only to volumes recovered by development projects.

Table 2 compares terminology used for discovered volumes based on technical certainty classes. Most classifications recognize three cumulative estimates or scenarios based on decreasing technical certainty: low/best/high estimate. Many agencies apply specific terms to the associated incremental volumes; the SPE terms in the discovered commercial category are proved, probable and possible. While the same low/best/high estimates are applied to contingent and prospective resources, only the Chinese, USGS, and UNFC provide terms for the incremental estimates.

		SPE 2001	SEC 1978	UK-SORP 2001	CSA 2002	RF* 2005	PRO ** 2005	NPD 2001	USGS 1980	UNFC*** 2003
In-Place										
Low Estimate	Increment						Measured			
Best Estimate	Increment						Indicated			
High Estimate	Increment						Inferred			
Recoverable										
Commercial Low Estimate	Increment	Proved	Proved	Proven	Proved	A+B+C1	PVEIRR		Measured	111
	Cumulative	Proved (1P)		Proven	Proved	A+B+C1	PVEIRR	Low Est		Low Est
Commercial Best Estimate	Increment	Probable		Probable	Probable	C2	PBEIRR		Indicated	112
	Cumulative	Proved + Probable (2P)		Proven + Probable	Proved + Probable			Base Est		Best Est
Commercial High Estimate	Increment	Possible			Possible	C2	PSTEUR		Inferred	113
	Cumulative	Proved + Probable + Possible (3P)			Proved + Probable + Possible			High Est		High Est
Sub-commercial Low Estimate	Increment						PVSEIRR		Measured	121, 231
	Cumulative	Low Est			Low Est	Low Est		Low Est		Low Est
Sub-commercial Best Estimate	Increment						PBSEIRR		Indicated	122, 232
	Cumulative	Best Est			Best Est	Best Est		Base Est		Best Est
Sub-commercial High Estimate	Increment						PSTEUR		Inferred	123, 233
	Cumulative	High Est			High Est	High Est		High Est		High Est

Table 2: Correlation of Certainty Classes for Discovered Volumes

*The Russian classes A–Reasonable Assured, B–Identified, and C1-Estimated are roughly equivalent to proved developed producing, proved developed non-producing and proved undeveloped. C2 is generally equivalent to probable and possible combined.

**The Chinese make an initial certainty classification based on in-place volumes (measured, indicated, inferred) that carry through to technically recoverable and ultimately to economically recoverable. All recoverable estimates are EUR-based (before production). Production is separated from proved developed leaving PDRER - proved developed remaining economic reserves. PVEIRR is proved economic initially recoverable; PBEIRR is probable economic initially recoverable; PVSEIRR is proved sub-economic initially recoverable reserves; PBSEIRR is probable sub-economic initially recoverable. PSTEUR is possible technical EUR and is not divided into commercial and sub-commercial.

*** UNFC numeric codes refer sequentially to the level of Economic, Feasibility (project status) and Geological certainty.

The SPE and CSA use the terms low/best/high estimates for prospective resources, with the understanding that these recoveries are conditional on discovery. There are no terms supplied for incremental volumes. Others treat undiscovered as a completely separate category in which the same technical certainties may not apply; for example, UNFC codes all undiscovered as 334 where 4 refers to potential geological conditions.

US Security and Exchange Commission (SEC-1978)

The SEC rules and guidelines address proved reserves only. The SEC prohibits additional disclosure of unproved reserves, i.e. probable and possible, as well as Contingent and Prospective Resources. While SPE and SEC proved reserve definitions are quite similar, SEC regulations are generally considered to be slightly more restrictive. Key differences between SEC and SPE systems are:

- While both proved definitions apply “current economic conditions”, the SEC specifically requires use of year-end prices and costs while the SPE will, in some circumstances, allow use of average prices and costs.

- SPE allows use of either deterministic or probabilistic methodologies. While the SEC does not forbid probabilistic analyses, the disclosed quantities must be demonstrated to meet the defined deterministic criteria.

- SPE generally requires a well test to classify reserves as proved but can be waived if the estimate is fully supported by wireline formation tests, logs and cores. The SEC states that a well test is mandatory and can be only avoided in the Gulf of Mexico (GOM) deep water if the estimate is fully supported by seismic, wire line conveyed sampling, logs and cores.

- Both the SPE and the SEC limit proved reserves to those recovered above the lowest known occurrence of hydrocarbons. In the absence of data on fluid contacts, SPE states that the lowest known structural occurrence of hydrocarbons controls the proved limit unless otherwise indicated by definitive geological, engineering or performance data. In contrast, the SEC effectively rules out the use of conclusive technical data other than direct well observations and incremental proved below LKH can only be based on performance history.

- Regarding unconventional hydrocarbons, the SEC allows coal bed methane to be classified as proved reserves if the recovery is shown to be economic. While the SEC has ruled that bitumen recovered by mining is not petroleum reserves, there are no published guidelines for bitumen produced by in situ methods. The SPE reserve definitions apply to both conventional and unconventional hydrocarbons.

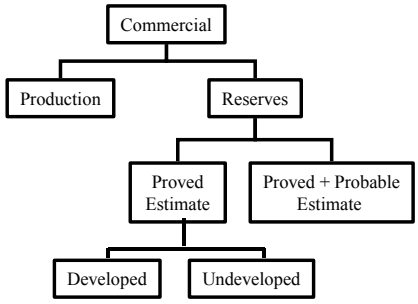
- The SPE guidelines define developed producing and non-producing status while SEC defines developed with no sub-categories.

- Both SEC and SPE guidelines set similar criteria around commerciality to include not only economics but also some evidence of a commitment to proceed with development projects within a reasonable time frame. This includes confirmation of market, production and transportation facilities, and the required lease extensions. Neither set of definitions specifies the documentation to support these claims. Neither definition requires “absolute certainty” in terms of approvals, contracts, market, etc.

- The SEC requires a reasonable certainty of procurement of project financing; the SPE does not specifically address financing requirements although all proved reserves must be “reasonably certain” to be produced.

UK Statement of Recommended Practices (SORP-2001)

Note: Initial offerings in the UK employ guidelines of the London Stock Exchange (which have different reserves guidelines) while annual reporting thereafter utilize SORP.



SORP is primarily an accounting standards document. It does not discuss the full reserves and resource classification system (no possible reserves, no contingent or prospective resources) nor does it supply detailed guidance on the recommended evaluation practices. Under SORP, reserves may be disclosed, at company's choice, as either "Proven developed and undeveloped oil and gas reserves" (option 1) or "Proven and Probable oil and gas reserves" (2P- option 2). These alternatives are mutually exclusive.

Its 2P definitions clearly require that "there should be a 50% statistical probability that the actual quantity of recoverable reserves will be more than the amount estimated as proven and probable and a 50% statistical probability that it will be less". Further "the equivalent statistical probabilities for the proven component of proven and probable reserves are 90% *(probability actual =/>than estimated)* and 10% (=/< than) respectively".

The commercial and technical criteria for the 2P case are very similar to those set by the SPE definitions. Specific criteria include:

- Reserves may only be considered proven and probable if producibility is supported by either actual production or conclusive formation test. *(SPE probable does not require a flowing well test.)*
- 2P includes immediately adjoining undrilled portions beyond proved which can be reasonably judged as economically productive based on available geophysical, geological and engineering data.
- improved recovery 2P reserves can be included on the basis of successful pilots or operation of an installed program in the reservoir or other reasonable evidence (successful analogs or reservoir simulation studies).
- reserves may be considered commercially producible if management has the intention of developing and producing them.

The Proven Developed and Undeveloped definitions in Option 1 duplicate those of the basic SEC guidance, thus SORP does not subdivide Proven Developed into Producing and Non-Producing. *(It is noted that some issuers interpret that while the words duplicate the SEC proved definitions, there is no obligation to consider the supplemental guidance issued by SEC staff and thus the reported proved reserves under SORP may not equal those estimated for SEC disclosures).*
Regarding non-conventional hydrocarbons, the Proven definition is taken from the SEC and the 2P definition does not address the issue.

Canadian Security Administrators (CSA- 2002)

The disclosure rules for Canadian registered companies are contained in CSA's National Instrument (NI) 51-101 which references resource definitions and application guidelines contained in the Canadian Oil and Gas Evaluation Handbook Volume 1 authored by the Canadian chapter of the Society of Petroleum Evaluation Engineers. The underlying reserve definitions are those published by the Petroleum Society of the Canadian Institute of Mining, Metallurgy and Petroleum in 2002 and referred to hereafter as the "CIM definitions".

NI 51-101 requires two sets of disclosures: Proved plus Probable using a defined forecast of costs and prices (2P forecast case) and Proved using prices as of the effective date of the assessment (1P constant case, similar to SEC Proved). Reserves impairment is based on the 2P forecast case. Issuers have the option of also disclosing one or all of: possible reserves, contingent resources and prospective resources.

The overall classification is identical and the reserves definitions are very similar to those of the SPE; however, the following issues are noted:

- The CIM definitions state that "the qualitative certainty levels are applicable to both individual Reserve Entities and to Reported Reserves being the sum of entity level estimates used in disclosures. While defining the same probability hurdles (P90, P50, P10) as the SPE, the CIM apply these at the reporting level (country or corporation) while the SPE applies them at the entity level (field, property or project). In large portfolios the central limit theorem would allow lower confidence targets at the entity level. *(although COGEH still requires a "high degree of certainty" at the entity level).* Both SPE and CIM guidance discourages fully probabilistic aggregation beyond the field/project level. However, since the CIM claims that even deterministic estimates have an inferred confidence level, the same portfolio effect may potentially be reflected in their deterministic estimates.

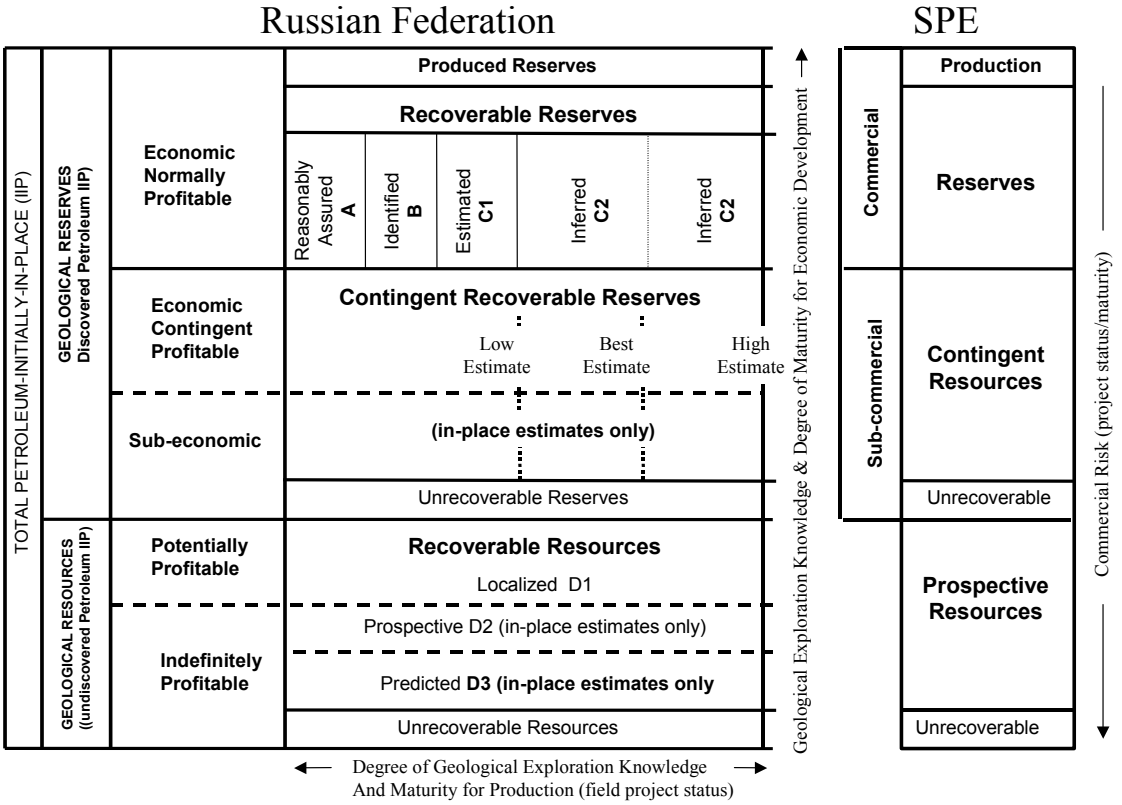
- Although NI 51-101 does specifically include bitumen (including mined bitumen) as reserves, the CIM definitions do not address the issue and COGEH guidelines do not include bitumen or synthetic oil as product types. SPE guidelines are designed to incorporate both conventional and unconventional reserves but do not specifically address in situ recovery versus mining extraction methods.

- The CIM classification allows the subdivision into Developed (separated into Developed Producing and Developed Non-producing) and Undeveloped at all reserves certainty levels whereas the current SPE definitions apply these status categories only to proved reserves.

- The CIM reserves definitions state that, "the fiscal conditions under which reserve estimates are prepared should generally be those which are considered to be a reasonable outlook on the future. Security regulators or other agencies may require that constant or other prices and costs be used in the determination of reserves and value. In any event, the fiscal assumptions used in the preparation of reserves estimates must be disclosed".

Russian Federation Classification Scheme (RF-2005)

Comparisons of the new Russian Federation and SPE/WPC/AAPG classifications can be best approached by first examining separation into categories based on the "commercial axis":



There is overall alignment at major boundaries. The Russians split the undiscovered into 3 categories that can be roughly described as prospects (D1), leads (D2), and plays (D3). The SPE and other organizations such as the NPD apply a project maturity axis to describe a similar approach.

While the SPE classification refers to recoverable volume throughout, the Russians estimate only in-place volumes for their D3 and D2 classes and the sub-economic portion of their Contingent Recoverable Reserves. The logic is that lacking sufficient definition for computing development plan economics, it is not feasible to forecast recovery to an economic limit. In the SPE approach, analogous developments would be used to estimate recovery efficiency.

The overall intent of the Contingent Recoverable Reserves category is similar to the SPE's Contingent Resources, that is, these are discovered volumes that because of some contingency (economics and/or technology), it is not currently feasible to proceed with development. Those volumes categorized as sub-economic by RF-2005 due to access constraints such under parks, cities, or in water protection zones (environmental) or lack of local pipelines and/or infrastructure may still have economic potential and would not be segregated in the SPE classification unless project status categories were also applied. The RF-2005 proposal also includes shut-in wells in the Sub-economic

Contingent category; without further clarification it is not obvious why this is not classified as developed but non-producing.

The Russians use the term “reserves” for all types of discovered volumes (in-place, economic, sub-economic) whereas the SPE uses the term reserves only for the remaining, commercially recoverable portions of discovered volumes. *(This may be typical of linguistic difficulties that are encountered internationally when technical terms are translated using their general meaning.)*

The Russian reserves classes A, B, and C1 grossly correlate to SPE Proved Developed Producing (PDP), Proved Developed Non-Producing (PNP) and Proved Undeveloped (PUD) respectively (see above comparison graphic). Recoverable estimates in their category B have all the certainty of Category A but are not on production for some reason. Category C1 correlates to SPE PUD in areas one drainage unit offset to Proved Developed but does not specifically address proved reserves in deeper reservoirs or the case where a relatively large expenditure is required to a) re-complete an existing well or b) install production or transportation facilities for primary or improved recovery projects.

Category C2 encompasses SPE probable and possible (unproven) and can only be dissected by detailed examination of the information available. Although probabilistic methods are rarely applied in Russia, this could be used as a basis for defining a 2P (best) versus 3P (high) estimate. The RF 2005 requires reporting by field/reservoir and thereafter aggregations to various levels and ultimately total Russia; aggregation is arithmetic by category based on the deterministic method.

RF-2005 does not address treatment of unconventional hydrocarbons (tight gas, coal bed methane, bitumen). The only reference to unconventional hydrocarbons is that heavy oils should be classified as “very complicated” accumulations.

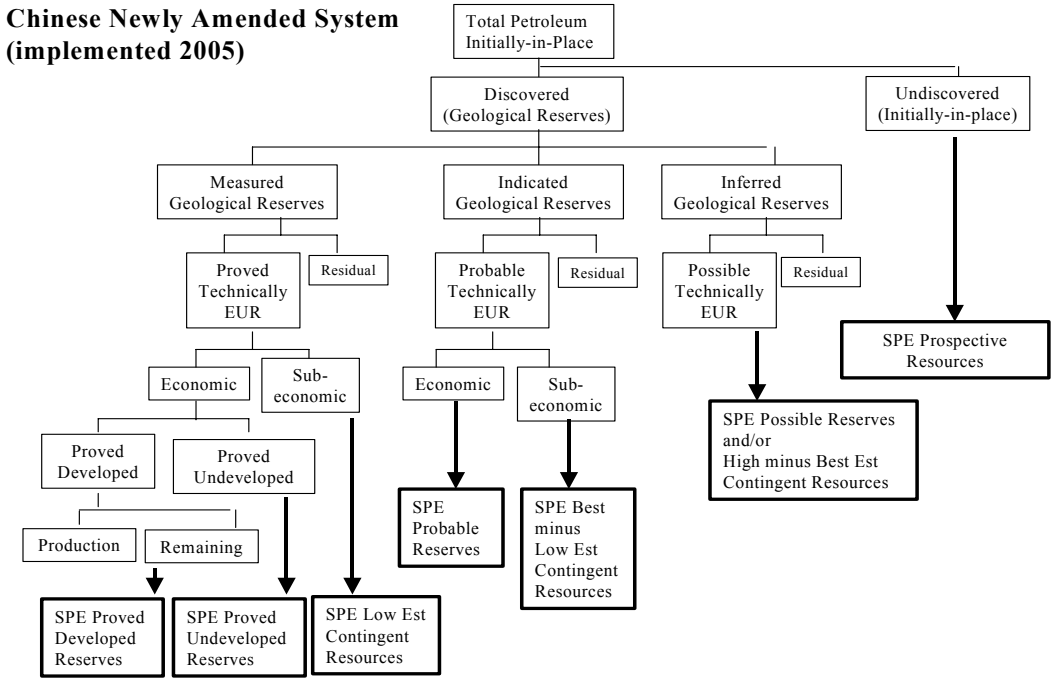
Significant differences versus SPE guidelines include:

- RF 2005 includes incremental reserves due to application of “established” improved recovery methods and infill drilling in Category A (equivalent to SPE PDP) without the requirement for a successful pilot in the subject reservoir or a commitment to proceed with the incremental development.
- In historical Russian classifications, one value of recovery ratio was established in the original development plan and there was no provision to forecast a range of resulting recovery efficiencies. To some extent, this is still true, although incremental reserves from forecast application of a new recovery method can be included in category C1.
- The Russian classification does not provide for using more conservative commercial criteria for proved versus unproved reserves. All reserves are evaluated using the criteria “commercially recoverable if brought to production under competitive market conditions, with use of equipment and technology of recovery and treatment ensuring that the requirements for rational use of the subsoil and environmental protection are observed”.

Since the Russian classification is based on geologic certainty of in-place volumes, there is a much greater emphasis on volumetric analysis in all categories whereas most Western analysts would focus on production performance-based estimates (decline, material balance) in Proved and Probable estimations for mature properties.

China Petroleum Reserves Office (PRO-2005)

There is a broad general agreement between the new Chinese (PRO-2005) and the SPE classification systems. However, there are some interpretational differences:



a) It is key to remember that under the Chinese classification system:
   1) the term “reserves” is used for both discovered in-place volumes and technically recoverable volumes in addition to economically recoverable volumes.
   2) Further all certainty criteria are assigned to estimated in-place volumes and ultimate recoverable volumes, not restricted to remaining volumes. Thus, the Chinese Proved and subset Proved Developed Estimated Initially Recoverable Reserves must be reduced by prior cumulative production before comparison to SPE reserves.

b) The Chinese have retained their industrial flows criteria by completion depth as a reference to define a commercial discovery but staff are encouraged to estimate local or field-wide criteria as well. In general, a commercial rate would allow recovery of the cost of drilling a producing well (excluding abandonment costs).

c) For Proved Technical Estimated Ultimate Recovery (PTEUR), the feasibility studies assume recent average prices and costs but for Proved Economic Initially Recoverable Reserves (PVEIRR), more stringent criteria include use of prices and costs as of the assessment date. *(In practice, Chinese companies may apply their internal forecast prices in feasibility studies to define PTEUR.)*

d) For PBEIRR/Probable, Chinese guidelines allow use of either historical average or forecast costs and prices whereas the SPE Probable and Possible apply forecast costs and prices.

e) The Chinese subdivide the undiscovered resources (comparable to SPE/WPC/AAPG Prospective Resource) into two categories: Petroleum Initially-in-place in Prospects at early stages of exploration and Unmapped Petroleum Initially-in-place that is based on regional reconnaissance mapping only.

f) While the China classification makes reference to probability targets, their post-discovery assessments are usually based on deterministic scenarios and it is rare that probabilistic analyses are used. While 2P and 3P match SPE guidance at P50 and P10, the Chinese definitions for Proved reference a hurdle of P80 versus the SPE P90. The Chinese documents include phrases such as “indicated geological reserves are estimates with a moderate level of confidence with a relative error not more than +/-50%”. This does not relate to actual probabilistic targets and is supplied as a general guide. It would appear that this implies a higher degree of uncertainty than normally associated with SPE probable estimates.

g) In the detailed definition of LKH, the Chinese specifically state that they would accept reliable pressure data as a primary criteria; the SPE requires a lowest penetration “unless otherwise indicated by definitive geological, engineering or performance data”.

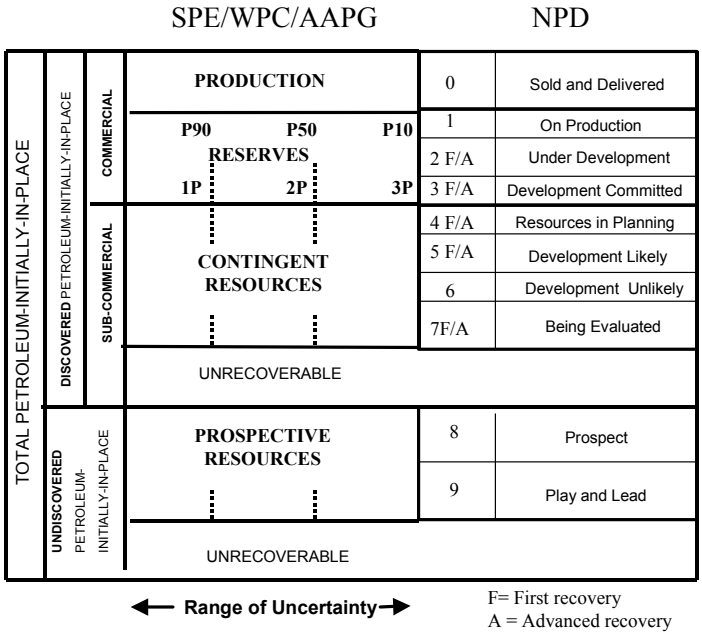
The Chinese expect that there should be no material difference between SPE Proved Ultimate and their PVEIRR. However, it should be noted that it is common for the feasibility studies to include waterflood in the initial plans for oil reservoir development and improved recovery volumes may not be uniquely identified.

The issue of combining a range of recovery efficiencies with in-place uncertainties to define proved versus probable and possible recoverable volumes is problematical in the Chinese system. In many cases, the assessment focuses on “geological uncertainty” and an analog recovery factor is applied.

Regarding non-conventional hydrocarbons, the same classification is applied to Coal Bed Methane reserves; the Chinese have not yet developed regulations for bitumen or oil sands.

Norwegian Petroleum Directorate (NPD-2001)

The Norwegian Petroleum Directorate classification (NPD-2001) is based on the SPE/WPC/AAPG 2000 classification but expanded to utilize categories that differentiate projects based on their commerciality, that is, their maturity towards full producing status. These categories can also be viewed as qualitative measures of commercial risk or chance of commerciality.



The horizontal axis relates to the uncertainty in recoverable hydrocarbon quantities associated with each development project. There may be several projects recovering oil and gas from the same accumulation, and these may be in different stages of maturity, and thus in different categories. The NPD has found it to be convenient to distinguish between the first project (F) and additional projects (A). For example, the incremental recovery associated with an Enhanced Oil Recovery (EOR) project would be tracked using the “A” attribute and the quantities associated with primary recovery project use the “F” modifier while the estimate of original oil in-place may remain constant.

Probabilistic hurdles are similar to the SPE guidance, that is, low estimate/P90 or P80 and high estimate/P10 or P20. The P80/P20 option is rarely used and was included to accommodate major issuers who used that convention in earlier times. The NPD substitutes the term “base estimate” for best estimate. It reflects the current understanding of the extension, characteristics and recovery factor of the reservoir. The base estimate can be calculated deterministically or stochastically. If calculated by a stochastic method, it should correspond to the mean value (not the median/P50).

As the NPD classification is developed for the resource management needs of the Norwegian Government and the business process management needs of the Norwegian companies, emphasis has been more on reflecting changes in ultimate recoverable estimates than on annual financial reporting. The concept of proved reserves according to deterministic criteria is not recognized as we know it from the SEC or SPE definitions. P90 reserves are however both a reasonable and simple, well defined substitute,

remembering that future, uncommitted projects are not allowed to contribute to the 2P nor 3P reserves as this would distort the P90 of the distribution.

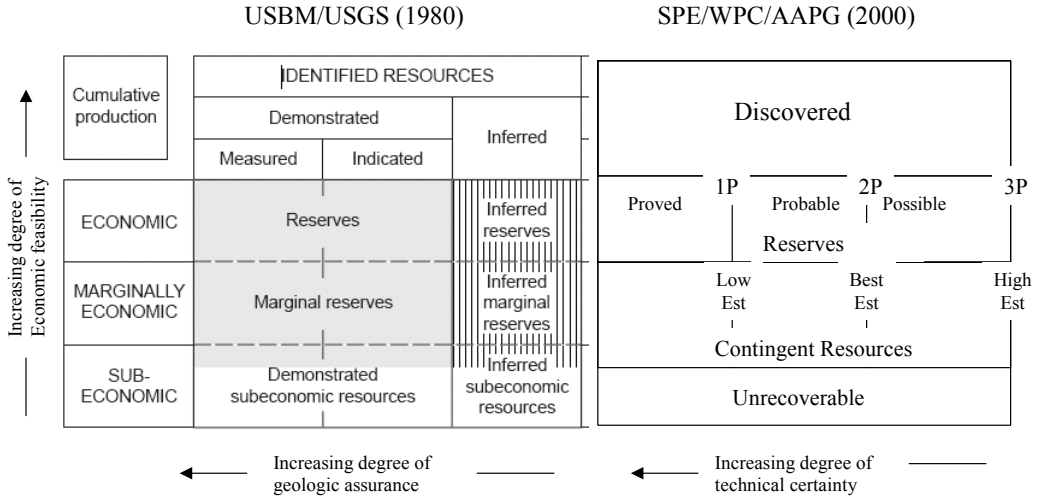
While the terms Proved, Probable and Possible are not utilized, the definitions of low/1P, base/2P, and high/3P estimated quantities allow derivation of these entities if required (notwithstanding that the base is the mean and not P50).

The NPD defines a discovery as one petroleum deposit, or several petroleum deposits collectively, which have been discovered in the same wildcat well, in which through testing, sampling, or logging there has been established a probability of the existence of mobile hydrocarbons (includes both a commercial and a technical discovery).

The NPD does not give definitions of commercial/economic or sub-commercial/sub-economic but depends on the status categories to segregate Reserves from Contingent Resources. Contingent Resources are defined as petroleum resources that have been discovered but no decision has yet been taken regarding their (development for) production. It is noted that their category 3 (reserves which the licensees have decided to recover) may include projects for which the authorities have not yet approved a Plan of Development (PDO) or granted exemption therefrom. Thus the differentiation of Reserves from Contingent resources may seem to rest solely on the licensees' internal commitment to proceed with development. Under the petroleum law, the licensees are however given the right to produce the petroleum. The government approval of the PDO is an occasion to align interests in the way development will take place and not an occasion to remove a right already granted.

US Geological Survey (USGS-1980)

The following graphic illustrates the overall comparison of the USBM/USGS (1980) and the SPE/WPC/AAPG (2000) classifications for the discovered portion of total resources.



The USGS classification is based on two parameters whereby resources are classified by feasibility of economic recovery and degree of geologic certainty. The SPE classification classifies resources based on 3 parameters: feasibility of economic recovery (commerciality) in the y-axis and a combination of degree of geologic assurance and degree of recovery efficiency termed technical uncertainty on the x-axis. Although some differences exist, the classification schemes are comparable.

The USGS hypothetical and speculative undiscovered resources combined correlate to SPE Prospective Resources; they can be classified by technical uncertainty (low/best/high estimate or a probability distribution) but there is no attempt to segregate undiscovered volumes according to commercial certainty.

Although the USGS measured, indicated, and inferred classes of reserves are assigned to reflect geologic assurance, these classes have been loosely interchanged with, respectively, the proved, probable, and possible classes. While measured and proved are comparable, probable and possible may not be directly interchangeable with indicated and inferred. Some earlier publications suggest that USGS inferred is not a high side estimate of indicated but refers to only unexplored deposits for which estimates of the quality and quantity are based on geologic evidence and projections and may not have any direct sampling or measurements. Later publications indicate closer alignment with SPE possible reserves that may be a combination of high-side estimates of drilled (sampled) areas and adjacent undrilled areas (fault blocks and satellite features).

The shaded area in USGS classification is termed the “reserves base”; “it may encompass those parts of the resources that have a reasonable potential for becoming economical within the planning horizons *(30 years)* beyond those that assume proven technolgy and current economics”. Thus, it appears that inferred reserves may be based on forecast conditions while demonstrated (measured and indicated) are based on

current conditions. This contrasts with SPE guidance that only proved is based on current conditions while probable and possible may be based on forecast conditions.

Users should be aware of the "reserves" terminology used in current USGS reports as illustrated in this chart based on results information in the USGS World Petroleum Assessment 2000.

World Excluding United States (conventional)

Oil - billion barrels

	F95	F50	F5	Mean
1- Cumulative Production				539
2 – Remaining Reserves				859
3 – Known Reserves (1+2)				1398
4 – Reserves Growth	192	612	1031	612
5 - Undiscovered	334	607	1107	649
6 – Future Volumes (2+5)				1508
7 – Future Grown Volumes (2+4+5)				2120
8 – Total Endowment (1+2+4+5)				2659

"Remaining reserves" are taken from NRG Associates and Petroconsultants (IHS) reports and may represent proved or proved plus probable reserves as defined in their data sources (typically using SPE definitions). "Reserves Growth" as discussed above is based on USGS projections of future (30 year) additions from new recovery methods, improved prices, satellite development, etc. using proprietary algorithms derived from analog fields of similar maturity. The volumes may include what would be currently classified under SPE guidelines as possible, contingent resources and even some portions of unrecoverable and speculative potential (for satellite accumulations). The USGS does not quote reserve growth for individual fields, it is only statistically meaningful for large aggregations; the 2000 report only quotes reserves growth on a total world basis. The SPE term "estimated ultimate recovery" may be applied to either USGS terms "known reserves" or "future endowment".

The reserves growth and undiscovered resource aggregations use probabilistic models and will have portfolio effects. The USGS uses P95 for the lowside and P05 for the upside with two measures of central tendency being the median (P50) and the mean. Cumulative production and remaining reserves are aggregated arithmetically.

The 2000 USGS world assessment does not include unconventional hydrocarbons (continuous accumulations) from tight gas, coal bed methane, heavy oil ($<15^0$ API), and tar sands but do recognize their potential. As extraction and processing technolgy develops, the geologic descriptions are matured and their recovery becomes economically feasible, they will be assessed in the same manner as conventional hydrocarbons.

USGS "economic" implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty. This would not conflict with SPE guidance. The USGS definitions do not include more detailed guidance on such issues as pricing, discovery criteria and proved (measured) limits (e.g. LKH, DSU offsets).

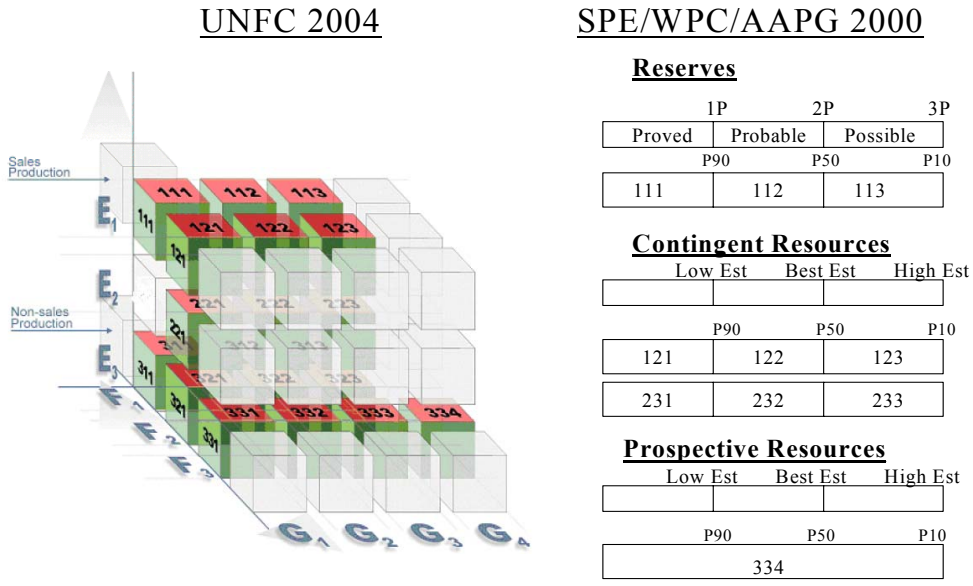
United Nations Framework Classification (UNFC-2004)

The UNFC was originally developed to support consistent reporting of coal resources but was later extended to apply to all minerals. The classification was developed under the auspices the United Nations Economic Commission for Europe (UNECE) and subsequently endorsed by the UN Economic and Social Council (ECOSOC) in 1997 and recommended for worldwide implementation. In 2000, it was proposed to study its application to all energy resources including uranium and petroleum. The study was carried out by the UNECE Ad Hoc Group of Experts on the Harmonization of Energy Reserves/Resources Terminology; it included broad representation from governments and industry including prior members of the SPE Oil and Gas Reserves Committee. The result was the UN Framework Classification for Energy and Mineral Resources (UNFC), published in 2004 and subsequently endorsed for worldwide implementation by the ECOSOC.

The study teams built on existing standards; in the case of petroleum, the primary reference standard was the 2000 SPE/WPC/AAPG classification but care was taken to accommodate other systems such as that used in the Russian Federation. The classification is based on three key attributes:

- Economic (E)
- Field Project Status/Feasibility (F)
- Geological (G)

Subdividing each attribute results in a 3-dimensional matrix composed of 36 potential categories, 19 of which are applied to petroleum. An alpha-numeric numbering system bridges the language barrier for international communication (by adopting the standard sequence “EFG”, it is further reduced to a pure numeric system). The following figure illustrates mapping of the UNFC and SPE classifications.



Comparison of UNFC and SPE/WPC/AAPG Classification

The category boundary conditions are sufficiently similar to allow detailed correlations between the two systems.

The economic and feasibility axes are combined in the SPE 2-dimensional system where the single vertical axis is the degree of commerciality or the chance of reaching producing status within a reasonable time frame.

The G-Axis is correlative to the horizontal axis in the SPE classification that represents the range of uncertainty in quantities to be recovered. It is recognized that the recoverable quantities reflect uncertainties both on the quantities initially-in-place and also on the efficiency of the development project applied.

UNFC introduces the principle of non-sales quantities both to make the material balance complete and to allow for the use of the UNFC in the management of important economical resources that are not traded commercially. In oil and gas, this will typically be fuel, flare, and processing losses.

The UNFC uses field status categories to effectively separate reserves and contingent resources. UNFC has introduced the concept of justified, but not committed projects to define reserves, but excluded such projects from contributing to committed reserves. Committed reserves are foreseen as the primary basis for supplementing financial reports. This allows the continued communication of large recoverable quantities, such as those reported from the Middle East, as reserves and not as a high grade of contingent resources.

The UNFC introduced a sub-category (E1.2 – Exceptional Economic) to accommodate projects that are not normally economic but production is supported by government subsidies based on strategic requirements.

The UNFC geologic (technical) uncertainty categories are similarly based on low/best/high estimates with the same probability hurdles (P90/P50/P10) as recommended in the SPE system. Estimates may be based on either deterministic or probabilistic methods in both systems.

The SPE classification maintains the same technical uncertainty classes (low/best/high estimates) from pre- to post-discovery with the only change being in field status or discovery risk. The UNFC classifies all undrilled resources as G4; any subdivision by technical uncertainty is given by non-numeric qualifications.

The UNFC is a high level set of principles and definitions but currently lacks the detailed application guidelines (e.g. LKH constrains on proved) to fully implement the system. The Ad Hoc Group of Experts has been charged with developing application guidelines and that project is ongoing in liaison with the SPE Oil and Gas Reserves Committee.

Findings and Analysis

Overview – Classification & Assessment Approach

For those agencies that assess the total hydrocarbon resources, there is a high degree of commonality in classification approach.

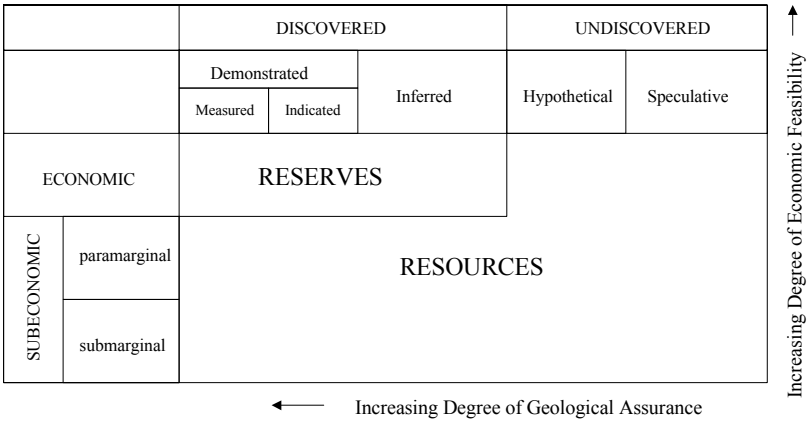


Figure 2: McKelvey Box (unmodified)

Most of these systems, including the current SPE definitions, are based on the classification approach recommended by V.E. McKelvey in the early 1970's and captured graphically in the McKelvey box diagram (figure 2). In this classical diagram, the horizontal axis denotes geological certainty while the vertical axis denotes the degree of economic feasibility. Thus, all of the agencies recognize three major categories: undiscovered, discovered economic and discovered sub-economic.

The following simplistic description of an exploration to production/abandonment life cycle provides background to address key differences in reserves and resource classification and definitions used by individual agencies.

In the initial phase, a potential accumulation is identified, the hydrocarbon type(s) is forecast, a range of in-place volumes assessed, and a chance of discovery is estimated. Assuming a discovery, a high-level development plan is applied to estimate a production rate versus time profile and associated cash flow schedule. Integration over time to a defined economic limit yields an Estimated Ultimate Recoverable (EUR) and associated Future Net Revenue (FNR). These undiscovered volumes are termed Prospective Resources.

Based on results of an exploratory well, all or a portion of the recoverable volumes in the accumulation may be re-categorized as discovered based on defined criteria. These discoveries may be economic or sub-economic depending on the development plan and costs/prices assumed. The sub-economic include Contingent Resources (and unrecoverable) while the economic are "provisionally" categorized as Reserves.

Additional analysis and potentially appraisal drilling may be required to fully define the detailed development plan, associated recoverable volume estimates, and project economics to justify the investment commitment to move into a development phase leading to commercial production. Once such a project commitment is confirmed, the

time integration of the product delivery schedule defines quantities to be finally classified as Reserves. Based on these analyses and by applying additional guidelines, the recoverable volumes scenarios can be separated into low estimate (proved), best estimate (proved plus probable or 2P) and a high estimate (proved plus probable plus possible or 3P).

Most agencies prescribe additional rules to define the low estimate or proved class. Reserves may be further classified as developed and undeveloped based on the status of the wells and associated production facilities required to implement production.

In the following analysis the terms "proved" and "proven" reserves are considered synonymous. Also, most definitions use the generic term "quantities" to describe the amount of product recovered from a reservoir although the measurements are typically in terms of volumes at defined surface conditions (temperature and pressure). For purposes of this discussion, the terms quantities and volumes are considered synonymous.

Comparison by Major Issue

Using the above activity flow, the resulting classification process can be related to a series of key decision points (Figure 3).

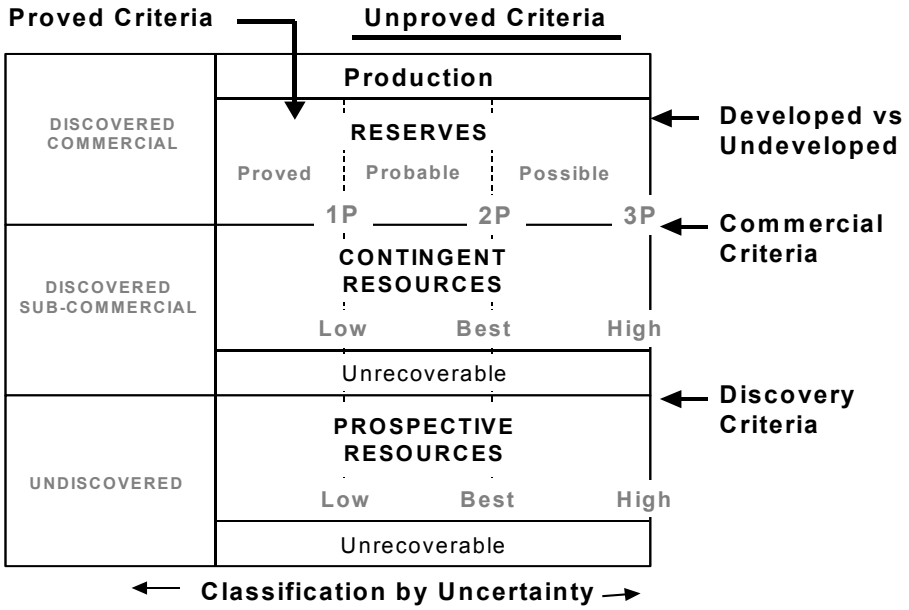


Figure 3: Decision Points in Resource Classification

The following issues regarding decision criteria are identified for further consideration by the Definitions subcommittee:

Classification by Discovery Criteria

The initial step in the assessment process is to clearly identify those accumulations that have met the criteria to be classified as "discovered" based on the results of one or more exploratory wells. The principle is well documented in the SPE glossary definition of Know Accumulation*: "The term accumulation is used to identify an individual body of moveable petroleum. The key requirement to consider an accumulation as known, and*

hence contain reserves or contingent resources, is that each accumulation/reservoir must have been penetrated by a well. In general, the well must have clearly demonstrated the existence of moveable petroleum in that reservoir by flow to surface or at least some recovery of a sample of petroleum from the well. However, where log and/or core data exist, this may suffice, provided there is a good analogy to a nearby and geologically comparable known accumulation".

While at this junction, we need not segregate reserves and contingent resources, most of the agencies' guidelines require actual production or a conclusive flowing well test at "commercial rates" as indicative that a reservoir has been "discovered" and there is the potential to ultimately define "proved reserves". There is some latitude in definition of "commercial rates" as this obviously varies by location, existing infrastructure, hydrocarbon type/quality, price/cost and fiscal terms. For example, China issues a table of completion depth versus flow rate as a minimum guidance.

In some cases, the productivity can be based on alternate testing methods that record short duration drawdowns and capture fluid/gas samples (wireline formation tests) but typically require additional supporting evidence (logs, cores, seismic). This appears to be the intent in SPE definitions but is accepted by the SEC only in deep water Gulf of Mexico wells. The level of evidence is based on production or a conclusive test in neighboring wells completed in the same or analogous reservoirs when supported by logs and cores in the subject reservoir. The appropriateness of the analog based on similarities of the reservoir and the distance of offset are interpretations that must be individually justified.

Thus, most of the definitions, including those of the SPE, focus on the well rates related to proved reserves but are more circumspect regarding establishing discovery criteria for unproved reserves and contingent resources. The China definitions allow recognition of "geological reserves" in "known reservoirs after the oil and gas is found by drilling".

SPE probable reserves can be based on well logs but lack core data or definitive tests and are not analogous to producing or proved reservoirs in the area. In the SPE 1997 definitions, possible reserves can be assigned in formations that appear to be petroleum bearing based on log and core analysis but may not be productive at commercial rates. *(Clearly this appears to be closer to contingent resources in their 2000 classification).*

The Canadian CIM definitions are explicit in that "potential accumulations that have not been penetrated by a wellbore may (only) be classified as Prospective Resources". "Confirmation of commercial production of an accumulation by production or a formation test is required for classification of reserves as proved". However, in the absence of production or formation testing, probable and /or possible reserves may be assigned based on well logs/cores which indicate analogy to proved reservoirs in the immediate area.

Notwithstanding the requirement for a well penetration, users typically assign unproven reserves to adjacent fault blocks without conclusive evidence that faults are non-sealing allowing pressure communication.

The Norwegian Petroleum Directorate (NPD) defines a discovery as one petroleum deposit, or several petroleum deposits collectively, which have been discovered in the same wildcat well, in which through testing, sampling, or logging there has been

established a probability of the existence of mobile hydrocarbons (includes both commercial and a technical discoveries).

The flow rate and mobile hydrocarbon criteria in the current definitions clearly refer to conventional petroleum and would be difficult to apply to non-conventional hydrocarbon deposits such as bitumen that is immobile under natural conditions.

Classification by Commercial Criteria

Not all accumulations that meet the criteria of a "discovery" can be commercially developed in a timely manner. Even where the discovered accumulation is large and flow rates are substantial, there may be some contingency that prevents development and hence classification as "reserves". Example contingencies include: lack of available market, lack of current producing or transportation infrastructure, environmental or legal constraints. In many cases the reservoirs are not economically producible with current technology and the contingency is a combination of technology development and/or product sales price.

Some reservoirs have tested oil or gas but at rates too low to meet current economic criteria, thus the conflict with the *"commercial flow rate"* requirement in the above discovery criteria.

For agencies publishing a full reserves and resource classification, there is always a category equivalent to contingent resources (SPE, Canada, Norway); synonyms are sub-economic (China), marginally economic (USGS), or sub-commercial (Russia). All classifications, excepting China's, recognize full geological/or technical uncertainty classes (low/best/high estimate or equivalent) within the contingent resources category.

- What is Commercial?

Three aspects that arise throughout the various classifications as criteria for reserves versus contingent resources are: economic, commercial and commitment (or intent). There is general agreement that economic means the project income will cover the cost of development and operations (at zero discount rate). There is not enough detail supplied to judge whether cash flows are uniformly computed (before/after tax?, what pricing assumptions?). The Canadians recommend using a reasonable outlook; the Chinese use current market conditions, the Russian reserves can be brought to production under competitive market conditions. In most definitions commercial is used synonymously with economic.

Interestingly the current SPE definition of commercial makes no reference to economics but focuses on demonstrated intent to bring to production status within a reasonable time frame. "Intent may be demonstrated with firm funding/financial plans, declarations of commerciality, regulatory approvals and satisfaction of other conditions that would otherwise prevent the project from being developed and brought to production". The Russian and Chinese do not directly address "intent" but refer to an approved development plan that will be carried out in the near future. Similar to the SPE approach, under the CIM guidelines undeveloped recoverable volumes must have a sufficient return on investment to justify the associated capital expenditure in order to be classified as reserves as opposed to Contingent Resources.

Thus most agencies require intent to develop and some element of positive economics for a development project to be commercial. *There is some latitude in whether proved*

reserve must be economic standalone, and whether a standalone project must be economic – in some cases the economics are defined on a multi-project business level.

- Project Status Categories

Project status categorization links the geologic endowment with the industrial and the financial resources deployed to exploit it. In the 2000 classification, when referring to their classification graphic, the SPE states "the vertical axis represents the level of status/maturity of the accumulation. Many organizations choose to further subdivide each resource category using the vertical axis to classify accumulations on the basis of the commercial decisions required to move the accumulation towards production".

The Norwegian Petroleum Directorate (NPD) states that: "Originally recoverable resources in a field or discovery are classified according to their position in the development chain from a discovery being identified until production of the resources is complete. The system is designed to allow a single field or discovery being able to contain resources classified in different project status categories".

The NPD focuses on the "project" being applied to convert in-place hydrocarbons into recoverable sales products. Their model allows several development projects, both primary and secondary (additional) to be applied to the same accumulation. In this approach, reserves and contingent resources are separated by the project maturity that is based on commitment by the owners and does not specifically address economics.

The SPE 2001 supplemental guidance notes that project status can be viewed as related to development risk (figure 4); that is, higher levels of maturity reflect higher probability (lower risk) that the accumulation will achieve commercial production. While some users suggest that reserves should have 90% probability of reaching producing status, neither the SPE of NPD directly associate quantitative risk factors with their project status categories.

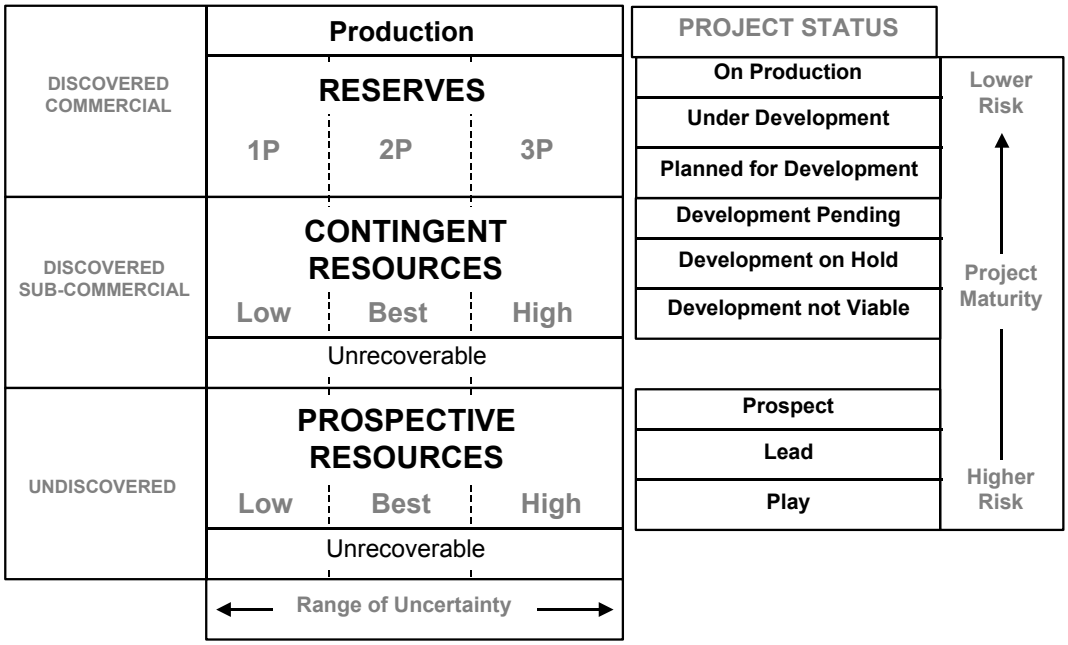


Figure 4: Project Status Categories/Commercial Risk

The UNFC addresses this issue using two axes within their 3-d cube system: E = Economic and commercial viability and F= Field project status and feasibility. The highest assurance category is a project that is both economic and is either on production or a firm commitment to develop has been documented. By using the two axes an explicit description of both economic and project status can be designated. Note that UNFC "reserves" may include SPE reserves plus other recoverable quantities through justified but not committed projects. Both NPD and current SPE guidelines allow some latitude in defining commitment to qualify as reserves (for example partner concurrence but lacking final government approvals).

Classification by Uncertainty

All classifications use the horizontal axis to describe an uncertainty range of volume outcomes and identify three subdivisions: proved/low estimate, 2P /best estimate, and 3P/high estimate. In all cases, except for the China classification, these same subdivisions are used in contingent resources. The USGS terms measured, identified, and inferred are generally correlative to proved, probable, possible although the boundaries may not exactly align. The NPD refers to the intermediate scenario as the "base estimate".

The Russian, Chinese, and USGS classifications appear to retain more of the original McKelvey approach in which the horizontal axis is indeed "geological uncertainty" related to in-place volumes and the characteristics of the reservoir. This certainty is based on the phase of exploitation and well density. It appears that recovery efficiency is often defined as somewhat fixed based on analogs and is taken as the optimum rate associated with an approved development plan. Quite often this includes incremental recoveries associated with established improved recovery processes routinely applied in these types of accumulations. It is difficult for these classifications to accommodate combinations of in-place volume uncertainty and recovery efficiency uncertainty; these combined uncertainties are central to the SPE classification.

This approach is best illustrated in the Chinese classification. Their term "reserves" includes both geological reserves (in-place) and recoverable reserves. The initial uncertainty classification (measured, indicated, inferred) is based on in-place volumes and the phase of exploitation; for example measured geological reserves are estimated with a high level of confidence, have been proved economically recoverable by appraisal drilling, fluid contacts or LKH established, and limits are delineated by reasonable well spacing. In-place volumes in each of these certainty classes are then subdivided into technically recoverable and economically recoverable. Despite this different approach, the Chinese economically recoverable reserves categories (PVEIRR and PBEIRR) are very comparable to the SPE proved and probable before production.

All agencies identify a "grey area" between possible reserves and contingent resources. It is noted that the Chinese inferred/possible category does not differentiate economic versus uneconomic as the volumes are not sufficiently defined to make that distinction.

Clarifications may be required to explain how uncertainty distributions and./or scenarios underlying the reserves and resource classes may address a combination of in-place volumes uncertainty and recovery efficiency uncertainty as regards the development project(s) applied. In addition, there will be uncertainty associated with the realization of uncommitted projects.

- Deterministic versus Probabilistic Methods and Aggregation Issues

While each of the agencies can accommodate either deterministic or probabilistic methods for uncertainty analysis, only in Western Europe is probabilistic analysis routinely applied to discovered volume assessments. The standard targets in probabilistic assessments are set at low estimate/proved =/>P90, best estimate/2P =/>P50, and high estimate/3P =/>P10. *There are two exceptions: China guidelines specify proved =/> P80; NPD guidelines allow either P90 or P80 for low estimates, P10 or P20 for high estimates and if the best estimate (= their base estimate) is calculated by stochastic methods, it should correspond to the mean value (not P50).*

There is not universal agreement on the entity level to which these targets apply; this is commonly referred to as the "aggregation issue". The SPE specifies the guidance applies to the field or property level (pre-aggregation) whereas Canadian (CIM) guidance specifies the reporting level (post-aggregation). Given the effect of the central limit theorem, the arithmetic summation of field Proved volumes in a large portfolio of properties would typically be much less than the P90 of the probabilistic aggregation of the distributions associated with these same properties. This same portfolio effect will cause the arithmetic sum of P10 volumes to be much greater than the P10 of the probabilistic aggregate. *(The actual variance is a function of the dependencies defined in the probabilistic aggregation model; the mean of the aggregate is not impacted by dependency variations.).* Note that both the CIM and SPE recommend that probabilistic aggregation be confined to the field, property or project level.

Comparisons of SPE and CIM proved volumes may still be problematical since the CIM suggests that even deterministic estimates have an "inferred confidence level" that would approximate the probability targets. The original Canadian guidance included examples in which reporting level P90 can be achieved where the inferred proved confidence level of individual properties in the portfolio is significantly less than P75. However, the NI 51-101 regulations also require that proved estimates at the entity level should reflect a high degree of confidence.

The SEC supplemental guidance requires that proved reserves be defined at the field level and then arithmetically summed to the reporting level. *(While UK-SORP option 1 duplicates SEC definitions, some issuers do not interpret that the SEC's supplemental guidance applies)*. None of the other classifications directly address the aggregation issue. While they do not clearly identify the entity level being assessed, it is inferred that it is at the reservoir or field level.

Many users interpret that the current SPE definitions consider deterministic and probabilistic methods as distinct and thus the criteria (e.g. the proved estimate should have high degree of confidence and at least P90 probability) are not necessarily synchronized. Consideration should be given to clarification using the Canadian logic that deterministic scenarios have an inferred confidence level and the same quantitative probability targets should apply. The guiding principle is that the reserve volumes assigned to each uncertainty class should be similar despite the method applied.

The aggregation approach may depend on what the results are being used for. For internal portfolio management fully probabilistic aggregation that preserves the beneficial "portfolio effect" may be appropriate. For 2P reserve disclosures, probabilistic aggregation and arithmetic summation may yield similar results. Regarding proved reserves disclosures, arithmetic aggregation may be the only method that preserves the

entity level high degree of certainty. *The ideal solution would be to disclose both the arithmetic and probabilistic aggregate Proved to demonstrate the benefits of a large, diversified portfolio in protecting against negative corporate Proved revisions.*

Proved Reserves Criteria

All the agencies give specific guidance that limit quantities assigned to their low estimate case (proved, measured) including:

- LKH – most are similar to SPE guidance, that is, if a hydrocarbon/water contact is not penetrated in a wellbore, volumetric calculations of proved reserves should be restricted by the lowest known structural elevation of occurrence of hydrocarbons as defined by well logs, core analysis or formation testing *(in the same reservoir).* China guidelines allow use of reliable pressure data to define the fluid contact. The SEC allows that "upon obtaining performance history sufficient to reasonably conclude that more (proved) reserves will be recovered than those estimated volumetrically down to LKH, positive reserve revisions should be made". The SPE allows the use of definitive geological, engineering or performance data, which would include pressure data, but in general only if supported by other data confirming the existence of a single pressure system.

- Lateral Extent – in addition to the drilling spacing unit (DSU) (or drainage area) of the productive well, proved reserves are limited to immediate offset locations (8 offset DSU's including diagonals) assuming they are within the productive limits of the reservoir, appear to have lateral continuity to the productive wells based on geological and engineering data and thus can be reasonable judged as economically productive. Geophysical data is specifically listed in addition to geological and engineering data used in judging proved limits in UK SORP proven plus probable disclosure option 2. The SEC rules that seismic data and/or pressure analysis cannot be the sole indicator(s) of lateral continuity. Where legal drilling units have not been defined, the SEC will accept "technically justified drainage area".

- Existing Conditions – There is similar language in most classifications that proved reserves are those quantities with reasonable certainty to be commercially recoverable under current economic conditions, operating conditions and government regulations including prices and costs as of the evaluation date. While the SPE allows that current conditions may be based on average historical prices and costs, SORP option 1, and China use costs/prices on the date of assessment except as stipulated in contacts or agreements. The SEC specifies pricing determined by the market on the last day of the reporting company's fiscal year (typically December 31). The Russian definitions are less prescriptive; they require that all reserves be commercially efficient for recovery under competitive market conditions, with up-to-date equipment and technologies. Under Canadian regulations, the proved (developed producing and non-producing, undeveloped, and total) reserves are defined under both evaluation date (that is, year-end/constant) and defined forecast cost/price scenarios; the proved plus probable estimates use forecast cost/prices schedules only. Reserve impairment [ceiling test and depletion] is calculated using the 2P/forecast case. UNFC and USGS definitions do not address specific pricing criteria. In the case of the UNFC, this is not considered a functional criterion to be included in the classification itself, but a prescriptive one, to be fixed, when required in regulatory specifications or guidelines. This allows, for instance, the

use of historical or forecast prices based on “futures markets” or some other standard reference.

- Discovery Criteria – As previously discussed, many agencies, including the SPE, require more rigorous discovery criteria for proved (e.g. a flowing well test) than for unproved reserves (well log indications of productivity). This leads to assessments that may have unproven reserves without associated proved reserves; this is problematical for reserves defined using probabilistic methods.

The potential result of applying these special proved reserves criteria is to distort the underlying classification system; as shown in figure 5; in many cases the resulting Proved reserve quantities may be less than the low estimate whether derived by deterministic or probabilistic methods.

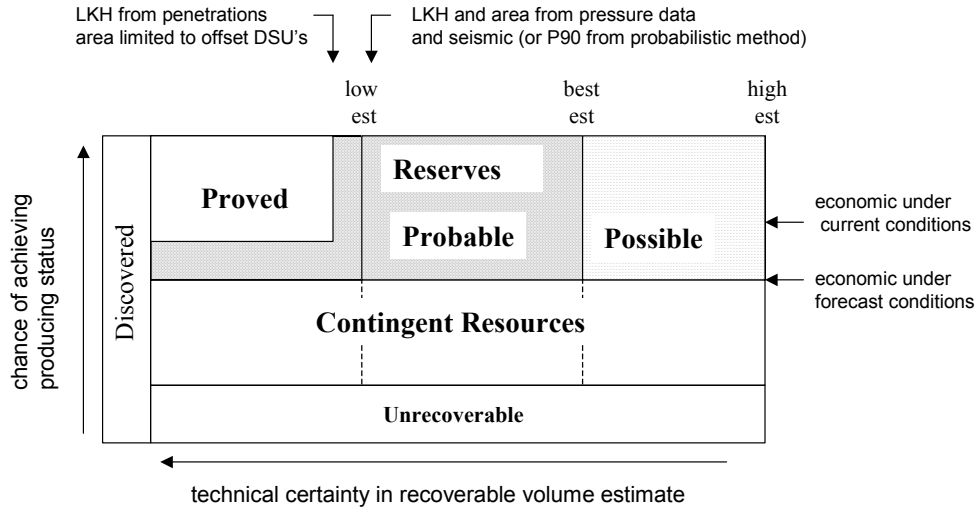


Figure 5: Impact of Proved Reserves “Special Criteria”

The practical solution may be to admit that there are two processes involved in reserves classification. First reserves are defined as commercial or non-commercial based on a 2P/forecast case and then a distribution of recoverable quantities is based on a defined development plan. Even where the probabilistic method is used, a separate deterministic, conservative case for proved may be required to incorporate specific regulatory downside cost/pricing estimates and technical criteria that limit the portions of the reservoir considered. The full suite of modern acquisition and analysis tools (3-d seismic, pressure gradient analysis, wireline formation tests, reservoir simulation, etc.) should be accommodated. The drilling spacing unit/drainage area criteria become difficult to apply in offshore operations, horizontal wells and complex multi-lateral completions.

Unproved Reserves Criteria

All classifications (excluding SEC) recognize lower certainty levels of reserves based on distance from producing wells, more limited availability of geological (and geophysical) and engineering data. Most define a best estimate (2P) and high estimate (3P) case. The Russian class C2 (inferred) includes probable and possible combined. While most classifications have the same general requirements for commerciality, there is variation.

- the SPE, China, UK SORP (option 2) allow use of forecast conditions different from proved. Canada uses forecast conditions for their base case but also require a constant case for proved. The Russians use the same conditions (commercially efficient under competitive market conditions) for all classes.
- the Canadian and SPE guidelines do not require a flowing well test to define probable and possible reserves.
- the Chinese state that it is not possible to separate possible from high estimate Contingent Resources due to lack of information.
- it is likely that the Russian C2 and the USGS inferred categories also includes some Contingent Resources
- the UNFC does not explicitly describe probable and possible criteria but refer to their best and high estimate cases based on geologic certainty. It furthermore allows all quantities to be described in terms of a probability distribution or a range using the SPE standards (P90, P50 and P10).

The SPE is the only classification that attempts to describe probable and possible reserves with specific deterministic criteria (e.g. updip/downdip fault blocks).

There certainly is ambiguity in the current SPE definitions (and others) between unproven reserves and contingent resources. Again use of a logical assessment sequence that first segregates reserves and contingent resource based on commercial criteria may be the key. This model needs to have a central reference point suggested by the Canadians as being the 2P/forecast case. Thereafter, 3P is an upside version (both of in-place and recovery efficiency) of the 2P case but uses the same commercial conditions. The option of including alternative development scenarios (including improved recovery or infill drilling) in the upside 3P case needs careful consideration and is difficult to synchronize with investments to yield valid associated values. Use of the NPD project-based model may be the practical solution.

Improved Recovery (IR) Reserves

"Improved Recovery is the extraction of additional petroleum, beyond primary recovery, from naturally occurring reservoirs by supplementing the natural forces in the reservoir. It includes water-flooding, secondary processes, tertiary processes and any other means of supplementing natural reservoir recovery processes".

For attribution of incremental proved reserves through application on new improved recovery methods, both the SPE and SEC require that there be successful testing by a pilot project or favorable response from an installed program in the subject reservoir. For established IR methods, proved reserves can be booked based on successful projects in analogous reservoirs with similar rock and fluid properties. The SEC has slightly more rigorous criteria for analogous reservoirs. UK and Canadian guidelines are similar to those of the SPE.

Historically Russian and Chinese classifications did not require a successful pilot for established IR methods; in fact the recovery efficiency derived for most oil development plans includes waterfloods. The current Russian classification retains this approach but the new Chinese proved definitions require that the IR technology be demonstrated by a successful pilot or successful response in an analogous field. All require some level of commitment to proceed with facilities installation prior to booking proved reserves.

SPE and Canadian classifications use similar criteria for unproved. Probable reserves can be assigned based on analogs when rock and fluid are favorable but no pilot has yet been implemented: Possible reserves can be assigned when success is less completely assured. There should be a reasonable certainty that the IR project will be implemented for reserves attribution. IR volumes can be assigned as contingent resources when the project results are risky due to poor economics, lack of technology, or lack of commitment.

For both internal project assessments and regulatory disclosures, the incremental recoveries and costs associated with improved recovery methods must be specifically identified.

The Canadian NI 51-101 reconciliation guidelines include infill drilling and compression under improved recovery processes.

Developed/Undeveloped

All classifications except the USGS provide for segregating proved reserves into Developed and Undeveloped based on the status of production facilities. Most criteria are similar to those stated under SPE guidelines: “developed reserves are expected to be recovered from existing wells including reserves behind pipe that can be brought to production with minimal cost. Improved recovery reserves are considered developed only after the necessary equipment has been installed.” The Canadian system similarly defines Proved develop producing and non-producing and these categories are roughly equivalent to Russian A and B categories.

Undeveloped reserves are expected to be recovered from new wells on undrilled acreage, from deepening existing wells to a different reservoir; or where a relatively large expenditure is required to re-complete an existing well. While not using these same terms, all agencies generally recognize that new capital is required to bring undeveloped reserves to developed status.

The Canadian guidance proposes that it is logical to distinguish developed versus undeveloped reserves in all uncertainty categories. Under this logic, even a proved developed reservoir has upside geologic extent and recovery efficiency that should be captured in the probable and possible categories. Canadian NI 51-101 rules also require that any undeveloped reserve should have a documented plan for development within two years to retain its reserves classification.

Other Issues

- Probable Without Proved – Because of the split criteria for proved versus reserves in general (pricing, technology), it is theoretically possible to have probable and possible reserves but no part of reserves meet the proved criteria. This is compounded if one applies the two tiered discovery criteria within the SPE and Canadian systems. This becomes somewhat difficult to envisage if one is using the probabilistic methods that define volumes exceeding P90 as proved. The option is to require that, if no part of the reservoir/project meet the proved criteria, then the total volumes should be reclassified as contingent resources. None of the agencies, including the SPE, directly address this issue in current guidelines.

- Lease Fuel – An underlying principle in the UNFC is the conservation of mass in reserves and resource classifications and tracking, that is, all quantities need to be estimated whether produced, consumed, flared, lost, remaining recoverable (reserves or contingent resources) or unrecoverable such that the total adds back to the original in-place discovered resources in the subject accumulation. The key issue is whether to include gas (or oil) consumed as fuel to support production (and lease processing) operations in reserves disclosures. The Canadian guidelines treat lease fuel as part of shrinkage. The SPE and SEC allow issuers the option to include lease fuel consumed as part of reserves as long as an appropriate operating expense is allocated. UK-SORP requires issuers to consistently include or exclude such volumes for production and reserves. The issue is not specifically addressed in other classifications. This can become a major issue in LNG and bitumen upgrader projects as the volume of gas or bitumen consumed relative to the marketable product quantities can be significant *(if the reserves reference point is at the plant outlet – see below).*

- Reserves Reference Point – (also called measurement or custody transfer point). Most agencies support the principle that the quantities used in reserves estimations are based on measurements, product specification, and pricing at the initial custody transfer point. Typically in a gas project the measurement is of the marketed product in its condition as delivered to a sales pipeline. In some cases, the sales quantity may include minor non-hydrocarbons such as CO_2. Custody transfer can be obscured by varying ownerships or sharing of processing facilities. For example, in integrated extra-heavy oil or bitumen production and processing projects, it is not clear if the quantity for reserves estimates is the quantity at the upgrader inlet or synthetic crude oil measured at the upgrader outlet.

- Unconventional Hydrocarbons – Figure 6 illustrates the total spectrum of hydrocarbon types and accumulations.

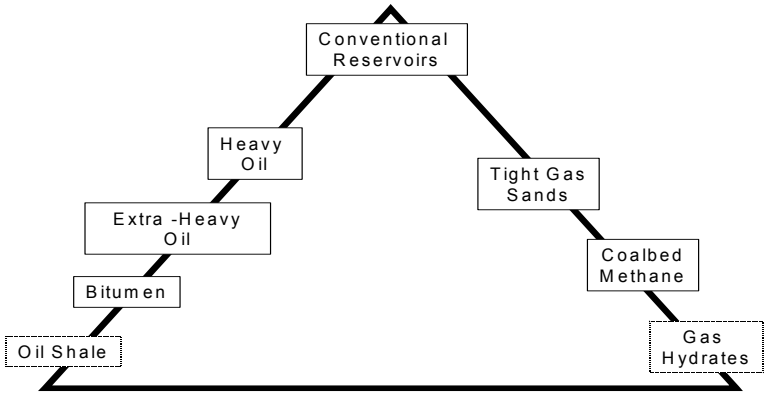


Figure 6: Conventional vs Unconventional Hydrocarbons

The SEC has accepted “down to” coalbed methane and extra-heavy oil as being part of conventional oil and gas operations, excludes oil shales, does not address gas hydrates and is currently ambivalent on bitumen. They exclude mined bitumen, provisionally include bitumen recovered by in situ methods and are currently studying whether upgraded synthetic oil can be defined as the sales product. The Canadian regulations include all bitumen as petroleum reserves

whether extracted by in situ or mining methods and define the custody transfer point for integrated operations at the upgrader outlet. Most classifications now accept coal bed methane but do not address the bitumen issue. The current SPE position is that their classification and definitions apply to all hydrocarbons, conventional and unconventional. Moreover the glossary definition of petroleum includes solid forms. However, the SPE gives no specific guidance around such issues as mined bitumen or upgrader processing. *Bitumen and oil shale may be excluded by discovery criteria that reference identification of "moveable" hydrocarbons; certainly these resources may not support a flowing well test.*

- Resource Entities - Historically North American operators used the "lease-well-reservoir" as the smallest reserve entity, that is, reserves were computed on a drilling spacing unit basis by completion interval. This was the level at which ownership and royalties could be allocated. In foreign operations where leases covered broad areas, the reservoir (or zone of a reservoir) became the reserve entity. Many European operators identify the project as operational unit and lease zones are aggregated to the project level to allocate costs versus volumes to establish economic criteria.

  It is not always clear in the various definitions which reserve entity is being assessed for risk and uncertainty analysis. Figure 7 illustrates the relationship between the reservoir, lease (property) and project entity. In-place volumes are estimated for reservoirs. Projects have associated cash flow attributes. The intersection of reservoir and project (through a well completion) defines a specific development project applied to a specific reservoir and attributes would be recoverable quantities and associated cash flows. Ownership and fiscal terms are typically defined for a lease. Thus aggregation or allocation of a reservoir–project to a lease would form the basic entity for resource assessment. By careful design of a data model, quantities and value can be associated with individual reservoirs, leases and projects (and wells).

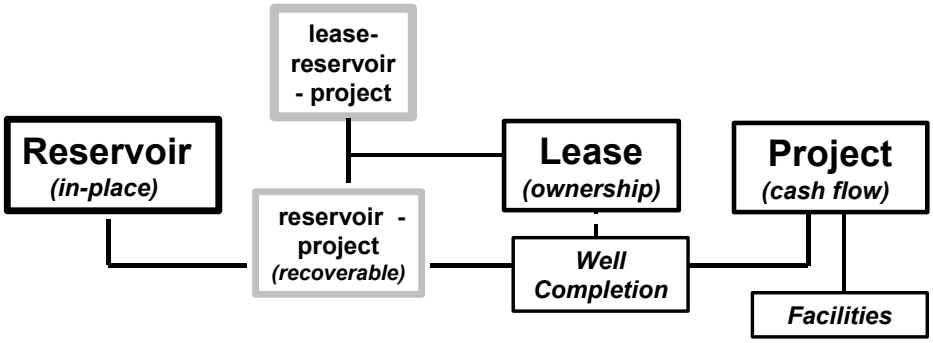


Figure 7: Resource Data Entities and Entity Relationships

The entity level defined for reserves disclosures varies between securities agencies and may be total corporate or by country; however issuers must maintain detailed accounting by lease and reservoir subject to audits. The SEC requires separate disclosures for PSC/PSA's. While the SEC requires products categorized as crude oil (includes condensate), gas and natural gas liquids, other agencies require a more detailed accounting by product type. The SPE does not address tracking resources by product or type of lease.

Conclusions and Recommendations

The following observations are based on an analysis of the reserves and resource classifications and associated definitions and guidelines as published by the eight agencies surveyed in this report.

There is general international agreement on a classification system for petroleum resources that defines three broad categories of recoverable quantities: undiscovered, discovered sub-commercial, and discovered commercial.

All classifications incorporate classes of resources within each category to describe uncertainty in estimating the quantities of hydrocarbons that may be recovered by applying development projects. The assessments accommodate uncertainty in both the in-place hydrocarbon volumes and a range of recovery efficiencies associated with projects being applied. All classifications define 3 scenarios to define this uncertainty range: a low, intermediate (termed "best") and high estimate. Most classifications agree that if these uncertainty distributions were derived stochastically, the associated cumulative probability hurdles would be P90/P50/P10. There is some variation in the deterministic qualitative criteria that define these scenarios.

To achieve greater consistency among project assessments, many of the classifications apply additional deterministic criteria to the low estimate of "discovered commercial", typically defined as "proved reserves". All classifications recognize that a portion of these discovered commercial volumes may be recovered with existing facilities (developed) while the remaining portion requires additional investment (undeveloped).

While there is variation in the terminology used to describe the resource categories and uncertainty classes, it is quite feasible to identify correlative terms. There is lack of clarity in the detailed definitions of boundary conditions between categories.

Based on this analysis, revisions to the current SPE resource classification, definitions and guidelines may consider the following as potential "best practices" to provide increased clarity and better align with business processes:

- Utilize a consistent set of criteria to segregate discovered from undiscovered without reference to ultimate commerciality. A discovery is a known accumulation(s). It has been penetrated by a wellbore and the resulting analysis of well logs, cores or formation tests indicates that significant hydrocarbons exist and are potentially recoverable. All such discovered volumes should be initially categorized as contingent resources.

- The guidelines should emphasize that recoverable quantities must clearly identify the development project applied to a specific accumulation and its in-place hydrocarbons. Without an associated development project, in-place volumes must be designated as unrecoverable. Economics and feasibility attributes are associated with development projects. The remaining quantities associated with projects categorized as "commercial" are assigned the term "reserves". The boundary between contingent resource and reserves thus rests on the term commercial as applied to a development project. It has two components: economics and feasibility or "intent". The most practical approach is to use the project maturity/chance of reaching production status to clarify reserves versus contingent resources. An appropriate chance may be 90% (i.e. 10% risk).

- Definitions and guidelines should accommodate both deterministic and probabilistic assessment methods. To maintain consistency, the same class confidence hurdles (P90/P50/P10) should be applied to estimates whether assessed using deterministic or probabilistic methods. While inherently qualitative, all deterministic estimates have an inferred probability. *Calibration tests utilizing both assessment methods are recommended.* Although the assessment should support either arithmetic summation or probabilistic aggregation, the guidelines should clearly identify the entity to which these certainty guidelines apply and the preferred entity is the project level.

- Guidelines around economics/intent should focus on the "best estimate", being the equivalent of proved plus probable (2P), of recoverable quantities associated with a project. While companies certainly evaluate upside and downside cases or the complete probabilistic distribution to make investment decisions, the most representative single estimate is generally accepted as 2P. (While there are valid arguments to use the mean as the preferred measure of central tendency, this may not be practical to maintain comparability to deterministic assessments.)

- From a business perspective, the inclusion of additional deterministic technical and commercial criteria for reserves classes (proved, probable, possible) or discrete estimates (1P,2P, 3P) may have value in providing increased consistency in assessments. The definitions should be broad enough to accommodate such criteria as imposed by regulatory agencies.

- Apply developed/undeveloped status to all reserves classes. Logically there is a range of recoveries associated with developed reserves. Reserves that remain undeveloped beyond a reasonable period demonstrate lack of commitment and should be reclassified as contingent resources.

- The definitions should encompass all hydrocarbons whether conventional or non-conventional (gas, liquid or solid phases). Supplemental guidelines may be required to address issues pertaining to extraction (mining, in situ) and processing (upgrading) that is required to yield a marketable product.

- The total system should provide for accounting of all components to support mass balance; that is, the sum of quantities sold, production and processing losses (including hydrocarbons consumed as fuel) and unrecoverable quantities should equal the estimate of initially-in-place hydrocarbons.

Documentation regards reserves and resources is best presented in a more structured manner consisting of:
- Overall Resource Classification – chart and resource category definitions
- Reserves Definitions - high level, principal-based
- Application Guidelines – detailed guidance, subject to periodic revisions
- Application Examples - illustrations of both common and exceptional issues

While not necessarily endorsing its content, the format used by the Petroleum Society of the Canadian Institute of Mining, Metallurgy and Petroleum provides a useful template.

SPE Oil and Gas Reserves Committee
Mapping Subcommittee Final Report – December 2005

APPENDIX A

Detailed Description of Agencies' Classification/Definitions

Includes a description of each classification/ references utilized plus comparison to SPE definitions using:

a) summary text/diagrams and
b) a table detailing position on key issues

US Security and Exchange Commission (SEC-1978)

Oil and Gas Reserves disclosures by all companies (both US and foreign-based) quoted on the US Stock Exchange are governed by SEC Accounting Rules (*S-X §210.4-10* and *S-K*) and two Statements of Financial Accounting Standards Board (FASB): *SFAS No.19* and *SFAS No.69*.

The *S-X* regulation, published in 1978, deals with the definitions of proved reserves (developed and undeveloped) to be used in determining quantities of oil and gas reserves to be reported in filings with the SEC. In 1997 (Oil and Gas Producing Activities – Topic 12) and 2001, ("Accounting and Financial Reporting Interpretations and Guidance") the SEC published additional clarifications on selected reserves disclosure issues.

The regulation *S-K* defines the standard instructions for filing forms. This regulation prohibits disclosure of estimated quantities of probable or possible reserves of oil and gas. The *SFAS No.19* ("Financial Accounting and Reporting by Oil and Gas Producing Companies"), published in 1977, requires the disclosure of the standardized measure of discounted future net cash flows from production of proved oil and gas reserves, computed by applying year-end prices of oil and gas. The *SFAS No.69* ("Disclosures about Oil and Gas Producing Activities") has been published in 1982. This Statement amends FASB Statement No.19.

The proved reserves are estimated using prices and costs as at the evaluation date (most companies use 31st December), without any escalation. The SEC does not require independent evaluations.

The SEC regulations and guidelines about reserves definitions can be accessed on the Internet at:

2004 Testing Requirements in Deep Water GOM
http://www.sec.gov/divisions/corpfin/guidance/oilgasltr04152004.htm
Guidance on Reserves Classification
http://www.sec.gov/divisions/corpfin/guidance/cfactfaq.htm#P279_57537
1997 Oil and Gas Producing Activities – Topic 12
http://www.sec.gov/interps/account/sabcodet12.htm
Regulation S-X (Reserves Definition)
http://www.sec.gov/divisions/corpfin/forms/regsx.htm#gas
Industry Guides (Disclosure of Oil and Gas Operations)
http://www.sec.gov/divisions/corpfin/forms/industry.htm
Regulation S-K
http://www.sec.gov/divisions/corpfin/forms/regsk.htm

FASB documents could be found at www.fasb.org.

The oil and gas industry is generally aware of additional interpretations based on SEC correspondence with individual companies and/or opinions expressed by SEC engineers in public forums. However, the guidance on SEC definitions contained herein is based solely on information published by the SEC and taken from the sources listed above.

Comparison to SPE Definitions

The SEC rules and guidelines address proved reserves only. The SEC prohibits additional disclosure of unproved reserves, i.e. probable and possible, as well as Contingent and Prospective Resources. While SPE and SEC proved reserve definitions are quite similar, SEC regulations are generally considered to be slightly more restrictive than associated SPE guidance. Key differences between SEC and SPE systems are:

- While both proved definitions apply "current economic conditions", the SEC specifically requires use of year-end prices and costs while the SPE will, in some circumstances, allow use of average prices and costs

- SPE allows use of either deterministic or probabilistic methodologies. While the SEC does not forbid probabilistic analyses, the disclosed quantities must be demonstrated to meet the defined deterministic criteria.

- SPE generally requires a well test to classify reserves as proved but can be replaced if the estimate is fully supported by wireline formation tests, logs and cores. The SEC states that a well test is mandatory and can be only avoided in the Gulf of Mexico (GOM) deep water if the estimate is fully supported by seismic, wire line conveyed sampling, logs and cores.

- Both the SPE and the SEC limit proved reserves to those recovered above the lowest known occurrence of hydrocarbons. In the absence of data on fluid contacts, SPE states that the lowest known structural occurrence of hydrocarbons controls the proved limit unless otherwise indicated by definitive geological, engineering or performance data. In contrast, the SEC effectively rules out the use of conclusive technical data other than direct well observations and incremental proved can only be based on performance history.

- Regarding unconventional hydrocarbons, the SEC allows coal bed methane to be classified as proved reserves if the recovery is shown to be economic. While the SEC has ruled that bitumen recovered by mining is not petroleum reserves, there are no published guidelines for bitumen produced by in situ methods. The SPE definitions apply to both conventional and unconventional hydrocarbons

- The SPE guidelines define developed producing and non-producing status while SEC defines developed with no sub-categories.

- Both sets of definitions set similar criteria around commerciality to include not only economics but also commitment to proceed with development projects within a reasonable time frame. This includes confirmation of market, production and transportation facilities, and the required lease extensions. Neither set of definitions specifies the documentation to support these claims.

- The SEC requires a reasonable certainty of procurement of project financing; the SPE does not address financing requirements.

The SPE does not represent these analyses as being definitive guidance for those required to disclose reserves and resources under criteria set by these agencies; issuers should obtain guidelines documentation directly from each agency.

Comparison of Reserves Definitions
Reserves Definition/Proved Criteria

	SPE/WPC (1997)	**U.S. SEC Reg. S-X (1987) Accounting Interpretation and Guidance (2001)**
Intended purpose	General application – not country specific	Securities reporting
Qualitative description of certainty- proved	Reasonable certainty to be commercially recoverable	Reasonable certainty to be commercially recoverable
Qualitative description of certainty- probable	Not proved, but more likely than not to be recoverable	Not Defined
Qualitative description of certainty- possible	Less likely to be recovered than probable	Not Defined
Quantification of probabilities associated with estimates.	Proved =/> P90 2P =/> P50 3P =/>P10	Not Addressed
Proved reserves relative to lowest known hydrocarbon (LKH)	No proved reserves below LKH as defined by well logs, core analysis or formation testing	No proved reserves below LKH. Make positive revision if performance history indicates more reserves than estimated volumetrically to the LKH .
Proved reserve extensions on undrilled acreage	Directly offsetting DSU's and/or where reasonably certain of continuity and commercial recovery	Limited to directly offsetting DSU's except where continuity of production from the existing productive formation has been demonstrated with certainty. Seismic data cannot be the sole indicator of continuity.
Proved reserves – requirements for testing	Generally require actual production or a conclusive flowing well test. In certain cases, proved reserves can be based on logs and/or cores and is analogous to producing or tested reservoirs	In most cases, reservoirs require actual production or a conclusive flowing well test at economic rates For deep water GOM can be avoided if the estimate is fully supported by seismic, wire line conveyed sampling, logs and cores.
Classification of enhanced recovery mechanism as proved	Successful pilot or existing project in subject or analogous reservoir	Successful pilot or existing project in subject or poorer quality analogous reservoir Not required if the IOR technique has been verified by routine commercial use in the area

Comparison of Reserves Definitions
Development Status

Development and production status categories	Developed producing and non-producing. Undeveloped.	Developed Undeveloped
Developed	Reserves expected to be recovered from existing wells including reserves behind pipe. Improved recovery reserves require that necessary equipment has been installed or when costs to do so are relatively minor.	Reserves that can be expected to be recovered through existing wells with existing equipment and operating methods. Additional oil and gas expected to be obtained through the application of fluid injection or other improved recovery techniques should be included as "proved developed reserves" only after testing by a pilot project or after the operation of an installed program has confirmed through production response that increased recovery will be achieved.
Developed - Producing	Reserves expected to be recovered from completion intervals which are open and producing at the time of the estimate. Improved recovery reserves are considered developed producing only after the improved recovery project is operational.	Not Defined
Developed – Non-Producing	Includes shut-in (open but not producing, waiting on market/pipeline connections, or mechanical problems) and behind pipe (requires additional completion or future recompletion) reserves.	Not Defined
Undeveloped	Reserves to be recovered from additional drilling, deepening existing wells to a different reservoir or where a relatively large expenditure is required to complete an existing well or install production or transportation facilities.	Reserves that are expected to be recovered from new wells on undrilled acreage, or from existing wells where a relatively major expenditure is required for recompletion
Allocation in Multi-well Pools	Not Defined	Not Defined

Comparison of Reserves Definitions
Unproved Reserves

Unproved Reserves	Technical, contractual, economic, or regulatory uncertainties preclude reserves being classified as proved. Unproved reserves may be estimated assuming future economic conditions (and technological development) different from those prevailing at the time of the estimate.	Not Defined.
Probable Reserves	Includes: 1) step-out areas from proved 2) formations that appear productive on logs but lack core, definitive tests, or productive analogs 3) incremental reserves attributable to infill drilling 4) reserves attributable to improved recovery methods but lack pilot 5) adjacent fault blocks up-dip to proved 6) reserves attributable to future workover treatments or other procedures without successful analogs 7) incremental reserves in proved reservoirs through alternative interpretations.	Not Defined
Possible Reserves	Includes: 1) areas beyond probable potentially productive based on geological interpretations 2) formations that appear petroleum bearing in cores and logs but may not be commercially productive on tests 3) reserves attributable to infill drilling that are subject to technical uncertainty 4) improved recovery reserves where no pilot is operational and reservoir characteristics may not support commercial application 5) adjacent fault blocks down-dip to proved areas.	Not Defined

Comparison of Reserves Definitions
Deterministic vs Probabilistic Methods

Deterministic vs Probabilistic Methods	Reserve estimates may be prepared using whether deterministic or probabilistic methods. Reserve numbers are generally defined within a range, not as one fixed quantity. The range may be described qualitatively by deterministic methods or quantitatively by probabilistic methods. (the probabilistic limits (e.g. Proved =/> P90) can only be specifically applied when the probabilistic method is applied)	Reserves estimates are prepared using mainly deterministic methodologies. If probabilistic methodologies are used, the limiting criteria in the SEC definitions, such as LKH, are still in effect and shall be honored.
Deterministic Method	Deterministic estimates do not address uncertainties in terms of probabilities; they require that volumes be described in terms of discrete estimates using defined criteria (e.g. LKH) including qualitative certainty.	Deterministic calculations are made with every input value singly determined. Reasonable certainty of these estimations can be made with a high degree of confidence. The best estimate of reserves is made on known geological, engineering and economical data.
Probabilistic Method	If probabilistic methods are used the defined quantitative limits (e.g. Proved =/> P90) apply at the entity level *(before aggregation).*	Not specified. SEC staff feels that it would be premature to issue any confidence criteria at this time.
Application of probability criteria and aggregation.	Numerical probabilities are only applied in probabilistic method and probability limits apply at the entity level. Probabilistic aggregation allowed to the field level only, then arithmetic summation to reporting level. Dependencies between entities and their distributions must be modeled in probabilistic aggregation.	Probabilistic aggregation of proved reserves can result in larger reserve estimates (due to decrease in uncertainty of recovery) than simple addition would yield. The SEC requires a straightforward reconciliation of this for financial reporting purposes.

Comparison of Reserves Definitions
Special Issues

Treatment of Unconventional Hydrocarbons	Classification applies to all petroleum deposits.	Includes only conventional hydrocarbons. Mined bitumen is a mining reserve, not a petroleum reserve. However, coal bed methane gas can be classified as proved reserves if the recovery of such is shown to be economically feasible.
Fuel Gas Reserves Status	Issuers have the option to include gas volumes consumed in operations in production and reserves if an appropriate expense is allocated.	Issuers have the option to include gas volumes consumed in operations in reserves if produced from the lease and reduces the OPEX.
Natural Gas Injection	To include injection gas as reserves, the volumes would have to meet the normal criteria (economic when available for production, existence of a firm market, available pipeline or other export option, part of established development plan).	Injected gas should be omitted from the reported production. The reporting as reserves (i.e. when blow down is done) is not indicated.
Gas Sales Volumes	Reported gas reserves reflect the condition of the gas at the point of sale. If sold as wet gas, associate liquids reserves are not reported separately. If sold with a non-hydrocarbon gas content, the full volume as sold is included in reserves. The price received will reflect quality.	Gas volumes are reported on an “as sold” basis.
Infill Drilling	Not Defined	Not Defined
Compression	Not Defined	Not Defined

Comparison of Reserves Definitions
Special Issues

Net Profits Interests	Not Defined	Not Defined
Production-Sharing Contracts	Under a PSC the host government retains ownership, however the contractor receives a stipulated share of production remaining after cost recovery. Reported reserves are based on the economic interest held subject to the specific terms and time frame of the agreement. Being tied to economic interest, reserves must be re-calculated annually based on product price and operating costs and may vary considerably. Under SPE definitions, an average price over the term of the contact may be used to define reserves.	To calculate the reserves entitlement the economic interest method is preferred.
Contract Extensions	Where agreements allow extension through negotiation of renewed contract terms, exercise of options to extend or other means additional reserves (of various categories) or contingent resources may be assigned depending the level of certainty and commercial viability associated with the contract extension.	For purposes of determining proved reserves, a registrant's estimate of oil & gas reserves should be limited to quantities expected to be produced during the term of its leases or concessions. Renewals should not be assumed unless the registrant has a demonstrated history of obtaining renewals. Automatic renewal of such agreements cannot be expected if the regulatory body has the authority to end the agreement unless there is a long and clear track record which supports the conclusion that such approvals and renewal are a matter of course.
Product Categorization	NA	NA

Comparison of Reserves Definitions
Economics/Commerciality

Commerciality	In order to assign reserves of any category, a project needs to be defined in terms of a commercially viable development plan and there should be evidence of firm intent to proceed.	In frontier areas, issuers must demonstrate reasonable certainty of a market and the existence (or is likely to exist in the near future) of an economic method to extract, treat and transport the hydrocarbon
Commitment	If the degree of commitment is not such that an accumulation is expected to be developed and placed on production within a reasonable time frame (e.g. 5 years), the estimated recoverable volumes should be classified as contingent resources (not reserves).	In frontier areas a commitment by the company to develop the necessary production, treatment and transportation infrastructure is essential to the attribution of proved undeveloped reserves. Significant lack of progress on the development of such reserves may be evidence of a lack of such commitment. Affirmation of this commitment may take the form of signed sales contracts for the products; request for proposals to build facilities; signed acceptance of bid proposals; memos of understanding between the appropriate organizations and governments; firm plans and timetables established; approved authorization for expenditures to build facilities; approved loan documents to finance the required infrastructure; initiation of construction of facilities; approved environmental permits etc. Reasonable certainty of procurement of project financing by the company is a requirement for the attribution of proved reserves.
Economics	The underlying economic evaluation based on perception (best estimate) of future costs and prices together with best-estimate production profile expected to equate to a proved plus probable scenario. To limit downside exposure the “low case” scenario should be at least “break-even“, which is consistent with the requirement that proved reserve are viable under “current economic conditions”.	Economics has to be computed property by property, applying year-end costs and prices and using only proved reserves. Future price changes shall be considered only to the extent provided by existing contractual arrangements. A positive cash flow is necessary to classify reserves as proved.
Development Plan Approvals	While some companies choose not to assign any proved reserves until the development plan has received all relevant formal approvals, SPE definitions require only a reasonable expectation that the necessary facilities to process and transport those reserves will be installed.	See the “Commitment” item.

Comparison of Reserves Definitions
Economics/Disclosure Guidelines

Prices & Costs for defining reserves "economic limit".	Proved: Existing economic conditions (year-end or appropriate period* average) (SPE *recommends prior 12 month period) Unproved: reserves may be based on forecast prices and costs	Prices and costs as of the last day of the company's fiscal year – no escalation
Abandonment Costs	Economic limit calculated including abandonment and reclamation costs.	Economic limit calculated including abandonment costs.
Net Present Value of Future Net Revenue (FNR).	Not Defined	The Standardized Measurement of Discounted Future Net Cash Flows have to be disclosed together with the future cash inflow, future development and production cost, future income tax expenses. A discount rate of 10 % is used.
Audit Requirements	No requirement for use of external evaluators. SPE "Standards Pertaining to the Estimating and Auditing of Oil and Gas Information" recommends standards for training, experience levels, and sets independence criteria for evaluators and auditors whether internal or external.	Not Required
Gross vs Net Reserves	See Note 1	See Note 1

Note 1:

SEC Net
FASB 69-10: “Net” quantities of reserves include those relating to the enterprise’s operating and non-operating interests in properties as defined in paragraph 11(a) of Statement 19. Quantities of reserves relating to royalty interested owned shall be included in “net” quantities. “Net” quantities shall not include reserves relating to interests of others in properties owned by the enterprise.
FASB 69-13: Net quantities shall not include oil and gas subject to purchase under long-term supply, purchase, or similar agreements and contracts.

SPE Regards Royalty
Within the U.S., royalty volumes are strictly omitted from reported reserves *(that is, they are reported on a net basis)*. In some cases outside the U.S., where royalty is paid in cash and the cash flow from the royalty is reflected in the company’s accounts, the corresponding royalty may be included in reserves.

UK Statement of Recommended Practices (SORP-2001)

The Oil Industry Accounting Committee (OIAC) was established in 1984 to develop and promulgate guidance for the United Kingdom (UK) upstream oil and gas industry. The OIAC was authorized by the U.K. Accounting Standards Board (ASB) to develop a Statement of Recommended Practices (SORP) for the preparation of financial disclosures.

The first version was issued in 1986 and the last update was published in June 2001. For accounting periods beginning on or after 24 December 2001, Financial Reporting Standard 18, Accounting Policies, requires disclosure for entities falling within the scope of a SORP, whether the SORP has been followed and give details of and explanations for any departures.

The major feature is that the reserves may be disclosed, at company's choice, as either "Proved and probable oil and gas reserves" or "Proved developed and undeveloped oil and gas reserves". These alternatives are mutually exclusive and two different definitions are provided. Thus, the comparison with SPE definitions was made separating these two possible choices.

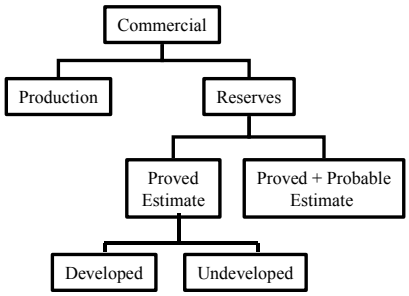
The degree of certainty of proven and probable reserves is given by a probabilistic definition (2P =/> P50) while proved developed and undeveloped use a deterministic definition ("reasonable certainty") almost equal to that defined by the SEC. In either submission, the key proved reserve boundaries (e.g. LKH and area extension) must be based on single-value deterministic estimates.

The proved developed and undeveloped reserves are defined with prices and costs as at the date the estimate is made. The proved and probable reserves definition does not address this aspect although such reserves quantification has to be based upon a reasonable assessment of the future economics of their production, a reasonable expectation of an available market, and evidence that the necessary production, transmission and transportation facilities are available or can be made available.

The SORP requires that the source of the estimate should be disclosed together with a description of the basis used to arrive at net quantities.

The SORP guidelines have a financial reporting purpose; methodological aspects are not contemplated. The SORP document can be accessed on the Internet at: www.oiac.co.uk/pronouncements.htm

Comparison to SPE Definitions



SORP is primarily an accounting standards document. It does not discuss the full reserves and resource classification system (no possible reserves, no contingent or prospective resources) nor does it supply detailed guidance on the recommended evaluation practices. Its reserves definitions are confined to the Proven and 2P estimate options defined above.

Its 2P definitions clearly require that "there should be a 50% statistical probability that the actual quantity of recoverable reserves will be more than the amount estimated as proven and probable and a 50% statistical probability that it will be less". Further "the equivalent statistical probabilities for the proven component of proven and probable reserves are 90% and 10% respectively.

The commercial and technical criteria for the 2P case are very similar to those set by the SPE definitions. Specific criteria include:

- Reserves may only be considered proven and probable if producibility is supported by either actual production or conclusive formation test.
- 2P includes immediately adjoining undrilled portions beyond proved which can be reasonable judged as economically productive based on available geophysical, geological and engineering data.
- Improved recovery 2P reserves can be defined based on successful pilots or operation of an installed program in the reservoir or other reasonable evidence (successful analogs or reservoir simulation studies).
- Reserves may be considered commercially producible if management has the intention of developing and producing them.

The Proved Developed and Undeveloped definitions duplicate those of the basic SEC guidance and estimates would meet all SPE guidelines. SORP does not subdivide Proved Developed into Producing and Non-Producing. *(It is noted that some issuers interpret that while the words duplicate the SEC proved definitions, there is no obligation to consider the supplemental guidance issued by SEC staff and thus the reported proved reserves under SORP may not equal those estimated for SEC disclosures).*

Regarding non-conventional hydrocarbons, the Proved definition is taken from the SEC and the 2P definition does not address the issue.

Comparison of Reserves Definitions
Reserves Definitions/Proved Criteria

	SPE/WPC (1997)	**U.K. SORP (2001)**	
		Disclosure of Proved and Probable	**Disclosure of Proved Developed and Undeveloped**
Intended purpose	General application – not country specific	Financial statements reporting in UK	
Qualitative description of certainty- proved	Reasonable certainty to be commercially recoverable	Not defined	Reasonable certainty to be commercially recoverable
Qualitative description of certainty- probable	Not proved, but more likely than not to be recoverable	Not defined	-
Qualitative description of certainty- possible	Less likely to be recovered than probable	-	-
Quantification of probabilities associated with estimates.	Proved =/> P90 2P =/> P50 3P =/>P10	Proved =/> P90 2P =/> P50	Not defined
Proved reserves relative to lowest known hydrocarbon (LKH)	No proved reserves below LKH as defined by well logs, core analysis or formation testing.	No proved reserves below LKH (no detailed criteria)	No proved reserves below LKH (no detailed criteria)
Proved reserve extensions on undrilled acreage	Directly offsetting DSU's and/or where reasonably certain of continuity and commercial recovery.	Limited to immediately adjoining portions not yet drilled, but which can be reasonably judged as economically productive based on geological, **geophysical** and engineering data.	Limited to immediately adjoining portions not yet drilled, but which can be reasonably judged as economically productive based on geological and engineering data.
Proved reserves – requirements for testing	Generally require actual production or a conclusive flowing well test. In certain cases, proved reserves can be based on logs and/or cores and is analogous to producing or tested reservoirs.	Producibility is supported by either actual production or conclusive formation test	Economic producibility is supported by either actual production or conclusive formation test
Classification of enhanced recovery mechanism as proved	Successful pilot or existing project in subject or analogous reservoir.	Successful pilot or existing project in subject or other reasonable evidence (analogous reservoirs, reservoir simulation studies).	Successful pilot or existing project in subject.

Comparison of Reserves Definitions
Development Status

Development and production status categories	Developed producing and non-producing. Undeveloped.	Not defined	Developed and Undeveloped
Developed	Reserves expected to be recovered from existing wells including reserves behind pipe. Improved recovery reserves require that necessary equipment has been installed or when costs to do so are relatively minor.	Not defined	Proved reserves that can be expected to be recovered from existing wells, equipment and operating methods. Improved recovery reserves included only after testing by a pilot project or after operation confirms increased recovery.
Developed - Producing	Reserves expected to be recovered from completion intervals that are open and producing at the time of the estimate. Improved recovery reserves are considered developed producing only after the improved recovery project is operational.	Not defined	Not defined
Developed – Non-Producing	Includes shut-in (open but not producing, waiting on market/pipeline connections, or mechanical problems) and behind pipe (requires additional completion or future re-completion) reserves	Not defined	Not defined
Undeveloped	Reserves to be recovered from additional drilling, deepening existing wells to a different reservoir or where a relatively large expenditure is required to complete an existing well or install production or transportation facilities	Not Defined	Proved undeveloped reserves are all other proved reserves that do not meet the proved developed definition.
Allocation in Multi-well Pools	Not Defined	Not Defined	Not Defined

Comparison of Reserves Definitions
Unproved Reserves

Unproved Reserves	Technical, contractual, economic, or regulatory uncertainties preclude reserves being classified as proved. Unproved reserves may be estimated assuming future economic conditions (and technological development) different from those prevailing at the time of the estimate.	A qualitative characterization of unproved reserves is not indicated	Estimates of proved reserves do not include: volumes classified as indicated additional reserves or where recovery is uncertain. -
Probable Reserves	Includes: 1) step-out areas from proved 2) formations that appear productive on logs but lack core, definitive tests, or productive analogs 3) incremental reserves attributable to infill drilling 4) reserves attributable to improved recovery methods but lack pilot 5) adjacent fault blocks up-dip to proved 6) reserves attributable to future workover treatments or other procedures without successful analogs 7) incremental reserves in proved reservoirs through alternative interpretations.	No qualitative criteria given-	
Possible Reserves	Includes: 1) areas beyond probable potentially productive based on geological interpretations 2) formations that appear petroleum bearing in cores and logs but may not be commercially productive on tests 3) reserves attributable to infill drilling that are subject to technical uncertainty, 4) improved recovery reserves where no pilot is operational and reservoir characteristics may not support commercial application 5) adjacent fault blocks down-dip to proved areas.	NA-	-

Comparison of Reserves Definitions
Deterministic vs Probabilistic Methods

Deterministic vs Probabilistic Methods	Reserve estimates may be prepared using wither deterministic or probabilistic methods. Reserve numbers are generally defined within a range, not as one fixed quantity. The range may be described qualitatively by deterministic methods or quantitatively by probabilistic methods. (the probabilistic limits (e.g. Proved =/> P90) can only be specifically applied when the probabilistic method is applied)	Reserves estimates are prepared using a probabilistic approach with deterministic constraints. (i.e. LKH).	Reserves estimates have to be prepared using only deterministic methods
Deterministic Method	Deterministic estimates do not address uncertainties in terms of probabilities; they require that volumes be described in terms of discrete estimates using defined criteria (e.g. LKH) including qualitative certainty.	Methods are not addressed in SORP	Methods are not addressed in SORP
Probabilistic Method	If probabilistic methods are used the defined quantitative limits (e.g. Proved =/> P90) apply at the entity level *(before aggregation).*	Methods are not addressed in SORP	-
Application of probability criteria and aggregation.	Numerical probabilities are only applied in probabilistic method and probability limits apply at the entity level. Probabilistic aggregation allowed to the field level only, then arithmetic summation to reporting level. Dependencies between entities and their distributions must be modeled in probabilistic aggregation.	Application of probability criteria and aggregation are not addressed in SORP.	-

Comparison of Reserves Definitions
Special Issues

Treatment of Unconventional Hydrocarbons	Classification applies to all petroleum deposits.	Classification applies to crude oil, natural gas and natural gas liquids. (unconventional hydrocarbons not addressed)	Estimates do not include crude oil, natural gas and natural gas liquids hydrocarbons that may be recovered from oil shales, coal, gilsonite and other such sources.
Fuel Gas Reserves Status	Issuers have the option to include gas volumes consumed in operations in production and reserves if an appropriate expense is allocated.	The figures both for production and commercial reserves should consistently either include or exclude any quantities of oil and gas consumed in operations.	See Proved and Probable.
Natural Gas Injection	To include injection gas as reserves, the volumes would have to meet the normal criteria (economic when available for production, existence of a firm market, available pipeline or other export option, part of established development plan).	Not defined	Not defined
Gas Sales Volumes	Reported gas reserves reflect the condition of the gas at the point of sale. If sold as wet gas, associate liquids reserves are not reported separately. If sold with a non-hydrocarbon gas content, the full volume as sold is included in reserves. The price received will reflect quality.	Not defined	Not defined
Infill Drilling	Not Defined	Not defined	Not defined
Compression	Not Defined	Not defined	Not defined

Comparison of Reserves Definitions
Special Issues

Net Profits Interests	Not defined	P.164 Where a purchaser's entitlement is represented by a specific proportion of future net revenue (such as in a net profits interest) the owner retains the primary interest in the underlying reserves. The 'purchaser', is not considered to hold a direct interest in the underlying reserves.	See Proved and Probable
Production-Sharing Contracts	Under a PSC the host government retains ownership, however the contractor receives a stipulated share of production remaining after cost recovery. Reported reserves are based on the economic interest held subject to the specific terms and time frame of the agreement. Being tied to economic interest, reserves must be re-calculated annually based on product price and operating costs and may vary considerably. Under SPE definitions, an average price over the term of the contact may be used to define reserves.	P.157-161 If there is production, the contractor receives a share of the production for recovery of its costs ('cost oil'). The remainder of the production ('profit oil') is shared between the contractor and the government in agreed ratios, the share of the profit oil taken by the government representing a form of taxation. The contractor's anticipated production revenues, from both the "cost oil" and the "profit oil" elements, are combined in their evaluation of the project economics	See Proved and Probable It appears that SORP would allow reporting of reserves based on economic interests. No guidance on the use of average prices is given.
Contract Extensions	Where agreements allow extension through negotiation of renewed contract terms, exercise of options to extend or other means additional reserves (of various categories) or contingent resources may be assigned depending the level of certainty and commercial viability associated with the contract extension.	Not defined	Not defined

Comparison of Reserves Definitions
Economics/Commerciality

Commerciality	In order to assign reserves of nay category, a project needs to be defined in terms of a commercially viable development plan and there should be evidence of firm intent to proceed.	Based on a reasonable assessment of future economics, a reasonable expectation that there is a market and the evidence that necessary production, transmission and transportation facilities are available or can be in the future are required.	Not defined
Commitment	If the degree of commitment is not such that an accumulation is expected to be developed and placed on production within a reasonable time frame (e.g. 5 years), the estimated recoverable volumes should be classified as contingent resources (not reserves).	Reserves may be considered commercially producible if management has the intention of developing and producing them.	Not defined
Economics	The underlying economic evaluation based on perception (best estimate) of future costs and prices together with best-estimate production profile expected to equate to a proved plus probable scenario. To limit downside exposure the “low case” scenario should be at least “break-even“ which is consistent with the requirement that proved reserve are viable under “current economic conditions”.	A reasonable assessment of future economics is required.	Not defined
Development Plan Approvals	While some companies choose not to assign any proved reserves until the development plan has received all relevant formal approvals, SPE definitions require only a reasonable expectation that the necessary facilities to process and transport those reserves will be installed.	Not defined	Not defined

Comparison of Reserves Definitions
Economics/Disclosure Guidelines

Prices & Costs for defining reserves "economic limit".	Proved: Existing economic conditions (year-end or appropriate period* average) (*SPE recommends prior 12 month period). Unproved: reserves may be based on forecast prices and costs.	Not defined. Associated costs may be accumulated in a cost pool. The source of estimates should be disclosed together with a description of the basis used to arrive at net quantities.	Prices and cost as the date the estimate is made. The source of estimates should be disclosed together with a description of the basis used to arrive at net quantities.
Abandonment Costs	Economic limit calculated including abandonment and reclamation costs.	FRS 12 specifically relates this concept to oil installations by examples, requiring provision for decommissioning costs.	See Proved and Probable
Net Present Value of Future Net Revenue (FNR).	Not defined	Not defined	Not defined
Audit Requirements	No requirement for use of external evaluators. SPE "Standards Pertaining to the Estimating and Auditing of Oil and Gas Information" recommends standards for training, experience levels, and sets independence criteria for evaluators and auditors whether internal or external.	P.248 Although the determination of the reserve quantities disclosed will be the responsibility of the directors, the source of the estimates should be disclosed together with a description of the basis used to arrive at net quantities.*(No audit requirements)*	Not required

SPE Regards Royalty
Within the U.S., royalty volumes are strictly omitted from reported reserves *(that is, they are reported on a net basis)*. In some cases outside the U.S., where royalty is paid in cash and the cash flow from the royalty is reflected in the company's accounts, the corresponding royalty may be included in reserves

SORP Regards Royalties:
P. 111 Government and other royalties payable are sometimes excluded from both the value of reported turnover and cost of sales on the basis that the reporting company has no legal right to the royalty oil or gas. In other cases all invoiced quantities are included in turnover, and royalty payments are charged to cost of sales. Variations in treatment render comparisons difficult, not only as regards turnover but also as regards the relationship between turnover, production and net oil and gas reserve quantity movements

P.247 Net quantities should only include amounts that may be taken by Governments as royalties-in-kind where it is the company's policy (see paragraph 198) to record as turnover the value of production taken as royalty-in-kind.

Canadian Security Administrators (CSA -2002)

Effective September 30, 2003, annual and ongoing oil and gas reserves disclosures by Canadian companies are governed by National Instrument (NI) 51-101 as issued by the Canadian Securities Administrators (CSA). The disclosure regulations reference guidelines as contained in the Canadian Oil and Gas Evaluation Handbook (COGEH) Volume 1 "Reserves Definitions and Evaluation Practices and Procedures" co-authored by the Society of Petroleum Evaluation Engineers (Calgary Chapter) and the Canadian Institute of Mining, Metallurgy, and Petroleum (CIM Petroleum Society) published in June 2002. The contained reserves definitions are referred to as "CIM 2002".

For purposes of this comparison, the "Canadian definitions" are those stated in CIM 2002 with additional criteria taken from the Canadian Oil and Gas Evaluation Handbook Volume 1 and referred to hereafter as the "CIM definitions". The base reserve and resource definitions are designed to be applicable independent of the regulatory disclosure rules applied, that is, they can be used whether filing under SEC or CSA regulations. While COGEH supplies "standards to be used within the Canadian oil and gas industry in evaluating reserves and resources", the actual reporting requirements are contained in the NI 51-101 regulations; several key features of these rules are supplied as background.

Under NI 5101, the statement of reserves data must include proved, proved plus probable (proved plus probable plus possible is optional) and the accompanying future net revenue at multiple defined discount rates. Issuers also have the option to disclose Contingent and Prospective Resources. The proved (developed producing and non-producing, undeveloped, and total) reserves are defined under both evaluation date (that is year-end/constant) and defined forecast cost/price scenarios; the proved plus probable estimates use forecast cost/prices schedules only. Reserve impairment [ceiling test and depletion] is calculated using the 2P/forecast case. Reserves in each certainty class must be reported by product type and country; price and costs schedules for each product type must be disclosed. NI 51-101 reserves disclosures include both conventional and unconventional hydrocarbons (including mined bitumen).

CSA regulations require that, for non-exempt Canadian issuers, independent qualified evaluators (external consultants) be employed to evaluate or audit, annually, at least 75% of each company's properties based on proved plus probable future net revenue. The remaining 25% must be independently reviewed. NI-51-101 recommends (but does not require) that each issuer's board should appoint a "Reserves Committee" to coordinate interaction between the directors, management and the independent evaluators. Exemption from independent evaluation is only available to companies with more than 100,000 boe per day production, and must be applied for, but is neither certain, nor in perpetuity. Separate exemptions, to be able to report using US requirements (FASB/SEC) are also available, but there is no production threshold. None of these exemptions provide an exemption from CSA review.

CSA NI 51-101 regulations and the CIM reserves definitions can be accessed on the internet at: http://www.albertasecurities.com/index.php?currentPage=3954

Dr. David Elliott with the Alberta Securities Commission reviewed this summary and provided assistance in completing a detailed comparison to the SPE definitions.

Comparison to SPE Definitions

CIM has adopted the overall 2001 SPE/WPC/AAPG reserves and resource classification; as illustrated in figure 1; it is identical with one exception. The CIM classification allows the subdivision into Developed (separated into Developed Producing and Developed Non-producing) and Undeveloped at all reserves certainty levels whereas the current SPE definitions apply these status categories only to proved reserves but has developed their own reserve definitions and assessment guidelines. The sum of prior production and reserves is defined as the "ultimate reserves". Reserves by definition must be remaining, recoverable with established technology under specified economic conditions, which are reasonable and disclosed. Note the quantitative certainty terms applied to 1P, 2P and 3P reserves are identical to those applied to low, best and high estimate for Contingent and Prospective Resources. It is emphasized that allocation to a resource category is based on information available as of the date of the evaluation.

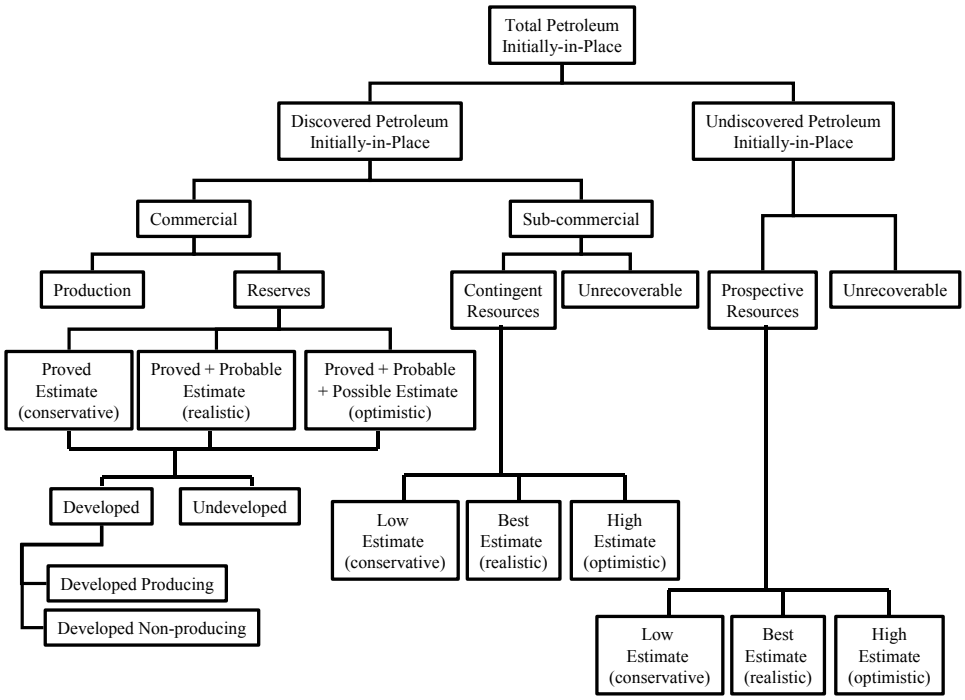


Figure 1: Canadian CIM Classification

While the reserves definitions are very similar to those of the SPE, the following issues are noted:

- For proved reserves, the CIM definitions use the quantitative term "high degree of certainty to be recoverable" versus the SPE term "reasonable certainty" (although the SPE defines reasonable certainty as "expressing a high degree of confidence that the quantities will be recovered").

- The CIM defines Probable reserves are "those additional reserves that are less certain to be recovered than proved reserves". Some users interpret that this implies that no probable reserves can be estimated without associated proved reserves. This may be contradicted with separate CIM guidance that "in the

absence of production or formation testing, probable and/or possible reserves may be assigned to an accumulation based on well logs and/or cores that support an analogy to other reservoirs in the area" that have produced or been tested. *(There is still debate on this issue)*

- The CIM definitions state that "the qualitative certainty levels are applicable to both individual Reserve Entities and to Reported Reserves being the sum of entity level estimates used in disclosures. While defining the same probability targets (P90, P50, P10) as the SPE, the CIM apply these at the reporting level (country or corporation) while the SPE applies them at the entity level (field, property or project). In large portfolios the central limit theorem would allow lower confidence targets at the entity level. *(although COGEH still requires a "high degree of certainty" at the entity level).* Both SPE and CIM guidance prohibits fully probabilistic aggregation beyond the field/project level. However, since the CIM claims that even deterministic estimates have an inferred confidence level, the same portfolio effect may be reflected in their deterministic estimates. While acknowledging the use of fully probabilistic analyses, the CIM expects that most Canadian assessments will use deterministic methods.

- SPE guidelines are designed to incorporate both conventional and unconventional reserves, but do not specifically list bitumen as a hydrocarbon type nor do they address in situ versus mining extraction methods. Although NI 51-101 does specifically include bitumen (including mined bitumen) as reserves, the CIM definitions do not address the issue and COGEH guidelines do not include bitumen or synthetic oil as product types.

- Similar to the SPE approach, under the CIM guidelines undeveloped recoverable volumes must have a sufficient return on investment to justify the associated capital expenditure in order to be classified as reserves as opposed to Contingent Resources. The CIM definitions further state that reserves may be assigned only in instances where production or development of these reserves is not prohibited by government regulations (e.g. where environmental conditions can not be satisfied).

- The CIM reserves definitions state that, "the fiscal conditions under which reserve estimates are prepared should generally be those which are considered to be a reasonable outlook on the future. Security regulators or other agencies may require that constant or other prices and costs be used in the determination of reserves and value. In such circumstances, the estimated reserve quantities must be recoverable under those conditions and should also be recoverable under fiscal conditions considered to be a reasonable outlook on the future. In any event, the fiscal assumptions used in the preparation of reserves estimates must be disclosed". As opposed to the SPE definitions, the same fiscal conditions are assumed for proven and unproven reserves.

The following chart compares in more detail SPE /WPC reserves and resource definitions (including 2001 clarifications) to the Canadian "CIM Definitions".

Comparison of Reserves Definitions
Reserves Definitions/Proved Criteria

	SPE/WPC (1997)	**Canadian CIM (2002)**
Intended purpose	General application – not country specific	General application and securities reporting in Canada
Qualitative description of certainty- proved	Reasonable certainty to be commercially recoverable	High degree of certainty to be recoverable [target for Entity]
Qualitative description of certainty- probable	Not proved, but more likely than not to be recoverable	Additional reserves less certain to be recovered than proved. Equally likely that remaining reserves will be higher or lower than 2P [target for Entity]
Qualitative description of certainty- possible	Less likely to be recovered than probable	Additional to 2P. Unlikely that the actual recovery will exceed the 3P estimate [target for Entity]
Quantification of probabilities associated with estimates.	Proved =/> P90 2P =/> P50 3P =/>P10 (target at field/property level)	Proved =/> P90 2P =/> P50 3P =/>P10 (target for reported reserves)
Proved reserves relative to lowest known hydrocarbon (LKH)	No proved reserves below LKH as defined by well logs, core analysis or formation testing.	No proved reserves below LKH as defined by well logs, core analysis or formation testing.
Proved reserve extensions on undrilled acreage	Directly offsetting DSU's and/or where reasonably certain of continuity and commercial recovery.	Generally limited to directly offsetting spacing units (DSU's) with a high degree of geologic continuity.
Proved reserves – requirements for testing	Generally require actual production or a conclusive flowing well test. In certain cases, proved reserves can be based on logs and/or cores and is analogous to producing or tested reservoirs.	Confirmation of commercial productivity of an accumulation by production or formation testing is required for classification of reserves as proved.
Classification of enhanced recovery mechanism as proved	Successful pilot or existing project in subject or analogous reservoir.	Successful pilot or existing project in subject or analogous reservoir. Commitment demonstrated by project funding, regulatory approvals.

Comparison of Reserves Definitions
Development Status

Development and production status categories	Developed producing and non-producing. Undeveloped.	Developed producing and non-producing. Undeveloped. Development status can also be applied to probable and possible.
Developed	Reserves expected to be recovered from existing wells including reserves behind pipe. Improved recovery reserves require that necessary equipment has been installed or when costs to do so are relatively minor.	Reserves that are expected to be recovered from existing wells and installed facilities or if facilities have not been installed, that would involve a relatively low expenditure.
Developed - Producing	Reserves expected to be recovered from completion intervals which are open and producing at the time of the estimate. Improved recovery reserves are considered developed producing only after the improved recovery project is operational.	Reserves expected to be recovered from completion intervals open at the time of the estimate. May be currently producing or if shut-in, must have been previously on production and the date of resumption of production must be known with certainty,
Developed – Non-Producing	Includes shut-in (open but not producing, waiting on market/pipeline connections, or mechanical problems) and behind pipe (requires additional completion or future recompletion) reserves	Reserves that either have not been on production or have previously been on production but are shut-in and the date of resumption of production is unknown.
Undeveloped	Reserves to be recovered from additional drilling, deepening existing wells to a different reservoir or where a relatively large expenditure is required to complete an existing well or install production or transportation facilities.	Reserves expected to be recovered from known accumulations where a significant expenditure (when compared to the cost of drilling a well) is required to render them capable of production. *(NI 51-101 requires reasons that a property will not be developed within 2 years)*
Allocation in Multi-well Pools	Not Defined	If appropriate, allocate total pool reserves between developed (producing and non-producing) and undeveloped categories based on recoverable estimates from specific wells, facilities and completion intervals in the pool.

Comparison of Reserves Definitions
Unproved Reserves

Unproved Reserves	Technical, contractual, economic, or regulatory uncertainties preclude reserves being classified as proved. Unproved reserves may be estimated assuming future economic conditions (and technological development) different from those prevailing at the time of the estimate.	In the absence of production or formation testing, probable and/or possible reserves may be assigned on the basis of well log and/or core analysis which indicates that the zone is hydrocarbon bearing and is analogous to productive reservoirs in the immediate area.
Probable Reserves	Includes: 1) step-out areas from proved 2) formations that appear productive on logs but lack core, definitive tests, or productive analogs 3) incremental reserves attributable to infill drilling 4) reserves attributable to improved recovery methods but lack pilot 5) adjacent fault blocks up-dip to proved 6) reserves attributable to future workover treatments or other procedures without successful analogs 7) incremental reserves in proved reservoirs through alternative interpretations.	Probable reserves may be assigned when a planned enhanced recovery project does not meet proved requirements but the project can be shown to be practically and technically reasonable, commercial success has been demonstrated in reservoirs with analogous rock and fluid properties and it is reasonably certain that the project will be implemented. *(COGEH does not detail requirements for assigning Probable to primary recovery projects)*
Possible Reserves	Includes: 1) areas beyond probable potentially productive based on geological interpretations 2) formations that appear petroleum bearing in cores and logs but may not be commercially productive on tests 3) reserves attributable to infill drilling that are subject to technical uncertainty 4) improved recovery reserves where no pilot is operational and reservoir characteristics may not support commercial application 5) adjacent fault blocks down-dip to proved areas.	Possible reserves may be assigned when a planned enhanced recovery project does not meet proved or probable requirements but the project can be shown to be practically and technically reasonable, commercial success has been demonstrated in reservoirs with analogous rock and fluid properties but there is some doubt of success in the subject reservoir, and it is reasonably certain that the project will be implemented. *(COGEH does not detail requirements for assigning Possible to primary recovery projects)*

Comparison of Reserves Definitions
Deterministic vs Probabilistic Methods

Deterministic vs Probabilistic Methods	Reserve estimates may be prepared using wither deterministic or probabilistic methods. Reserve numbers are generally defined within a range, not as one fixed quantity. The range may be described qualitatively by deterministic methods or quantitatively by probabilistic methods. (the probabilistic limits (e.g. Proved =/> P90) can only be specifically applied when the probabilistic method is applied)	Reserve estimates may be prepared using either deterministic or probabilistic methods; the methods are not distinct and separate. A deterministic estimate is a single value within a range of outcomes that could be derived from probabilistic analysis. There should be no material difference between Reported reserves prepared using deterministic and probabilistic methods. It is required that the guidelines (e.g. LKH) be met regardless of the analysis method used.
Deterministic Method	Deterministic estimates do not address uncertainties in terms of probabilities; they require that volumes be described in terms of discrete estimates using defined criteria (e.g. LKH) including qualitative certainty.	The discrete value for each parameter is selected based on the estimator's determination of the value that is most appropriate for the corresponding reserves category. *(all deterministic estimates have an inferred probability)*
Probabilistic Method	If probabilistic methods are used the defined quantitative limits (e.g. Proved =/> P90) apply at the entity level *(before aggregation).*	If probabilistic methods are used the defined quantitative limits (e.g. Proved =/> P90) apply at the Reporting Level *(after aggregation).*
Application of probability criteria and aggregation.	Numerical probabilities are only applied in probabilistic method and probability limits apply at the entity level. Probabilistic aggregation allowed to the field level only, then arithmetic summation to reporting level. Dependencies between entities and their distributions must be modeled in probabilistic aggregation.	Since probability criteria target the aggregate reporting level, estimates of reserves and future net revenue for individual properties may not reflect the same confidence level as estimates for the aggregate. Fully probabilistic aggregation may not be applied beyond the field level. Dependencies between entities and their distributions must be modeled in probabilistic aggregation. *(each entity level proved estimate must still have a "high degree of certainty" although specific confidence levels are not quantified)*

Comparison of Reserves Definitions
Special Issues

Treatment of Unconventional Hydrocarbons	Classification applies to all petroleum deposits.	Not defined in CIM *(NI 51-101 includes all conventional and unconventional hydrocarbons including mined bitumen)*
Fuel Gas Reserves Status	Issuers have the option to include gas volumes consumed in operations in production and reserves if an appropriate expense is allocated.	Fuel gas consumed before the first point of sale is treated as production shrinkage and is not included in reserves.
Natural Gas Injection	To include injection gas as reserves, the volumes would have to meet the normal criteria (economic when available for production, existence of a firm market, available pipeline or other export option, part of established development plan).	Not Defined
Gas Sales Volumes	Reported gas reserves reflect the condition of the gas at the point of sale. If sold as wet gas, associate liquids reserves are not reported separately. If sold with a non-hydrocarbon gas content, the full volume as sold is included in reserves. The price received will reflect quality.	Oil, gas, and by-product reserves must be reported on a marketable basis. This refers to the volume of reserves that changes ownership at the custody transfer point, The composition or quality may vary considerably; however the price received reflects the quality of the product that is being sold.
Infill Drilling	Reserves assigned to infill drilling with low uncertainty are Probable, infill areas with technical uncertainty are Possible. *(acceleration issue not addressed)*	The estimator must quantify from well interference effects that portion which represents accelerated production and that portion which represents incremental recovery. *(Treated as improved recovery for annual reconciliations in NI 51-101).*
Compression	Not Defined	Not addressed in CIM definitions*. (NI 51-101 guidance: Installation of field facilities such as compression, line lopping, etc are treated as a form of improved recovery for annual reconciliations.*

Comparison of Reserves Definitions
Special Issues

Net Profits Interests	Not defined	A net profits interest is an interest in production income only and not in production or reserves.
Production-Sharing Contracts	Under a PSC the host government retains ownership, however the contractor receives a stipulated share of production remaining after cost recovery. Reported reserves are based on the economic interest held subject to the specific terms and time frame of the agreement. Being tied to economic interest, reserves must be re-calculated annually based on product price and operating costs and may vary considerably. Under SPE definitions, an average price over the term of the contact may be used to define reserves.	Not Addressed in COGEH Vol 1 [Currently being addressed by a COGEH sub-committee]
Contract Extensions	Where agreements allow extension through negotiation of renewed contract terms, exercise of options to extend or other means additional reserves (of various categories) or contingent resources may be assigned depending on the level of certainty and commercial viability associated with the contract extension.	Not Addressed in COGEH Vol. 1 *(For securities disclosure, it would depend on the likelihood of contract extension. CSA would require a discussion of the issue so that an investor is aware of the pros and cons.)*
Product categorization	Not Defined	Reserves must be categorized according to their physical properties and their association with other products as the uses and values of the commodities will differ. See Note 2.

Comparison of Reserves Definitions
Economics/Commerciality

Commerciality	In order to assign reserves of any category, a project needs to be defined in terms of a commercially viable development plan and there should be evidence of firm intent to proceed.	Reserves may only be assigned to those volumes that are economically recoverable and where development is not prohibited by government regulation.
Commitment	If the degree of commitment is not such that an accumulation is expected to be developed and placed on production within a reasonable time frame (e.g. 5 years), the estimated recoverable volumes should be classified as contingent resources (not reserves).	In general, quantities must not be classified as reserves unless there is a reasonable expectation that the accumulation will be developed and place on production within a reasonable timeframe. *(No time defined, but it depends on the area. A full discussion of the issue is required in securities disclosures).*
Economics	The underlying economic evaluation based on perception (best estimate) of future costs and prices together with best-estimate production profile expected to equate to a proved plus probable scenario. To limit downside exposure the "low case" scenario should be at least "break-even", which is consistent with the requirement that proved reserves are viable under "current economic conditions".	The fiscal conditions under which reserve estimates are prepared should generally be a reasonable outlook on the future. Reserves are those volumes recovered before a project reaches its economic limit, that is, the production rate that provides revenues (net of royalties) equal to operating costs.
Development Plan Approvals	While some companies choose not to assign any proved reserves until the development plan has received all relevant formal approvals, SPE definitions require only a reasonable expectation that the necessary facilities to process and transport those reserves will be installed.	Not Defined in COGEH *(Security regulators would apply the standard of a reasonable expectation of approval.)*

Comparison of Reserves Definitions
Economics/Disclosure Guidelines

Prices & Costs for defining reserves "economic limit".	Proved: Existing economic conditions (year-end or appropriate period* average) (*SPE recommends prior 12 month period). Unproved: reserves may be based on forecast prices and costs.	"The fiscal conditions under which reserve estimates are prepared should generally be those which are considered to be a reasonable outlook on the future". *COGEH uses same forecast for proved & unproved. (NI 51-101 requires 2 disclosures: 1) proved at year-end costs & prices conditions 2) proved and probable (and 2P) using forecast case (if disclosed possible and 3P use forecast case)*
Abandonment Costs	Economic limit calculated including abandonment and reclamation costs.	Economic limit calculated including abandonment and reclamation costs.
Net Present Value of Future Net Revenue (FNR).	Not defined	*COGEH provides instruction on calculating cash flows and computing net present value but defers to the NI 51-101 to define required discount rates.*
Audit Requirements	No requirement for use of external evaluators. SPE "Standards Pertaining to the Estimating and Auditing of Oil and Gas Information" recommends standards for training, experience levels, and sets independence criteria for evaluators and auditors whether internal or external.	COGEH recommends standards for training, experience levels, and sets independence criteria for evaluators and auditors whether internal or external. COGEH further describes levels of evaluations, audits and reviews. *(NI 51-101 requires Canadian issuers to submit 75% of their properties based on 2P value for evaluation by external consultants)*
Gross vs Net Reserves	See Note 1	See Note 1

Note 1:
Gross vs Net from CIM
Gross: In relation to the reporting issuer's interest in production or reserves, company gross reserves are the issuer's working interest share before the deduction of royalties and without including any royalty interests of the reporting issuer.

Net: In relation to the reporting issuer's interest in production or reserves, company gross reserves are the issuer's working interest share after deduction of royalty obligations plus any royalty interests of the reporting issuer.

SPE Regards Royalty
Within the U.S., royalty volumes are strictly omitted from reported reserves *(that is, they are reported on a net basis)*. In some cases outside the U.S., where royalty is paid in cash and the cash flow from the royalty is reflected in the company's accounts, the corresponding royalty may be included in reserves.

Note 2: Product Categorization (as used in COGEH)

Under COGEH guidelines, reserves must be categorized according to their physical properties and their association with other products as the uses and values of the commodities will differ. The recommended categories are:

Oil
a) Light, Medium
b) Heavy (less than 25^0 API)

Natural Gas
a) Associated
- Gas Cap
- Solution Gas

b) Non-Associated

By-Products
a) Ethane
b) Butanes
c) Propanes
d) Pentanes Plus (Condensate)

Non-Hydrocarbons
a) Sulphur
b) Carbon Dioxide

NI 51-101 defines the following Production Groups and Product Types:

Conventional Production Groups	Product Types
Light & Medium Oil	Light and Medium Oil, Gas, Natural Gas Liquids and Sulphur
Heavy Oil	Heavy Oil , Solution Gas, Natural gas Liquids and Sulphur
Associated and Non-Associated Gas	Associated and Non-Associated Gas, Natural Gas Liquids, Sulphur and other by-products
Non-Conventional Production Groups	
In Situ Bitumen Recovery	Bitumen, Synthetic Oil
Oil Sands Mining Projects	Bitumen, Synthetic Oil
Coal Bed Methane	Natural Gas

The SPE guidance does not address product categorization

Russian Ministry of Natural Resources (RF-2005)

Russian reserve guidelines are in a state of transition from the system utilized within Soviet state companies to a new system more closely aligned with the needs of private industry.).

Figure 1 illustrated the nomenclature in three vintages of Russian classifications and their approximate correlation:

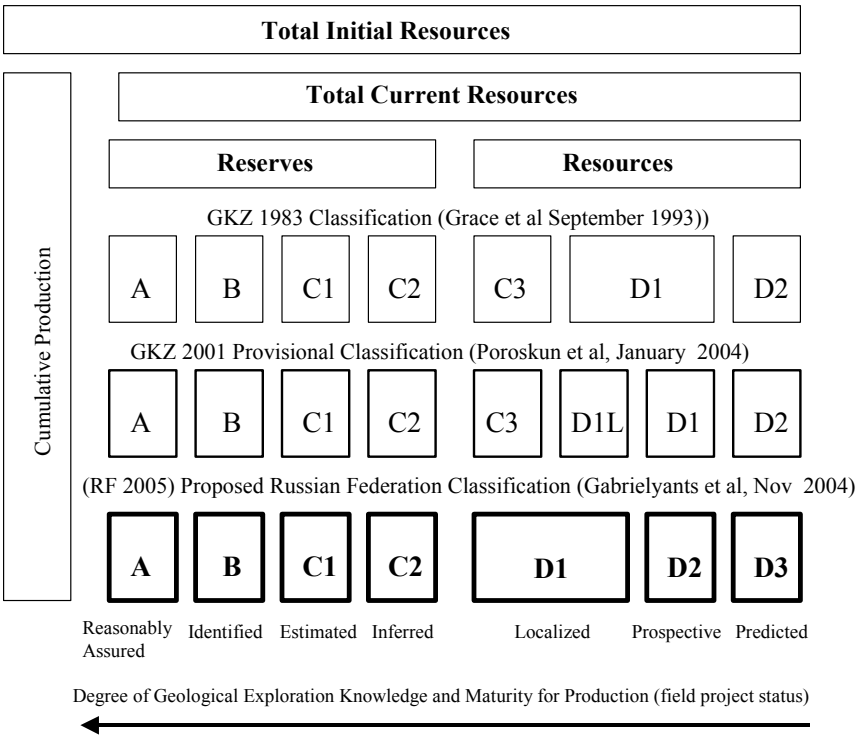


Figure 1: Russian Reserves Classifications

- GKZ 1983 being that applied within the former Soviet Union (FSU) and as described by Grace et al September 1993 article in the SPE Journal of Petroleum Technology "Comparative Reserves Definitions: U.S.A., Europe, and the Former Soviet Union".

- GKZ 2001 being the "Provisional Classification of Oil and Gas Reserves" as adopted in 2001 and utilized by the State Committee for Reserves of the Russian Federation (GKZ) to certify discoveries and approve development plans within the Russian Federation as described in Poroskun et al "Reserves/Resource Classification Schemes Used in Russia and Western Countries: A Review and Comparison", Journal of Petroleum Geology, Vol. 27 (1), January 2004.

- RF 2005 being the "Proposed New Russian Federation Classification" as described in a presentation made by G.A. Gabrielyants to the UNECE Ad Hoc Groups of Experts on Supply of Fossil Fuels in November 2004 plus a draft classification submitted by G. Malukhin to the SPE subcommittee on February 24, 2005.

GKZ 1983 provides background to the reserves and resource assessment approach historically applied in Russia. GKZ 2001 is a revised version and is that currently applied in the Russian Federation. RF 2005 is in advanced draft stages and we are advised that it will be implemented in the near future; thus it is this classification that we have utilized in this comparison to the current SPE reserves and resource classification.

RF 2005 Classification

RF 2005 establishes uniform principles for classification of reserves/resources of oil and natural combustible gas in the Russian Federation. Based on geological exploration knowledge and degree of maturity for economic development, oil and gas quantities found in the subsoil are divided into geological reserves (discovered) and geological resources (undiscovered). Geological Reserves are used in development planning including processing and transportation to forecast production and assess socio/economic impact. Geological Resources are estimated separately for oil and gas by province, region, districts, zones, areas and individual traps; such information is used in planning future exploration activities.

(Note that the Russian term "Geological Reserves (Resources)" refers to in-place volumes. "Recoverable Reserves" would match Western usage of the term "reserves").

A subject of reserves calculation is normally an accumulation of oil and/or gas (or a part of it) for which commercial hydrocarbon content has been proved *(thus the "reserves entity level" is a reservoir, field, or project)*.

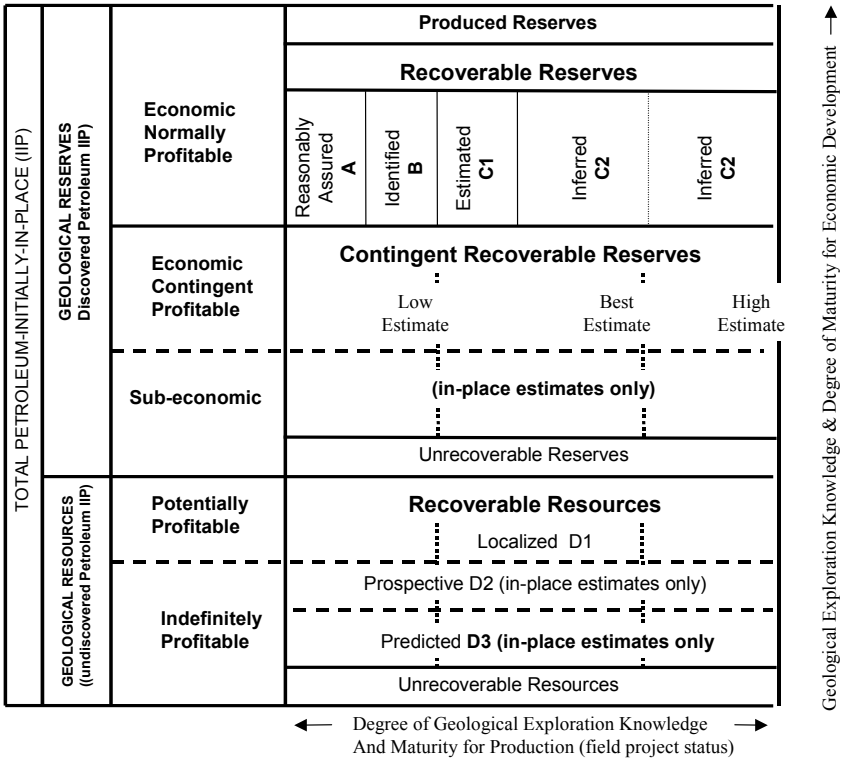


Figure 2: Proposed New Russian Federation Classification (RF 2005)

Referring to Figure 2, reserves are subdivided according two main aspects: commercial and geologic uncertainty/project status:

Commercial Producibility and Economic Efficiency – based on level of commercial producibility of a deposit and future net discounted cash flow (NPV) based on predicted performance indicators and fixed discount rates. Resources are grouped by Expected Monetary Value (EMV). Reserves are separated into three groups:

- **Economic Normally Profitable** are reserves which according to technical/economic calculations have been assessed, on a given date, to be commercially recoverable if brought to production under competitive market conditions, with use of equipment and technology of recovery and treatment ensuring that the requirements for rational use of the subsoil and environmental protection are observed.

- **Economic Contingent Profitable** are reserves not considered, on a given date, to ensure viability under competitive market conditions due to low performance characteristics but the development of which may be feasible through changing prices, new markets, or new technologies.

- **Sub-economic** are reserves the development of which, on a given date, is not considered feasible for economic, technical, or technological reasons. This includes not only non-commercial accumulations also those shut-in within the limits of water protection zones, populated areas, national parks, historical/cultural monuments, and deposits located far from transportation lines and producing infrastructure.

In economic deposits, on the basis of technological and technical/economic assessments, **recoverable reserves** are calculated and booked. Recoverable reserve is that portion of geological reserves which, on a date of calculation, proves commercially efficient for recovery under competitive market conditions with up-to-date equipment and technologies rationally applied and subsoil and environmental protection requirements are observed.

In sub-economic deposits geologic reserves *(in-place)* are calculated and booked but no estimates of recoverable reserves are made.

Petroleum Resources are subdivided into Potentially Profitable (positive EMV) and Indefinitely Profitable (insufficient information to compute EMV). Recoverable resources are only calculated for Potentially Profitable.

Degree of Geological Knowledge (geological structure and petroleum content) **and Maturity For Production** (field project status = degree to which a reservoir has been developed and prepared to become producing) is used to subdivide reserves into 4 categories:

- **Category A** (reasonable assured) includes actually producing reserves of a petroleum accumulation (or its portion) drilled on the basis of exploitation grid of wells in compliance with the appropriate production design document. All geology, rock and fluid characteristics (including fluid contacts) confirmed by drilling, sampling and well logging sufficient for building multidimensional simulation models. Profitable

exploitation is determined by an appropriate technological design document and confirmed by actual recovery operations. Category A includes:

  - reserves in commercially developed reservoirs being drained by production wells with the use of established recovery technologies
  - reserves in commercially developed reservoirs which for various reasons are not being drained at the date of calculation for which bringing to production is economically justified and will not require any essential additional expenditure
  - incremental reserves which can be profitably recovered from geological reserves *(in-place)* through the application of established improved recovery methods
  - incremental reserves which can be profitably recovered from geological reserves *(in-place)* through infill drilling within the primary grid of production wells

- **Category B** (identified) includes reserves of a petroleum accumulation which have been explored and matured for development, studied by seismic and drilled by wildcat, appraisal, and production wells from which commercial flows were obtained. All geology, rock and fluid characteristics are known reasonably well and sufficient for building reliable simulation models. Commercial producibility of a reservoir has been confirmed by pilot production data, geophysical well logging and justified by a technological development design document. Category B includes reserves of the reservoir portions in drainage zones of wells from which commercial flows have been obtained by testing and/or trial production.

- **Category C1** (estimated) includes reserves of a petroleum accumulation studied by seismic and adjacent to reserves of A and B categories provided that geological and geophysical information indicates with reasonable certainty that the objective formation is laterally continuous and there is a high degree of probability to commercial producibility from the objective formation in this portion of the reservoir. Production performance and profitability of development and production are determined/inferred by analogy with the explored portions of the reservoir. Category C1 includes reserves

  - in undrilled portion of the reservoir immediately adjacent to A and B categories at the distance equal to possible drainage zone *(one "spacing unit")*.
  - in portions of the reservoir in an area of unsampled wells in case producibility has been proved by sampling or production form other wells *(adjacent analogs).*

- **Category (C2)** (inferred) includes reserves of undrilled portions of the reservoir beyond one drainage zone offset to wells where A and B reserves are established. Geological and reservoir performance parameters are assumed by analogy with the explored part of the same reservoir or other accumulations within the same region. The information available is sufficient for generating preliminary geological simulation models and reserve calculation. C2 includes reserves:

- in reservoir portions between its proved outlines and boundaries of blocks with higher category reserves if there is enough geological and geophysical evidence to confirm continuity of the objective formation.
- in formations with unproved producing capability but explored with well logs in intervening wells that indicate productivity
- in undrilled tectonic blocks of productive reservoirs provided geological information is indicative of similar potentially productive formations.

Reserves estimated with categories A, B, and C1 should not be aggregated with those estimated as C2.

- **Category (D1)** (localized) includes petroleum resources in potentially producible formations confined to traps matured for drilling. Outlines, size and structure have been determined from geological and geophysical studies. Formation thickness, hydrocarbon pore volume of the reservoir, composition of oil and gas are assumed by analogy with explored deposits.

- **Category D2** (prospective) includes petroleum resources of lithological/stratigraphic complexes and horizons with proved commercial hydrocarbon content confined to large regional structures *(proven petroleum system).* Quantitative estimation of prospective resources is based on results of regional studies and analogies to discovered accumulations in the region.

- **Category D3** (predicted) includes petroleum resources of lithological/stratigraphic complexes and horizons for which commercial hydrocarbon content has not yet been established *(unproven petroleum system).* Quantitative estimation of predicted resources is based on presumed reservoir parameters from regional analogies and conceptual geologic interpretations.

RF 2005 reporting requires additional subdivisions of reserves and resources by:

- **Types of Oil and Natural Gas Deposits by Phase Relationship** using the following classification for petroleum deposits (accumulations)
  - Oil - with dissolved gas to saturation (no gas cap)
  - Oil and Gas –with a gas cap not exceeding 50% on a fuel equivalent basis
  - Gas and Oil - with oil fringe less than 50% by volume of equivalent fuel
  - Gas – containing only gas *(dry gas)*
  - Gas Condensate – gas with condensate further subdivided by C_{5+b} content (from low (below 25 g/m^3) to unique (over 500 g/$m^{3)}$ condensate
  - Oil-Gas-Condensate

- **By Size of Recoverable Reserves** subdivided according to:
  - Unique – over 300 Mt (2.1 billion bbls) oil or 500 BCM gas (17.5 tcf)
  - Large – 30 (210 mmb) to 300Mt oil, 30 (1.1 tcf) to 500 BCM gas
  - Medium – 3 (21 mmb) to 30 Mt oil, 3 (105 bcf) to 30 BCM gas
  - Small – 1 (7 mmb) to 3 Mt oil, 1 (35 bcf) to 3 BCM gas
  - Very Small – below 1 MT (7 mmb) oil, less than 1 BCM (35 bcf) gas

- **By Complexity of Geologic Structure** subdivided according to:

- Simple – one phase accumulations associated with weakly deformed structures; productive formation continuous (thickness, porosity, permeability) areally and vertically
- Complicated – one and two phase accumulations; productive formation discontinuous (thickness, porosity, permeability) areally and vertically with intervening seals (or tectonic dislocations)
- Very complicated - one and two phase accumulations; both productive formation discontinuous (thickness, porosity, permeability) areally and vertically and intervening seals (or tectonic dislocations), also includes heavy oils

RF 2005 specifies that calculation of reserves and estimation of resources may be carried out by deterministic or probabilistic methods. If deterministic methods are used, it is suggested to evaluate an associated error based on the accuracy of determining calculation parameters. When probabilistic methods are used, the following estimates of reserves/resources may be derived:

- a low estimate (P90) with 0.9 probability of being confirmed
- a best (or basic) estimate (P50) with a 0.5 probability of being confirmed
- a high estimate (P10) with a 0.1 probability of being confirmed

(At this time, the probabilistic method is not routinely applied in Russia, and if applied is most often confined to resource estimates. However, it is expected its use will increase throughout all phases of exploration and exploitation.)

The following url accesses the slides used by Gabrielyants in his 2004 presentation to the UNECE on the new Russian Federation Classification:
http://www.unece.org/ie/se/pdfs/adclass/day2/GabrielyantsRussianFed_UNFC.pdf

Mr. Grigoriy Malukhin provided extensive support in our understanding of the Russian Federation's classification and its detailed comparison to the SPE definitions. He was assisted by a national group consisting of Y. Podturkin, M. Zykin, V. Poroskun, I Gutman and K. Kavun.

The SPE does not represent the above summary as being definitive guidance for those required to report reserves and resources under criteria set by the Russian Federation. Analysts should obtain guidelines documentation directly from the appropriate agencies.

Comparison of SPE to Russian Federation Classification Scheme (RF 2005)

Comparisons of the new Russian Federation and SPE/WPC/AAPG classifications can be best approached by first examining separation into categories based on the commercial axis" (figure 3):

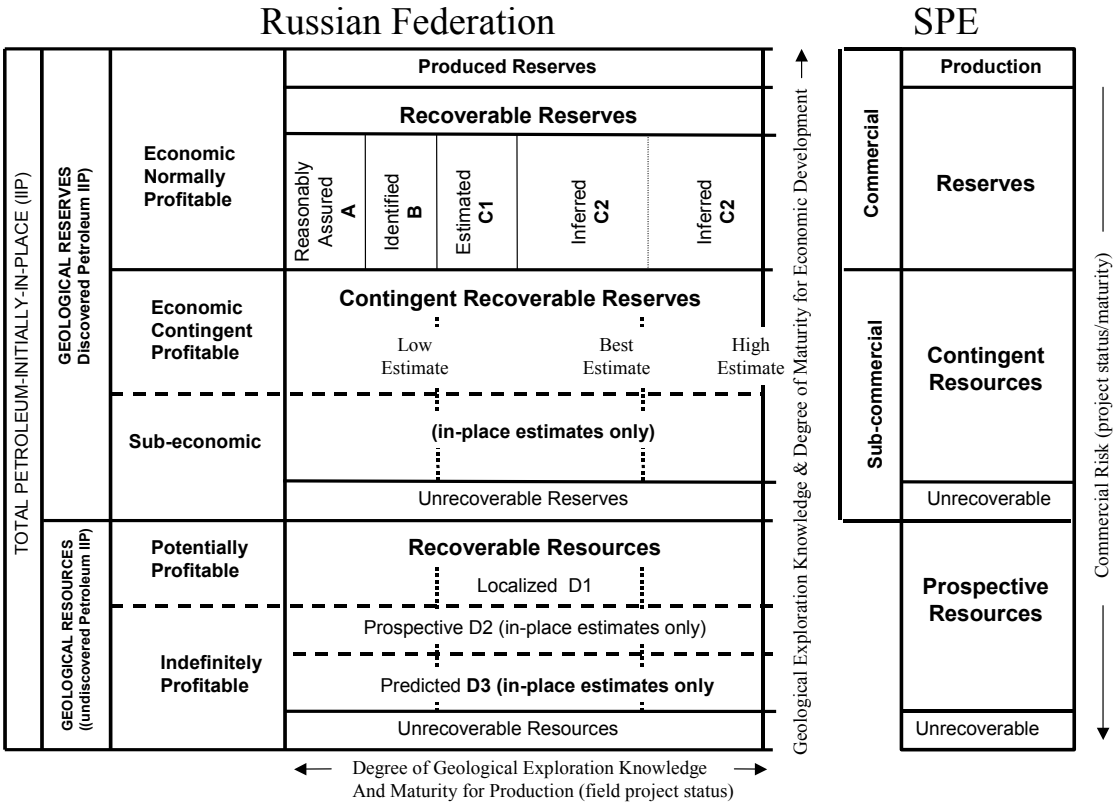


Figure 3: Comparison of New Russian Federation (RF 2005) and SPE Categories

There is overall alignment at major boundaries. The Russians split the undiscovered into 3 categories that can be roughly described as prospects (D1), leads (D2), and plays (D3). Other organizations such as the NPD apply a project maturity axis to describe a similar approach.

While the SPE classification refers to recoverable volume throughout, the Russians estimate only in-place volumes for their D3 and D2 classes and the sub-economic portion of their Contingent Recoverable Reserves. The logic is that lacking sufficient definition for computing development plan economics, it is not feasible to forecast recovery to an economic limit. In the SPE approach, analogous developments would be used to estimate recovery efficiency.

The overall intent of the Contingent Recoverable Reserves category is similar to the SPE's Contingent Resources, that is, these are discovered volumes that because of some contingency (economics and/or technology), it is not currently feasible to proceed with development. Those volumes categorized as sub-economic by RF 2005 due to access constraints such under parks, cities, or in water protection zones (environmental) or lack of local pipelines and/or infrastructure may still have economic potential and

would not be segregated in the SPE classification. The RF 2005 proposal also includes shut-in wells in their sub-economic Contingent category; without further clarification it is not obvious why this is not classified as developed but non-producing.

Gabrielyants presentation infers that a portion of volumes classified as possible reserves under SPE guidelines may fall in the Russian Contingent category. This may refer to volumes in adjacent undrilled fault blocks and satellite features that are often included in Possible reserves.

Figure 3 also highlights some terminology differences. The Russians use the term "reserves" for all types of discovered volumes (in-place, economic, sub-economic) whereas the SPE uses the term reserves only for the remaining, commercially recoverable portions of discovered volumes. *(This may be typical of linguistic difficulties that are encountered internationally when technical terms are translated using their general meaning.)*

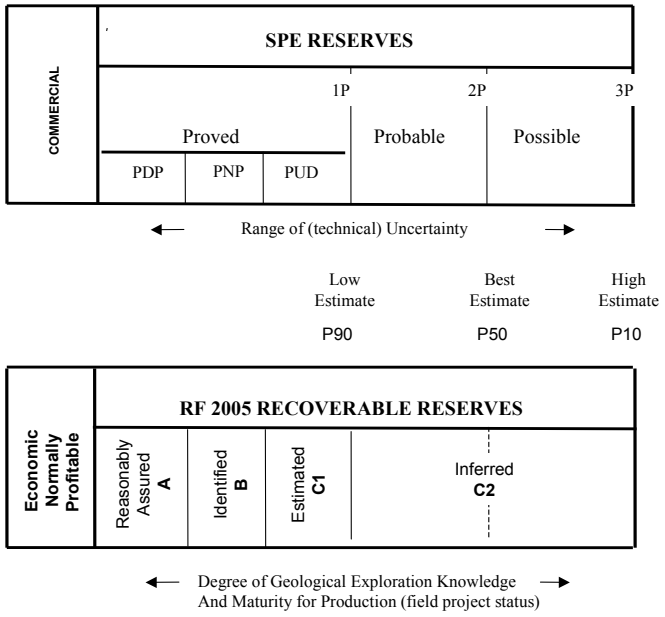


Figure 4: Comparison of New Russian Federation (RF 2005) and SPE Reserve Classes

Figure 4 shows that the Russian reserves classes A, B, and C1 grossly correlate to SPE Proved Developed Producing (PDP), Proved Developed Non-Producing (PNP) and Proved Undeveloped (PUD), respectively.

Recoverable estimates in their Category B have all the certainty of Category A but are not on production for some reason. It is not explicitly stated that the capital required to reach production status is "not significant" and there is some confusion in that category A includes "reservoirs that are temporarily shut-in and can be reactivated with minimal expenditures". Category B definitions probably include reserves existing behind pipe waiting future re-completions.

Category C1 correlates to SPE PUD in areas one drainage unit offset to Proved Developed but does not specifically address proved reserves in deeper reservoirs or the

case where a relatively large expenditure is required to a) re-complete an existing well or b) install production or transportation facilities for primary or improved recovery projects.

Category C2 encompasses SPE probable and possible (unproven) and can only be dissected by detailed examination of the information available. Although probabilistic methods are rarely applied in Russia, this could be used as a basis for defining a 2P (best) versus 3P (high) estimate. The RF 2005 requires reporting by field/reservoir and thereafter aggregations to various levels and ultimately total Russia; current aggregation is arithmetic by category based on the deterministic method. The Russian guidelines do not address the issue of portfolio effect in probabilistic aggregations.

RF 2005 classification applies to all reserves/resources of oil and natural combustible gas. It is not clear if the classification applies to unconventional hydrocarbons (tight gas, coal bed methane, bitumen). The only reference to unconventional hydrocarbons is that heavy oils should be classified as “very complicated” accumulations.

Significant differences versus SPE guidelines include:

- RF 2005 includes incremental reserves due to application of established improved recovery methods and infill drilling in Category A (equivalent to SPE PDP) without the requirement for a successful pilot in the subject reservoir or a commitment to proceed with the incremental development.
- In historical Russian classifications, one value of recovery ratio was established in the original development plan and there was no provision to forecast a range of resulting recovery efficiencies. This is still true, although incremental reserves from forecast application of a new recovery method can be included in category C1.
- The Russian classification does not provide for using a more conservative price forecast for proved versus unproved reserves. It appears as if all reserves are evaluated using the criteria “commercially recoverable if brought to production under competitive market conditions, with use of equipment and technology of recovery and treatment ensuring that the requirements for rational use of the subsoil and environmental protection are observed”.
- When reviewing their mapping to UNFC, Category B is considered contingent or undefined under project feasibility. Under SPE guidelines both B and C1 reserves can be brought to producing status without significant capital investment and thus there is no significant feasibility contingency.

Since the Russian classification is based on geologic certainty of in-place volumes, there is a much greater emphasis on volumetric analysis in all categories whereas most Western analysts would focus on production performance-based estimates (decline, material balance) in Proved and Probable estimations for mature properties.

The referenced Gabrielyants presentation to the UNECE (http://www.unece.org/ie/se/pdfs/adclass/day2/GabrielyantsRussianFed_UNFC.pdf) includes several examples that illustrate overall alignment of SPE and RF 2005 classifications.

Comparison of Reserves Definitions
Reserves Definitions/Proved Criteria

	SPE/WPC (1997)	New Russian Proposed (RF 2005)
Intended purpose	General application – not country specific	Government reporting in Russia
Qualitative description of certainty- proved	Reasonable certainty to be commercially recoverable	A - reasonably assured + B- identified + C1- Estimated
Qualitative description of certainty- probable	Not proved, but more likely than not to be recoverable	Part of C2- inferred
Qualitative description of certainty- possible	Less likely to be recovered than probable	Part of C2- inferred
Quantification of probabilities associated with estimates.	Proved =/> P90 2P =/> P50 3P =/>P10 (target at field/property level)	Low Est =/> P90 Basic Est =/> P50 High Est =/>P10 (levels not clearly defined)
Proved reserves relative to lowest known hydrocarbon (LKH)	No proved reserves below LKH as defined by well logs, core analysis or formation testing.	Category A has fluid contacts delimited by drilling, sampling and well logging.
Proved reserve extensions on undrilled acreage	Directly offsetting DSU's and/or where reasonably certain of continuity and commercial recovery.	C1 - geological and geophysical information indicates reasonable certainty that the objective formation is laterally continuous. Includes undrilled portion of the reservoir immediately adjoining the reserves of A+B categories at the distance equal to possible drainage zone.
Proved reserves – requirements for testing	Generally require actual production or a conclusive flowing well test. In certain cases, proved reserves can be based on logs and/or cores and is analogous to producing or tested reservoirs.	Attributed to drainage area and offsets for wells from which commercial flows have been obtained by testing and/or trial production.
Classification of enhanced recovery mechanism as proved	Successful pilot or existing project in subject or analogous reservoir.	Included in Category A based on original development plan – no pilot required for established methods (e.g. waterfloods).

Comparison of Reserves Definitions
Development Status

Development and production status categories	Developed producing and non-producing. Undeveloped.	Category A - producing, category B - non-producing, category C1- undeveloped
Developed	Reserves expected to be recovered from existing wells including reserves behind pipe. Improved recovery reserves require that necessary equipment has been installed or when costs to do so are relatively minor.	Category A represents developed producing (*and some non-producing)* and includes incremental reserves from established improved recovery methods as contained in the original development plan.
Developed - Producing	Reserves expected to be recovered from completion intervals which are open and producing at the time of the estimate. Improved recovery reserves are considered developed producing only after the improved recovery project is operational.	A - includes incremental reserves from established improved recovery.
Developed – Non-Producing	Includes shut-in (open but not producing, waiting on market/pipeline connections, or mechanical problems) and behind pipe (requires additional completion or future re-completion) reserves.	B - includes reserves in drainage zones of wells from which commercial flows have been obtained.
Undeveloped	Reserves to be recovered from additional drilling, deepening existing wells to a different reservoir or where a relatively large expenditure is required to complete an existing well or install production or transportation facilities	C1- assigned undrilled portions immediately adjoining the reserves of category A+B categories at a distance equal to possible drainage zone
Allocation in Multi-well Pools	Not Defined	Not Defined

Comparison of Reserves Definitions
Unproved Reserves

Unproved Reserves	Technical, contractual, economic, or regulatory uncertainties preclude reserves being classified as proved. Unproved reserves may be estimated assuming future economic conditions (and technological development) different from those prevailing at the time of the estimate.	Category C2 (inferred) includes all portions between accumulation outline and blocks with higher categories, untested formations with continuity to producing wells based on seismic and untested fault blocks deemed productive when compared to productive areas
Probable Reserves	Includes: 1) step-out areas from proved 2) formations that appear productive on logs but lack core, definitive tests, or productive analogs 3) incremental reserves attributable to infill drilling 4) reserves attributable to improved recovery methods but lack pilot 5) adjacent fault blocks up-dip to proved 6) reserves attributable to future workover treatments or other procedures without successful analogs 7) incremental reserves in proved reservoirs through alternative interpretations.	Not defined – that portion of C2 with less uncertainty.
Possible Reserves	Includes: 1) areas beyond probable potentially productive based on geological interpretations 2) formations that appear petroleum bearing in cores and logs but may not be commercially productive on tests 3) reserves attributable to infill drilling that are subject to technical uncertainty 4) improved recovery reserves where no pilot is operational and reservoir characteristics may not support commercial application 5) adjacent fault blocks down-dip to proved areas.	Not defined- that portion of C2 with more uncertainty.

Comparison of Reserves Definitions
Deterministic vs Probabilistic Methods

Deterministic vs Probabilistic Methods	Reserve estimates may be prepared using wither deterministic or probabilistic methods. Reserve numbers are generally defined within a range, not as one fixed quantity. The range may be described qualitatively by deterministic methods or quantitatively by probabilistic methods. (the probabilistic limits (e.g. Proved =/> P90) can only be specifically applied when the probabilistic method is applied)	Calculations/estimations may use either deterministic or probabilistic methods. (probabilistic methods are currently rarely applied).
Deterministic Method	Deterministic estimates do not address uncertainties in terms of probabilities; they require that volumes be described in terms of discrete estimates using defined criteria (e.g. LKH) including qualitative certainty.	If deterministic methods are used it is suggested to evaluate an error based on accuracy of determining calculation parameters.
Probabilistic Method	If probabilistic methods are used the defined quantitative limits (e.g. Proved =/> P90) apply at the entity level *(before aggregation).*	For probabilistic methods use targets (see above). (Level not defined)
Application of probability criteria and aggregation.	Numerical probabilities are only applied in probabilistic method and probability limits apply at the entity level. Probabilistic aggregation allowed to the field level only, then arithmetic summation to reporting level. Dependencies between entities and their distributions must be modeled in probabilistic aggregation.	Aggregation not specifically addressed. However, calculation and booking of reserves of oil and gas having commercial significance shall be implemented separately for each individual accumulation and the deposit as a whole in terms of quantities in-place, with no account taken of possible losses at the production stage.

Comparison of Reserves Definitions
Special Issues

Treatment of Unconventional Hydrocarbons	Classification applies to all petroleum deposits.	Not clear if reserve definitions include unconventional deposits beyond heavy oil.
Fuel Gas Reserves Status	Issuers have the option to include gas volumes consumed in operations in production and reserves if an appropriate expense is allocated.	Classification includes all production and losses for mass balance. Not clear if fuel gas is included in recoverable reserves
Natural Gas Injection	To include injection gas as reserves, the volumes would have to meet the normal criteria (economic when available for production, existence of a firm market, available pipeline or other export option, part of established development plan).	Not Defined
Gas Sales Volumes	Reported gas reserves reflect the condition of the gas at the point of sale. If sold as wet gas, associate liquids reserves are not reported separately. If sold with a non-hydrocarbon gas content, the full volume as sold is included in reserves. The price received will reflect quality.	Natural gas and helium reserves are calculated in terms of volumes adjusted to standard conditions (pressure 0.1 uPa, temperature 20^{o} C).
Infill Drilling	Reserves assigned to infill drilling with low uncertainty are Probable, infill areas with technical uncertainty are possible *(acceleration issue not addressed)*	Incremental reserves associated with infill drilling are included in Category A.
Compression	Not Defined	Not Defined

Comparison of Reserves Definitions
Special Issues

Net Profits Interests	Not defined	Not defined
Production-Sharing Contracts	Under a PSC the host government retains ownership, however the contractor receives a stipulated share of production remaining after cost recovery. Reported reserves are based on the economic interest held subject to the specific terms and time frame of the agreement. Being tied to economic interest, reserves must be re-calculated annually based on product price and operating costs and may vary considerably. Under SPE definitions, an average price over the term of the contact may be used to define reserves.	Not defined
Contract Extensions	Where agreements allow extension through negotiation of renewed contract terms, exercise of options to extend or other means additional reserves (of various categories) or contingent resources may be assigned depending the level of certainty and commercial viability associated with the contract extension.	Not defined
Product categorization	NA	See Note 2.

Comparison of Reserves Definitions
Economics/Commerciality

Commerciality	In order to assign reserves of nay category, a project needs to be defined in terms of a commercially viable development plan and there should be evidence of firm intent to proceed.	Recoverable reserves must prove commercially efficient for recovery under competitive market conditions, with up to date equipment and technologies rationally applied.
Commitment	If the degree of commitment is not such that an accumulation is expected to be developed and placed on production within a reasonable time frame (e.g. 5 years), the estimated recoverable volumes should be classified as contingent resources (not reserves).	Not defined
Economics	The underlying economic evaluation based on perception (best estimate) of future costs and prices together with best-estimate production profile expected to equate to a proved plus probable scenario. To limit downside exposure the “low case” scenario should be at least “break-even“ which is consistent with the requirement that proved reserves are viable under “current economic conditions”.	Economic Normally Profitable are reserves assessed on a given date according to be commercially recoverable if brought to production under competitive market conditions with use of equipment and technology of recovery and treatment ensuring that the requirements for rational use of subsoil and environmental protection are observed.
Development Plan Approvals	While some companies choose not to assign any proved reserves until the development plan has received all relevant formal approvals, SPE definitions require only a reasonable expectation that the necessary facilities to process and transport those reserves will be installed.	Not defined

Comparison of Reserves Definitions
Economics/Disclosure Guidelines

Prices & Costs for defining reserves "economic limit".	Proved: Existing economic conditions (year-end or appropriate period* average) (*SPE recommends prior 12 month period). Unproved: reserves may be based on forecast prices and costs.	Pricing not specifically addressed but reserves are as assessed on a given date to be commercial under competitive market conditions. Appear to use same assumptions for all reserves categories
Abandonment Costs	Economic limit calculated including abandonment and reclamation costs.	Not defined
Net Present Value of Future Net Revenue (FNR).	Not defined	Future Net Discounted cash flow (NPV) based upon predicted performance indicators and fixed discount rates.
Audit Requirements	No requirement for use of external evaluators. SPE "Standards Pertaining to the Estimating and Auditing of Oil and Gas Information" recommends standards for training, experience levels, and sets independence criteria for evaluators and auditors whether internal or external.	To be addressed in final version
Gross vs Net Reserves	See Note 1	See Note 1

Note 1:
Gross vs Net: Not addressed in Russian classification

SPE Regards Royalty
Within the U.S., royalty volumes are strictly omitted from reported reserves *(that is, they are reported on a net basis)*. In some cases outside the U.S., where royalty is paid in cash and the cash flow from the royalty is reflected in the company's accounts, the corresponding royalty may be included in reserves.

Note 2: Product Categorization Reporting Required in RF 2005
Categorize Types of Oil and Natural Gas Deposits by Phase Relationship using the following classification for petroleum deposits (accumulations)

- Oil - with dissolved gas to saturation (no gas cap)
- Oil and Gas –with a gas cap not exceeding 50% on a fuel equivalent basis
- Gas and Oil - with oil fringe less than 50% by volume of equivalent fuel
- Gas – containing only gas *(dry gas)*
- Gas Condensate –further subdivided by C_{5+b} content
    - Low by condensate contained (below 25 g/m^3)
    - Medium by condensate contained (25 -100 g/m^3)
    - High by condensate contained (100 - 500 g/m^3)
    - Unique by condensate contained (over 500 g/m^3)
- Oil-Gas-Condensate

The SPE has no requirements for product categorization.

China Petroleum Reserves Office (PRO–2005)

The current classification system was approved and issued in 2004 by the General Administration of Quality Supervision, Inspection and Quarantine of the Peoples Republic of China with implementation to be effective in 2005. Reserves and resource reporting is administered by the Petroleum Reserves Office of the Ministry of Land and Resources. Each Chinese company must report annually detailed volumes (by field, block, and reservoir) under this classification that are associated with new discoveries, extensions and changes in development plans on properties within the borders of China.

China began developing a modern oil and gas industry in the 1950's and utilized the petroleum classification system from the former Soviet Union (FSU). Several revisions of the classification and guidelines culminated in the adoption of the China National Reserves Committee recommendations in 1988. In this classification, discovered oil and gas resources are referred to as "Discovered Geological Reserves" and the assignment of oil and/or gas in-place volumes to reserves classes is based on the phase of exploration or development and the amount of information available. The three classes are:

Inferred	Early Exploration and discovery
Indicated	Exploration Well Test with Industrial Flows
Measured	End of Exploration to Development

In the Chinese 1988 definition of reserves, economic viability was not emphasized or lacked clarification. However, an element of economics was included through the "industrial flows" criteria are defined in the following table relating well test/production rate to reservoir depth:

Reservoir Depth (meters)	Well Test Production	
	Oil (tonne/d)	Gas ($10^4 m^3/d$)
<500	0.3	0.05
500 - 1000	0.5	0.1
1000 – 2000	1.0	0.3
2000 – 3000	3.0	0.5
3000 – 4000	5.0	1.0
>4000	10.0	2.0

The classes of recoverable reserves are the same as the corresponding "geologic reserves" (in-place). Estimated Ultimate Recoverable (EUR) volumes are computed as the product of estimated in-place volumes times the estimated recovery efficiency. This volumetric approach is continued even into the production decline phase.

In 1998, the Ministry of Land and Resources was set up with mineral resources/reserves management as one of its main responsibilities. The current classification (hereafter referred to as the China 2005 definitions) is the result of work by their Petroleum Reserves Office and takes into consideration criteria contained in the SPE/WPC/AAPG and the United Nations Framework Classification (UNFC) systems. It keeps the basic features of the 1988 classification but incorporates SPE terminology. Figure 1 illustrates the overall classification and the category names and acronyms.

In general, discovered in-place volumes are first classified as measured, indicated or inferred “geologic reserves” based on the phase of exploration and development. That portion that is estimated to be theoretically recoverable under given technological conditions is termed “technically EUR (estimated ultimate recoveries)” or “TEUR”. The equivalent recoverable reserve categories are defined as Proved, Probable and Possible based on the degree of geological confidence. Economic initially recoverable reserves (EIRR) are those quantities of petroleum that are anticipated to be economically recoverable under existing economic conditions and under current executed or planned to be established technical operating conditions.

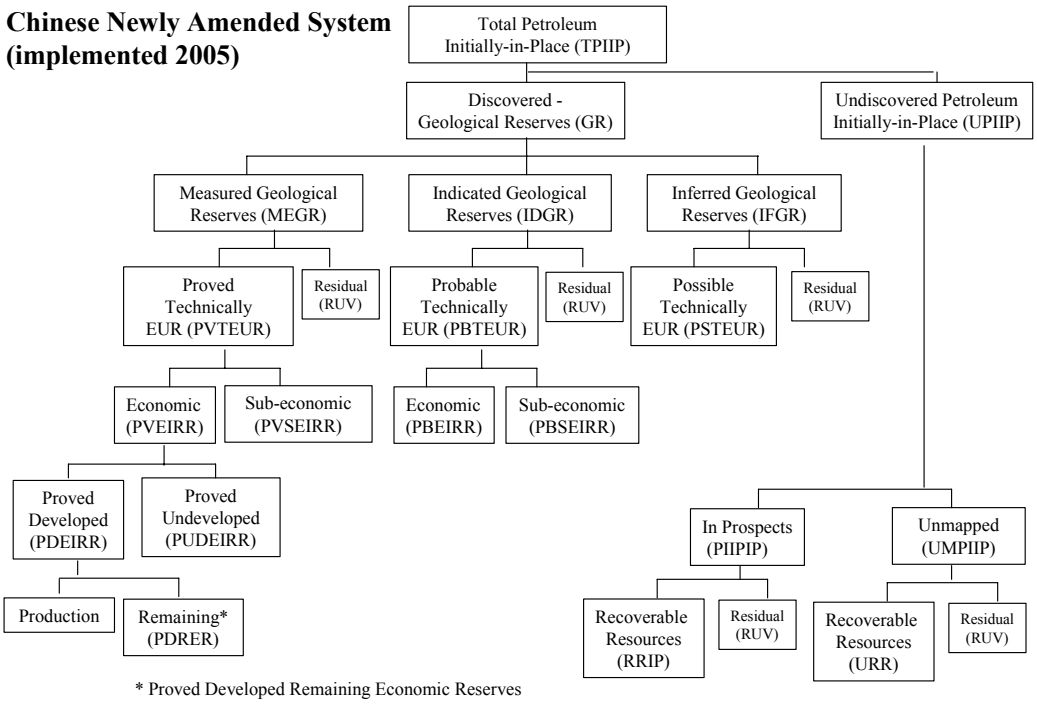


Figure 1: Classification Framework of Chinese Petroleum Resources/Reserves

Measured Geological Reserves are estimated with a high level of confidence after the reservoirs have been proved economically recoverable by appraisal drilling. A reasonable well spacing should be used in the delineation of measured limits. All parameters in the volumetric approach should have a high degree of certainty.

That portion of Measured Geological Reserves that can be technically recovered is termed proved technically EUR (PVTEUR); these ultimate recoveries are based on:

- primary and improved recovery technologies that have been operated or are planned to be operated in the near future
- already have a development plan in progress or to be carried out in the near future
- are economic based on existing being recent average prices and costs.

This category has an economic and sub-economic component. For proved economic initially recoverable reserves (PVEIRR):

- use unescalated prices and costs from the date of the evaluation
- the technology is operational or has been demonstrated by a pilot or is successful in an analogous field and is assured to be installed

- the development plan will be carried out in the near future (for gas, there should be existing or contracted pipelines and firm sales contacts).
- reserve boundaries are based on fluid contacts or reliable pressure data, or the lowest known hydrocarbons encountered in a well; confined to an area with reasonable well control
- economic productivity is confirmed by actual production or conclusive test or such evidence in the same formation in offset wells or similar formations in the same well
- feasibility studies show the development is economic
- there should be at least 80% probability that the quantities actually recovered in the future will equal or exceed the estimated initially recoverable reserves

The economic portion can be split into Proved Undeveloped and Proved Developed with the latter composed of cumulative production and remaining economically recoverable reserves. *(Thus, once adjusted for prior production, the economic recoverable measured is generally equivalent to SPE proved.)*

The sub-economic portion is defined as the difference between the proved technically estimated ultimate recoveries (PVTEUR) and the proved economic initially recoverable reserves (PVEIRR) and includes two parts:

- sub-economic PVTEUR volumes
- those PVTEUR volumes anticipated to be economic but the uncertainties of contractual and/or technical recoveries preclude such volumes being classified as PVEIRR.

(These "sub-economic/technically proved" volumes thus correlate closely to SPE low estimate Contingent Resources and part of SPE Probable Reserves.)

Indicated Geological Reserves are estimated with a moderate level of confidence when economic flow is obtained from a prospect well at the general exploration phase. That portion yielding technically estimated ultimate recoveries is called Probable (PBTEUR) and presumes the probably executed operation technology. Similar to the preceding, these estimates are split into economic and sub-economic. Economic may be based on recent average prices and costs or given forecast prices and costs. For the economic portion, there should be at lest 50% probability that the quantities actually recovered in the future will equal or exceed the estimated initially recoverable reserves (EIRR). *(This category is grossly similar to SPE Probable reserves. The uneconomic portion is the difference between the Probable TEUR and EIRR and may be generally correlated to that portion of SPE Contingent Resources between the low and best estimate.)*

Inferred Geological Reserves are estimated with a rather low level of confidence characteristic of an early discovery phase or in the case where interpretations indicate that additional oil and/or gas layers exist. That portion yielding technically estimated ultimate recoveries is called Possible (PSTEUR) and optimistically presumes the probably adopted operation technology. There should be at least a 10% probability that the quantities actually recovered in the future will equal or exceed the estimated initially recoverable reserves (EIRR). The Chinese classification considers that Inferred reserves have undetermined economics and thus, it is not possible to define economic and sub-economic categories of Possible. (*Thus this category may correlate to SPE Possible reserves or high minus best estimate Contingent Resources, or some combination of the two.)*

Comparison to SPE Definitions

As illustrated in figure 2, there is a broad general agreement between the new Chinese (2005) and the SPE classification systems. However, there are some interpretational differences:

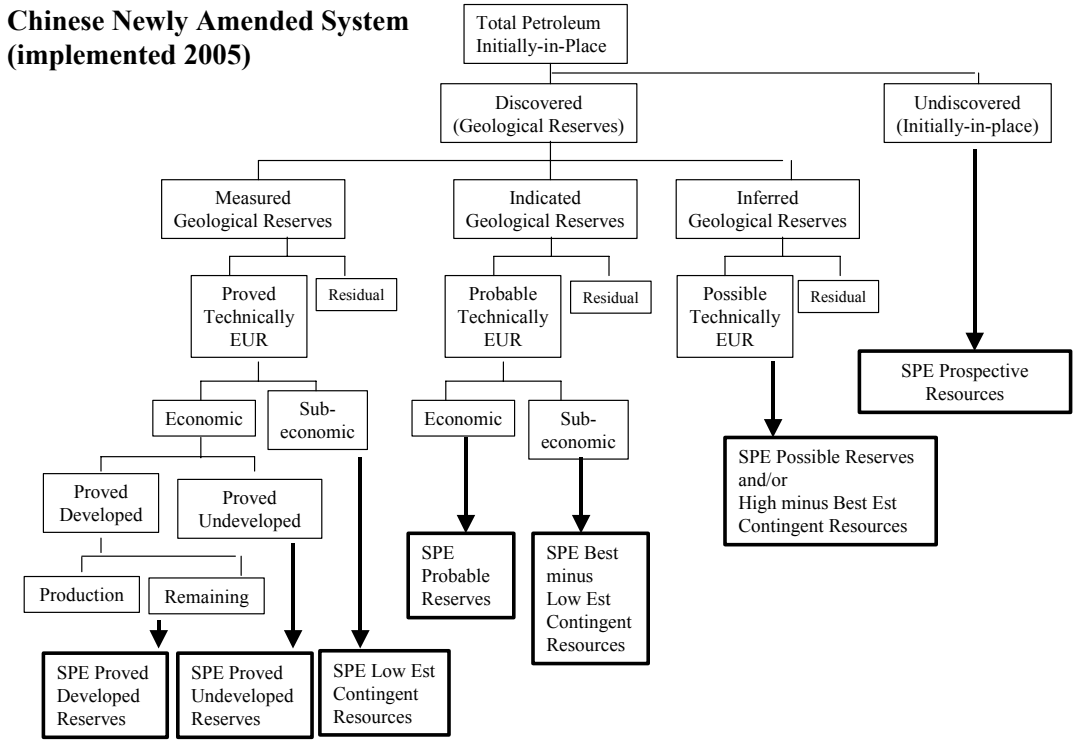


Figure 2: Comparison of Chinese (2005) and SPE Classifications

a) It is key to remember that under the Chinese classification system:

1) The term “reserves” is used for both discovered in-place volumes and technically recoverable volumes in addition to economically recoverable volumes.
2) Further, all certainty criteria are assigned to estimated in-place volumes and ultimate recoverable volumes, not restricted to remaining volumes.
3) The Chinese Proved and subset Proved Developed Estimated Initially Recoverable Reserves must be reduced by prior cumulative production before comparison to SPE reserves.

b) The Chinese have retained their industrial flows criteria as a reference to define a commercial discovery but staff are encouraged to estimate local or field-wide criteria as well. In general, a commercial rate would allow recovery of the cost of drilling a producing well (excluding abandonment costs).

c) For Proved Technical Estimated Ultimate Recovery (PTEUR), the feasibility studies assume recent average prices and costs but for Proved Economic Initially Recoverable Reserves (PVEIRR), more stringent criteria include use of prices and costs as of the assessment date. *(In practice, Chinese companies may apply their internal forecast prices in feasibility studies to define PTEUR.)*

d) For PBEIRR/Probable, Chinese guidelines allow use of either historical average or forecast costs and prices whereas the SPE Probable and Possible apply forecast costs and prices.

e) Although not discussed above, the Chinese subdivide the undiscovered resources (comparable to SPE/WPC/AAPG Prospective Resource) into two categories: Petroleum Initially-in-place in Prospects at early stages of exploration and Unmapped Petroleum Initially-in-place that is based on regional reconnaissance mapping only.

f) While the China classification makes reference to probability targets, their post-discovery assessments are usually based on deterministic scenarios and it is rare that probabilistic analyses are used. While 2P and 3P match SPE guidance at P50 and P10, the Chinese definitions for Proved reference a target of P80 versus the SPE P90. The Chinese documents include phrases such as “indicated geological reserves are estimates with a moderate level of confidence with a relative error not more than +/-50%”. This does not relate to actual probabilistic targets and is supplied as a general guide. It would appear that this implies a higher degree of uncertainty than normally associated with SPE probable estimates.

g) In the detailed definition of LKH, there is an indication that the Chinese specifically state that they would accept reliable pressure data as a primary criteria; the SPE requires a lowest penetration “unless otherwise indicated by definitive geological, engineering or performance data”.

The Chinese expect that there should be no material difference between SPE Proved Ultimate and their PVEIRR. However, it should be noted that it is common for the feasibility studies to include waterflood in the initial plans for oil reservoir development and improved recovery volumes may not be uniquely identified.

The Proved Reserves of the three major national oil companies that are disclosed to investors are in compliance with SEC guidelines since the estimations were performed by independent consulting firms. These quantities may not be equivalent to those reported by the same companies to the government under the above Chinese 2005 classification system.

The issue of combining a range of recovery efficiencies in combination with in-place uncertainties to define proved versus probable and possible recoverable volumes is problematical in the Chinese system. In practice, the probable (indicated) and possible (inferred) in-place volumes are estimated by exploration geologists using volumetric methods. When data meet the requirements of “Measured”, the property is turned over to a production company who define Measured In-place and associated Proved recoverable based on a development plan and debook the appropriate area of prior Probable in-place reserves. Typically the production company does not concern itself with probable and possible reserves estimates.

Once on production, the production company staff typically uses decline and/or material balance methods to estimate recoverable reserves but do not usually go back and revise the original in-place volume estimates. If the development drilling demonstrates that the original estimates of in-place volumes exceed the error limits (20% 0f Measured in-place volumes), it is referred to the Ministry (Petroleum Reserves Office) for review (audit) and changes.

Regarding non-conventional hydrocarbons, the same classification is applied to Coal Bed Methane reserves. The Chinese have not yet developed regulations for bitumen or oil sands.

Information on the Chinese classification system was supplied courtesy of Hu Yundong, China Petroleum Reserves Office, Ministry of Land and Resources. For a complete description of this classification and associated guidelines, contact the China Petroleum Reserves Office directly.

Comparison of Reserves Definitions
Reserves Definitions/Proved Criteria

	SPE/WPC (1997)	**China (2005)**
Intended purpose	General application – not country specific	Government reporting
Qualitative description of certainty- proved	Reasonable certainty to be commercially recoverable	High level of confidence and relative error not more than +/- 20%
Qualitative description of certainty- probable	Not proved, but more likely than not to be recoverable	Presumes the probably executed operational technology. Feasibility study shows development is economic.
Qualitative description of certainty- possible	Less likely to be recovered than probable	Optimistically presume the probably adopted operation technology. (No economic qualification.)
Quantification of probabilities associated with estimates.	Proved =/> P90 2P =/> P50 3P =/>P10	EIRR=/> P80 EIRR=/> P50 EIRR=/>P10 (EIRR = economical initially recoverable reserves).
Proved reserves relative to lowest known hydrocarbon (LKH)	No proved reserves below LKH as defined by well logs, core analysis or formation testing.	No proved reserves below LKH as defined by well logs, core analysis formation testing, **or pressure data**.
Proved reserve extensions on undrilled acreage	Directly offsetting DSU's and/or where reasonably certain of continuity and commercial recovery.	A reasonable well spacing should be used in the delineation of measured limits.
Proved reserves – requirements for testing	Generally require actual production or a conclusive flowing well test. In certain cases, proved reserves can be based on logs and/or cores and is analogous to producing or tested reservoirs.	Confirmation of economic productivity in the objective formation by actual production or a conclusive test. Or is similar to the same formation in an offset or similar formation in the same well with economic production.
Classification of enhanced recovery mechanism as proved	Successful pilot or existing project in subject or analogous reservoir.	Technology has been operated or demonstrated favorable by pilot or is successful in analogous field. Project assured to be installed.

Comparison of Reserves Definitions
Development Status

Development and production status categories	Developed producing and non-producing. Undeveloped.	Developed and Undeveloped. (no sub-categories of developed)
Developed	Reserves expected to be recovered from existing wells including reserves behind pipe. Improved recovery reserves require that necessary equipment has been installed or when costs to do so are relatively minor.	Reserves fully put into production after completing development well pattern drilling and associated facility installment. Improved recovery reserves require that necessary equipment is operational*. Must subtract prior production to get remaining.*
Developed - Producing	Reserves expected to be recovered from completion intervals which are open and producing at the time of the estimate. Improved recovery reserves are considered developed producing only after the improved recovery project is operational.	Not Defined (same as Developed)
Developed – Non-Producing	Includes shut-in (open but not producing, waiting on market/pipeline connections, or mechanical problems) and behind pipe (requires additional completion or future recompletion) reserves.	Not Defined
Undeveloped	Reserves to be recovered from additional drilling, deepening existing wells to a different reservoir or where a relatively large expenditure is required to complete an existing well or install production or transportation facilities.	Recoverable reserves in oil and/or gas reservoirs which have completed appraisal drilling or have a pilot project but the production pattern is not fulfilled.
Allocation in Multi-well Pools	Not Defined	Not Defined

Comparison of Reserves Definitions
Unproved Reserves

Unproved Reserves	Technical, contractual, economic, or regulatory uncertainties preclude reserves being classified as proved. Unproved reserves may be estimated assuming future economic conditions (and technological development) different from those prevailing at the time of the estimate.	Discovered recoverable portions of Indicated or Inferred Geological Reserves.
Probable Reserves	Includes: 1) step-out areas from proved 2) formations that appear productive on logs but lack core, definitive tests, or productive analogs 3) incremental reserves attributable to infill drilling 4) reserves attributable to improved recovery methods but lack pilot 5) adjacent fault blocks up-dip to proved 6) reserves attributable to future workover treatments or other procedures without successful analogs 7) incremental reserves in proved reservoirs through alternative interpretations.	Only the recoverable portion of Indicated in-place volumes and the recovery efficiency may be estimated assuming probably operation technology different from those prevailing at the time of the estimate.
Possible Reserves	Includes: 1) areas beyond probable potentially productive based on geological interpretations 2) formations that appear petroleum bearing in cores and logs but may not be commercially productive on tests 3) reserves attributable to infill drilling that are subject to technical uncertainty 4) improved recovery reserves where no pilot is operational and reservoir characteristics may not support commercial application 5) adjacent fault blocks down-dip to proved areas.	Only the recoverable portion of Inferred in-place volumes and the recovery efficiency may be estimated optimistically assuming possible operation technology different from those prevailing at the time of the estimate.

Comparison of Reserves Definitions
Deterministic vs Probabilistic Methods

Deterministic vs Probabilistic Methods	Reserve estimates may be prepared using wither deterministic or probabilistic methods. Reserve numbers are generally defined within a range, not as one fixed quantity. The range may be described qualitatively by deterministic methods or quantitatively by probabilistic methods. (the probabilistic limits (e.g. Proved =/> P90) can only be specifically applied when the probabilistic method is applied)	*(Although probability targets are defined, Chinese post-discovery estimates are almost entirely based on the deterministic methods. There is nothing in the definitions that would prevent probabilistic analyses*)
Deterministic Method	Deterministic estimates do not address uncertainties in terms of probabilities; they require that volumes be described in terms of discrete estimates using defined criteria (e.g. LKH) including qualitative certainty.	Not Defined
Probabilistic Method	If probabilistic methods are used the defined quantitative limits (e.g. Proved =/> P90) apply at the entity level *(before aggregation).*	Not Defined
Application of probability criteria and aggregation.	Numerical probabilities are only applied in probabilistic method and probability limits apply at the entity level. Probabilistic aggregation allowed to the field level only, then arithmetic summation to reporting level. Dependencies between entities and their distributions must be modeled in probabilistic aggregation.	Not Defined

Comparison of Reserves Definitions *(draft version Mar 7-05)*
Special Issues

Treatment of Unconventional Hydrocarbons	Classification applies to all petroleum deposits.	Classification applies to all petroleum deposits.
Fuel Gas Reserves Status	Issuers have the option to include gas volumes consumed in operations in production and reserves if an appropriate expense is allocated.	Not Defined
Natural Gas Injection	To include injection gas as reserves, the volumes would have to meet the normal criteria (economic when available for production, existence of a firm market, available pipeline or other export option, part of established development plan).	Not Defined
Gas Sales Volumes	Reported gas reserves reflect the condition of the gas at the point of sale. If sold as wet gas, associate liquids reserves are not reported separately. If sold with a non-hydrocarbon gas content, the full volume as sold is included in reserves. The price received will reflect quality.	Not Defined
Infill Drilling	Not Defined	Not Defined
Compression	Not Defined	Not Defined

Comparison of Reserves Definitions
Special Issues

Net Profits Interests	Not Defined	Not Defined
Production-Sharing Contracts	Under a PSC the host government retains ownership, however the contractor receives a stipulated share of production remaining after cost recovery. Reported reserves are based on the economic interest held subject to the specific terms and time frame of the agreement. Being tied to economic interest, reserves must be re-calculated annually based on product price and operating costs and may vary considerably. Under SPE definitions, an average price over the term of the contact may be used to define reserves.	Not Defined
Contract Extensions	Where agreements allow extension through negotiation of renewed contract terms, exercise of options to extend or other means additional reserves (of various categories) or contingent resources may be assigned depending the level of certainty and commercial viability associated with the contract extension.	Not Defined
Product Categorization	Not Defined	Not Defined

Comparison of Reserves Definitions
Economics/Commerciality

Commerciality	In order to assign reserves of any category, a project needs to be defined in terms of a commercially viable development plan and there should be evidence of firm intent to proceed.	The feasibility study indicates that the development is economic.
Commitment	If the degree of commitment is not such that an accumulation is expected to be developed and placed on production within a reasonable time frame (e.g. 5 years), the estimated recoverable volumes should be classified as contingent resources (not reserves).	Program assured to be installed
Economics	The underlying economic evaluation based on perception (best estimate) of future costs and prices together with best-estimate production profile expected to equate to a proved plus probable scenario. To limit downside exposure the “low case” scenario should be at least “break-even“ which is consistent with the requirement that proved reserves are viable under “current economic conditions”.	Based on market conditions of the time, i.e. oil and /or gas prices and development costs at the time of reserve estimation, oil and gas production is believed technically feasible with the other conditions allowable, such as environment, etc. The economic viability refers to the reserves revenue being able to return the investment.
Development Plan Approvals	While some companies choose not to assign any proved reserves until the development plan has received all relevant formal approvals, SPE definitions require only a reasonable expectation that the necessary facilities to process and transport those reserves will be installed.	Not Defined

Comparison of Reserves Definitions
Economics/Disclosure Guidelines

Prices & Costs for defining reserves "economic limit".	Proved: Existing economic conditions (year-end or appropriate period* average) (SPE *recommends prior 12 month period). Unproved: reserves may be based on forecast prices and costs.	To be classified as economic, both Proved and Probable must be economic under current conditions of prices and costs. Current may be defined by recent average prices and costs. *(no provisions for escalation noted)* *(Unproved my use historical averages or defined forecasts prices and costs)*
Abandonment Costs	Economic limit calculated including abandonment and reclamation costs.	Not Defined
Net Present Value of Future Net Revenue (FNR).	Not Defined	Not Defined
Audit Requirements	No requirement for use of external evaluators. SPE "Standards Pertaining to the Estimating and Auditing of Oil and Gas Information" recommends standards for training, experience levels, and sets independence criteria for evaluators and auditors whether internal or external.	Not Defined
Gross vs Net	Note 1	Note 1

Note 1:

Gross vs Net Gross: The Chinese definitions do not address the issue of royalties.

SPE Regards Royalty
Within the U.S., royalty volumes are strictly omitted from reported reserves *(that is, they are reported on a net basis)*. In some cases outside the U.S., where royalty is paid in cash and the cash flow from the royalty is reflected in the company's accounts, the corresponding royalty may be included in reserves.

Norwegian Petroleum Directorate (NPD–2001)

One of the principal tasks of the Norwegian Petroleum Directorate (NPD) is to maintain an overview of petroleum resources so that authorities can have the best possible basis for planning measures to ensure that they are well managed, and to forecast future production and activity.

The NPD's annual updating of the resource account for expected recoverable resources focuses on classification by maturity. This system was developed in 1997. Based on experience gained in using the system and in cooperation with several oil companies, the NPD developed and published its current revised system in 2001. The current system builds on the SPE/WPC/AAPG 2000 classification but expands on the project maturity aspect.

The main principal in the NPD classification system is that originally recoverable resources in a field or discovery must be classified according to their position in the development chain, either from a discovery being made, or a new opportunity to increase recoverable resources in a field being identified, until production of the resources is complete. The system is designed to allow a single field or discovery being able to contain resources in different project status categories, i.e. resources at different stages of maturity in the development chain.

All resources must, as far as possible, be reported with a high and a low estimate in addition to the "base estimate". This allows an opportunity to describe the uncertainty in the resource quantities in both the individual fields and the full resource account (total portfolio).

The resources are divided into ten different project status categories (Figure 1).

		Resource class	Project status category	
TOTAL RECOVERABLE PETROLEUM RESOURCES	Discovered	Historical Production [S]	0	Sold and delivered petroleum
		RESERVES [R]	1	Reserves in production
			2 F/A	Reserves with an approved plan for development and operation
			3 F/A	Reserves which the licensees have decided to recover
		CONTINGENT RESOURCES [C]	4 F/A	Resources in the planning phase
			5 F/A	Resources where recovery is likely but not clarified
			6	Resources whose recovery is not very likely
			7F/A	Resources that have not yet been evaluated
	Undiscovered	UNDISCOVERED RESOURCES [P]	8	Resources in Prospects
			9	Resources in leads, and unmapped resources.

F= First oil/gas
A = Additional oil/gas

Figure 1: Norwegian Petroleum Directorate Classification

Categories 0 to 7 cover the discovered, recoverable resources, Possible future measures to improve the recovery factor are placed in category 7 along with discoveries that have not yet been evaluated. Categories 6 and 9 cover undiscovered resources.

The “F” label identifies quantities linked to the initial recovery project while “A” are additional quantities from improved recovery projects. There are cases where “A” can be negative; for example, oil recovery improvements may involve gas consumption.

All companies operating in Norway must annually submit resource information according to this classification. Moreover, the major Norwegian-based oil and gas companies have adopted the same or similar system for internal resource management.

A complete description of the NPD classification can be found on their website at: http://www.npd.no/regelverk/r2002/frame_e.htm

Comparsion to SPE Definitions

The Norwegian Petroleum Directorate classification (NPD 2001) is based on the SPE/WPC/AAPG 2000 classification (figure 2) with a modification to utilize project status categories to differentiate projects based on their commerciality, that is, their maturity towards full producing status. These categories can also be viewed as qualitative measures of commercial risk or chance of commerciality.

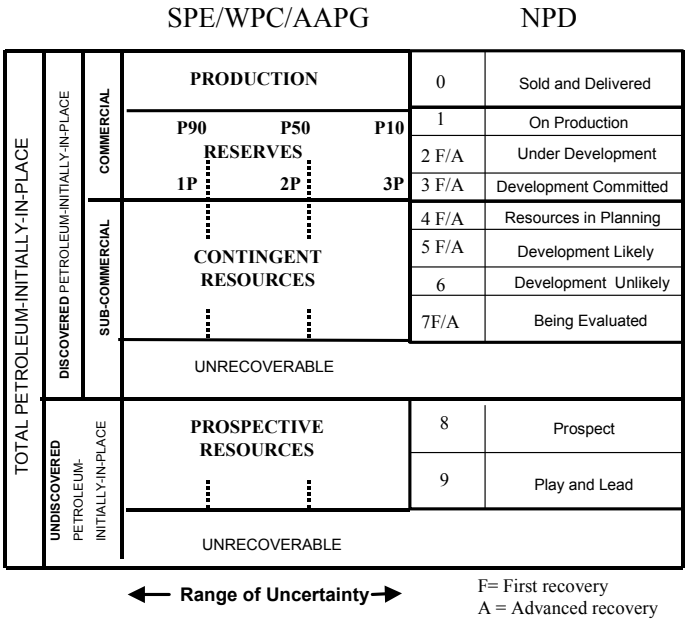


Figure 2: Comparison of SPE and NPD Classifications

The NPD classification is a good example of a modified application of the SPE 2000 classification. It adheres to the guidelines provided, in that it is project status based. This means in principle that the uncertainty on the horizontal axis relates to the outcomes of specified recovery projects, and that there is one line for each project.
While the project status categories follow the illustrative example provided in the SPE guidelines (shown above) to a great extent, they have been adapted to match the requirements of the Norwegian legal and regulatory system.

It follows from the project status approach that there may be several projects recovering oil and gas from the same accumulation, and these may be in different stages of maturity, and thus in different categories. The NPD has found it to be convenient to distinguish between the first (F) project and additional (A) projects.

Probabilistic quantification is provided for, following the SPE scheme, but also allowing other legacy fractile to be used, in order not to unnecessarily burden companies who were using P80 and P20 when the existing classification was introduced. With time, P90, best estimates and P10 have prevailed and the P80 and P20 fractiles are no longer used as standards.

The NPD substitutes the term “base estimate” for “best estimate”. It reflects the current understanding of the extension, characteristics and recovery factor of the reservoir. The base estimate can be calculated deterministically or stochastically. If the base estimate is calculated by a stochastic method, it should correspond to the mean value (not the median/P50).

As the NPD classification is developed for the resource management needs of the Norwegian Government and the business process management needs of the Norwegian companies, emphasis has been more on reflecting relevant quantities that comparable ones. The latter is of course of the essence in financial reporting. As a consequence, the NPD classification is lacking in precision when it comes to technical and economic criteria defining reserves. The concept of proved reserves according to deterministic criteria is not recognized as we know it from the SEC or SPE definitions. P90 reserves are however both a reasonable and simple, well-defined substitute, remembering that future, uncommitted projects are not allowed to contribute to the 2P nor 3P reserves. While the terms Proved, Probable and Possible are not utilized, the definitions of low/1P, base/2P, and high/3P estimated quantities allow derivation of these entities if required (notwithstanding that the base is the mean and not P50).

The NPD defines a discovery as one petroleum deposit, or several petroleum deposits collectively, which have been discovered in the same wildcat well, in which through testing, sampling, or logging there has been established a probability of the existence of mobile hydrocarbons (includes both a commercial and a technical discovery).

The NPD does not give definitions of commercial/economic or sub-commercial/sub-economic but depends on the status categories to segregate Reserves from Contingent Resources. Contingent Resources are defined as petroleum resources that have been discovered but no decision has yet been taken regarding their development. It is noted that their category 3 (reserves which the licensees have decided to recover) may include projects for which the authorities have not yet approved a Plan of Development (PDO) or granted exemption therefrom. Thus the differentiation of Reserves from Contingent resources may seem to rest solely on the licensees’ internal commitment to proceed with development. Under the petroleum law, the licensees are however given the right to produce the petroleum. The government approval of the PDO is an occasion to align interests in the way development will take place and not an occasion to remove a right already granted.

There being no further definitions of technical or commercial criteria for reserves or uncertainty classes, no detailed comparison table has been prepared.

United States Geological Survey (USGS - 1980)

The United States Geological Survey (USGS) was created by an act of congress in 1879 as as an independent fact-finding agency that collects, monitors, analyzes, and provides scientific understanding about natural resource conditions, issues, and problems. The USGS stands as the sole science advisory agency for the U.S. Department of the Interior. Because it has no regulatory or management mandate, the USGS provides impartial science that serves the needs of our changing world.

As part of its mandate, the USGS periodically assesses both U.S. and worldwide petroleum resources. Their latest world survey was completed in 2000 (http://pubs.usgs.gov/dds/dds-060/index.html#TOP). The USGS has developed methodologies to estimate the total hydrocarbon volumes that will be available for production. This includes volumes projected to be associated with existing discoveries and future discoveries.

Volumes within existing discoveries are based on published information collated from vendors (NRG and IHS) or other government agencies (U.S. Department of Energy). The USGS does not change, process, alter, redefine, or systematically check the accuracy of this data. This known discovered volumetric data is accepted in the classification as presented. Most are classifed using the general SPE definitions and are normally proved for the US and proved plus probable in other areas of the world. The focus of USGS reports is to forecast ultimate potential by assessment units which sum three resource elements:

- prior production and known reserves (from vendor data)
- projected field growth in these known/discovered accumultions
- predicted undiscovered potential in both proved and unproven plays.

USBM/USGS(1980) Classification

The current “official’’ classification scheme is that jointly developed by the USGS and the US Bureau of Mines and referred to as the USBM/USGS (1980) system (figure 1).

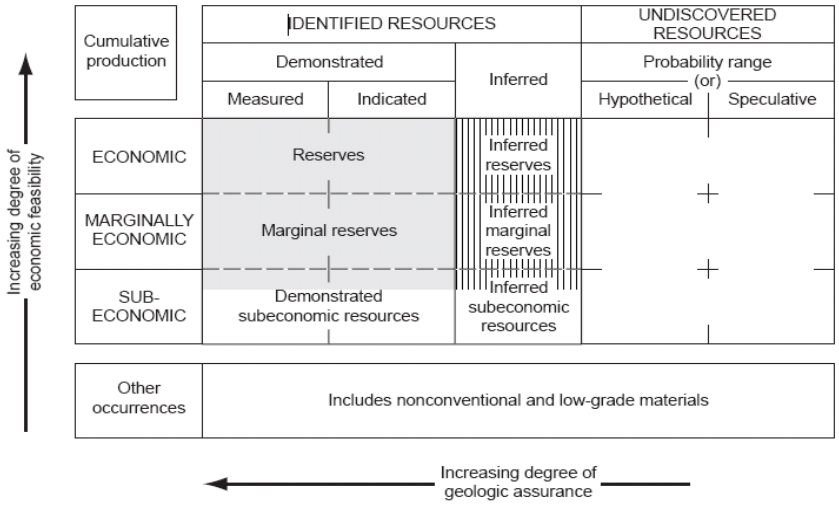


Figure 1: USBM/USGS (1980) Classification of Oil & Natural Gas Resources

This same classification is applied to both petroleum accumulations and mineral deposits. While the USGS does not actually apply this classification to discovered accumulations since they rely on vendor data (which generally use SPE defintions), the concepts contained are still useful as historical perspective and to explain their global assessment methodolgies.

Resources include reserves and all other petroleum accumulations that may eventually become available - including known accumulations that are not recoverable under current economic conditions or current technology, or unknown accumulations of varying degrees of richness that may be inferred to exist, but not yet discovered. Therefore, resources can be classified in terms of geologic assurance as discovered (identified) and undiscovered.

According to the USBM/USGS (1980), “identified resources” are those whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. Undiscovered resources are those whose existence are only postulated from geologic information and theory and comprise accumulations that are separate from identified resources [that is, existing outside of known oil and (or) natural gas accumulations].

Resources are also classified in terms of feasibility of economic recovery as economic, marginally economic and sub-economic (Fig. 1). “Marginal reserves” are defined as “that part of the reserve base which, at the time of determination, borders on being economically producible. Its essential characteristic is economic uncertainty. Included are resources that would be producible, given postulated changes in economic or technologic factors”.

A degree of uncertainty is typically reported for the estimated quantities of discovered and undiscovered resources that are potentially recoverable. The uncertainty of estimated resource quantities may be expressed probabilistically, either as a range or single-value statistic such as a mean, mode, median (P_{50}), or some other percentile.

Discovered (identified) resources are divided according to geological (in-place) assurance into measured and indicated, and inferred classes defined as follows:

- Measured - Quantity is computed from dimensions revealed in outcrops, trenches, workings, or drill holes; grade and (or) quality are computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely and the geologic character is so well-defined that size, shape, depth, and mineral content of the resource are well established.

- Indicated - Quantity and grade and (or) quality are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation

- Inferred - Estimates are based on an assumed continuity beyond measured and (or) indicated resources, for which there is geologic evidence. *Inferred resources* may or may not be supported by samples or measurements.

Demonstrated resources are the sum of measured and indicated resources. The estimated economically recoverable portion of discovered (identified) is classified as reserves. These are the quantities that can be economically produced at the time of the determiniation. The part of the discovered (identified) from which reserves growth is estimated is called the “reserves base” (sum of shaded and hachured areas in fig 1).

Successive estimates of the total crude oil, natural gas, and natural gas liquids to be recovered in fields and reservoirs generally increase through time with continued development and production, the result commonly being additions of reserves. These additions are directly related to increases in the total size (cumulative production plus remaining reserves) of the field or reservoir. Reserve growth *(also called field growth, reserve appreciation, and ultimate recovery appreciation)* is therefore that part of the identified resources, over and above measured reserves, estimated to be added to existing fields and reservoirs within a defined timeframe *(usually 30 years)*. Reserve growth occurs for a variety of geologic, engineering, operational, and economic reasons, including: (1) delineation of additional in-place hydrocarbons, including addition of new reservoirs and extensions (2) improved recovery efficiency, and (3) revisions resulting from recalculation of viable reserves under changing economic and operating conditions.

The USGS divides undiscovered resources into hypothetical and speculative classes to reflect geologic assurance. Hypothetical resources are undiscovered resources that may be reasonably expected to exist under geologic conditions analogous to those in known producing districts or regions. Speculative resources are undiscovered resources that may exist elsewhere, in districts or regions with no discovered.

Recent USGS assessments consider three types of technically recoverable resources: (1) undiscovered conventional accumulations of oil and natural gas, (2) additions of oil and natural gas from untested cells within continuous accumulations (unconventionals), and (3) the potential future additions to reserves of known conventional accumulations by reserve growth. Each of these resource types requires a different technique for evaluation and assessment. The oil and natural gas from undiscovered conventional accumulations clearly equate to the undiscovered resource classification, whereas oil and natural gas from development of continuous accumulations may equate to both discovered and undiscovered classes.

Although based on the best geologic and historical information and theory available, petroleum volumes assessed are unknown quantities, not measurements, and therefore should be expressed with probability distributions of uncertainty.

USGS assessment methodology is described within their World Assessment 2000 report available at their website: http://pubs.usgs.gov/dds/dds-060/index.html#TOP

Dr. Timonthy R. Klett assisted in our understanding of the USBM/USGS reserves and resource classification and further provided two key references:

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Principles of the mineral resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-A, 5p.

U.S. Bureau of Mines and U.S. Geological Survey, 1980, Principles of a reserve/resource classification for minerals: U.S. Geological Survey Circular 831, 5p.

Comparison to SPE Definitions

Figure 2 graphically illustrate the overall comparison of the USBM/USGS (1980) and the SPE/WPC/AAPG (2000) classifications for the discovered portion of total resources.

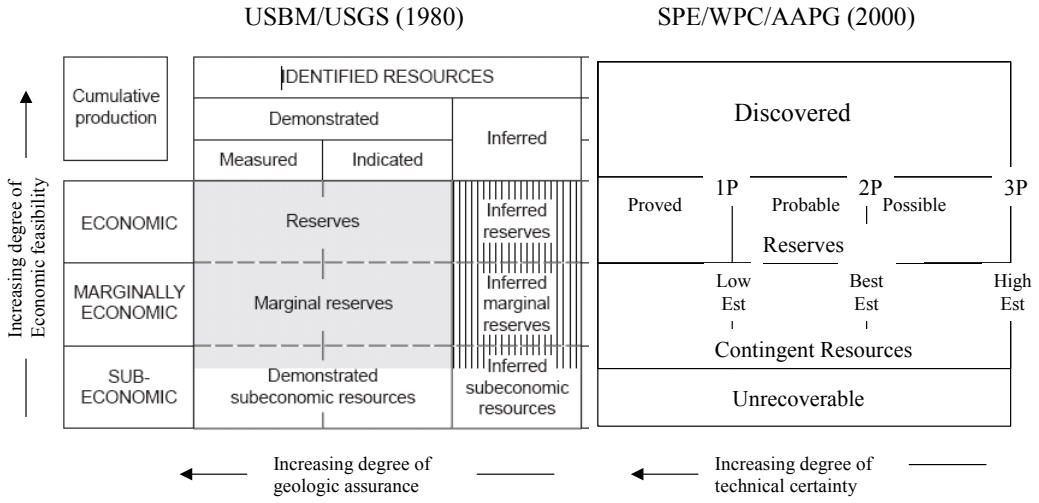


Figure 2: Comparison of USGS and SPE Classification (discovered portion)

The USGS classification is based on two parameters whereby resources are classified by feasibility of economic recovery and degree of geologic certainty. The SPE system classifies resources based on 3 parameters: feasibility of economic recovery (commerciality) in the y-axis and a combination of degree of geologic assurance and degree of recovery efficiency termed technical uncertainty on the x-axis. Although some differences exist, the classification schemes are comparable.

As shown in the previous figure 1, the USGS hypothetical and speculative undiscovered resources combined correlate to SPE Prospective Resources; they can be classified by technical uncertainty (low/best/high estimate or a probability distribution) but there is no attempt to segregate undiscovered volumes according to commercial certainty.

The shaded area in Figure 2 is termed the “reserves base”. It may encompass that part of the resources that has a reasonable potential for becoming economical within the planning horizons *(30 years)* beyond those that assume proven technology and current economics”. Thus, it appears that inferred reserves may be based on forecast conditions while demonstrated (measured and indicated) are based on current conditions. This contrasts with SPE guidance that proved is based on current conditions while probable and possible are based on forecast conditions.

Although the USGS measured, indicated, and inferred classes of reserves are assigned to reflect geologic assurance, these classes have been loosely interchanged with, respectively, the proved, probable, and possible classes. While measured and proved are comparable, probable and possible may not be directly interchangeable with indicated and inferred. Some earlier publications suggest that USGS inferred is not a high side estimate of indicated but refers to only unexplored deposits for which estimates of the quality and quantity are based on geologic evidence and projections and may not have any direct sampling or measurements. Later publications indicate closer alignment

with SPE possible reserves that may be a combination of high side estimates of drilled (sampled) areas and adjacent undrilled areas (fault blocks and satellite features).

Users should be aware of the "reserves" terminology used in current USGS reports as illustrated in figure 3:

World Excluding United States (conventional)

Oil - billion barrels

	F95	F50	F5	Mean
1- Cumulative Production				539
2 – Remaining Reserves				859
3 – Known Reserves (1+2)				1398
4 – Reserves Growth	192	612	1031	612
5 - Undiscovered	334	607	1107	649
6 – Future Volumes (2+5)				1508
7 – Future Grown Volumes (2+4+5)				2120
8 – Total Endowment (1+2+4+5)				2659

Figure 3: USGS World Petroleum Assessment 2000 – Results Summary

"Remaining reserves" are taken from NRG Associates and Petroconsultants (IHS) reports and may represent proved or proved plus probable reserves as defined in their data sources (typically using SPE definitions). "Reserves Growth" as discussed above is based on USGS projections of future (30 year) additions from new recovery methods, improved prices, satellite development, etc. using proprietary algorithms derived from analog fields of similar maturity. The volumes may include what would be currently classified under SPE guidelines as possible, contingent resources and even some portions of unrecoverable and speculative potential (for satellite accumulations). The USGS does not quote reserve growth for individual fields, it is only statistically meaningful for large aggregations; the 2000 report only quotes reserves growth on a total world basis. The SPE term "estimated ultimate recovery" may be applied to either USGS terms "known reserves" or "future endowment".

The reserves growth and undiscovered resource aggregations use probabilistic models and will have portfolio effects. The USGS uses P95 for the lowside and P05 for the upside with two measures of central tendency being the median (P50) and the mean. Cumulative production and remaining reserves are aggregated arithmetically.

The 2000 USGS world assessment does not include unconventional hydrocarbons (continuous accumulations) from tight gas, coal bed methane, heavy oil ($<15^0$ API), and tar sands but do recognize their potential. As extraction and processing technology develops, the geologic descriptions are matured and their recovery becomes economically feasible, and they will be assessed in the same manner as conventional hydrocarbons.

USGS "economic" implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty. This would not conflict with SPE guidance. The USGS definitions do not include more detailed guidance on such issues as pricing, discovery criteria and proved (measured) limits (e.g. LKH, DSU offsets).

Given that the USBM/USGS (1980) classification is only used as a concept reference, a detailed SPE/USGS comparison table is not appropriate.

United Nations Framework Classification (UNFC–2004)

The United Nations Framework Classification (UNFC) for Energy and Mineral Resources is a universally applicable scheme for classifying/evaluating energy and mineral reserves and resources.

The classification was originally focused on coal resources and was adopted by the United Nations Economic Commission for Europe (UNECE) in 1997. It was expanded to include all mineral reserves and resources in 1999. In 2001, the UNECE created an Intergovernmental Ad Hoc Group of Experts on the Harmonization of Energy Reserves/Resources Terminology to extend the principles of UNFC to other energy resources (oil, natural gas, and uranium). Regards petroleum, the group focused on full compatibility with the SPE/WPC/AAPG classification. In addition, several national classification systems played an important role in the harmonization process including the recently revised classification of the Russian Federation.

The current classification has been endorsed by the United Nations Economic and Social Council (ECSOC) and recommended for adoption as a worldwide standard. It has been reviewed and endorsed by the Organization of Petroleum Exporting Countries (OPEC), and is being considered for adoption as a reporting standard by the Committee of European Security Regulators (CESR) and the International Accounting Standards Board ‘s working group on extractive industries.

The classification is designed to allow incorporation of currently existing terms and definitions into this framework and thus make them comparable and compatible on an international basis. The approach has been simplified through the use of a three-digit code clearly indicating the essential characteristics of extractable energy and mineral commodities in market economies, notably (i) degree of economic/commercial viability (ii) field project status and feasibility, and (iii) level of geological knowledge. The three criteria are easily visualized in three dimensions as shown in Figure 1.

- E_1 Economic
- E_2 Potentially economic
- E_3 Intrinsically economic

- F_1 Mining report/Feasibility
- F_2 Pre-feasibility
- F_3 Geological Study

- G_1 Detailed Exploration
- G_2 General Exploration
- G_3 Prospecting
- G_4 Reconnaissance

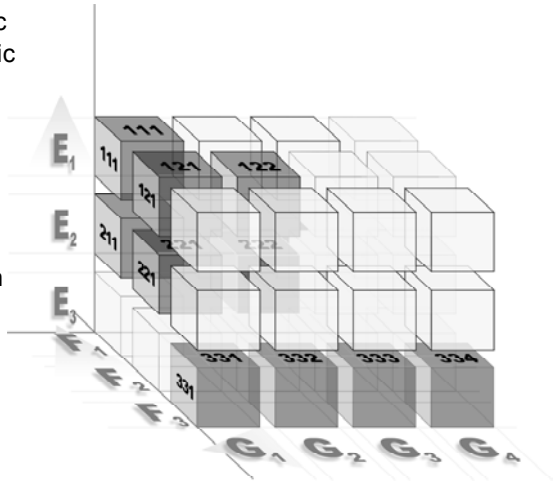


Figure 1: The UNFC for Solid Fuels and Mineral Commodities

To aid in understanding the numeric code sequence is always fixed, that is EFG and a quantity can be characterized numerically as 1:1:1: and the numeric value indicates the

degree of quality where “1” is the highest quality. Thus, 1:1:1 refers to quantities that are: economically and commercially recoverable (E1), have been justified by means of a feasibility study or actual production to be technically recoverable (F1) and are based on reasonably assured geology (G1).

Subcategories may be added under the main categories when required in the following format: 1.1;1;1 where a subcategory E1.1 has been defined. Semicolons now separate the main category codes. Figure 2 illustrates the codes and sub-codes as defined for petroleum classifications:

E1	***Economic***	***F1***	***Justified Development and/or Production Project***	***G1***	***Reasonably Assured Geological Conditions***
E1.1	*Normal Economic*	*F1.1*	*Project in Production*		
E1.2	*Exceptional Economic*	*F1.2*	*Committed Development Project*		
		F1.3	*Uncommitted Development Project*		
E2	***Potentially Economic***	***F2***	***Contingent Development Project***	***G2***	***Estimated Geological Conditions***
E2.1	*Marginal Economic*	*F2.1*	*Under Justification*		
E2.2	*Sub-marginal Economic*	*F2.2*	*Unclarified or On hold*		
		F2.3	*Not Viable*		
E3	***Intrinsically Economic***	***F3***	***Project Undefined***	***G3***	***Inferred Geological Conditions***
E3.1	*Non-sales*				
E3.2	*Undetermined*				
E3.3	*Unrecoverable*				
				G4	***Potential Geological Conditions***

Figure 2: UNFC Petroleum Categories and Sub-Categories

Assistance in promoting our detailed understanding of UNFC was provided by Sigurd Heiburg, Chairman of the UN Ad Hoc Group of Experts on the Harmonization of Energy Reserves/Resources Terminology

A complete description of the UNFC including definitions of the above terminology can be accessed at the following website address:
(http://www.unece.org/ie/se/pdfs/UNFC/UNFCemr.pdf)

Additional descriptions have been published in:
SPE 84124: The United Nations Framework Classification for World Petroleum Resources; T.S. Ahlbrandt et al, 2003
SPE 90839: Updated United Nations Framework Classification for Reserves and Resource of Extractive Industries; T.S. Ahlbrandt et al, 2004

UNFC is functional in its basic form. In defining key concepts, such as proved reserves, the more prescriptive requirements are left to be included in specifications/guidelines. Note that the Ad Hoc Group of Experts has been charged with developing application guidelines and that project is ongoing in liaison with the SPE Oil and Gas Reserves Committee.

Comparison to SPE Definitions

The SPE/WPC/AAPG (1997 and 2000) classification was initially developed independently of the UNFC pattern (1997). SPE and UNECE joined forces in 2001 through the UNECE Ad Hoc Group of Experts on the Harmonization of Energy Reserves/Resources Terminology where there was both formal and real representation of the SPE/WPC/AAPG Oil and Gas Reserves Committee. The result was the UN Framework Classification for Energy and Mineral Resources (UNFC), developed over the 1997 UNFC pattern.

The SPE classification and the UNFC differ in appearance in that economic, field project status and geologic criteria all are explicit in the UNFC, while the SPE is implicit on the field project status and explicit or verbal on the two others. Most importantly, the structure of the SPE classification reappears in the UNFC, primarily through the shared use of the field project status criterion and through identical design for the communication of uncertainty. Figure 3 illustrates mapping of the two classifications.

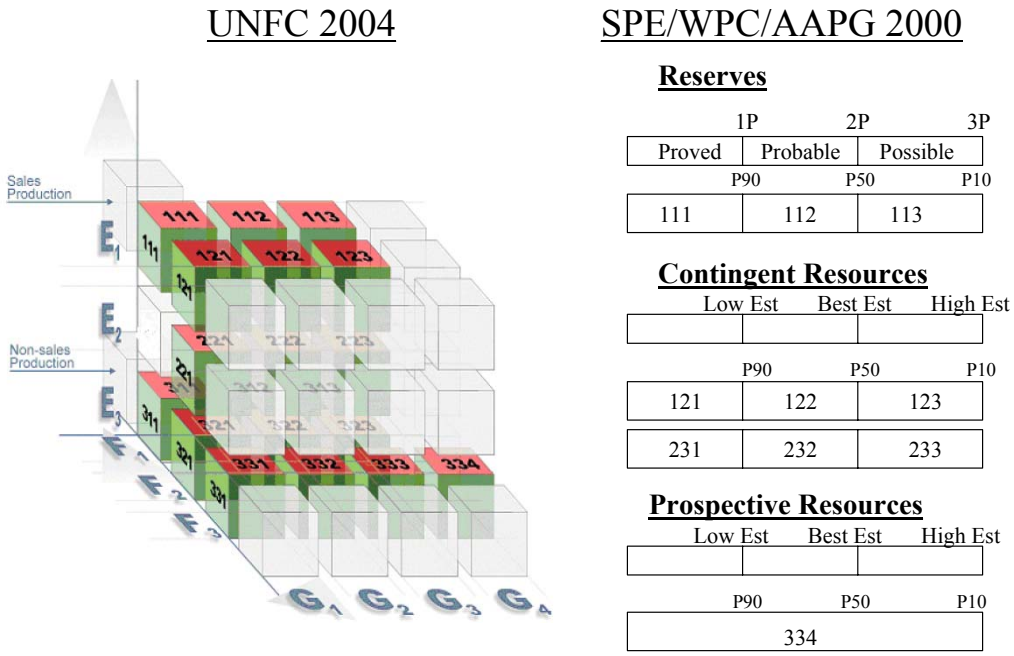


Figure 3: Comparison of UNFC and SPE/WPC/AAPG Classification

The graphical representation of the two classifications differs in that the UNFC is three-dimensional with three explicit criteria:

1. Economic
2. Field project status/Feasibility
3. Geological

This makes UNFC a more differentiated, and thus in some respects a stronger code, but also one that may appear to require complex routines in practical application. The strength of the UNFC is readily apparent when considering that it may be reduced by simply combining classes to nearly coincide with the SPE classification.

UNFC introduces the principle of a reserves reference point defining produced quantities and qualities, and thus value more precisely. This is not explicit in the SPE classification. UNFC introduces the principle of non-sales quantities both to make the material balance complete and to allow for the use of the UNFC in the management of important economical resources that are not traded commercially. In oil and gas, this will typically be fuel, flare and processing losses.

UNFC has taken the full consequence of the introduction by SPE of concept of contingent resources, and excludes such quantities from reserves. This prevents low probability future projects from influencing P90 Proved Reserves values. SPE has done the same, but in indirect ways, as there has not been an opportunity yet to revisit the reserves definitions.

UNFC has introduced the concept of justified, but not committed projects to define reserves, but excluded such projects from contributing to committed reserves. Committed reserves are foreseen as the primary basis for supplementing financial reports. This allows the identification of large recoverable quantities, such as those reported from the Middle East, as reserves and not as a high grade of contingent resources. While important from the point of view of communication, this action is of no consequence in the numerical treatment of classes in the UNFC.

Neither classification resolves the issue of ownership of reserves, and thus what quantities a stakeholder may be entitled to. When developing the UNFC, this dimension was left out on purpose. It was considered appropriate to elaborate ownership issues in other contexts, primarily that of international financial reporting standards.

An apparent weak point in both classifications (and in current SEC requirements) is the disconnect that appears when a project is committed and will go ahead, but where the geologically proved quantities alone are not the basis for the decision. In some cases, the project may not be economic on the basis of the quantities that are geologically proved or P90 alone.

One possible solution under the UNFC that should be discussed is the possibility of applying the subcategory E1.2 Exceptional economic. The initial justification for introducing this category was precisely to distinguish the production that will occur under subsidized conditions from normal profitable production. (Much of the strategic uranium production ended up in this category when the nuclear disarmament flooded the market). The scheme would be to place proved in E1.2 in those cases where the field itself (taking the probability distribution or some higher fractile than the P90 value into account) is economic and E1.1. From a distance, this would all be E1, meaning that production is committed to occur and will show up in the market.

SPE specifies proved reserves to be limited to those quantities that are commercial under current economic conditions. The above logic can therefore not be applied there.

The SPE classification maintains the same technical uncertainty classes (low/best/high estimates) from pre- to post-discovery with the only change being in field status or discovery risk. The UNFC classifies all undrilled resources as G4; any subdivision by technical uncertainty is given by non-numeric qualifications.

Comparison of Reserves Definitions
Reserves Definitions/Proved Criteria

	SPE/WPC (1997)	UNFC (2004)
Intended purpose	General application – not country specific.	General application – not country specific.
Qualitative description of certainty- proved	Reasonable certainty to be commercially recoverable.	G1 Quantities that are estimated to be recoverable from a known (drilled) accumulation, where sufficient technical data are available to establish the geological and reservoir production characteristics with a high level of confidence.
Qualitative description of certainty- probable	Not proved, but more likely than not to be recoverable	G2 Quantities that are estimated to be recoverable from a known (drilled) accumulation, where sufficient technical data are available to establish the geological and reservoir production characteristics with a reasonable level of confidence.
Qualitative description of certainty- possible	Less likely to be recovered than probable.	G3 Quantities that are estimated to be recoverable from a known (drilled) accumulation, where sufficient technical data are available to establish the geological and reservoir production characteristics with a low level of confidence.
Quantification of probabilities associated with estimates.	Proved =/> P90 2P =/> P50 3P =/>P10 (target at field/property level)	Low est =/> P90 Best Est =/> P50 or median or mean High Est =/>P10 (target level not defined)
Proved reserves relative to lowest known hydrocarbon (LKH)	No proved reserves below LKH as defined by well logs, core analysis or formation testing.	*To be defined in guidelines*
Proved reserve extensions on undrilled acreage	Directly offsetting DSU's and/or where reasonably certain of continuity and commercial recovery.	*To be defined in guidelines*
Proved reserves – requirements for testing	Generally require actual production or a conclusive flowing well test. In certain cases, proved reserves can be based on logs and/or cores and is analogous to producing or tested reservoirs.	Have been justified by means of a feasibility study or actual production to be technically recoverable (F1)
Classification of enhanced recovery mechanism as proved	Successful pilot or existing project in subject or analogous reservoir.	*(No specific criteria for enhanced recovery projects. To be defined in guidelines)*

Comparison of Reserves Definitions
Development Status

Development and production status categories	Developed producing and non-producing. Undeveloped.	Proved reserves can be categorized as developed or undeveloped.
Developed	Reserves expected to be recovered from existing wells including reserves behind pipe. Improved recovery reserves require that necessary equipment has been installed or when costs to do so are relatively minor.	Proved developed reserves are quantities of proved reserves that are estimated to be recovered from existing wells and will be processed and transported to market using facilities and infrastructure that exist at the date of the estimate.
Developed - Producing	Reserves expected to be recovered from completion intervals which are open and producing at the time of the estimate. Improved recovery reserves are considered developed producing only after the improved recovery project is operational.	F1.1 The development project is completed and the facilities are producing.
Developed – Non-Producing	Includes shut-in (open but not producing, waiting on market/pipeline connections, or mechanical problems) and behind pipe (requires additional completion or future recompletion) reserves	*To be defined in guidelines*
Undeveloped	Reserves to be recovered from additional drilling, deepening existing wells to a different reservoir or where a relatively large expenditure is required to complete an existing well or install production or transportation facilities.	See inverse of developed. Undeveloped projects are committed only when it can be demonstrated that there is intent to develop them and bring them to production.
Allocation in Multi-well Pools	Not Defined	Not defined

Comparison of Reserves Definitions
Unproved Reserves

Unproved Reserves	Technical, contractual, economic, or regulatory uncertainties preclude reserves being classified as proved. Unproved reserves may be estimated assuming future economic conditions (and technological development) different from those prevailing at the time of the estimate.	Not specifically defined. Unproved reserves are total reserves minus proved reserves by implication In order to make fill use of the precision offered by the UNFC, it is recommended not to use the broader, and somewhat ambiguous, terms, probable and possible reserves. Instead, the term slow, best and high estimate may be used stating precisely the classes of interest.
Probable Reserves	Includes: 1) step-out areas from proved 2) formations that appear productive on logs but lack core, definitive tests, or productive analogs 3) incremental reserves attributable to infill drilling 4) reserves attributable to improved recovery methods but lack pilot 5) adjacent fault blocks up-dip to proved 6) reserves attributable to future workover treatments or other procedures without successful analogs 7) incremental reserves in proved reservoirs through alternative interpretations.	1.1.2 economically and commercially recoverable (E1), have been justified by means of a feasibility study or actual production to be technically recoverable (F1) and are based on estimated geological conditions (G2). *Additional deterministic criteria may be defined in guidelines*
Possible Reserves	Includes: 1) areas beyond probable potentially productive based on geological interpretations 2) formations that appear petroleum bearing in cores and logs but may not be commercially productive on tests 3) reserves attributable to infill drilling that are subject to technical uncertainty 4) improved recovery reserves where no pilot is operational and reservoir characteristics may not support commercial application 5) adjacent fault blocks down-dip to proved areas.	1.1.3 economically and commercially recoverable (E1), have been justified by means of a feasibility study or actual production to be technically recoverable (F1) and are based on inferred geological conditions (G3). *Additional deterministic criteria may be defined in guidelines*

Comparison of Reserves Definitions
Deterministic vs Probabilistic Methods

Deterministic vs Probabilistic Methods	Reserve estimates may be prepared using wither deterministic or probabilistic methods. Reserve numbers are generally defined within a range, not as one fixed quantity. The range may be described qualitatively by deterministic methods or quantitatively by probabilistic methods. (the probabilistic limits (e.g. Proved =/> P90) can only be specifically applied when the probabilistic method is applied)	Quantities in classes may be represented by one or more discrete estimates or by a probability distribution that reflects a range of uncertainty in the estimate of that quantity. Deterministic estimates shall reflect the same principles and approximately the same probabilities as would be associate with estimates derived from a probability distribution
Deterministic Method	Deterministic estimates do not address uncertainties in terms of probabilities; they require that volumes be described in terms of discrete estimates using defined criteria (e.g. LKH) including qualitative certainty.	When a quantity is represented by discrete estimates there shall be quoted as a minimum, a low, a best and a high estimate.
Probabilistic Method	If probabilistic methods are used the defined quantitative limits (e.g. Proved =/> P90) apply at the entity level *(before aggregation).*	When a quantity is represented by a probability distribution, a low, a best and a high estimate shall be quoted (see "Quantification of probabilities associated with estimates.") *Target level not defined.*
Application of probability criteria and aggregation.	Numerical probabilities are only applied in probabilistic method and probability limits apply at the entity level. Probabilistic aggregation allowed to the field level only, then arithmetic summation to reporting level. Dependencies between entities and their distributions must be modeled in probabilistic aggregation.	*Not addressed*

Comparison of Reserves Definitions
Special Issues

Treatment of Unconventional Hydrocarbons	Classification applies to all petroleum deposits.	*(Classification applies to all petroleum deposits?) To be addressed in guidelines*
Fuel Gas Reserves Status	Issuers have the option to include gas volumes consumed in operations in production and reserves if an appropriate expense is allocated.	Included in non-sales quantities produced but not sold (E3.1). *(Inclusion in reserves disclosures is based on regulatory guidelines.)*
Natural Gas Injection	To include injection gas as reserves, the volumes would have to meet the normal criteria (economic when available for production, existence of a firm market, available pipeline or other export option, part of established development plan).	Not Defined
Gas Sales Volumes	Reported gas reserves reflect the condition of the gas at the point of sale. If sold as wet gas, associate liquids reserves are not reported separately. If sold with a non-hydrocarbon gas content, the full volume as sold is included in reserves. The price received will reflect quality.	*Not addressed*
Infill Drilling	Reserves assigned to infill drilling with low uncertainty are Probable, infill areas with technical uncertainty are possible *(acceleration issue not addressed)*	*Not addressed.*
Compression	Not Defined	Not defined

Comparison of Reserves Definitions
Special Issues

Net Profits Interests	Not defined	Not defined
Production-Sharing Contracts	Under a PSC the host government retains ownership, however the contractor receives a stipulated share of production remaining after cost recovery. Reported reserves are based on the economic interest held subject to the specific terms and time frame of the agreement. Being tied to economic interest, reserves must be re-calculated annually based on product price and operating costs and may vary considerably. Under SPE definitions, an average price over the term of the contact may be used to define reserves.	Not defined
Contract Extensions	Where agreements allow extension through negotiation of renewed contract terms, exercise of options to extend or other means additional reserves (of various categories) or contingent resources may be assigned depending the level of certainty and commercial viability associated with the contract extension.	Not defined
Product categorization	Not Defined	Not defined

Comparison of Reserves Definitions
Economics/Commerciality

Commerciality	In order to assign reserves of any category, a project needs to be defined in terms of a commercially viable development plan and there should be evidence of firm intent to proceed.	Quantities in classes may be considered commercial if the reporting entity has the intention of developing and producing them and such intention is based upon: • a reasonable assessment of future production economics being satisfactory • a reasonable expectation of available market • evidence that production and transportation facilities can be made available • evidence that legal, contractual, environmental and other concerns will allow the recovery project to be realized.
Commitment	If the degree of commitment is not such that an accumulation is expected to be developed and placed on production within a reasonable time frame (e.g. 5 years), the estimated recoverable volumes should be classified as contingent resources (not reserves).	Development projects for recovery of a commodity are committed when firm commitments have been made for the expenditures and activities needed to bring a discovered accumulation to the production stage *(no time frame defined).*
Economics	The underlying economic evaluation based on perception (best estimate) of future costs and prices together with best-estimate production profile expected to equate to a proved plus probable scenario. To limit downside exposure the "low case" scenario should be at least "break-even" which is consistent with the requirement that proved reserves is viable under "current economic conditions".	E.1 Production is justified under the technological, economic, environmental and other relevant commercial conditions, realistically assumed or specified at the time of the estimation. E1.1 Normal Economic – Production is justified under normal conditions. Assumptions regarding future economic conditions may be constrained by regulation. E1.2 Exceptional Economic quantities are at present not economic to produce under normal economic conditions– their production is made possible through government subsidies and/or other considerations
Development Plan Approvals	While some companies choose not to assign any proved reserves until the development plan has received all relevant formal approvals, SPE definitions require only a reasonable expectation that the necessary facilities to process and transport those reserves will be installed.	F1.3 Development plans have demonstrated production of the reported quantities to be justified but commitments to carry out the development works have not yet been made *(without an approved plan of development, legal/regulatory conditions for commerciality are not met and without commitment, no reserves are assigned.*

Comparison of Reserves Definitions
Economics/Disclosure Guidelines

Prices & Costs for defining reserves "economic limit".	Proved: Existing economic conditions (year-end or appropriate period* average) (*SPE recommends prior 12 month period). Unproved: reserves may be based on forecast prices and costs.	Proved reserves are a specifically defined subset of Committed Reserves. Reasonably certain to be commercially recoverable under current economic conditions, operating methods and government regulations. Total Committed Reserves E1.F1 E1 – see economics F1 – Production is justified under technological, economic, environmental and other relevant commercial conditions, realistically assumed or specified at the time of estimation.
Abandonment Costs	Economic limit calculated including abandonment and reclamation costs.	Commercial value of quantities includes estimated project abandonment costs Economic limit calculated including abandonment and reclamation costs.
Net Present Value of Future Net Revenue (FNR).	Not defined	The commercial value of the quantities would generally be the present value of future cash flows obtainable as a result of production of the recoverable quantities. (See Note 1 for calculation guidelines)
Audit Requirements	*No requirement for use of external evaluators.* SPE "Standards Pertaining to the Estimating and Auditing of Oil and Gas Information" recommends standards for training, experience levels, and sets independence criteria for evaluators and auditors whether internal or external.	The studies referred to in the UNFC mist be under taken by a person(s) with the appropriate qualifications to assess resources/reserves of the type of commodity in question. The qualifications and experience required will vary from country to country. In certain circumstances licensing may be required. *(No requirement for use of external evaluators.)*
Gross vs Net Reserves	See Note 1	See Note 1

Note 1:

UNFC Regards Project Value Calculations

The calculation of commercial value shall reflect:

1. The expected quantities of production whose value is measured.
2. The estimated costs associated with the project to develop, recover and produce the quantities of production at is reference point, including environmental and abandonment costs charged to the project based on costs already incurred and the reporter's view of the costs expected to apply in future periods.
3. The estimated revenues from the quantities of production based on the reporter's view of the prices expected to apply to the respective commodities in future periods. Such prices are to be based on reliable data, the basis of which and reason why the reporter considers such price assumptions to be appropriate will be disclosed. Examples of such reliable data are agreed contract prices, the published forward price curve for the appropriate commodity, an average of a group of analysts' forecast prices and an average of historic achieved prices if this is considered to be a good estimate of the applicable future price.
4. The portion of costs and revenues accruing to the reporter.
5. Future production and revenue related taxes and royalties expected to be paid by the reporter.
6. The application of discount factors that reflect a specific risk or uncertainty associated with the estimated cash flows. Where risk is reflected in the discount rate, estimates of future revenues and costs should be discounted at a rate appropriate to that cash stream

SPE Regards Royalty

Within the U.S., royalty volumes are strictly omitted from reported reserves *(that is, they are reported on a net basis)*. In some cases outside the U.S., where royalty is paid in cash and the cash flow from the royalty is reflected in the company's accounts, the corresponding royalty may be included in reserves.