31 January 2007

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"Revised Reserves and Resources Guidelines Available for Industry Review"
available on the web at http://www.spe.org/spe/jsp/basic/0,,1104_5806693,00.html

Page 2
The "Range of Technical Uncertainty" reflects a range of estimated quan tities potentially **recoverable** from an accumulation by a project
unrecoverable isassumed to be also within the range, as shown in the box, and cannot be described as *recoverable*, better to write *to be contained*

Page 3
PRODUCTION is the cumulative quantity of petroleum that has been recovered over a defined time period.
The time should be indicated with the term production as *production at end 2006, or production for 2006*
and not just production see Canadian COGEH wording adding *(as of date)*

Page 4
It is a basic principle that Reserves and Resources quantities are by definition remaining and recoverable.
It is remaining at a certain date, if the date is given, if not, it is the initial reserves or resources. Remaining implies that there is already some production!
Resources in general include unrecoverable which cannot be recoverable, it is only prospective and contingent resources which are recoverable as said below

While the sum of Reserves, Contingent Resources and Prospective Resources has been historically referred to as "remaining recoverable resources."
Recoverable resources is different from resources and total resource base

Page 6
Figure 2-1 where P50 is indicated in line with 2P for reserves, 2C for contingent resources and Best Estimate for pr ospective resources
On page 12 it is written For Contingent Resources, the general cumulative terms low/best/high estimates are denoted as 1C/2C/3C respectively.
So 2C is best estimate
Best estimate is statistically defined as the mode or best value or mos t likely, different (except for symmetrical distribution as Gauss, which is unlikely because large values occur less often than small values) from P50 = median and from mean = expected value.
In Canada definitions of oil and gas reserves
(cogeh_sections5_definitions_51_101_2w667.pdf)
In the case of reserves, the range of uncertainty is reflected in estimates for proved reserves. proved + probable reserves. and proved + probable + possible reserves. For resources, low estimate, best estimate, and high estimate categories are recommended. These categories represent **conservative, realistic, and optimistic estimates** for both reserves and resources, and are illustrated in Figures 5-4
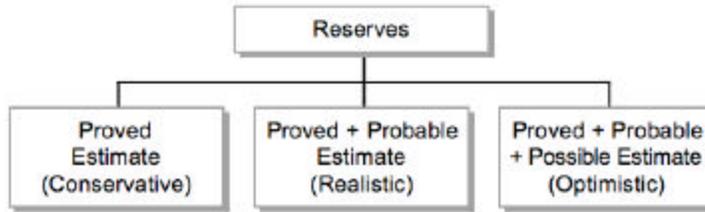
Figure 5-4 Reserves. Each reserves estimate (proved, proved + probable, proved + probable + possible) is mutually exclusive and must not be aggregated.
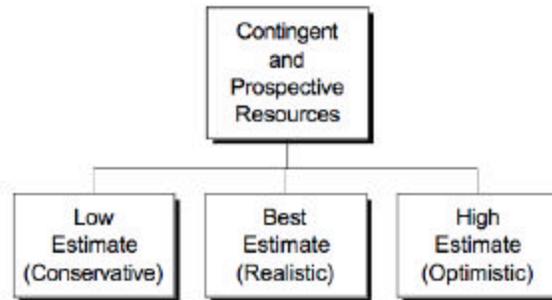

Figure 5-5 Contingent and Prospective Resources. Each resources estimate (low, best, and high) is mutually exclusive and must not be aggregated.

And 5.5

- Low Estimate: This is considered to be a conservative estimate of the quantity that will actually be recovered from the accumulation. If probabilistic methods are used, this term reflects a P90 confidence level.

· **Best Estimate**: This is considered to be the best estimate of the quantity that will actually be recovered from the accumulation. If probabilistic methods are used, this term is a measure of central tendency of the uncertainty distribution (**most likely/mode, P50/median, or arithmetic average/mean**.)

- High Estimate: This is considered to be an optimistic estimate of the quantity that will actually be recovered from the accumulation. If probabilistic methods are used, this term reflects a P10 confidence level.

The best estimate is badly defined as being either the mode, median or mean, which are quite different when the probability distribution is not symmetrical. It is a pity that because most of people confuse mode, median and mean, instead of pushing them to learn probability, that this definition allows to use different parameters and adds confusion.

In usual geological distribution, mode is close to P65 and mean to P40. It is almost impossible for a geologist to define P50, which is defined as the probability of the middle point of a list of cases. Each field being different, there is no list to pick the median. Using the definition of the median being equal to *as likely as unlikely* is misleading because a geologist is used to guess what is the most likely, which is different, being the peak of the probability distribution, again mostly unsymmetrical. Each case being different, probability in assessing reserves or resources is subjective. When the net pay is estimated on a log recorded in a well, the pick is on the inflection point of the log which corresponds to the most likely = mode = best estimate. Volumetric estimate needs to multiply net pay, area, porosity, saturation, and volume factor. Only multiplying mode values gives the mode of the product. It is why geologists rely on mode estimates within a range of minimum and maximum.

Decision of development is taken on the net present value of the projected field, based on the mean value (or expected value) and not on the median or the mode.

R.Megill in AAPG Explorer July 1990 wrote "Mean is Best value to represent whole" because median could be far from mean when the skew is large.

Mean can be estimated with Monte Carlo runs, but also with a simple equation between the minimum, most likely and maximum = Bourdaire's mean

see Bourdaire J.M.. R.J.Byramjee. R.Pattinson 1985 "Reserve assessment under uncertainty - a new approach" Oil & Gas Journal June 10 - p135-140

It is why P50 is a bad indicator and should be replaced by best estimate for reserves, as it is used for contingent and prospective resources! The method of assessment in a probabilistic approach of the technical uncertainty is the same, only commercial status differs.

On page 21 it is written

Based on the distribution of potential results and by applying guidelines, evaluators can define a low (1P/1C), **best (2P/2C)** and high (3P/3C) estimate of remaining recoverable quantities using the scenario approach and/or examine the compliance with deterministic guidelines in the incremental approach

So 2P, 2C is *best estimate* and not P50.

All Figures 2-1, 2-2, 2-3 mentioning P50 are in contradiction with chapter 3-4 and definition

Page 11

There should be at least a 50% probability (P50) that the quantities actually recovered will equal or exceed the best estimate.

No, best estimate is not only P50 but could be mode or mean

Page 12

For Contingent Resources, the general cumulative terms low/best/high estimates are denoted as 1C/2C/3C respectively. The associated incremental quantities are termed Measured, Indicated and Inferred

Why to keep obsolete terms as measured, indicated and inferred? These terms are coming from the McKelvey box (AAPG 1975)

1C, 2C and 3C are enough. There are no incremental terms for prospective resources, but low, best and high estimate, do the same for contingent resources.

Incremental terms are not necessary for a good reserve assessment, which needs only a range mini or low, mean, or mode, maxi or high: that's all.

In fact probable is estimated by subtracting 1P to 2P, there is no incremental, and probable (and possible) is not necessary and could be deleted in a modern classification.

Page 12

Proved Reserves are those quantities of petroleum which, by analysis of geological and engineering data, can be estimated with **reasonable certainty** to be commercially recoverable, from a given date forward, from known reservoirs and under defined economic conditions, operating methods, and government regulations. If probabilistic methods are used, there should be at least a **90% probability** that the quantities actually recovered will equal or exceed the estimate. If deterministic methods are used, the term reasonable certainty is intended to express a similar **high degree of confidence** that the quantities will be recovered.

US proved reserves are reported annually by USDOE/EIA with positive and negative revisions and it is easy from them to compute the probability of the proved reserves being the percentage of positive revisions over the positive plus negative revisions. The plot shows that for oil the probability has decreased from 80% in the 70s down to 55% now. The supposed 90% for proved reserves is far away because *reasonable certainty* can be 51% for many.

US probability of the estimate of proved reserves from revisions of USDOE annual reports

Jean Laherrere 2005
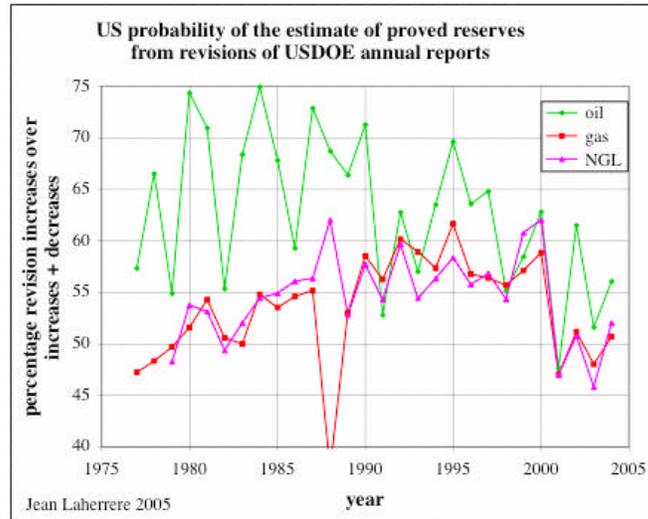
There is also a contradiction in this wording of *reasonable certainty* and *high degree of confidence*, anyone can choose what he wants! It is intersting to notice that the FDA is using the same wording *reasonable certainty of no harm* to allow the sale of a new product: consumers expect at least 99% probability!

This reasonable term was introduced about 50 years ago in the first reserve definition and is still undefined, and misused It is time to change it!

Page 14

The "**Best Estimate**" is the estimate considered the closest to the **quantity that will actually be recovered** from a project between the date of the estimate and the time of abandonment; for Reserves it is defined as the sum of Proved plus Probable (2P).

This definition of best estimate by the quantity to be recovered is not in fact a definition, because it is the definition of reserves and contingent and prospective resources = what is recoverable.

Page 15

Conventional Resources exist in discrete petroleum accumulations related to localized geological structural feature and/or stratigraphic condition, typically with each accumulation bounded by a down-dip contact with an aquifer, and which is significantly affected by hydrodynamic influencessuch as **buoyancy of petroleum in water**.

I believe that it is a very good definition but it should be mentioned that it is far away from what is usually used, where deepwater and EOR with steam or polymer are included by many as unconventional. Instead of buoyancy in water, why not to say that it is extra-heavy oil (being heavier than water)?

Unconventional Resources exist in petroleum accumulations that are pervasive throughout a large area and that are not significantly affected by hydrodynamic influences (also called "continuous -type deposits"). Examples include coalbed methane (CBM). "basin- centered" gas, shale gas, gas hydrate, **some portions of natural bitumen**, and oil shale deposits. Typically such accumulations require specialized extraction technology (e.g.. dewatering of CBM, massive fracturing programs for shale gas, steam and/or solvents to mobilize bitumen for in-situ recovery, and, in some cases, mining activities). Moreover, the extracted petroleum may require significant processing prior to sale (e.g.. bitumen upgraders).

What is the meaning of *some portions of natural bitumen*? Extra-heavy oil with a viscosity lower than 10 000 centipoises, meaning that it is not bitumen (Orinoco which is produced with cold production with high rate compared to Texas) is not mentioned in this paper (outside with upgraders) despite being heavier than water and needing upgrader (but what about Orimulsion?). Extra-heavy oil, which is not bitumen, is missing in the glossary.

Following the glossary page 46
Conventional Crude Oil 2007 - 2.4 Petroleum found in liquid form, flowing naturally or capable of being pumped without further processing or dilution (see Crude Oil).
Orinoco is produced with cold production (progressive cavitation pump) without any dilution (only for transport) is then conventional, then the buoyancy is contradictory!
Some of the extra-heavy oil fields have been trapped with down-dip contact with an aquifer but being close to surface they lost the light components and became extra-heavy. Where do you put them? Some of gas hydrate trapped in permafrost where trapped before the permafrost came and are bounded by a down-dip contact with aquifer, as I assumed are Mallik (Canada) or Messoyakah (Western Siberia) hydrate reservoirs which belong to conventional gasfields.

Page 24
Proved: 93 - 98% (the probability of recovering Proved quantities)
Probable: 70 - 75% (the probability of recovering incremental Probable quantities)
Possible: 25 - 30% (the probability of recovering incremental Possible quantities)
Why to give a different definition for proved, probable and possible, different from 1P, 2P, and 3P. It is confusing!
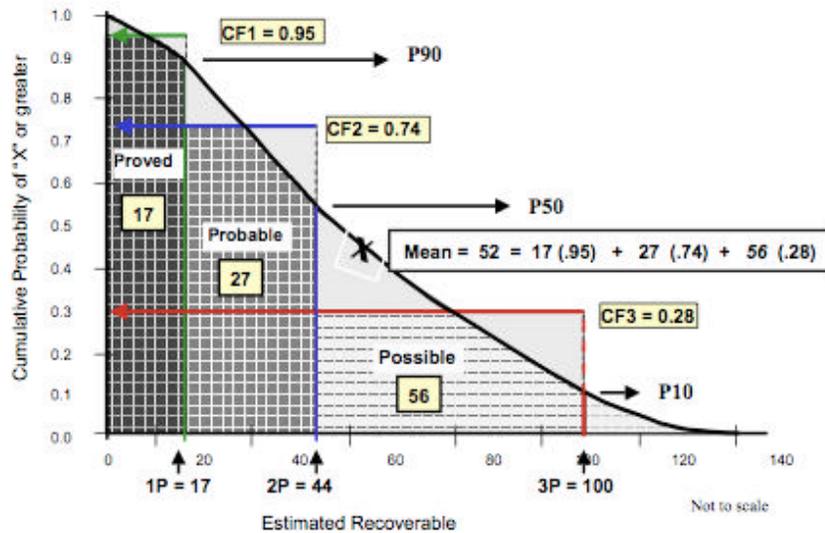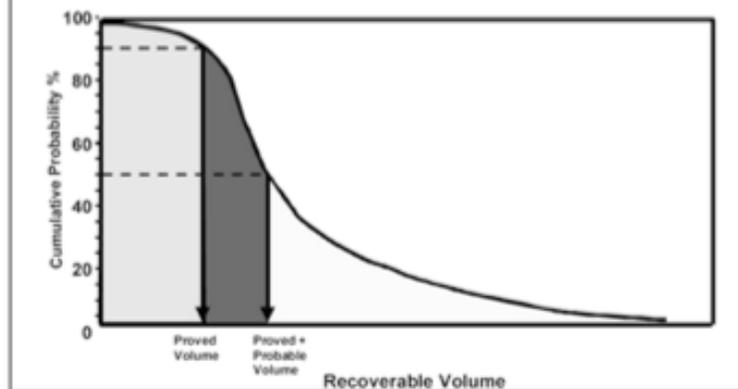Figure 3-1

Figure 3-1: Deriving Category Confidence Factors

The curve seems to be wrong on approaching the Y axis (steep slope at start), being more an arithmetic aggregation than a probabilistic aggregation as shown by figure 3-2.
In SPE 2001 the curve for UK starts horizontally contrary to figure 3-1

Figure 9.3—U.K. Proven and Probable Reserves

P50 seems badly plotted due to your change of definition!

A more precise graph is needed!

2P = 44 corresponds to P55 and not P50 which on the graph is about 48

the most likely = mode being the inflection point corresponds to P75 at 28, mini = P95 to 10 and maxi = P10 to 107.

Applying Bourdaire's equation mean = 0.33*mini + 0.33*mode + 0.33*maxi

$\cong$ (10+28+107)/3 $\cong$ 50 close to P45

Bourdaire's mean is based on a mathematical approach when Swanson's mean (AAPG dec2001 p1883-1891 where in fact P90 = mini was called P10 !) started as a rule of thumb (1972) which was justified mathematically later in 2001 approximately for a mode stly skewed distribution in an article which ignores Bourdaire 1985 OGJ paper.

Swanson's mean =0.3*P90+0.4*P50+0.3*P10 =0.3*15+0.4*48+0.3*100 = 54, higher than Bourdaire, corresponding to P40. Both equations assume a lognormal distribution.

In 1993 Ed Capen proposed a Modified Swanson's Rule where

mean = 0.05*P97+0.65*P60+0.3*P10.

Bourdaire gives also the standard deviation as (maxi-mini)/3., with the check that mini should be > mode/2 and maxi >7.7 mode. His graph is a check with the relationship between mini/mode and maxi/mode.

Value relationships*

Fig. 4

*Relationship between the central value V₂ (mode) and the extreme values (V₁, V₃) in a log-normal distribution with a zero lower bound. Note that V₁/V₂ must be >0.5.
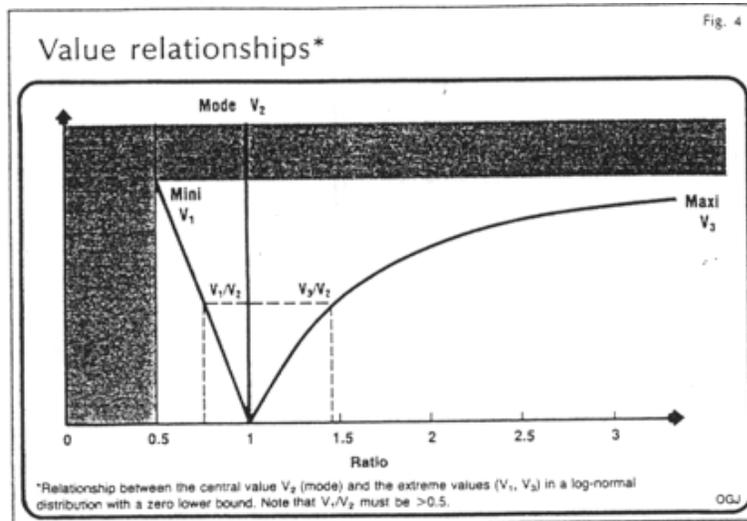
Figure 3-1 displays a mini at 10 too small compared to the mode at 28, meaning that the distribution is not lognormal from Bourdaire's rules!

Other approaches (started from Esso) using P99 and P1 seem to me impractical, because as a geologist I am unable to grasp the difference between P99 and P95 or P90! I can only guess what is a reliable mini (or maxi).

In the 1997 SPE/WPC task force the first draft was proposed with Proved = P80, probable = P50 and possible = P15. I recommended to Anibal Martinez to take 1P=95, 2P= mean and 3P=P5, which, after many discussions and compromises, was transformed into 1P=P90, 2P=P50 and 3P=P10. But many articles (IFP 31 May 2005) can be found with proved =P90. probable =P50 and possible =P10!

In fact I pushed to change the probabilistic approach but I left the deterministic approach as it was proposed, probable being defined as *as likely as unlikely* or in fact **probable = P50**, being in contradiction with the new probabilistic approach where it is **proved plus probable =P50** Historic can find in my paper (see appendix):

-Laherrere J.H. 2004 «Shell's reserves decline and the SEC's obsolete rule book » draft Energy Politics issue II summer p23-45.
http://www.hubbertpeak.com/laherrere/ShellDecline2004.pdf

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3.5.2 Aggregation Methods
Except in the rare situation when all the reservoirs being aggregated are 100% dependent, the P90 volume of the aggregate is always greater than the arithmetic sum of the reservoir level P90 volumes and the P10 of the aggregate is always less than the arithmetic sum of the reservoir level P10 volumes.
It should be mentioned that all reported world proved reserves by USDOE/EIA or BP Statistical Review, copying OGJ national answers (published the last week of December for the next 1st of January, before any technical study could be carried out) adding (independent) country proved reserves are wrong and contribute for a large part in the so-called reserve growth.

Page 25
Congratulations for your graph showing the large discrepancy between the incorrect arithmetic addition (used by USDOE/EIA) and the correct probabilistic aggregation
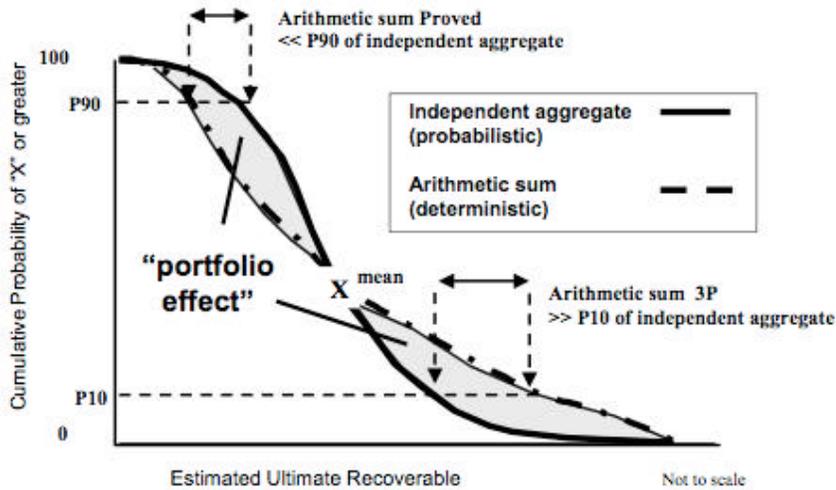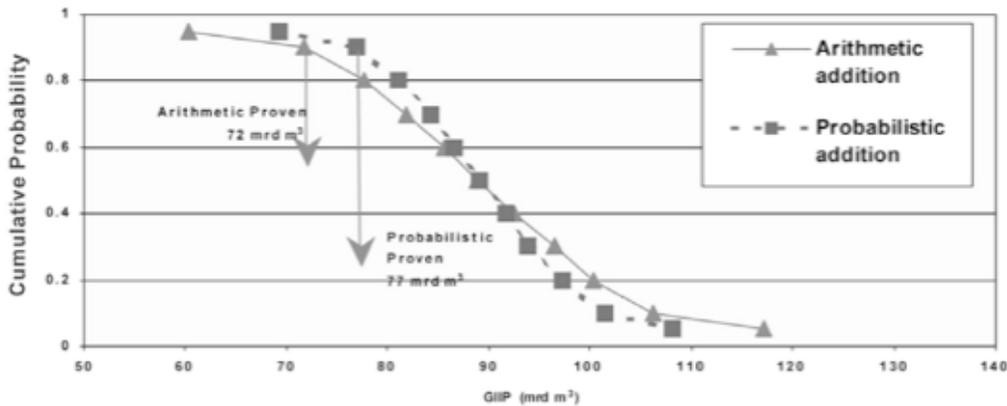
Figure 3-2: Deterministic versus Probabilistic Aggregation

This graph is a big improvement compared to the similar SPE 2001 following graph on the subject where the neutral point was P50 and not the mean

Figure 6.5—Arithmetic and Probabilistic Addition, A and B

Page 25

However, **for consistency** in reporting estimates of resource quantities categorized by certainty, all aggregations beyond the field, property, or project level **should use arithmetic summation**.

To be clear: in name of consistency it means: let's continue to do incorrect aggregations! Where is the goal of guidelines 2001 to see petroleum reserves definition not static but evolving? It is time to evolve!

Page 31

The SPE recognizes that, while the vast majority of committed projects meet the normal economic criteria to generate a positive net present value on a stand-alone basis.

Net present value is usually computed on the **mean value** to decide field development and also on the minimum value to be sure in this case of not being too negative, and the maximum to see how much is the bonanza, if lucky, despite unlikely. Designing an offshore platform only on proved values is bad practice and will cost a lot of money. The SPE should recognize the importance of the 2P or mean value and the negative aspect of proved estimate. The SPE should recognize publicly that the SEC rules are completely obsolete (based on SPE 1964

definitions which have been changed several times since) and should be changed in allowing companies to report also probable reserves, as Canada did in 2003 with the Canada National Instrument 51-101 by joining the **rest of the world, which works on proven plus probable**. When USGS 2000 estimates the undiscovered reserves outside US it was with the backdated 2P from Petroconsultants (already obsolete being as end of 1995 with about 1500 missing fields)

Page 34
SPE proposal on figure A-2 is good by **removing P90. P50 and P10** to allow deterministic or probabilistic approach leaving only low, best and high estimate
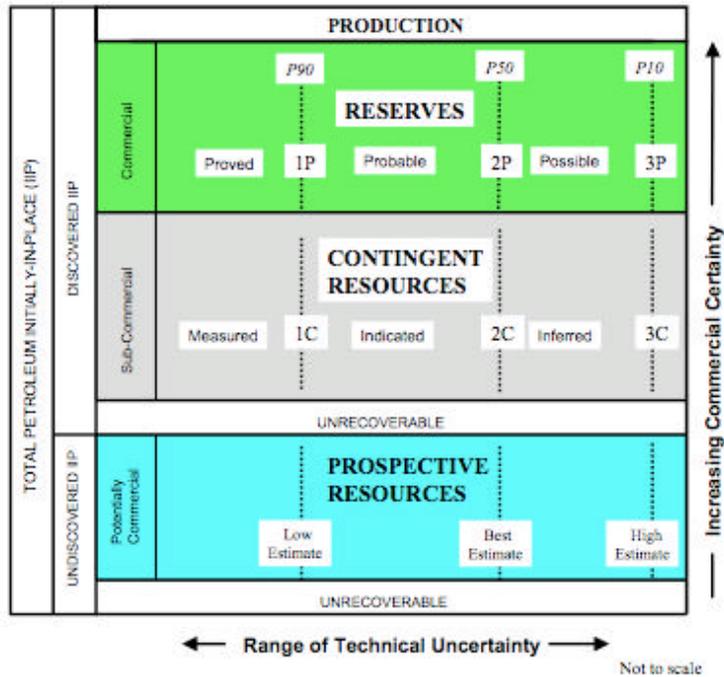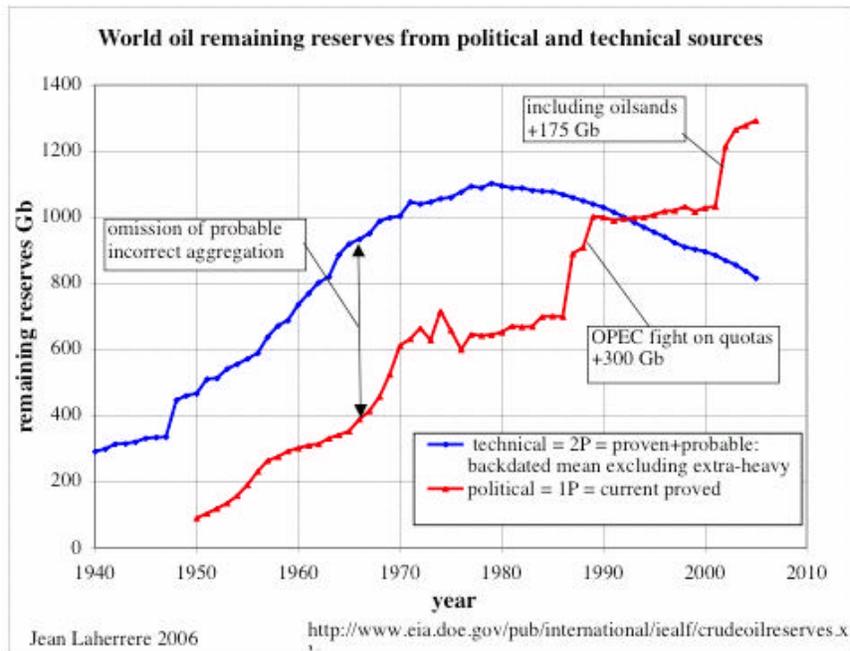

Figure A-2: 2007 SPE Classification and Categorization System

Page 41
Considerable confusion exists regarding the terminology applied to probabilistic evaluations. The SPE system describes distributions referencing probability of exceedance versus recoverable volumes (e.g., "there should be at least a 50% probability that the quantities actually recovered will equal or exceed the sum of estimated Proved plus Probable"). **However, the deterministic criteria for the categories refer not to cumulative but to discrete incremental volumes such as Probable**. There is confusion because determinists do not want to change, being ignorant on probability. As far as I know, there is no way, when a barrel is produced, to know if it comes from proved or probable or possible reserves, as long as the cumulative production is below the low estimate. It is why exceedance is needed.
 It is not because bankers refused uncertainty, that uncertainty has to be hidden under a so-called reasonable certainty. Certainty does not exist in future, only in the past!
This underlines the difficulty in performing reconciliation using the probabilistic method. An increase in Proved Reserves in a project may be due to both technical improvements and to changes in the portfolio mix, which must then be allocated back to the project. This certainly complicates resources auditing.
It is not a question of difficulty, but of seeing what is right and want is wrong. Arithmetic addition of proved reserves is wrong and explains the strange behavior of proved remaining reserves for the last 50 years, compared to the backdated mean.

World oil remaining reserves from political and technical sources

Jean Laherrere 2006   http://www.eia.doe.gov/pub/international/iealf/crudeoilreserves.x

Reporting only proved reserves to follow SEC rules is wrong.

OPEC members use proved reserves to fix quotas, and since the 1986 oil countershock, OPEC members cheat on quotas and proved reserves, which were never audited. Iran reports 130 Gb when former NIOC VP E states that it is only one third. Same with Kuwait, where PIW stated the reserves have to be cut in half and Kuwait Parliament is asking for an audit (which will remain confidential?).

The definition of oil is changed mainly on conventional and OGJ added 175 Gb to Canada when Wood Mackenzie add about 15 Gb

The proved oil reserves as reported by USDOE are a joke and the SPE is guilty of not saying so!

USDOE/EIA proved reserves as end of 2005 posted 5 Oct. 2006

Oil Gb	OGJ	BP	WO	(WO Sept.2006)
World	1 292.935 5	1 201.331 538 509 4	1 119.615 3	1 119.058 3
Russia	60.000	74.436 476 05	74.4	
Norway	7.705	9.691 349	8.033	
Canada	178.7924	16.500	12.025	
China	18.25	16.038 12	16.188 5	

Gas Tcf	OGJ	BP	WO	WO Sept.2006	Cedigaz
World	6 124.016	6 359.172	6 226.554 6	6 215.219 6	6 380.62
Russia	1 680.000	1 688.046	1 688.748 9		1 688.76
Norway	84.26	84.896 5	83.272 1		109.759 02
Canada	56.577	55.950 5	53.700		55.974 275
China	53.325	82.955	55.606 1		82.990 25

And the number of significant digits is stupid (14 with BP) when the second digit is different
The comparison of world proved reserves additions from published data and the confident 2P technical data is striking. Every geologist and petroleum engineer knows that since 1980 the world production is more than the discovery and all these additions are artificial, mainly political.

World oil annual discovery (smooth) and production, as political additions (so-called proved)
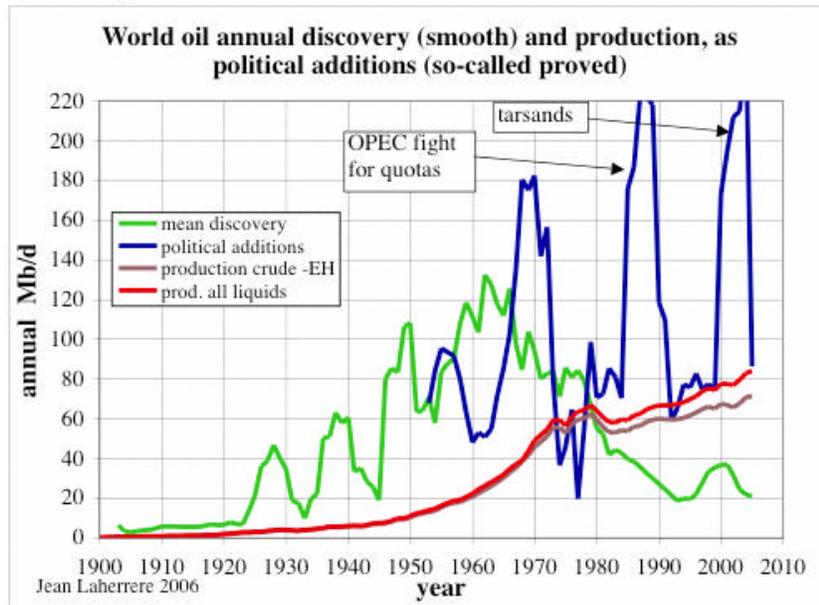
Given these complexities, the committee set guidelines that:
• Retain the probability targets for 1P/2P/3P (and 1C/2C/3C and low/best/high) scenarios **(P90/P50/P10)** at the project level.
Again P50 should be best estimate and P90 the low and P10 the high, as written in the glossary,
1P 2007 - 2.2.2 Taken to be equivalent to Proved Reserves; denotes **low estimate** scenario of Reserves.
2P 2007 - 2.2.2 Taken to be equivalent to the sum of Proved plus Probable Reserves; denotes **best estimate** scenario of Reserves.
3P 2007 - 2.2.2 Taken to be equivalent to the sum of Proved plus Probable plus Possible Reserves; denotes **high estimate** scenario of reserves.
Why giving different definitions? It is confusing! Pleasing everyone is not the best way to improvement!

Page 46
Cumulative Production 2007 - 1.1 The sum of production of oil and gas to date (see also Production).
The problem is that many papers speak about cumulative production without giving a date, cumulative production should compulsory be given with a date

Page 47
Deterministic Estimate 2007 - 3.5 The method of estimation of Reserves or Resources is called deterministic if a **discrete** estimate(s) is made based on known geological, engineering, and economic data.
I doubt that it is a good definition but my English is far from being perfect and Webster's dictionary does not help to describe *discrete*. I feel that a probabilistic estimate can be described with this definition if only mean is computed.

Page 49
Gas Hydrates 2007 - 2.4 Gas hydrates are naturally occurring crystalline substances composed of water and gas, in which a solid water-lattice accommodates gas molecules in a cage-like structure, or clathrate. At conditions of standard temperature and pressure (STP), one volume of saturated methane hydrate will contain as much as 164 volumes of methane gas. Because of this large gas-storage capacity, **gas hydrates are thought to represent an important future source of natural gas**. Gas hydrates are included in unconventional resources, and the technology to support commercial production has yet to be developed.

Because of this large storage capacity, I believe more in the potential of gas hydrates in transport (cheaper than LNG) and not in source, because every known oceanic gas hydrate occurrence is too heterogeneous vertically (millimetric to decimetric) as horizontally (metric) to be produced.

Conclusions
In the SPE Guidelines 2001 it is written:
The SPE and the WPC accept that petroleum reserves definitions are not static and **will evolve**.
It appears that the SPE 2007 evolution is too short towards a good definition, despite progress.
Ed Capen (1993 SPE 25830) wrote: *The bigger surprise is that an industry which prides itself on its use of science, technology, and frontier risk assessment methodologies finds itself in the 1990's with a reserves definition more reminiscent of the 1890's*. If some progress have been done with SPE/WPC 1997, 2000, 2001, then draft 2006, most major oil companies are listed on the US stock market and are obliged to follow the SEC rules, which were written in 1978 with a SPE wording of 1964 (reasonable certainty). Everyone recognizes that SEC rules are obsolete, obliging to report only proved reserves, assumed to be the minimum. Canada has dropped them in 2003, **joining the rest of the world which reports 2P (best estimate**).
Proved reserves please the bankers because they want to be sure that the borrower has enough sure assets to reimburse his loan. But proved reserves assumed to be the minimum is a bad way to forecast future production, which should be based on mean value. Bankers and politicians do not like uncertainty and range, they want one value and want to add them. It is incorrect to add independent minimum values, because it is unlikely that they will be all at minimum. Only field mean values could be added to represent the mean of the country. If only one value is reported to assess the potential of production and not on the potential to pay back debts, the best value is the best estimate being the mean.
Refusing uncertainty by speaking of reasonable certainty is unreasonable in a modern world. Deterministic approach has to be considered as obsolete and to be replaced by probabilistic approach. Incremental terms have to be abandoned as measured, indicated, inferred, proved, probable and possible, keeping only **low, best and high estimate**.
Trying to please everyone (in particular those who refuse to learn the complexity of probability) in keeping obsolete or ambiguous terms is a bad way to evolve!
The **best estimate** is left in the guidelines to be either **median, or mode, or mean**. This indicates that they have the same use, which is not. **Mode has to be used when assessing the volume by multiplying** net pay, area, porosity, saturation, volume factor, because the mode of the product is the product of each mode. **Mean has to be used when aggregating fields** (or countries), because only the mean of the country is the sum of all the fields. Median values cannot be multiplied or added, except if the distribution is symmetrical (no skew), which is unlikely. Most assume that the middle point (median) corresponds to the average, which is wrong in a skewed distribution, which is the usual case.
Mean (expected) value should be strongly recommended as to be the best estimate.
How to dare to speak of proved reserves corresponding to a probability of 90% when the recent US annual reports show that negative revisions of the proved reserves are as large as positive revisioins.
Keeping most of items of the McKelvey's box with only two axes is ignoring the UNFC last classification (with many bad points), which provides three axes, distinguishing geologic uncertainty from commercial feasibility.

A check (straight plot of the three values on a log probability paper) has to be suggested to see if the three values of low, best and high values follow a lognormal distribution as it is assumed in almost all methodology and found also in nature. This check allows also finding the third value if only two are known.

Formula for finding mean (only value which can be added) has to be recommended, but Swanson' mean is too specific to little skew cases.

But the main recommendation is to do everything possible to obtain the change of the SEC rules to come in line with the rest of the world, in order that proved reserves will be replaced by best estimate reserves.

Annex.

Some historical dates:

-1936 API reserves definitions with proved reserves

-1961 API-AGA: Proved = "beyond reasonable doubt"

-1964 API. SPE « reasonable certainty »

-1975 USGS McKelvey classification of resources

-1978 SEC-FASB: Proved = "with reasonable certainty"

-1979 Khalimov: Russian classification A+B+C1 reserves reported to be equivalent to proved reserves, despite a different determination

-1979 McKay Esso: Proved (P) = probability 95 %; Proved + Probable (2P)= 50%; Proved + Probable + Possible (3P) = 5%. but minimum =99%, most likely =50%, maximum =1%

-1980 AAPG. SPE and API use SEC definitions

-1983 WPC (Martinez) Proved = "reasonable certainty" or 90% probability

-1985 Grossling : expected value = 2.3 Proved for Non-OPEC; 1.5 Proved for OPEC

-1985 Bourdaire: Proved (P) = 95% (minimum); 2P = mode (most likely); 3P = 5% (maximum); mean = "expected value" = (mini+mode+maxi)/3

-1987 definitions WPC (Martinez) Proved = 85%-95% Probability = "high degree of certainty"

-1990 Laherrere: Proved(P) = 85%-95% ; 2P = 50% ; 3P = 5% -15%

-1991 Caldwell proposes that "reasonable certainty" equates with a 75% probability, between Proved and Probable

-1991 SPE refuses to adopt the probabilistic approach

-1993 DeSorcy: Proved = 80% probability; Probable = 40%-80% probability; Possible = 10%-40%; "Expected Reserves" = Proved + 0.6 Probable + 0.25 Possible; "Established Reserves" = Proved + 0.5 Probable

-1993 Khalimov: Russians reserves are « grossly exaggerated » because they are based on a maximum theoretical recovery, A+B+C1=3P

-1994 Ross: Proved = 75% probability

-1994 NPD drops Proved, Probable and Possible in favor of 90%; 50% (called Most Probable?), 10% and defines 7 classes of resources

-1994 PDVSA (Roger) uses a probabilistic range of 80-50-20%

-1995 SPE/WPC task force on reserve definition headed by A. Martinez (I was a member) proposes a hybrid system whereby the Determinist terms are defined as follows: Proved = "reasonable certainty", but also having a "high degree of confidence"; Probable = "more likely than not"; Possible = "less likely than not"; and the Probabilistic terms are defined as follows: Proved (1P) = 80-85% probability; Proved + Probable (2P) = 40-60% probability; and Proved + Probable + Possible (3P) = 15% probability

-1997 SPE/WPC final text for probabilistic reserves: 1P = 90%, 2P= 50%, 3P=10% and Martinez approaches the SEC to adopt probabilistic approach (without success). Resources are not mentioned.

-2000 SPE/WPC/AAPG definitions of resources (contingent & prospective)
-2003 Canada National Instrument 51-101 obliges to report proved as 90 % and 2P as 50%. 3P is optional
-2004 International Accounting Standards Board (in UK) project to publish rules to be adopted by SEC. but date of completion likely after 2007.

Most of reserves experts were very critical towards the US practice.
"There are currently almost as many definitions for reserves as there are evaluators, oil and gas companies, securities commissions and government departments. Each one uses its own version of the definitions for its own purposes" DeSorcy 1993
"The resource base [of the former Soviet Union] appeared to be strongly exaggerated due to inclusion of reserves and resources that are neither reliable nor technologically nor economically viable" Khalimov 1993
"An industry that prides itself on its use of science. technology and frontier risk assessment finds itself in the 1990s with a reserve definition more reminiscent of the 1890s" *"illegal addition of proved reserves"* Capen 1996
"Why our reserves definition don't work anymore" Caldwell 1996
"Virtual reserves - and other measures designed to confuse the investing public" Tobin 1996
"The term "reserves" often is treated as if it were synonymous with "proved reserves". This practice completely ignores the fact that any prudent operator will have, at least internally, estimates of probable and possible reserves" Ross 1998

Reserves definitions discrepancies
The SPE/WPC 1997 text is the result of many compromises between different opposite views (conservative approach of most industry seniors who did not understand probability at this time against scientific approach based on subjective probabilities) and is far from perfect, but now nobody wants to change because it would be to re-open a «can of worms » and lead again to too many discussions. There are several contradictions in SPE/WPC wording because in a deterministic approach, proved which is defined as what is estimated to be recoverable with reasonable certainty is also assumed to be a high degree of confidence. The deterministic probable reserves are defined as more likely than not (in fact a 50 % probability) whereas others use an incremental approach in which probable is what is added to «proved » to reach a 50% confidence. This confusion seems to be accepted, using same words in both approach but different. This confusion as P50 corresponding to probable and not to 2P = proven plus probable is still found in OGJ 19 Jan.2004 page 31.

There are two different people estimating reserves and they seems to live in different worlds : « one value » against «one range ». certainty (determinists) against uncertainty (probabilists). and different terms (P2 against 2P). adding the confusion.
Deterministic approach
Proved P1   *reasonable certainty*
Probable P2   *more likely than not*
Possible P3   *less likely than probable*
Probabilistic approach
Proved 1P   *at least 90% probability*
Proved + Probable 2P   *at least 50% probability*
Proved + Probable +Possible 3P   *at least 10 % probability*
Harrell Ryder Scott 24 Oct. 2002

In fact most actors love this ambiguity, which allows reporting what they want, according to their own internal policies. Most of words are ambiguous: oil, reasonable certainty, high degree, low estimate, best estimate, high estimate without any quantification. MMS uses a different probabilistic approach, more scientific and correct as using the mean and not the median: "*Cumulative probability distributions: A distribution showing the probability of a given amount or more occurring. These distributions include the values for the resource estimates presented throughout this report: a low estimate having a 95 percent probability (19 in 20 chance) of at least that amount (F95), a high*

estimate having a 5 percent probability (1 in 20 chance) of at least that amount (F5), and a mean (m) estimate representing the average of all possible values. Values of the fractiles are not additive. Deterministic: A process in which future states can be forecast exactly from knowledge of the present state and rules governing the process. It contains no random or uncertain components." MMS 1995