Department of Mineral Fuels
MINISTRY OF ENERGY

# Petroleum Reserves Classification in Thailand


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**Department of Mineral Fuels**

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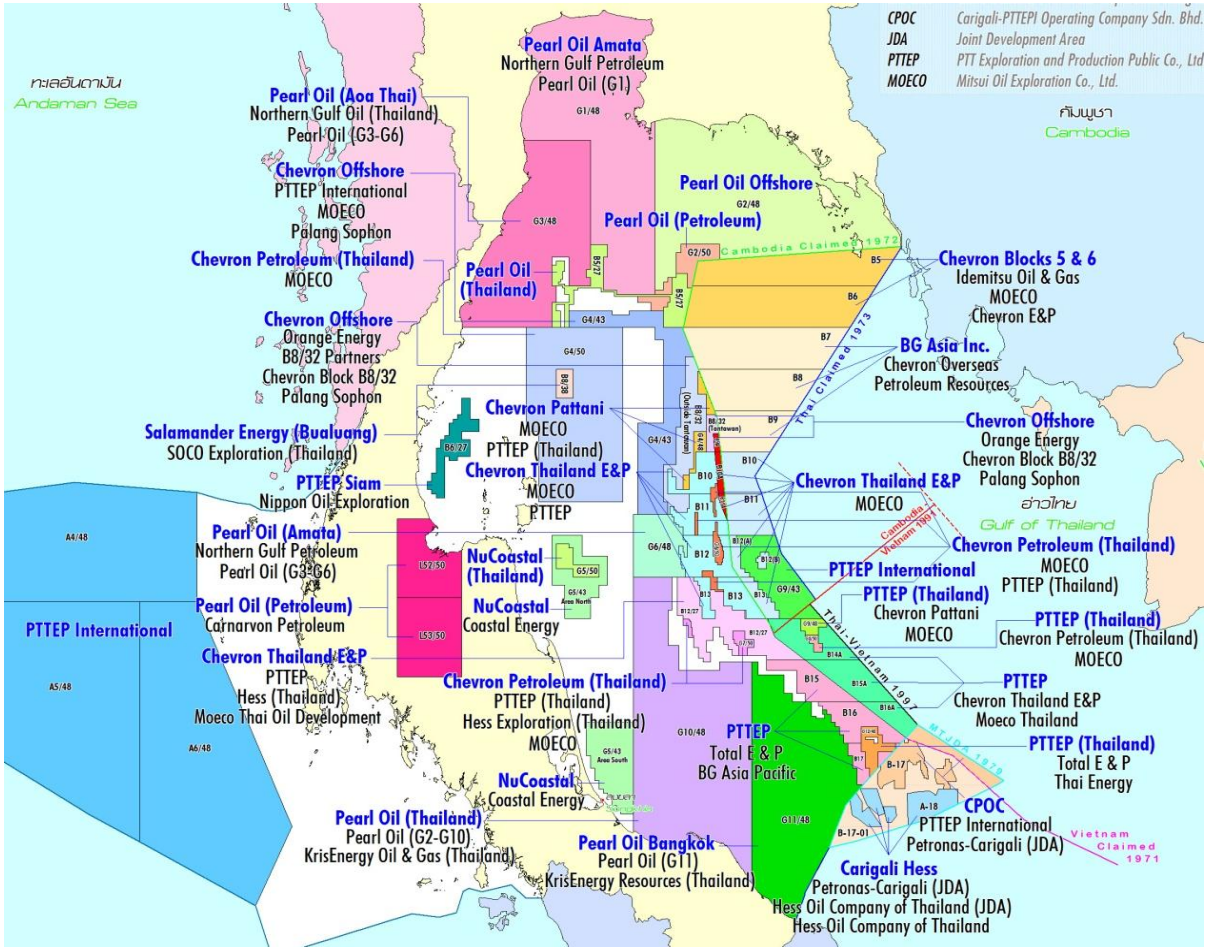
- Introduction
- Definitions
- Dealing with diversity

# Fiscal Regime: Concession System

## 20 bidding rounds, 21st bidding coming 2012



# Department of Mineral Fuels (DMF)

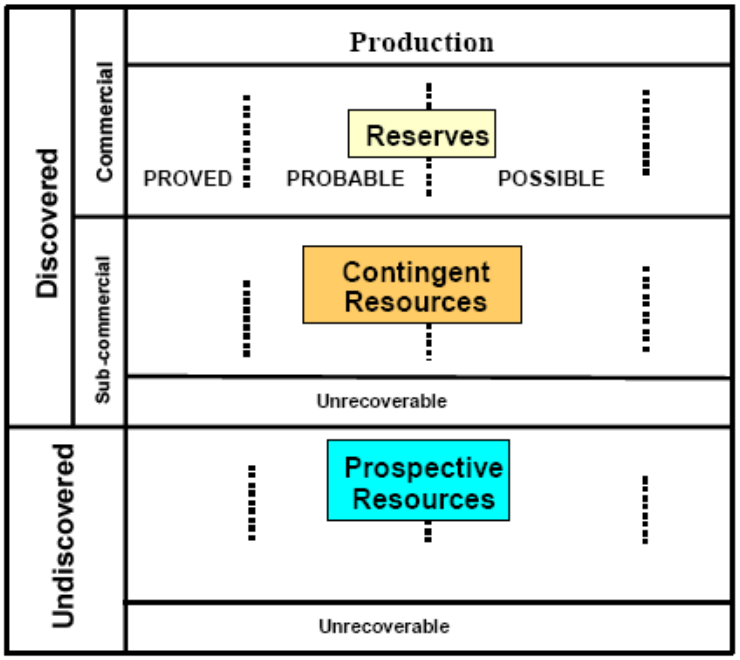
## DMF is the National Hydrocarbon Executive Agent

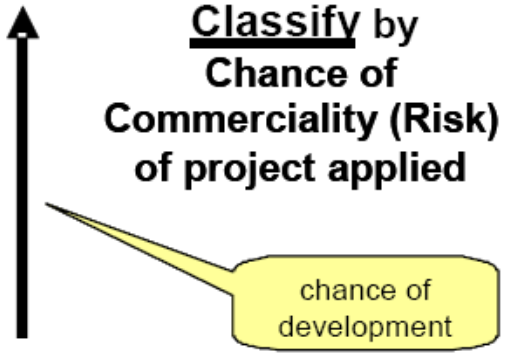
- Planning, promoting and monitoring in policy and management of upstream petroleum business in Thailand including Joint Developing Area and Overlapping Areas
- Cooperating with other countries to encourage Thailand's E&P business

www.dmf.go.th

# Definitions

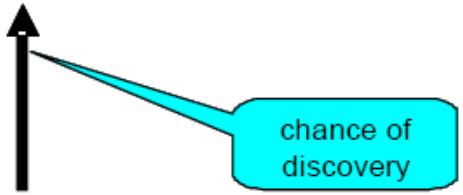
# Reserves vs. Resources




Production Area Approval (E1, E2)

Discovery vs Relinquishment




Exploration Block

Categorize based primarily on technical uncertainty of sales quantities associated with a project

http://www.spe.org/industry/reserves/docs/PRMS_guide_non_tech.pdf
http://www.spe.org/industry/reserves/docs/OGR_Mapping_Final_Report.pdf

# Operating Expenditure (OPEX): Petroleum Act 2514 (B.E.)

Personnel
Materials
Overheads
Lease
Abandonment

Royalty

xx% * Sale Revenue

Tax

xx% * Taxable Income

Taxable Income

= Revenue - Intangible CAPEX - Depreciation - OPEX

# Capital Expenditure (CAPEX)

Exploration/ G&G (Sunk Cost)

Wells

Facilities

Pipelines

Wellhead platform
Central Processing Platform
Living Quarter
Riser

---

Tangible & Intangible Expense

Intangible

- xx % of Well Cost

Tangible

- Sunk Cost
- 100 % Facilities & Pipelines
- 100-xx% of Well Cost

**Proved Reserves (P1)**

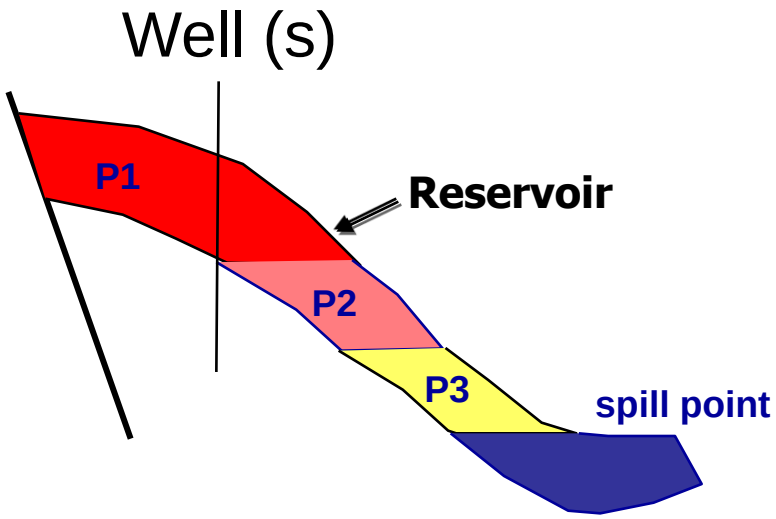
**Flow Test**

**Probable Reserves (P2)**

**Ref. Flow Test/ Analog**

**Possible Reserves (P3)**

**High uncertainty Including Upside**



# Layers of Information

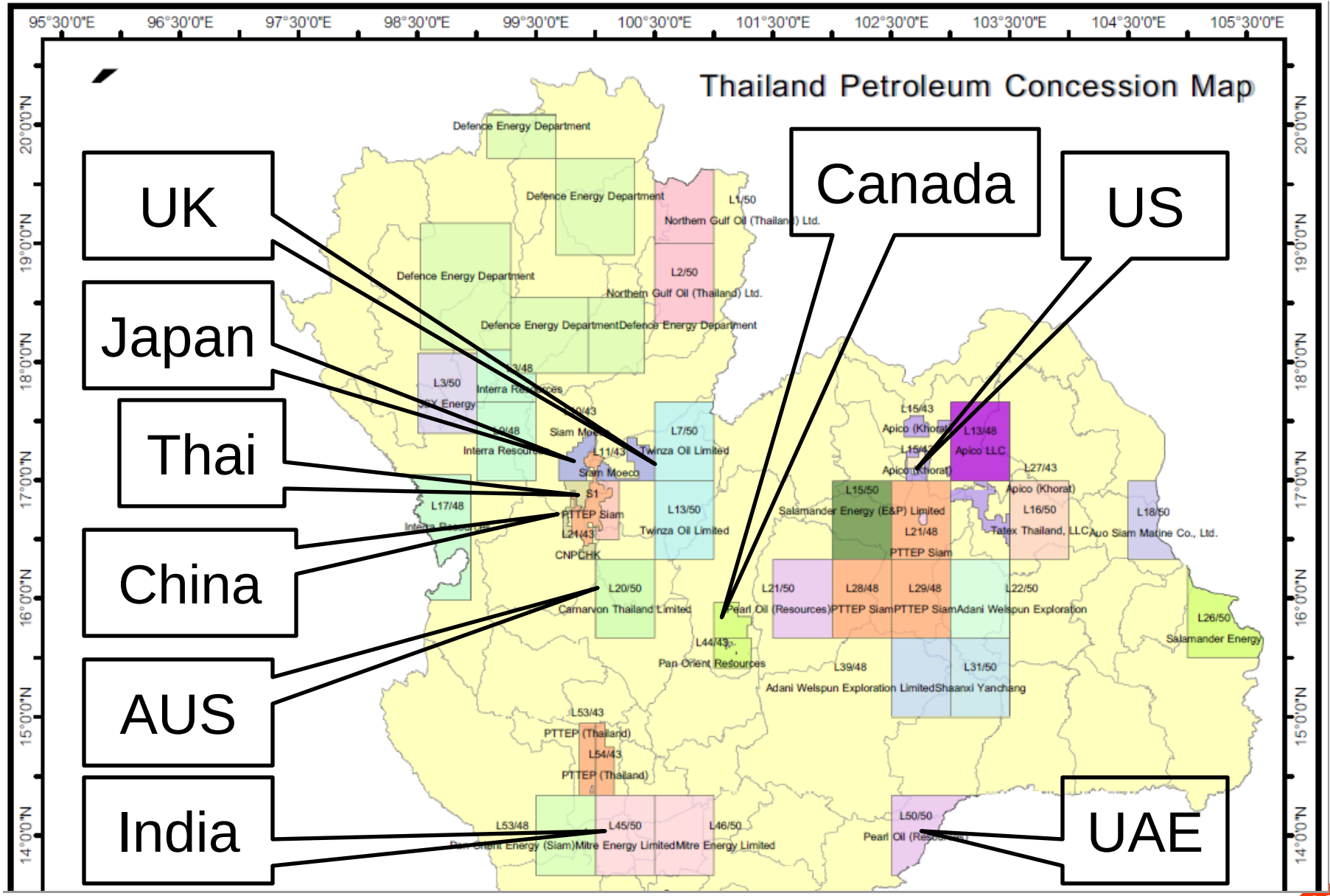
**Proven reserves (P1)** - defined as oil and gas "Reasonably Certain" to be producible using current technology at current prices, with current commercial terms and government consent

**Probable reserves (P2)** - defined as oil and gas "Reasonably Probable" of being produced using current or likely technology at current prices, with current commercial terms and government consent

**Possible reserves (P3)** - defined as oil and gas “Less likely” to be recoverable than probable reserves. Commerciality of probable and possible reserves may be based on future expected economic conditions.

http://www.spe.org/industry/reserves/docs/PRMS_guide_non_tech.pdf
http://www.spe.org/industry/reserves/docs/OGR_Mapping_Final_Report.pdf

# Dealing with diversity



# Reserves Estimation Methods

*Example: North GOT*

## Undeveloped areas

**Subsuface Data**
- **Seismic**
- **Core**
- **Log**
- **RFT**

→

**P5/50/95**
- **Area**
- **Col Height**
- **net pay**
- **Porosity**
- **Saturation**

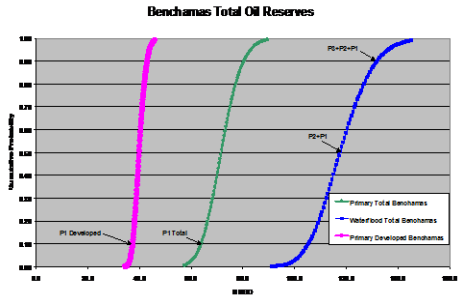
→

**3 Point**
**OGOP/OOIP**

↓

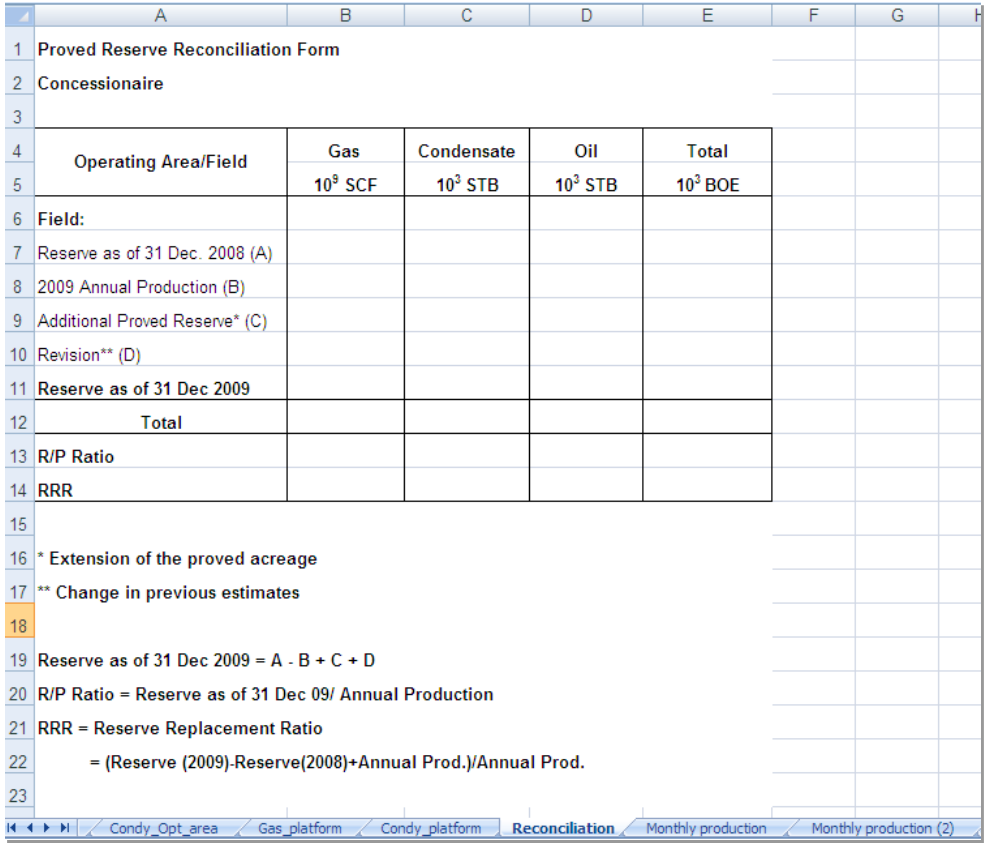
**P10/50/90**
- **Condensate Yield**
- **Primary Recovery**
- **Secondary Recovery**
- **Geologic Risk**

→ *In-house Software (Crystal Ball)* →



# Dealing with diversity

- 2003-2006 D&M
- Auditing methods
- Standard forms
- Train DMF staff



Proved Reserve Reconciliation Form

Concessionaire

| Operating Area/Field | Gas $10^9$ SCF | Condensate $10^3$ STB | Oil $10^3$ STB | Total $10^3$ BOE |
|---|---|---|---|---|
| Field: | | | | |
| Reserve as of 31 Dec. 2008 (A) | | | | |
| 2009 Annual Production (B) | | | | |
| Additional Proved Reserve* (C) | | | | |
| Revision** (D) | | | | |
| Reserve as of 31 Dec 2009 | | | | |
| Total | | | | |
| R/P Ratio | | | | |
| RRR | | | | |

* Extension of the proved acreage

** Change in previous estimates

Reserve as of 31 Dec 2009 = A - B + C + D

R/P Ratio = Reserve as of 31 Dec 09/ Annual Production

RRR = Reserve Replacement Ratio

= (Reserve (2009)-Reserve(2008)+Annual Prod.)/Annual Prod.

Condy_Opt_area | Gas_platform | Condy_platform | Reconciliation | Monthly production | Monthly production (2)

# Conclusions

- Using different method to estimate reserves and resources

- Company report is required only petroleum reserve and method

- Fully Access to exploration data and Interpretation

- PA Approval➔ Not only commerciality of the project, but also indicating petroleum potential of the block is highly demanded

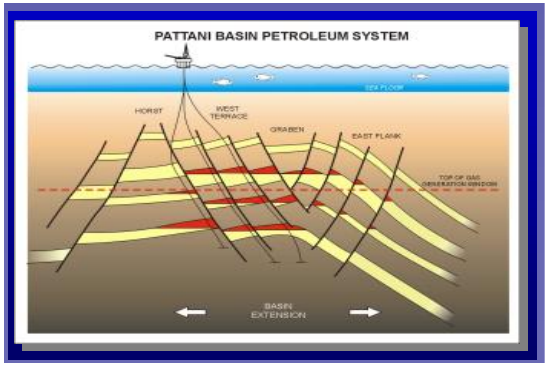
-EIA for Exploration and Production are needed to be submitted separately

- Probabilistic vs. Deterministic

Questions

Answers

Discussion




Thank You!

# Strategies in Exploration & Production

Geological & Geophysical Data Integration

- 3-D seismic interpretation

X-sections along fault planes & along well courses

Structural Mapping

Amplitude Maps

- Log characteristic vs. Well performance correlation

# Definitions

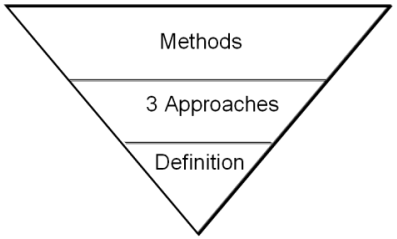
## Terms used in petroleum evaluation [edit]

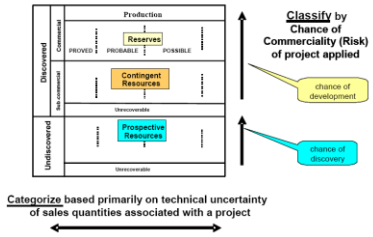
- Lead - a structure which may contain hydrocarbons
- Dry Hole - A formation that contains brine instead of oil.
- Flat Spot - An oil-water contact on a seismic section; flat due to gravity.
- Bright Spot - On a seismic section, coda that have high amplitudes due to a formation containing hydrocarbons.
- Prospect - a lead which has been fully evaluated and is ready to drill
- Play - A particular combination of reservoir, seal, source and trap associated with proven hydrocarbon accumulations
- Chance of Success - An estimate of the chance of all the elements (see above) within a prospect working, described as a probability. High risk prospects have a less than 10% chance of working, medium risk prospects 10-20%, low risk prospects over 20%. Typically about 40% of wells recently drilled find commercial hydrocarbons.
- Hydrocarbon in Place - amount of hydrocarbon likely to be contained in the prospect. This is calculated using the volumetric equation - GRV x N/G x Porosity x Sh x FVF
  - GRV - Gross Rock volume - amount of rock in the trap above the hydrocarbon water contact
  - N/G - net/gross ratio - percentage of the GRV formed by the reservoir rock ( range is 0 to 1)
  - Porosity - percentage of the net reservoir rock occupied by pores (typically 5-35%)
  - Sh - hydrocarbon saturation - some of the pore space is filled with water - this must be discounted
  - FVF - formation volume factor - oil shrinks and gas expands when brought to the surface. The FVF converts volumes at reservoir conditions (high pressure and high temperature) to storage and sale conditions
- Recoverable hydrocarbons - amount of hydrocarbon likely to be recovered during production. This is typically 10-50% in an oil field and 50-80% in a gas field.

**http://en.wikipedia.org/wiki/Hydrocarbon_exploration**

# Definitions

# Layers of Information



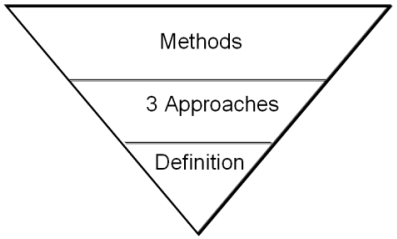



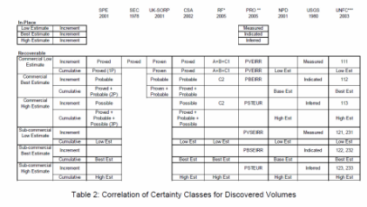

| | | SPE 2001 | SEC 1978 | UK-SORP 2001 | CSA 2002 | RF* 2005 | PRO ** 2005 | NPD 2001 | USGS 1980 | UNFC*** 2003 |
|---|---|---|---|---|---|---|---|---|---|---|
| **In-Place** | | | | | | | | | | |
| Low Estimate | Increment | | | | | | Measured | | | |
| Best Estimate | Increment | | | | | | Indicated | | | |
| 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

http://www.spe.org/industry/reserves/docs/PRMS_guide_non_tech.pdf
http://www.spe.org/industry/reserves/docs/OGR_Mapping_Final_Report.pdf

# Definitions



# Layers of Information

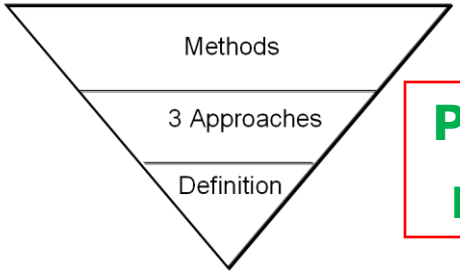
| | SPE 2001 | SEC 1978 | UK-SORP 2001 | CSA 2002 | RF 2005 | PRO 2005 | NPD 2001 | USGS 1980 | UNFC 2003 |
|---|---|---|---|---|---|---|---|---|---|
| **In-Place** | | | | | | | | | |
| Total Petroleum Initially-In-Place | Total PIIP | | | Total PIIP | Total PIIP | Total PIIP | ** | Total PIIP | Total 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

http://www.spe.org/industry/reserves/docs/PRMS_guide_non_tech.pdf
http://www.spe.org/industry/reserves/docs/OGR_Mapping_Final_Report.pdf

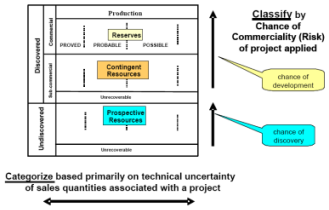
# 2. Statistic Approach




## Review Volumetric Approach

**Petroleum Resources = Petroleum volume x FVF x RF**

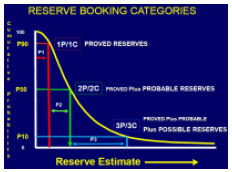
**Resources = Pay x Area x Porosity x Saturation x FVF x RF**




## 2.1 Statistic Approach

**Petroleum Resources = Petroleum volume x FVF x RF**

**Resources = Pay * Area * Porosity * Saturation * FVF * RF**

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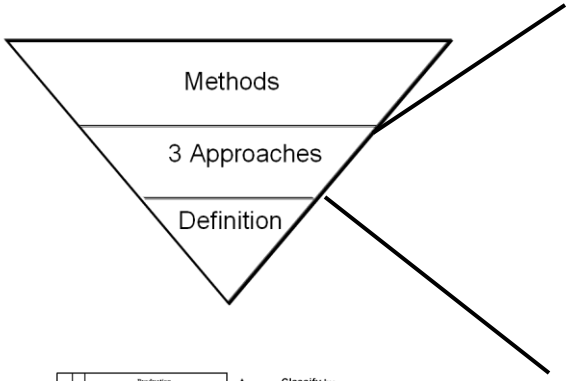
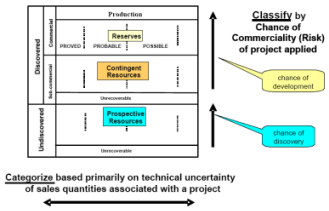
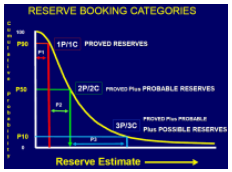
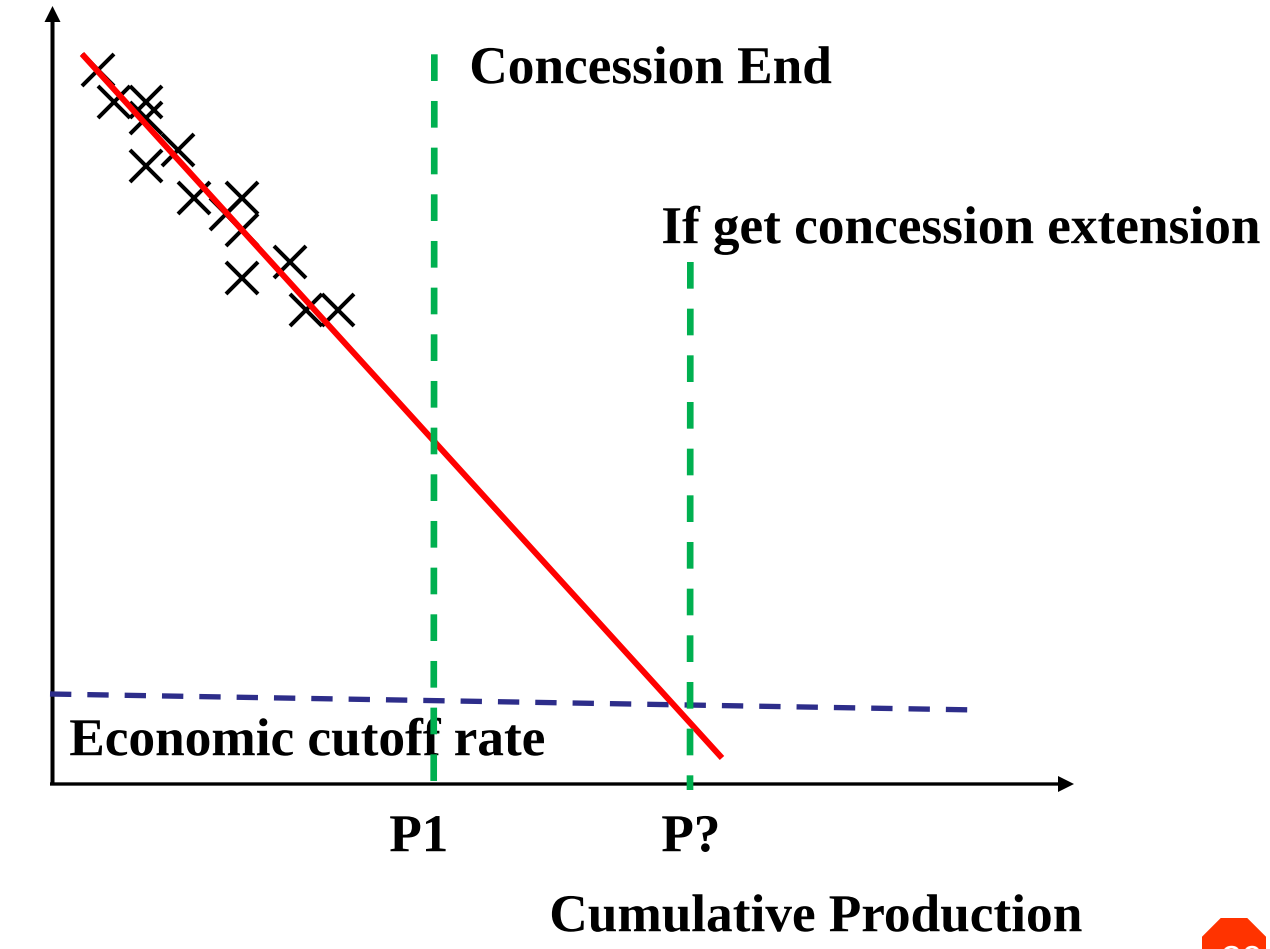
# 3. Performance Based Approach

## 3.2 p/z

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# Statistic Approach