

Short Course on
Petroleum Reserve Estimation, Production, and
Production Sharing Contract (PSC)

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Resource and Reserve Classification System

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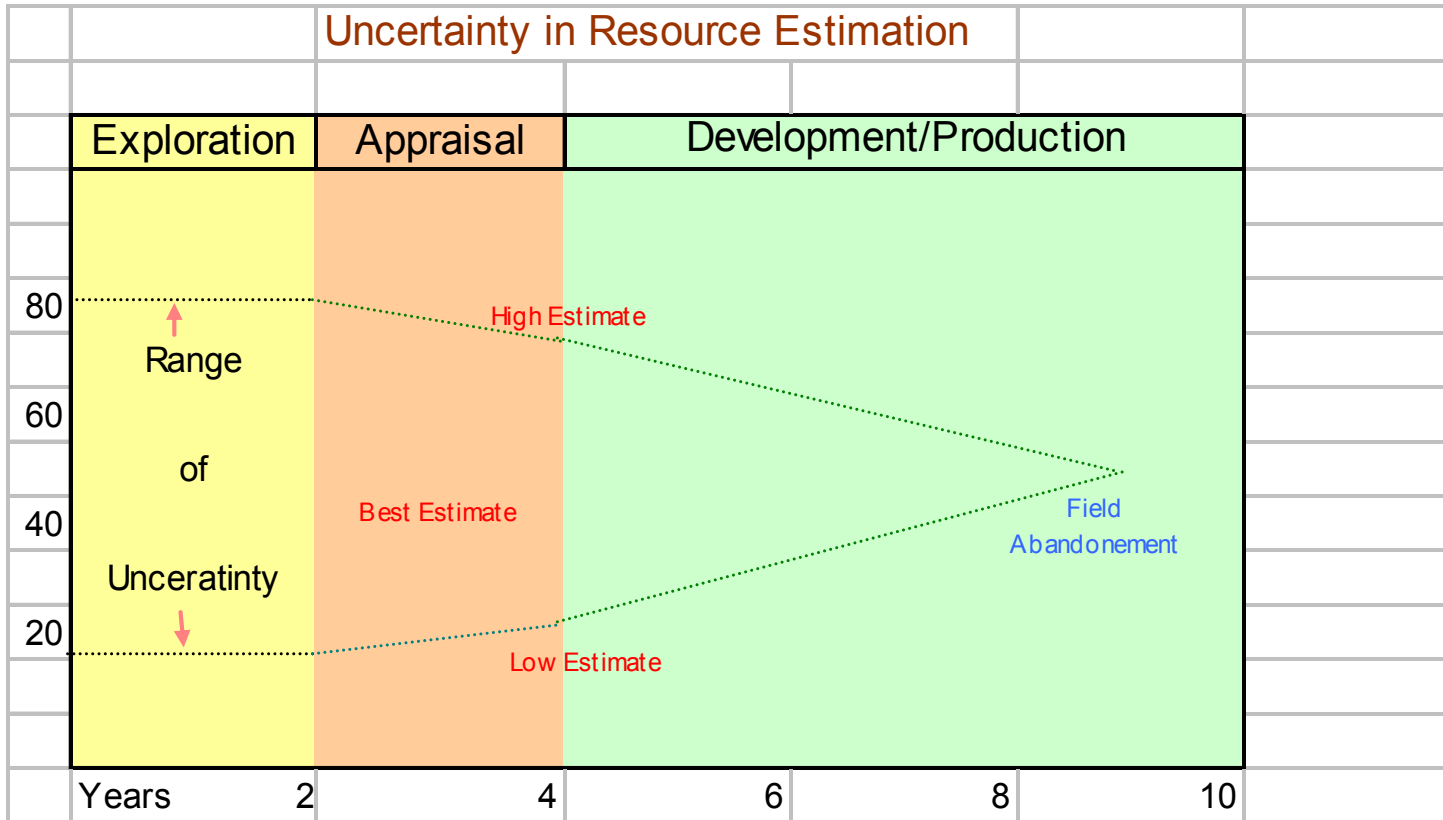
Resource and Reserve Classification System

- Petroleum is the main driving force for continued development of economy of a country.
- It is essential to know the petroleum reserve as well as any additional quantity that is expected to be available within a time frame through field development, technological advances and exploration for planning and the development of a country.

Resource and Reserve Classification System

- Petroleum reserve can not be measured directly.
- The volume is estimated on the basis of geological and engineering knowledge and principle.
- The estimate have inherent degree of uncertainty.

Resource and Reserve Classification System



Resource and Reserve Classification System

- There are almost as many definitions for reserves of oil and gas and related substances as there are evaluators, E & P companies, financial agencies, securities commission, and government departments. Each uses its own version of the definitions for its own use (Petroleum Society of CIM, 1994).
- Such a situation made it imperative to develop a universal set of definitions for reserves that can be used universally or can meet the demand of all users.

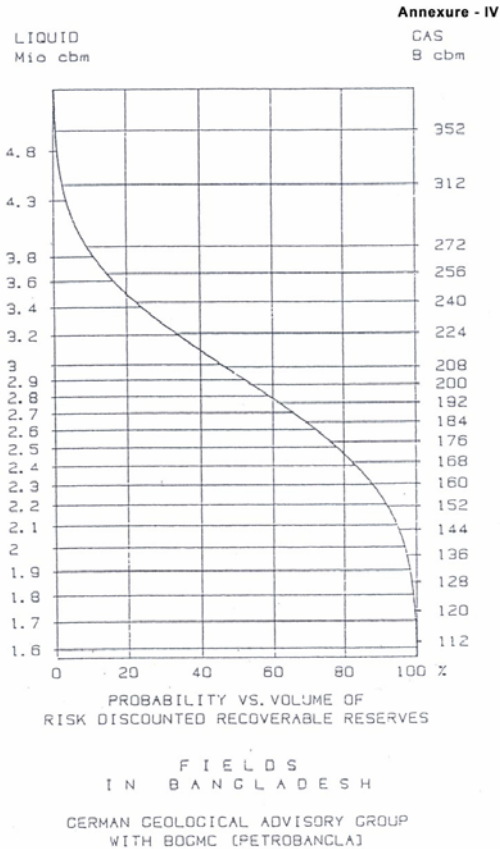
Resource and Reserve Classification System

- The traditional method known as deterministic method ignores the range of uncertainty, giving single number for each class of reserve.
- This system is most commonly used worldwide.
- The system involves selection of a single value for each parameter used in reserve estimation. The value for each parameter is selected based on estimator's determination.
- This system is widely practiced in Bangladesh

Resource and Reserve Classification System

- Probabilistic analysis involves describing a full range of possible values for each parameter.
- This approach requires computer software to perform repetitive calculations to generate full range of possible outcome and their associated probability of occurrence.

Resource and Reserve Classification System Probabilistic Method



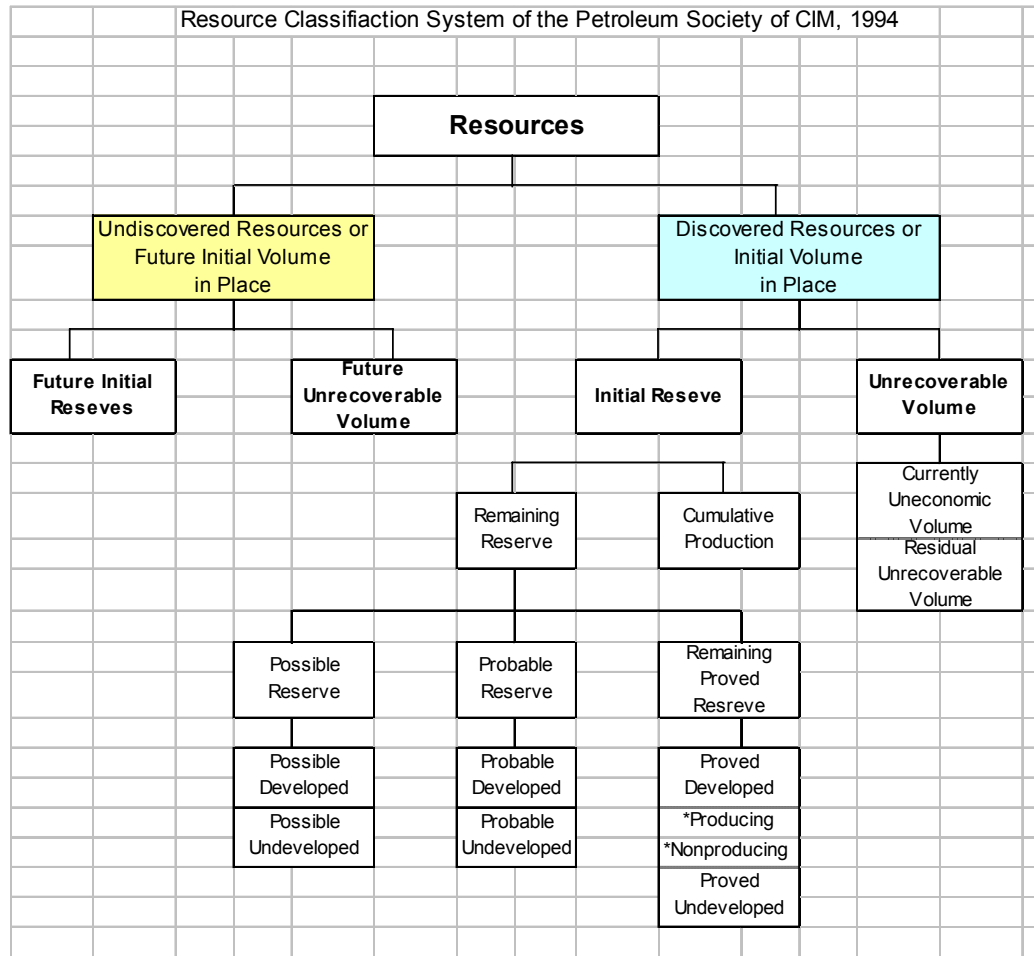
Resource and Reserve Classification System

- In 1930s API made attempts to standardize classification.
- Since then evolution of technology has intensified the need for an improved nomenclature to achieve consistency among professionals working with reserve terminology.
- SPE and WPC drafted a strikingly similar sets of reserve definitions and these were introduced in 1987.

Resource and Reserve Classification System

- In 1993 the Petroleum Society of CIM published a monograph containing a report on reserve definitions.
- In 2000 SPE, WPC and AAPG jointly approved and published "Petroleum Resources Classification and Definitions".
- The Petroleum Society published "Definitions and Guidelines for Estimating and Classifying Oil and Gas Reserve" in 2002.

Resource and Reserve Classification System



Resource and Reserve Classification System

TOTAL PETROLEUM IN PLACE	DISCOVERED PETROLEUM INITIALLY IN PLACE	COMMERCIAL	PRODUCTION		
			RESERVES		
			PROVED	PROVED plus PROBABLE	PROVED plus PROBABLE plus POSSIBLE
	DISCOVERED PETROLEUM INITIALLY IN PLACE	SUB-COMMERCIAL	CONTINGENT RESOURCES		
			LOW ESTIMATE	BEST ESTIMATE	HIGH ESTIMATE
			UNRECOVERABLE		
	PETROLEUM INITIALLY IN PLACE	PLACE	PROSPECTIVE RESOURCES		
			LOW ESTIMATE	BEST ESTIMATE	HIGH ESTIMATE
			UNRECOVERABLE		

SPE Classification

Resource and Reserve Classification System

TOTAL PETROLEUM IN PLACE	DISCOVERED PETROLEUM INITIALLY IN PLACE	COMMERCIAL	PRODUCTION		
			RESERVES		
			PROVED	PROVED plus PROBABLE	PROVED plus PROBABLE plus POSSIBLE
		SUB - COMMERCIAL	CONTINGENT RESOURCES		
			LOW ESTIMATE	BEST ESTIMATE	HIGH ESTIMATE
			UNRECOVERABLE		
	UNDISCOVERED PETROLEUM INITIALLY IN PLACE	PROSPECTIVE RESOURCES			
		LOW ESTIMATE	BEST ESTIMATE	HIGH ESTIMATE	
		UNRECOVERABLE			
			← RANGE OF UNCERTAINTY →		
SPE/WPC/AAPG Resource Classification System					

Resource and Reserve Classification System

- Debate on whether and how to include probabilistic criteria in reserve definitions has been going on for many years. Despite the inclusion of the criteria in the 1997 version of the SPE/WPC reserve definitions, the meaning of the definitions remain unclear.
(SPE 68591, Purvis & Strickland 2001)
- The definition of Proved is ambiguous as to whether the quantification of the volume should be 'estimated with reasonable certainty' or whether the presence of some amount of volume should be reasonably certain. (SPE 68591, Purvis & Strickland 2001)

Resource and Reserve Classification System

- The Coordination Committee for Coastal and Offshore Geoscience Programmes in East and Southeast Asia (CCOP) in 1999 formulated a Petroleum Resource Classification System for its member countries. The classification system was meant to be supplementary to both classification system used by the member countries and SPE/WPC classification.

Resource and Reserve Classification System

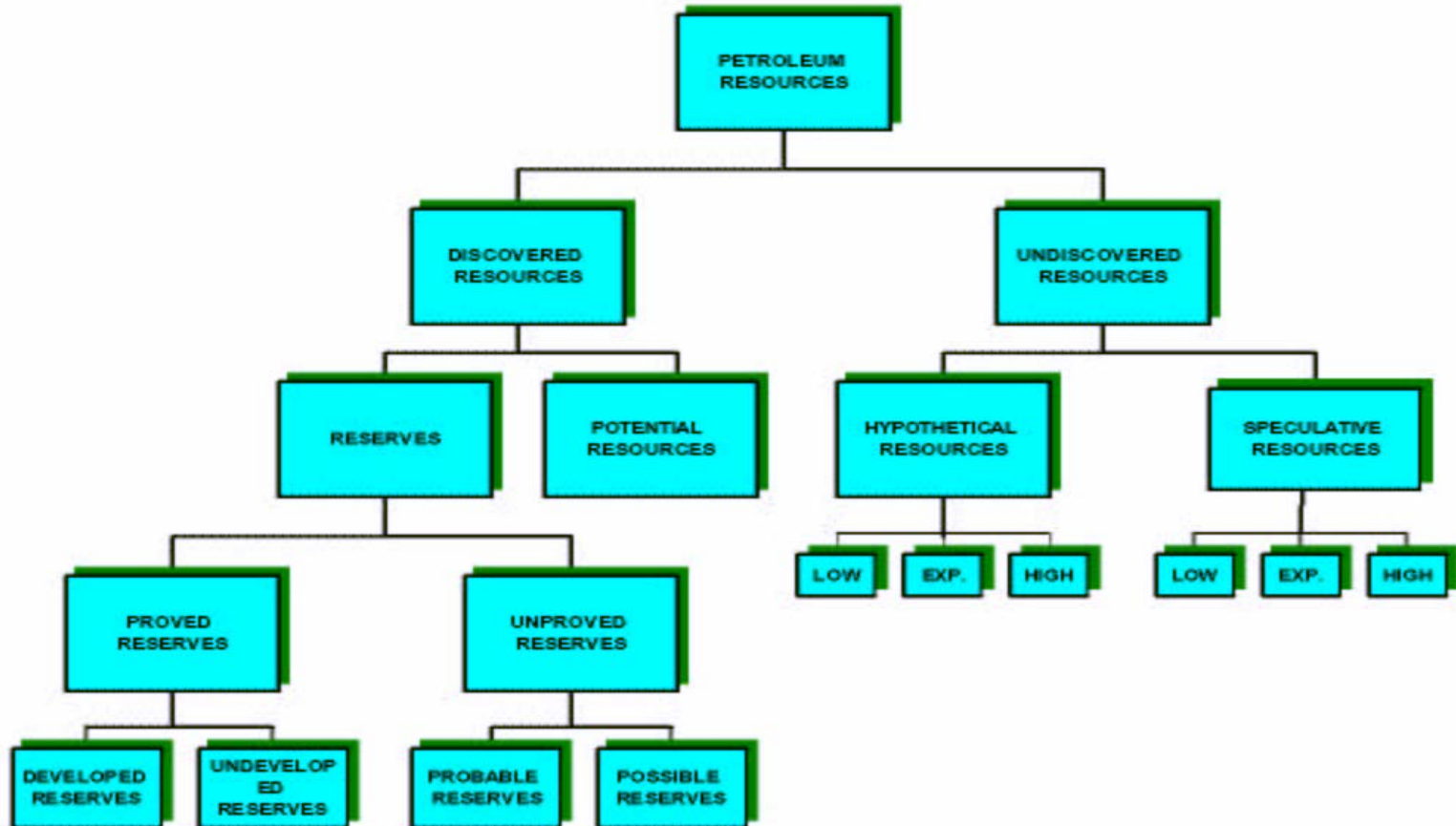


Fig : 3.1.5 CCOP Petroleum Resource Classification Chart of Recoverable Resources

Resource and Reserve Classification System

- Norwegian Petroleum Directorate annually update resource account for the expected recoverable resources, there the resources are classified according to their maturity. Such system which reflects maturity of the resources was introduced in 1997. This classification is revised with time.

Resource and Reserve Classification System

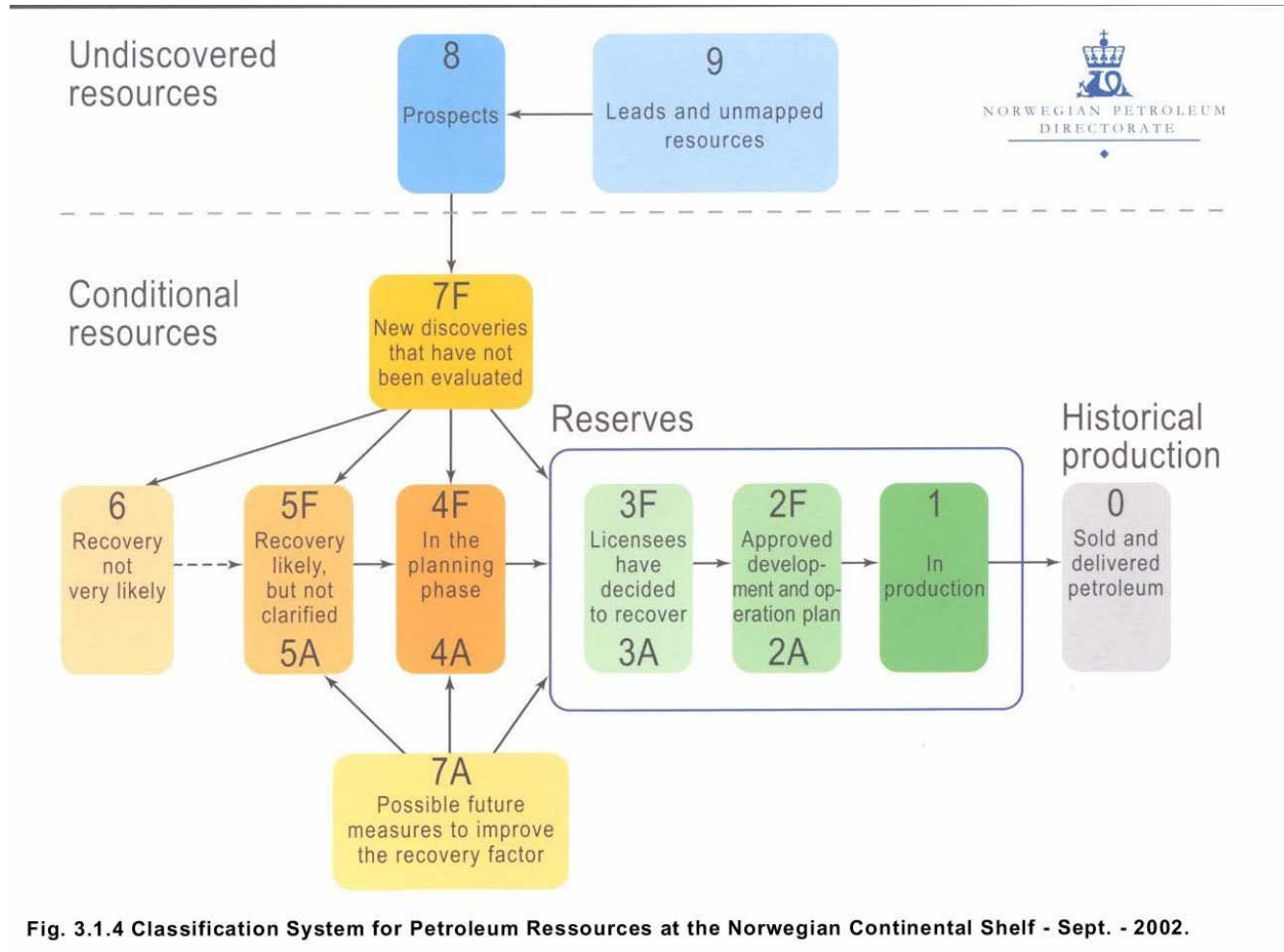


Fig. 3.1.4 Classification System for Petroleum Resources at the Norwegian Continental Shelf - Sept. - 2002.

Resource and Reserve Classification System

- To provide a methodology for evaluation of energy resources on a common ground, Economic Commission for Europe (ECE) of UNESCO in 1992 launched for solid fuel and mineral commodities its Framework Classification for reserve/resources (UNFC). The proposed UNFC system incorporated SPE/WPC/AAPG system. In 2001 UNECE Committee on Sustainable Energy established an Ad HOC Group after considering the successful work of UNFC. The classification system was presented in OPEC secretariat, EAGE Conference, AAPG Conference, SPE Annual Technical Meeting in 2003.

Resource and Reserve Classification System



UNFC for petroleum

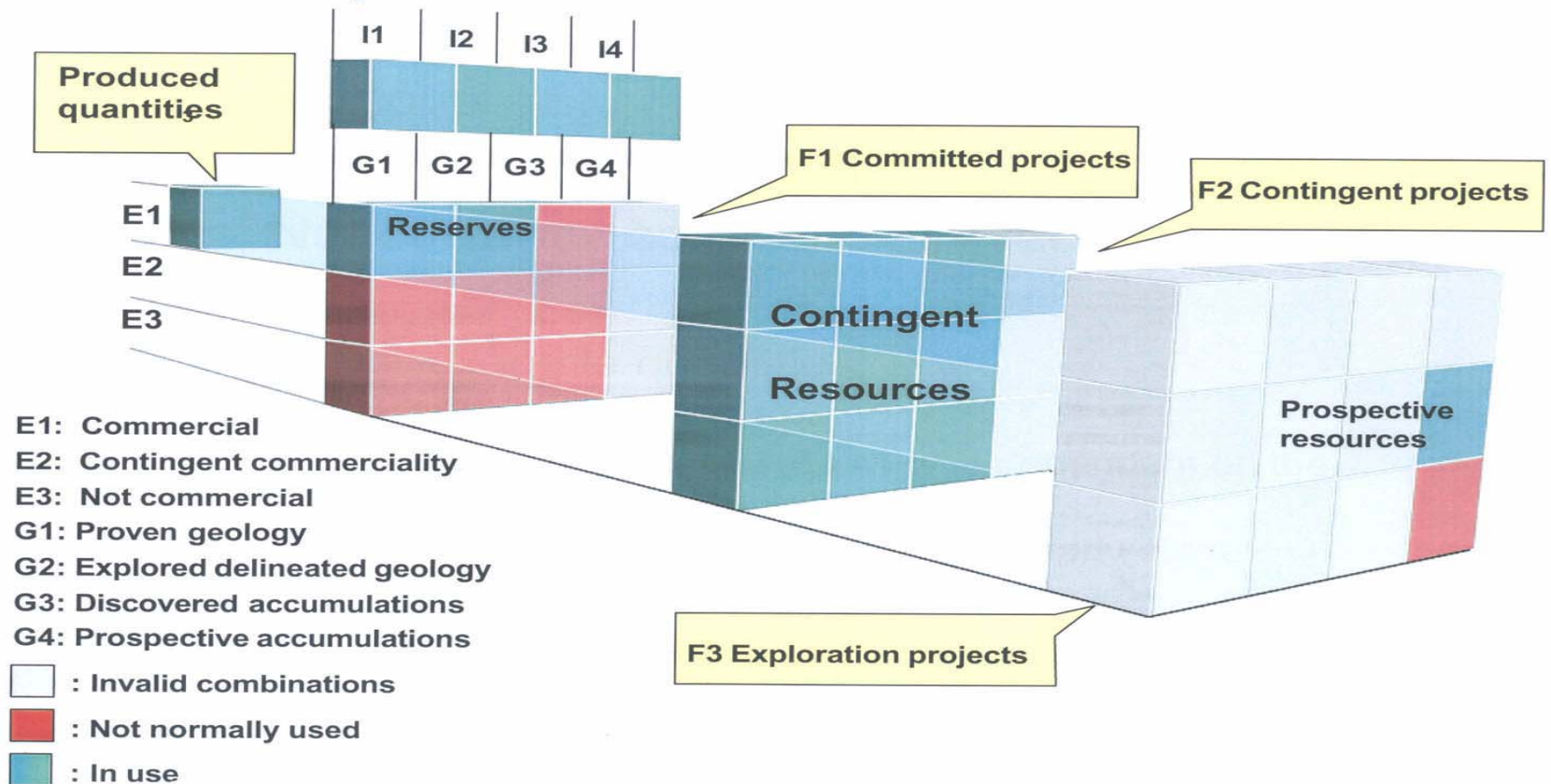


Fig. 3.1.7 Classification System for Petroleum Resources - May 2003

Resource and Reserve Classification System

- 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”:
 - US Security and Exchange Commission (SEC – 1978)
 - UK Statement of Recommended Practices (SORP – 2001)
 - Canadian Security Administrators (CSA - 2002)
 - Russian Ministry of Natural Resources (RF – 2005)
 - China Petroleum Reserves Office (PRO – 2005)
 - Norwegian Petroleum Directorate (NPD – 2001)
 - United States Geological Survey (USGS – 1980)
 - United Nations Framework Classification UNFC – 2004)
- The overall structure of, and reserves definitions within, each system were compared to the 0997 SPE/WPC reserves definitions, and the 2000 SPE/WPC/AAPG classification, the 2001 supplemental guidelines, and the 2004 glossary (hereafter referred to as “SPE definitions”).
- All though terminology varies, there is a high degree of commonality.

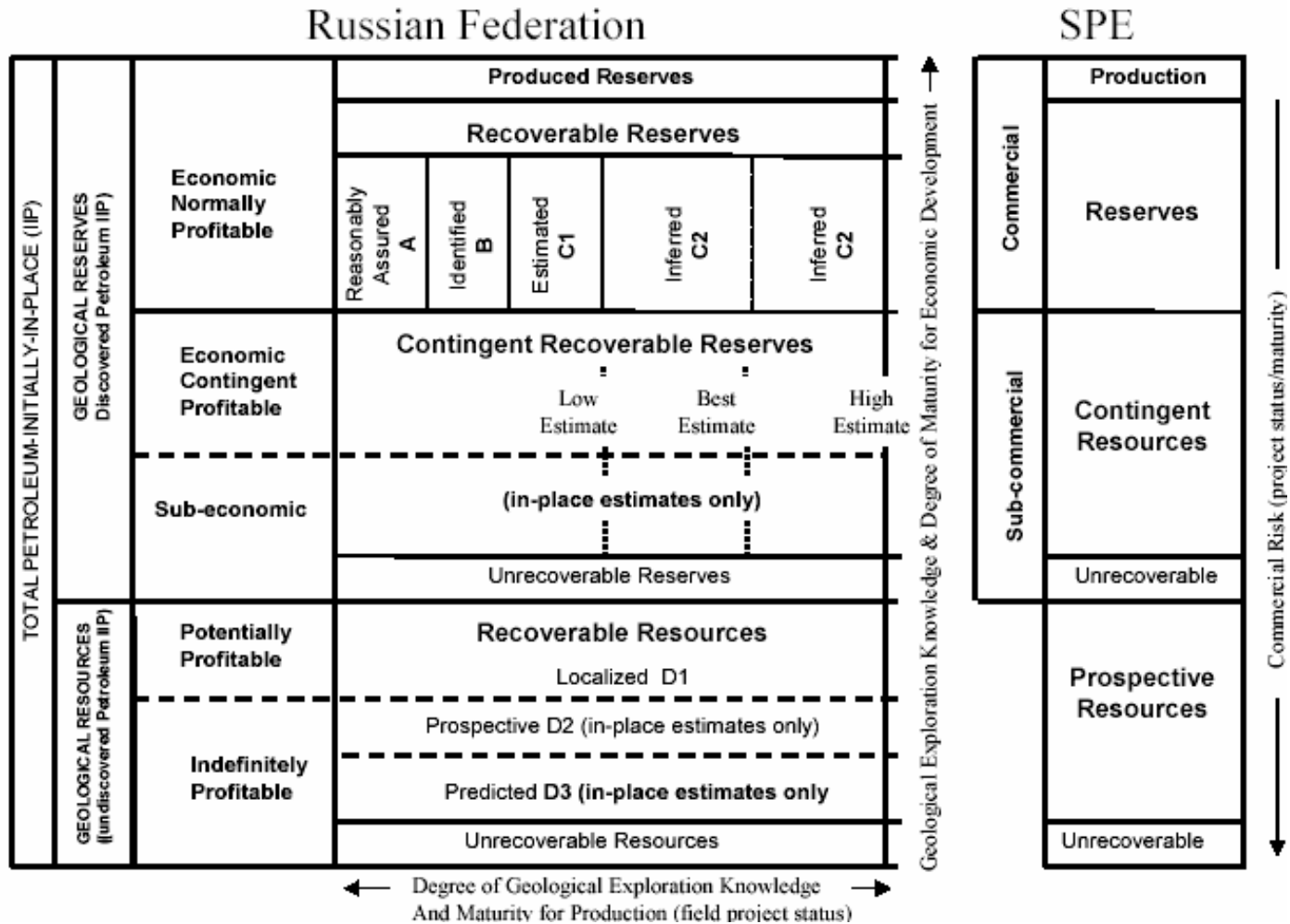
Resource and Reserve Classification System

- All systems defined 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.

Resource and Reserve Classification System

- **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 disclosure 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, uranium).**

Resource and Reserve Classification System



Resource and Reserve Classification System

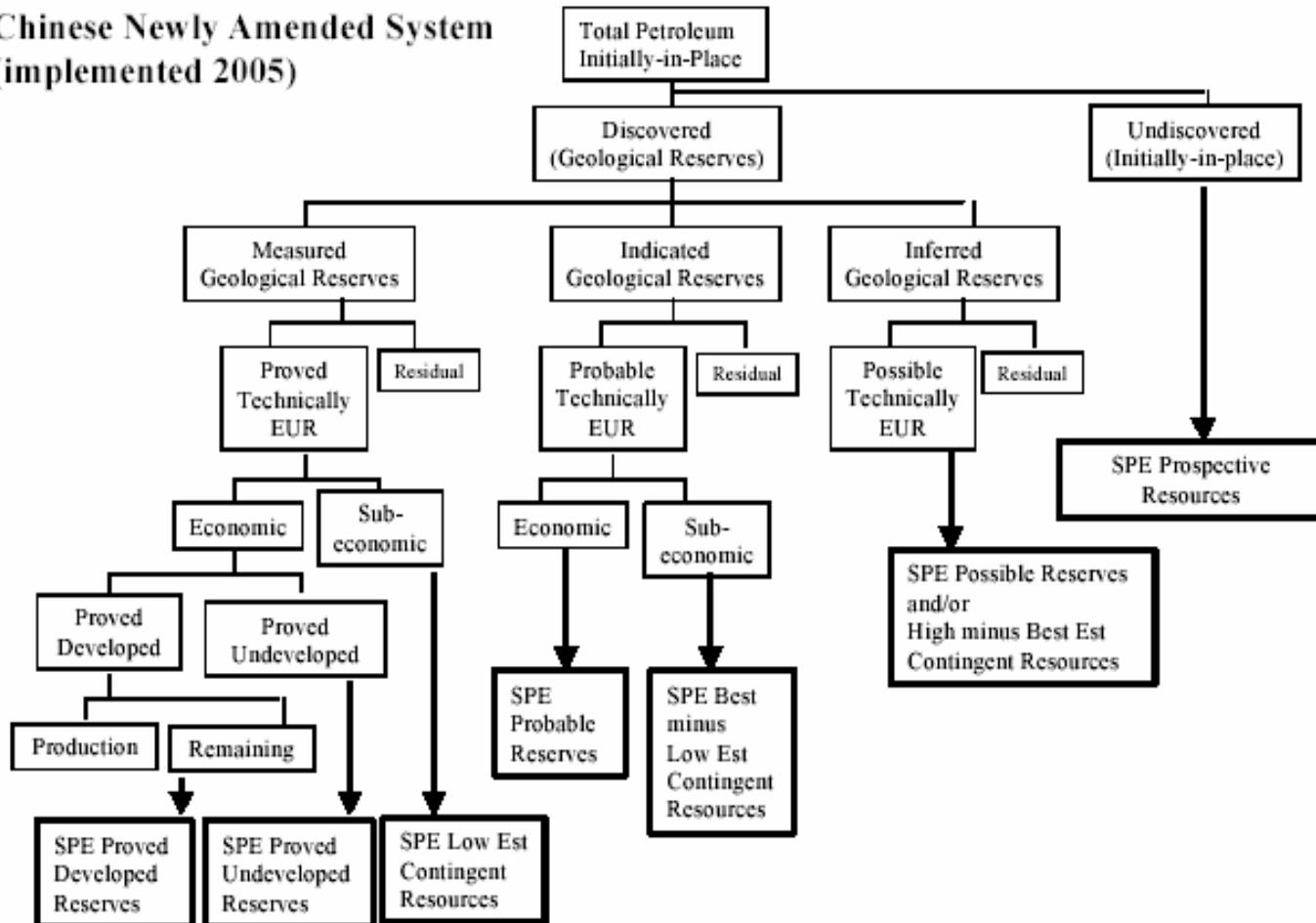
		SPE/WPC/AAPG		NPD			
TOTAL PETROLEUM-INITIALLY-IN-PLACE	DISCOVERED PETROLEUM-INITIALLY-IN-PLACE	COMMERCIAL	PRODUCTION		0	Sold and Delivered	
			P90	P50	P10	1	On Production
			RESERVES			2 F/A	Under Development
			1P	2P	3P	3 F/A	Development Committed
			...			4 F/A	Resources in Planning
	DISCOVERED PETROLEUM-INITIALLY-IN-PLACE	SUB-COMMERCIAL	CONTINGENT RESOURCES			5 F/A	Development Likely
			...			6	Development Unlikely
			...			7F/A	Being Evaluated
			UNRECOVERABLE				
			UNRECOVERABLE				
UNDISCOVERED PETROLEUM-INITIALLY-IN-PLACE	PROSPECTIVE RESOURCES			8	Prospect		
	...			9	Play and Lead		
	UNRECOVERABLE						

← Range of Uncertainty →

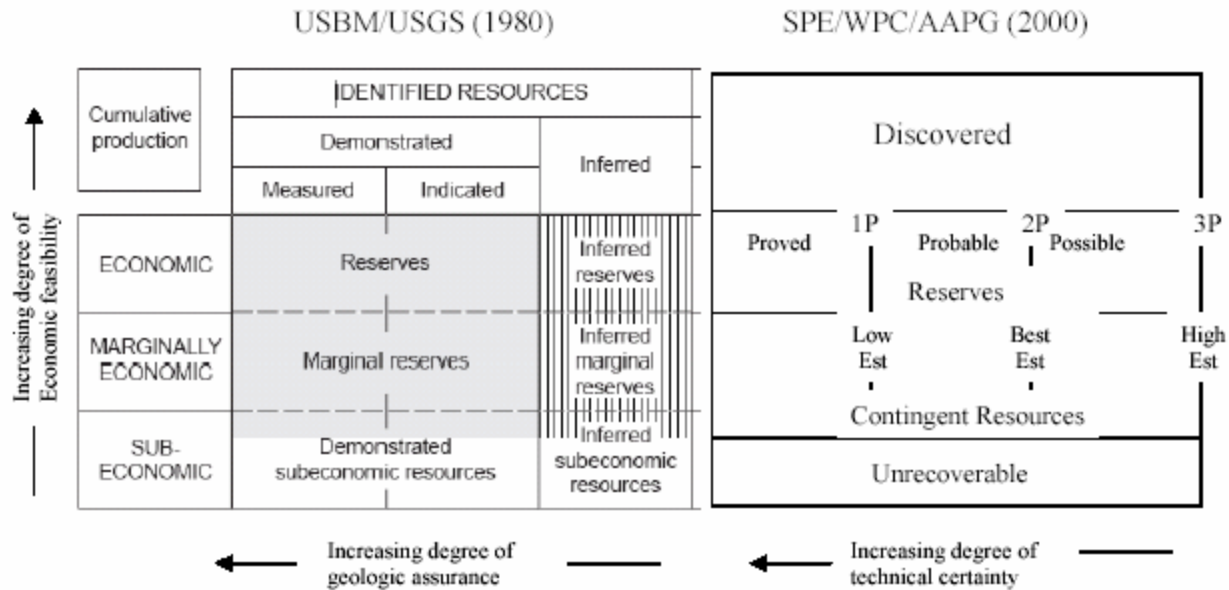
F= First recovery
A = Advanced recovery

Resource and Reserve Classification System

Chinese Newly Amended System
(implemented 2005)

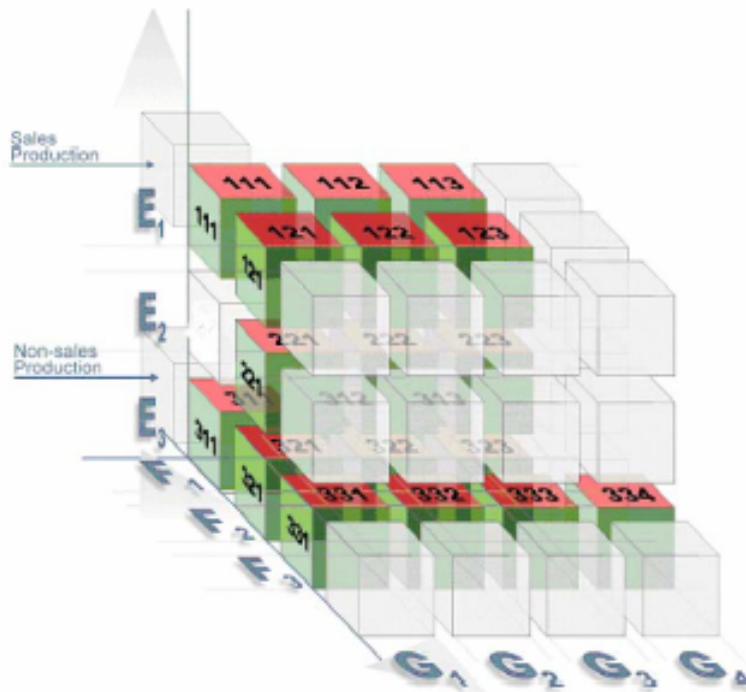


Resource and Reserve Classification System



Resource and Reserve Classification System

UNFC 2004



SPE/WPC/AAPG 2000

Reserves

1P	2P	3P
Proved	Probable	Possible
P90	P50	P10
111	112	113

Contingent Resources

Low Est	Best Est	High Est
P90	P50	P10
121	122	123
231	232	233

Prospective Resources

Low Est	Best Est	High Est
P90	P50	P10
334		

Comparison of UNFC and SPE/WPC/AAPG Classification

Resource and Reserve Classification System

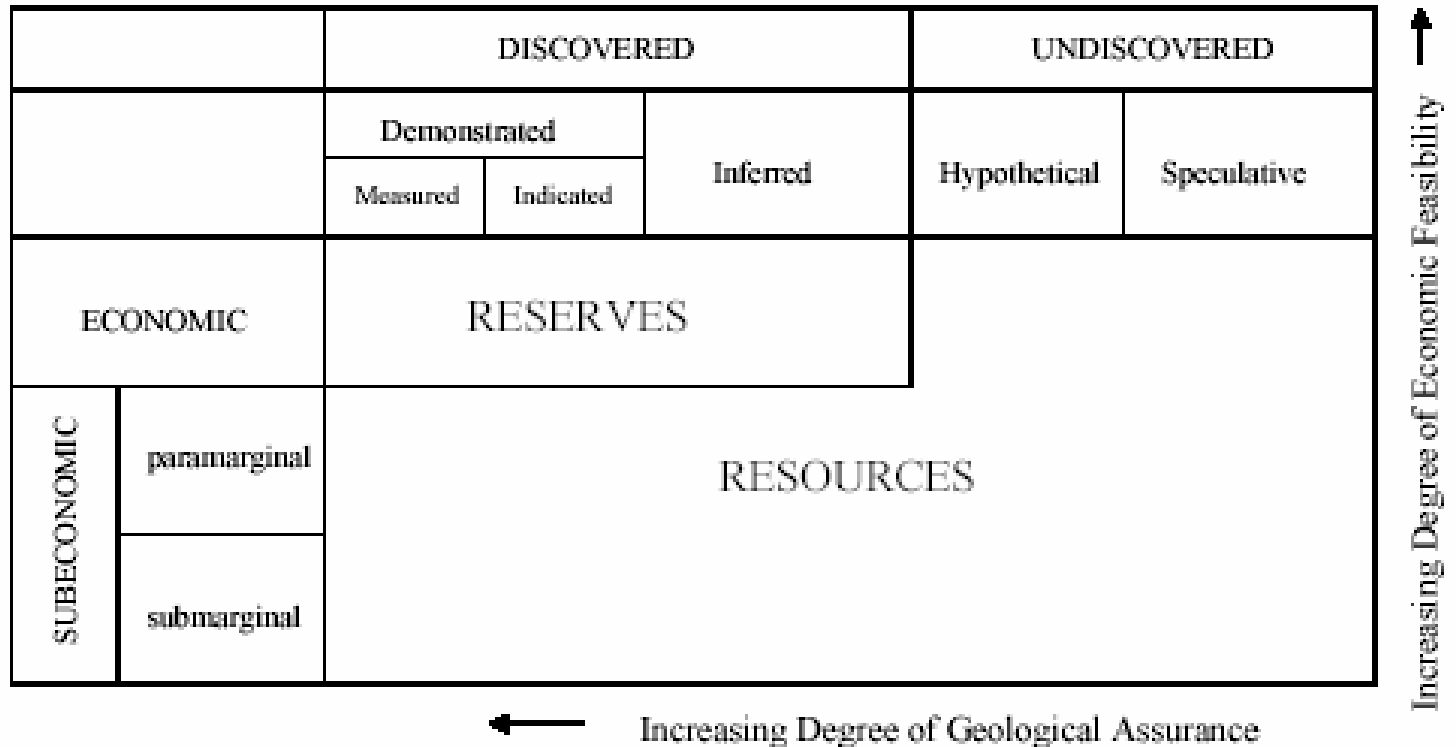


Figure 2: McKelvey Box (unmodified)

Resource and Reserve Classification System

Reserve Classification as practiced in Bangladesh

Resource and Reserve Classification System

- One of the earliest reserve estimation report (1957) was on Sylhet Gas Field. The author considered an area of 900 acre for Proven reserve. No probable reserve was assigned but Possible reserve was estimated.
- Subsequent two estimates placed total estimated volume of gas in the producing sands under proven category.

Reserve Classification in Bangladesh

Methodology followed in Bangladesh

- During early sixties state own enterprise for exploration and production (OGDC) was established with technical assistance from former Soviet Union. The soviet geoscientists used 3.14 Sq Km. or 776 acre (Max) for estimating proven reserve for single well case.
- Placement under probable and possible reserve was dependent on a number of factors like location of the well in respect to the structure. GWC etc.

Reserve Classification in Bangladesh

Methodology followed in Bangladesh

- In 1974, J. R. Carmichael of Shell estimated the reserve of Bakhrabad and the method appears to a combination of deterministic and probabilistic method.
- Probabilistic method was first applied in 1979 by Petrol Consult GmbH.
- IMEG in 1980 estimated the reserve of several gas gas fields and they followed the system derived by J. J. Arps (JPT, April 1982).

Reserve Classification in Bangladesh

Methodology followed in Bangladesh

- In Welldrill's estimate (1986) of gas reserve is not restricted by any formal guidelines of reserve definitions but the values would fit within 'proved' and 'probable' classifications. The report did not include any possible volume and recoverable reserve was not indicated.
- German Geological Advisory Group (GGAG, 1986) in Petrobangla estimated gas reserve of the country using both probabilistic and deterministic method.

Reserve Classification in Bangladesh

Methodology followed in Bangladesh

- Gasunie Engineering in 1989 did a study and used the term 'proved reserve', 'expected reserve' and 'high reserve'. Gasunie also used another term 'speculative/ possible' reserve.
- Scimitar (1989) estimated the reserve of Jalalabad. They used an area of 1000 acre and 1500 acre. This resulted in two figures for GIIP as well as Reserve.

Reserve Classification in Bangladesh

Methodology followed in Bangladesh

- Welldrill (1991) did another study on gas reserve of the country. Welldrill did not follow any formal guideline for reserve definitions. According to Welldrill in all cases the value would fit within 'Proved' and 'Probable' classification. No possible reserve was indicated.

Reserve Classification in Bangladesh

Methodology followed in Bangladesh

- Reserve of Jalalabad, Bibiyana and Moulvi Bazar gas fields were estimated by D & M. For Bibiyana gas field in absence of a Gas Sales and Purchase Agreement (GPSA) no Proven reserve was indicated. Very recently GPSA was signed and the reserve considered as Probable (PVD) can be placed under Proven category.
- For estimating reserve of Moulvi Bazar GPSA was not an issue for placing certain volume under proven category

Reserve Classification in Bangladesh

Methodology followed in Bangladesh

- From the information presented it is evident that due to the absence of an officially recognized classification system, different classification system was used.
- Petrobangla's official publication (1989) used undifferentiated proven and probable recoverable reserve. GIIP was not mentioned. In subsequent version of this publication undifferentiated proven and probable GIIP was indicated. Possible figure was not mentioned. This practice is still continuing.

Reserve Classification in Bangladesh

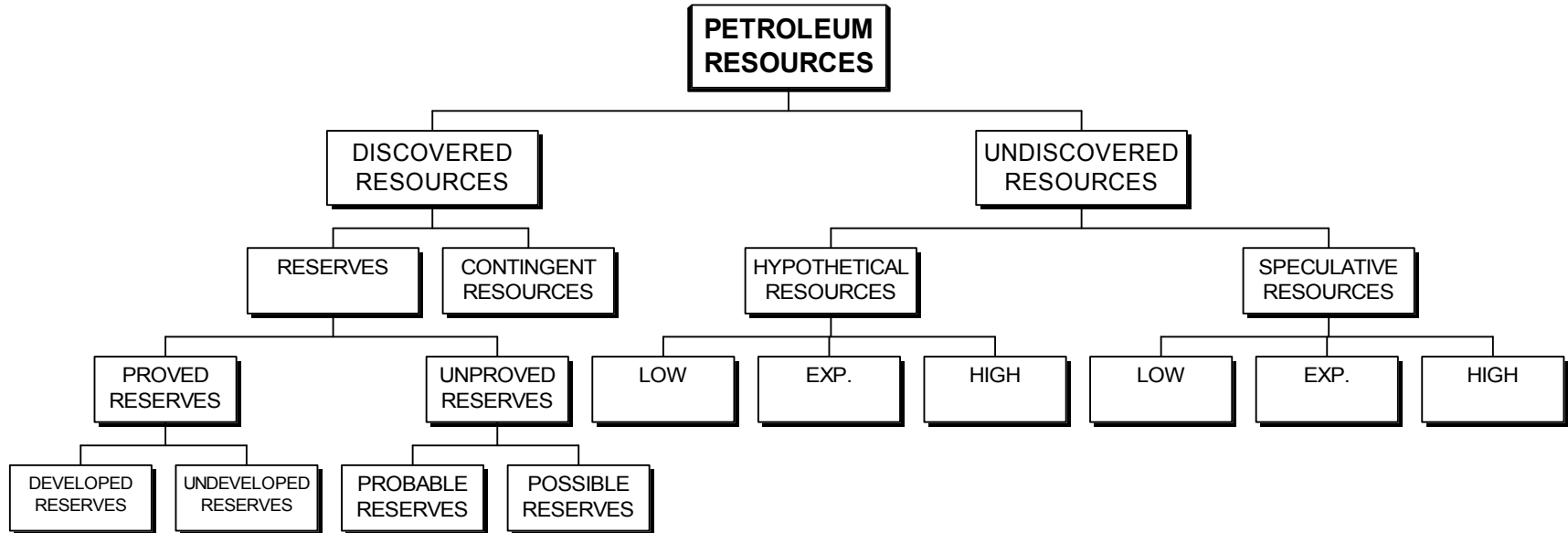
Methodology followed in Bangladesh

- In any producing field material balance method is a standard procedure for updating reserve figure.
- First such attempt was taken for updating of reserve of Sylhet field during 1960's.
- In 1986 for the first time reserve of Titas field was estimated using pressure data.
- One serious problem in continuing such study in Bangladesh is lack of data. As production and supply was running neck to neck there was no option for shutting down well(s) for pressure survey.

Reserve Classification in Bangladesh

- Introduction of any classification system for the first time is time consuming.
- HCU and Petrobangla drafted a classification system for Bangladesh. This was made part of the report 'Bangladesh Petroleum Potential and Resource Assessment 2001'.
- After review HCU and Petrobangla drafted classification system can be introduced for use in near future.

Reserve Classification for Bangladesh



Reserve Classification in Bangladesh

Increasing segregation	Discovered Resources				Undiscovered Resources	
	Discovered Resources comprise the total discovered deliverable petroleum quantities from the start of production to the cease of production, based on current understanding of the quantities in place and the recovery factor.				The total estimated petroleum to be accumulated that has not yet been discovered.	
	Reserves				Contingent Resources	
	Petroleum which are anticipated to be commercially recovered from known accumulations from a given date forward.				There are not commercially producible at present date.	
	Proved Reserves		Unproved Reserves			
	Petroleum that can be estimated with reasonable certainty to be commercially recovered.		Unproved reserves are less certain to be recovered than proved reserves.			
	Developed Reserves	Undeveloped Reserves	Probable Reserves	Possible Reserves		
These are expected to be recovered from existing wells	These are expected to be recovered from new wells	There are more likely than not to be recovered.	There are less likely than likely to be recovered.			
Increasing Certainty						
Note : The Petroleum Resource Classification System has been considered on the basis of SPE/WPC/AAPG and CCOP adopted system.						

Reserve Classification in Bangladesh

- Recovery factor is an integral part of reserve estimation. According to SPE/WPC/AAPG classification recoverable reserve is reported.
- For gas reservoirs producing by expansion drive, there is no physical reason why the gas not be recovered down to near atmospheric pressure. However production rate decreases rapidly as the pressure approaches atmospheric that some abandonment pressure is established for economic production. (Petroleum Society of CIM, 1994).
- Most depletion drive gas reservoirs with reasonable permeability will produce 70 to 90 percent of GIIP. (Petroleum Society of CIM, 1994).

Thank you for your patience