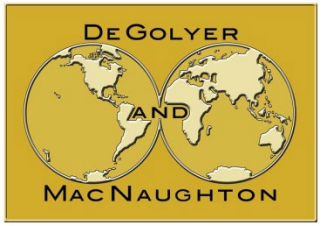
GEO INDIA 2022

Introduction to the International Classification and Categorization of Petroleum Resources

DeGolyer and MacNaughton

October 2022

Jaipur, Rajasthan, India



Worldwide Petroleum Consulting

Heritage of Independence

The First in the Field

84 Years Of Knowledge, Integrity, and Service

Independent Evaluations for the Petroleum Industry

DeGolyer and MacNaughton History

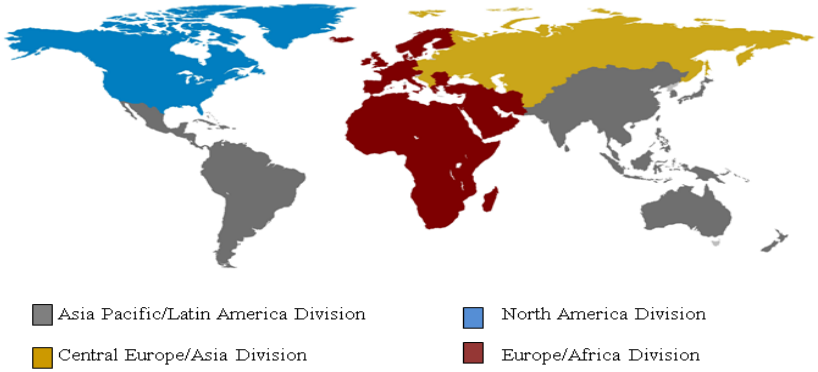
D&M has been an industry leader for more than 80 years

- Established in 1936
- Largest independent petroleum consultant in the world
  - Worldwide staff of more than 250
  - Headquarters in Dallas, Texas USA
    - Major Satellite Offices in Houston and Central Asia
    - Other Offices in Algiers, Baku, Buenos Aires, Limassol, Nur-Sultan
- Completely independent entity
  - Employee owned
- Experience in more than 100 countries and virtually every basin in the world
  - D&M currently evaluates more than 60% of the world's reserves
  - Pioneers as the first independent evaluators in Russian, Middle Eastern, Chinese, South American, and Middle Eastern unconventional reservoirs
  - 80-Percent of projects outside of North America
- Industry leader in reserves and technical evaluations

D&M Company Profile-Structure

Focused Deployment Allows Technical Personnel to Maintain Experience and Expertise

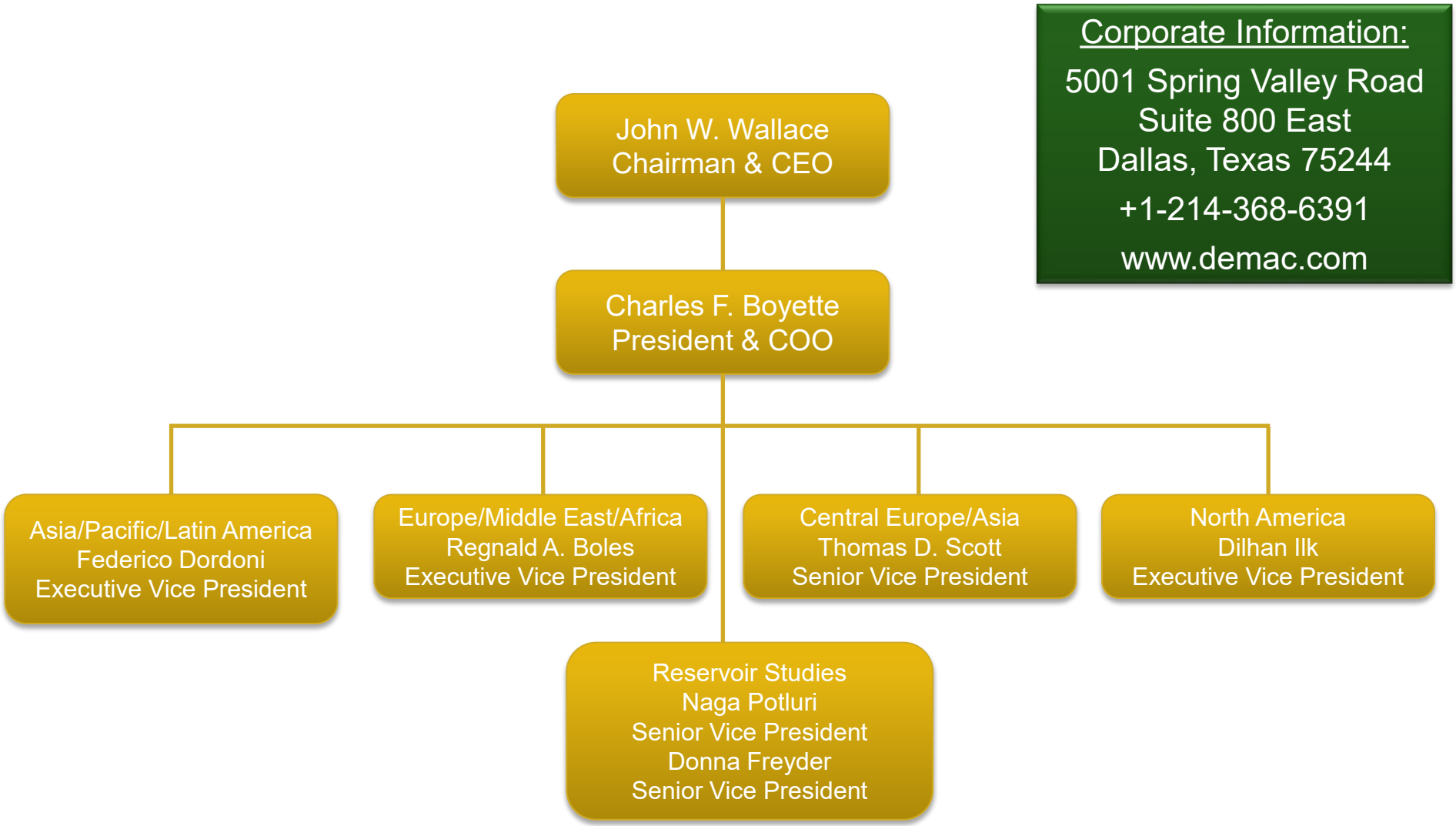
- Designed for Stability
- Organization
  - Europe/Africa Division
  - Central Europe/Asia Division
  - Asia Pacific/Latin America Division
  - North America Division
  - Reservoir Studies Division



- Dallas, Houston, Nur-Sultan, Buenos Aires, Baku, Limassol, and Algiers
  - Engineers, Geologists, Petrophysicists, Geophysicists, Economists
  - Full-Time Employees, with an Average Experience > 20 years
  - Large University-Educated Support Staff
  - Multi-Lingual
- Full Resources Range
  - Reserves ,Contingent Resources, Prospective Resources

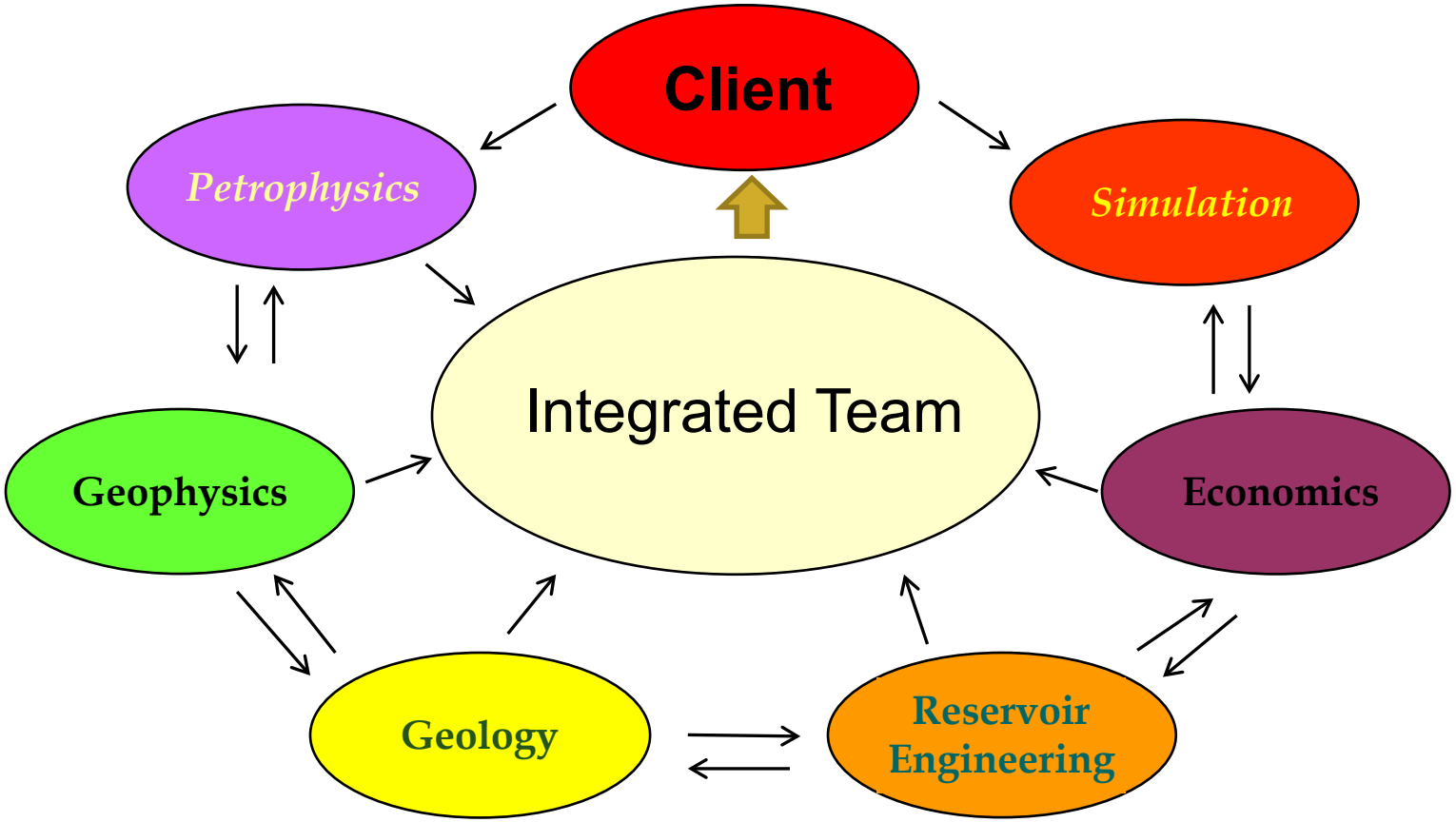
DeGolyer and MacNaughton Organization

D&M divisions are organized geographically and by discipline



Fully Integrated Approach

Client Benefits from a Full Technical Evaluation



Seminar Objectives

This seminar will:

- Explain the key concepts and definitions of the international classification and categorization of petroleum resources
- Standards (SEC, PRMS, LSE, others)
- Present definitions and guidelines for classifying and categorizing petroleum resources utilizing PRMS reserves definitions
- Explain reserve-estimation workflows technical and economic analyses used by D&M
- Explain data requirements needed to evaluate a company's net reserve position

International Petroleum Resources

- What are petroleum resources and reserves?
- What are the benefits of having international reserves?
- Why and how are reserves estimates used?
- Reserves definitions

What Are Petroleum Resources?

- Petroleum resources are estimated quantities expected to be produced from given geographic areas and geologic intervals
- Estimated recoverable quantities of:
  - Crude oil
  - Natural gas
  - Condensate
  - Natural gas liquids (NGL)
    - propane, butane, etc.
  - Associated substances
    - Helium, sulfur, etc.
- But….these quantities are not the whole story

What Are Petroleum Reserves?

- *Reserves* are limited by certain constraints:
  - Economic to produce (revenue exceeds costs)
  - Legal (license requirements and term, regulatory requirements)
  - Timing (development planned within ~ 5 years)
  - Technical (development plans, production technology)
  - Contracts (sales agreements, contractor agreements)
  - Other (market conditions, company planning, joint interest partner agreements, system infrastructure)

What Are Petroleum Reserves?

- If the answer is “yes” to all of these… then the recoverable quantities may be reserves
- If the answer is “no” to any of these… you may have technical recoverable quantities, but none may be classified as reserves

  - Have you discovered it (with a well)?
  - Can you produce it?
  - Do you have committed plan to develop it?
  - Can you produce it and sell it for a profit?
  - Are you going to produce and sell it in the not-distant future?
  - Are you allowed to produce and sell it for a profit?

What Are Petroleum Reserves?

Questions: Technical Recoverable Quantities vs. “Reserves”

- If a field has been discovered, but the company has no committed development plans for the field… are there reserves?
- If the company approves the development plans and is committed to develop the field, but the current sales price is too low and the field is not economic to develop… are there reserves?
- What if the sales price increases and the field is estimated to be very profitable, but the country where the field is located will not approve the production license or denies access to a sales/export market… are there reserves?

Answers: all “No”

What Are Petroleum Reserves?

Technical Recoverable Quantities vs. Reserves

- Technical Recoverable Quantities – have met all technical guidelines for reserves but commercial or economic viability has not been established

- Reserves – portion of technical recoverable quantities that are commercially producible
  - Approved development plan
  - Legal and regulatory requirements met
  - Sales market and sales contracts
  - Economically viable (positive future net revenue)

- "Reserves" must be economic…technical recoverable quantities may not be

Reserves Formulae

Defining EUR, Remaining Technical Recoverable Quantities and Reserves

- **EUR** = Estimated ultimate recovery
- **OOIP** = Original oil in-place, and **OGIP** = Original gas in-place
- **RF** = Recovery factor, the percent of OOIP or OGIP that is recoverable

- **EUR(oil)** = OOIP x RF, and **EUR(gas)** = OGIP x RF

- **Remaining Technical Recoverable Quantities** ("as of" a given date)
  = EUR – Cumulative production on the "as of" date

- **Reserves** (as of a given date) = That portion of the remaining technical recoverable quantities that are commercially producible

- **Reserves are always** …
  - Associated with an "as of" date
  - Remaining recoverable quantities
  - Commercially and economically producible

Reserves Formulae

Defining EUR, Technical Recoverable Quantities and Reserves

- $\underline{\text{EUR}} = \begin{matrix}\text{OOIP}\\ \text{or}\\ \text{OGIP}\end{matrix} * \text{RF}$

Where:
EUR = Estimated Ultimate Recovery
OOIP = Original Oil in Place
OGIP = Original Gas in Place
RF = Recovery Factor

- (EUR) – Cumulative Production
  DATE
  DEVELOPMENT PLAN
  RISKED
  = <u>Remaining Technical Recoverable Quantities</u>

- { (EUR) – Cumulative Production
  DATE
  DEVELOPMENT PLAN
  RISKED } **ECONOMICS**

= <u>RESERVES</u>

What Are Petroleum Reserves?

Fundamental Basis of Reserves and Resources Estimates

- Oil and gas reserves are based on interpretation of geologic and engineering data available at the time of the estimate
- Time of estimate – “as of date”
- Uncertainty-based estimate
  - Based on perceived uncertainties
    - Reservoir characteristics
    - Fluid properties
    - Development scheme
    - Market
    - Economics
  - Categorized and classified based on degrees of uncertainties

What Are Petroleum Reserves?

Assessing Risk and Uncertainties

- Reserves estimation is an inexact science
- Reserves are estimated under conditions of uncertainty
- Data from fields or reservoirs is often incomplete
- Background and experience are necessary to accurately assess reserves

What Are Petroleum Reserves?

Assessing Risk and Uncertainties

- There is a range of uncertainties (risks) associated with every reserves estimate
- How is range of uncertainty captured?
  - A scale to represent range of uncertainties
    - Proved, probable, possible
    - P90, P50, P10
    - Low, best, high, mean
- All types of uncertainty
  - Technical: porosity, area, thickness, productivity, recovery factor, etc.
  - Economic: prices, costs, returns
  - Regulatory
  - Political
  - Commitment

International Classification of Petroleum Resources

- What are petroleum reserves?
- What are the benefits of having international reserves?
- Why and how are reserves estimates used?
- Reserves definitions

Benefits of International Reserves System?

- What are the benefits of having international reserves?
  - A standard by which value and performance of assets may be compared to other companies around the world
  - Allow access to international financial institutions
    - Stock exchanges
    - Investment banks

International Classification of Petroleum Resources

- What are petroleum reserves?
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Why and How are Reserves Estimates Used?

- Companies are in business to make money and satisfy their investors
- Reserves are the assets of oil and gas companies
- Companies have to manage their assets to effectively conduct business and to meet investor (owner) expectations
- Laws or regulations require certain disclosures of reserves

Why and How are Reserves Estimates Used?

- A standard by which value and performance of the company is measured
  - Gives a “snapshot” of the company’s performance at a given date
- Allows the company and its investors to compare its performance to similar companies
  - To attract and protect investors
- Long and short term planning
  - To compare investment opportunities within company
  - To evaluate the effectiveness of investment programs

Why and How are Reserves Estimates Used?

Reporting, Planning, and Financing

- Government reporting and shareholders
  - Annual Report to Shareholders – Listed and non-listed companies
  - Energy Ministries/State Oil Company

- Financing
  - Project Finance – value of collateral
  - Borrowing Base
  - To justify capital projects
    - Processing facilities
    - Transportation infrastructure
    - LNG projects

Why and How are Reserves Estimates Used?

Project Planning and Financing

- Acquisition and Divestment
  - Reserves bookings
  - Disclosures
  - Pre-sale/purchase evaluation
  - Appraisal vs fair market value
- Tax Valuations
  - Proved reserves for depletion, depreciation and amortization
  - Ad valorem taxes assessed by states and local governments
  - Estate tax valuation
- Dispute Resolution
  - Equity determinations
  - Property trades
  - Fair market value

Why and How are Reserves Estimates Used?

Project Planning and Financing

- Proved (90% certainty)
  - Generally only category reported to U.S. regulatory agencies
  - Generally category used by lenders
- Probable (50% certainty)
  - Combined with proved, often basis for field development plans and commitments
- Possible (10% certainty)
  - Identifies upside potential and areas for further investigation and data collection within discovered accumulations

International Classification of Petroleum Resources

- What are petroleum reserves?
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Reserves Definitions

Reserves Definitions and Classification Systems

- Petroleum Resources Management System (PRMS)
  - Society of Petroleum Engineers / World Petroleum Congresses / American Association of Petroleum Geologists / Society of Petroleum Evaluation Engineers (SPE/WPC/AAPG/SPEE)
- U.S. Securities and Exchange Commission (SEC)
- London Stock Exchange (LSE)
- Government Reporting
  - Certain CIS Countries, China, Norway

Reserves Definitions

Reserves Definitions Answer These Questions…

- How are petroleum reserves and resources estimated?
  - How do we apply geoscience technologies?
  - How do we apply field performance data?
  - Economics?
  - Regulatory?
- What is specific criteria and methodology to be used?
- How are risk factors applied?

The answers depend on which definitions are used to make the estimates.

Reserves Definitions

International Reserves Definitions Through Time

- 1936-1964 : American Petroleum Institute (API)
- 1939-present : DeGolyer and MacNaughton
- 1964-1980 : Society of Petroleum Engineers (SPE)
- 1978-present : U.S. Securities and Exchange Commission (SEC)*
- 1981-1997: SPE Revised Definitions
- 1983 : World Petroleum Congress (WPC)
- 1997: SPE/WPC Joint Definitions
- 1999: SPE/WPC Resources Added
- 2007: SPE Petroleum Resources Management System (PRMS)
- 2010: SEC New Regulations
- 2018: PRMS Revised

*** Note: SEC Guidelines from 1978 did not actually define reserves**

Reserves Definitions

Different Reserve Guidelines

- Petroleum Resources Management System (PRMS)
  - Proved, probable, and possible reserves
  - Contingent and prospective resources
  - Quickly becoming the world standard
- U.S. Securities and Exchange Commission (SEC)
  - Stringent limits (technically and economically)
  - Required of any U.S.-listed company
  - Understood by financial institutions
- London Stock Exchange (LSE)
  - “Proven” and probable reserves
  - Less specific definitions
  - PRMS…ok

Resources System Overview

Important Things to Remember About Resources

- Resources Estimation is an Inexact Science
- Resources are Estimated Under Conditions of Uncertainty
- Data from Fields or Reservoir is often Incomplete
- Background and Experience are Necessary to Accurately Assess Resources