PetroSkills®

Oil and Gas Reserves Evaluation
Petroleum Resources Management System
SPE - PRMS

Public lecture in American Chamber of Commerce,
by Iskander Diyashev

Our Major Focal Point is Rules, Not Geology or Engineering

- **SPE-PRMS – 2007** Endorsed by:
  - Society of Petroleum Engineers (SPE)
  - American Association of Petroleum Geologists (AAPG)
  - World Petroleum Congress (WPC)
  - Society of Petroleum Evaluation Engineers (SPEE)
  - Sanctioned 2010 by the Society of Exploration Geophysicists (SEG)
- **SPE-PRMS – 2018** Endorsed by:
  - All of the above (SPE, AAPG, WPC, SPEE, SEG) plus
  - Society of Petroleum Well Log Analysts (SPWLA)
  - European Association of Geoscientists & Engineers (EAGE)

SPE-PRMS
1.0 Basic Principles and Definitions

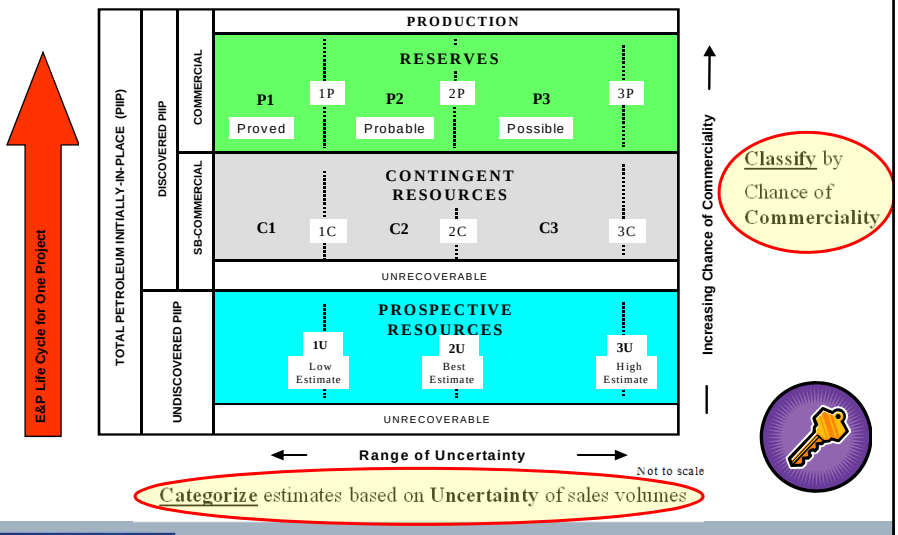
- *"The estimation of petroleum resource quantities involves the interpretation of volumes and values that have an inherent degree of uncertainty."*
- *"Use of a consistent classification system enhances comparisons between projects, groups of projects, and total company portfolios according to forecast production schedules and recoveries."*
- *"Such a system must consider both technical and commercial factors that impact the project's economic feasibility, its productive life and its related cash flows."*

1.1 Rationale for SPE-PRMS

- Create a common set of standard definitions to promote:
  - Consistency
  - Transparency
  - Reliability
- Create **the** acknowledged standard for the oil and gas industry throughout the world.
- Became the basis for much, if not most, of the SEC's "Modernization of Oil and Gas Reporting" (published 12/31/08 and effective 12/31/09)

Draft of Guidelines for Application of the PRMS. Chapter 1 p. 5

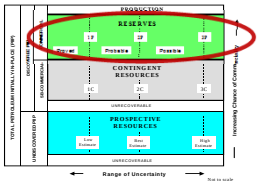
SPE-PRMS
1.1 Resources Classification Framework



SPE-PRMS
1.1 Reserves Definitions

- *"**Reserves** are those quantities of petroleum anticipated to be commercially recoverable from known accumulations from a given date forward under defined conditions."* (Must satisfy 4 Criteria)

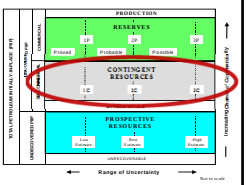
  1. **Discovered**
  2. **Recoverable**
  3. **Commercial**
  4. **Remaining**



- Based on specific development projects

SPE-PRMS
1.1 Resources Definitions

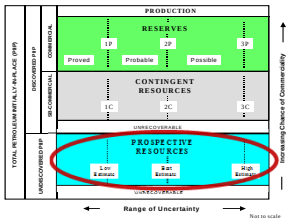
- *"**Contingent Resources** are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations, but which are not currently considered commercially recoverable."*



  - They may include:
    1. **Projects with no viable market**
    2. **Projects dependent on technology under development**
    3. **Projects in the early stage of evaluation**

SPE-PRMS
1.1 Resources Definitions

- *"**Prospective Resources** are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from undiscovered accumulations by future development projects."*
- *"It is a basic principle that Reserves & Resources quantities are by definition remaining and recoverable."*

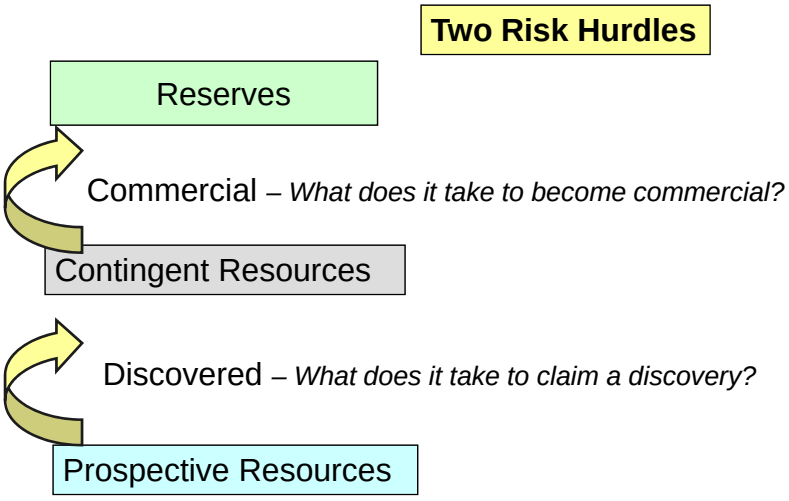


SPE-PRMS
1.2 Project Based Resources Evaluation

- **Classification framework based on a Project**

  - A project may develop one or many reservoirs, or one reservoir may be part of many projects.
  - Incremental development in a producing field (expansion of secondary recovery, infill drilling, compression, facility modification,…) or
  - Integrated development or grouping of several fields with common facilities or pipelines with a common ownership
  - One project may have quantities in several resource or reserve categories

SPE-PRMS
2.1.2 Determination of Commerciality



SPE Oil & Gas Reserves Committee

SPE-PRMS
2.1.1 Determination of Discovery Status

- Established through testing, sampling and/or logging the existence of a significant quantity of potentially moveable hydrocarbons.

- May Still Be **Reserves** or **Contingent Resources**
  - Does not require a flowing well test
  - Can be based on samples, well logs, or analogs
  - "Potentially" moveable (includes "unconventional" resources)

  Accommodates government agencies **tracking total resource base**

SPE-PRMS
2.1.2 Determination of Commerciality

- *"To be included in the **Reserves** class, there must be a high confidence in the commercial producibility of the reservoir as **supported by actual production or formation tests**."*

- ***"In certain cases**, Reserves may be assigned on the basis of **well logs and/or core analysis** that indicate that the subject reservoir is hydrocarbon bearing and is **analogous** to reservoirs in the same area that are producing or have demonstrated the ability to produce on formation tests."*

SPE-PRMS
2.1.2 Determination of Commitment

Discovered recoverable volumes (**Contingent Resources**) may be considered commercially producible, and thus **Reserves**, **if** the entity claiming commerciality has demonstrated **firm intention to proceed with development** and such intention is based upon:

SPE-PRMS
2.1.2 Basic Requirements of Commerciality - 1

- Evidence to support reasonable timetable for development
- Reasonable assessment of future economic conditions
- Reasonable expectation of market
- Evidence that facilities are or will be made available
- Evidence that legal, contractual, social, environmental, and economic concerns will be met.

SPE-PRMS 2018 UPDATE: Commerciality

- Evidence to support reasonable timetable for development
- Reasonable assessment of future economic conditions
- Reasonable expectation of market
- Evidence that facilities and will be made available
- Evidence that legal, contractual, social, environmental, and economic concerns will be met.

Economic is required as one element of commercial – it is NOT sufficient alone

SPE-PRMS
2.1.2 Basic Requirements of Commerciality - 2

The project must be economic according to criteria defined by the evaluator.

- Commitment to develop the project from the company, partners, and government approvals must be reasonably expected.
- The company commitment can be demonstrated with an approved FID (final investment decision).
- A company must establish a **verifiable** track record of consistently executing projects as planned.
- *"The basis of this assumption should be clearly documented."*

SPE-PRMS Section 2.1.2
What is a Reasonable Timeframe?

A reasonable time frame for the initiation of development depends on the specific circumstances and varies according to the scope of the project. While **five years** is recommended as a benchmark, a longer time frame could be applied.

Example potential exceptions to 5 year guidance

- Gas cap waiting on associated oil depletion (if there is a gas market)
- Major projects with longer development schedules
- A longer time frame could be applied where, for example, development of economic projects are deferred at the option of the producer for, among other things, market-related reasons, or to meet contractual or strategic objectives
- **Exceptions must be clearly documented**

SPE-PRMS
2.1.3.2 Reserves Status

Recoverable quantities may be subdivided based on funding and operational status of wells and associated facilities into:

- **Developed** (existing wells)
  - Producing
  - Non-producing
  - Shut-in
  - Behind pipe
- **Undeveloped**
  - New wells required
  - Major capital expense
    - Deepening, facilities, injection, deep water recompletion

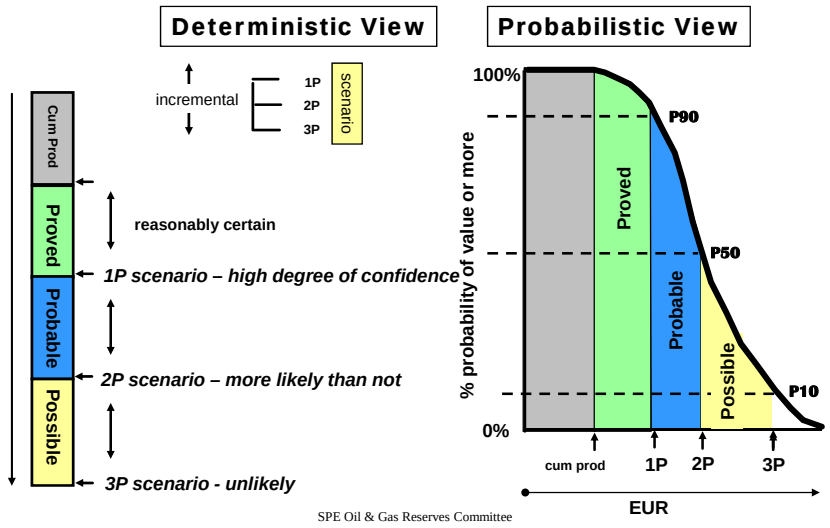
SEC has only two Status Classes
DEVELOPED or UNDEVELOPED

SPE-PRMS
2.2.1 RANGE of UNCERTAINTY

- Deterministic methodology
  - Best estimates of reservoir parameters combined to achieve a single point result.
- Probabilistic (stochastic) methodology
  - Ranges are determined for all reservoir parameters and probabilities are assigned to the various configurations.

	Deterministic	Probabilistic
Proved	Reasonable Certainty	At least 90% probability
Probable	More likely than not	At least 50% probability for sum of proved plus probable
Possible	Less likely than not	At least 10% probability for sum of proved plus probable plus possible

SPE-PRMS
2.2.1 RANGE of UNCERTAINTY



SPE Oil & Gas Reserves Committee

Range of Uncertainty Comparisons

- In each **PRMS classification**, the range of uncertainty is characterized by 3 different scenarios reflecting the low, best, and high estimate of future recoverable volumes.
- **Reserves**: Proved (1P), Proved + Probable (2P) or Proved + Probable + Possible (3P)
- **Contingent Resources**: 1C, 2C or 3C
- **Prospective Resources**: Low Estimate (1U), Best Estimate (2U) or High Estimate (3U)

Draft of Guidelines for Application of the PRMS. Chapter 2 p. 13

Which Estimate is Best?

- **The purpose and use of the reserves report must be considered.**
  - Oil companies generally use the “best estimate” or the “expectation case” which is usually a Proved + Probable estimate or a P50 estimate for project evaluation.
  - Investors, banks, accountants, regulatory bodies, utilities, and others nearly always demand a Proved or P90 estimate.
  - Investors and regulatory bodies also like to see the “best estimate” for their planning.

Draft of Guidelines for Application of the PRMS. Chapter 6 p. 83

SPE-PRMS
2.2.2 PROVED RESERVES

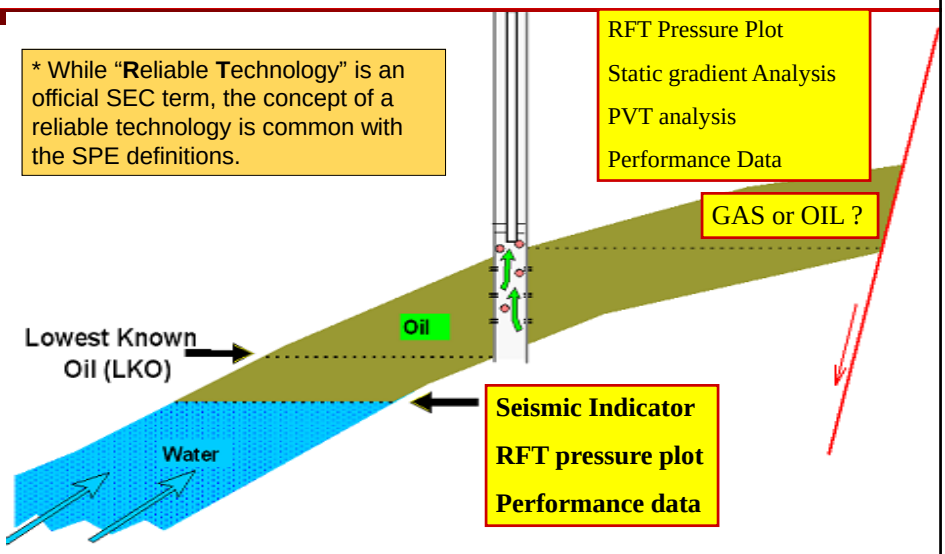
- *"**Proved Reserves** are those quantities of petroleum which, by analysis of*
- ***geoscience** and **engineering** data,*
- *can be estimated with reasonable certainty to be **commercially recoverable**,*
- *from a **given date forward**,*
- *from **known reservoirs** and*
- *under **defined economic conditions**, **operating methods**, and **government regulations.**"*

SPE-PRMS
2.2.2 PROVED RESERVES – Table 3

- *"In the **absence** of fluid contacts, Proved quantities in a reservoir are **limited by the lowest known hydrocarbon (LKH) as seen in a well penetration***
  - *unless otherwise indicated by definitive geoscience, engineering, or performance data.*
  - *Such definitive information may include*
    - *Pressure gradient analysis and*
    - *Seismic indicators.*
    - *Seismic data alone **MAY** not be sufficient to define fluid contacts for Proved reserves."*

DEFAULT CASE – ADDITIONAL DOWNDIP AREA REQUIRES ADDITIONAL JUSTIFICATION

SPE-PRMS Endorses Use of Reliable Technology* to Define Reservoir Limits – Similar in New SEC Rules



SPE-PRMS
PROVED UNDEVELOPED RESERVES ("PUD")

- Locations in undrilled areas that can be judged with reasonable certainty to be commercially productive.
- Interpretations of available geoscience and engineering data indicate with reasonable certainty that the objective formation is laterally continuous with drilled locations
- Locations are within the known proved area

SPE-PRMS
2.2.2 PROBABLE RESERVES

- May be estimated by either deterministic or probabilistic methods
- Located in "Known" Reservoirs
- Those additional reserves which analysis of geoscience and engineering data indicate are less likely to be recovered than proved reserves but more certain to be recovered than possible reserves.
- In this context, when probabilistic methods are used, there should be at least a 50% probability that the quantities actually recovered will equal or exceed the sum of the estimated proved + probable (2P) reserves.

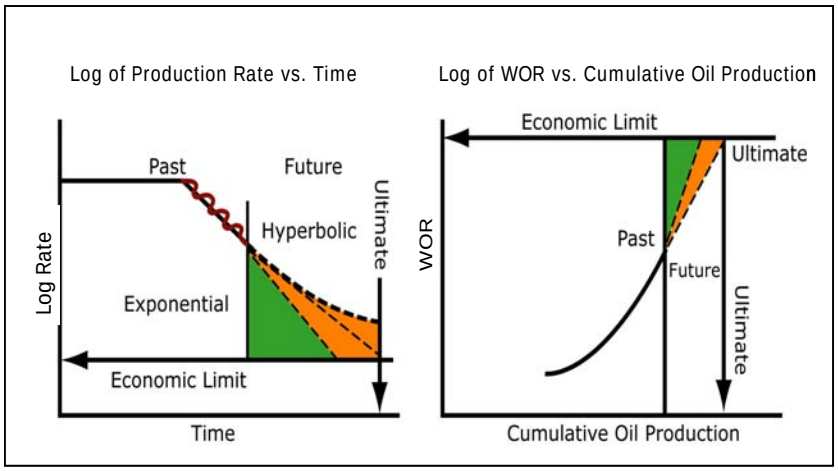
SPE-PRMS
PROBABLE RESERVES – Table III

- ***"Caution** should be exercised in assigning Reserves to adjacent (untested) reservoirs isolated by major, potentially sealing, faults until this reservoir is penetrated and evaluated as commercially productive."*
- *"Justification for assigning Reserves should be **clearly** documented."*
- *"Reserves should NOT be assigned to areas that are clearly separated from a known accumulation by non-productive reservoir (absence of reservoir, structurally lower, or negative test results)"*
  - Exceptions May Include:
    - Fault Blocks with Seismic Attributes Analogous to Proved Reservoirs

SPE-PRMS
PROBABLE RESERVES

- Typical Examples
  - Volumes below “lowest known” hydrocarbons
  - Incremental recovery factor greater than RF used for proved. Enhanced recovery without successful testing
  - Untested zones without good analogy, based on log data only
  - Fault blocks without penetrations if clearly supported and documented based on new technology or analogy
  - Certain step-out development wells
  - Alternative performance interpretation

ALTERNATE PERFORMANCE INTERPRETATIONS



SPE-PRMS
2.2.2 POSSIBLE RESERVES

- May be estimated by either deterministic or probabilistic methods
- Located in "Known" Reservoirs
- Those additional reserves which analysis of geoscience and engineering data indicate are **less likely** to be recovered than probable reserves.
- In this context, when probabilistic methods are used, there should be at least a **10% probability** that the quantities actually recovered will equal or exceed the sum of the estimated proved + probable + possible (3P) reserves.

SPE-PRMS
POSSIBLE RESERVES

- Typical examples
  - Areas further removed from geologic control
  - Geophysically defined limits
  - Questionable log analysis
  - Questionable commerciality

Fault blocks without penetrations if clearly supported and documented that do not qualify as probable

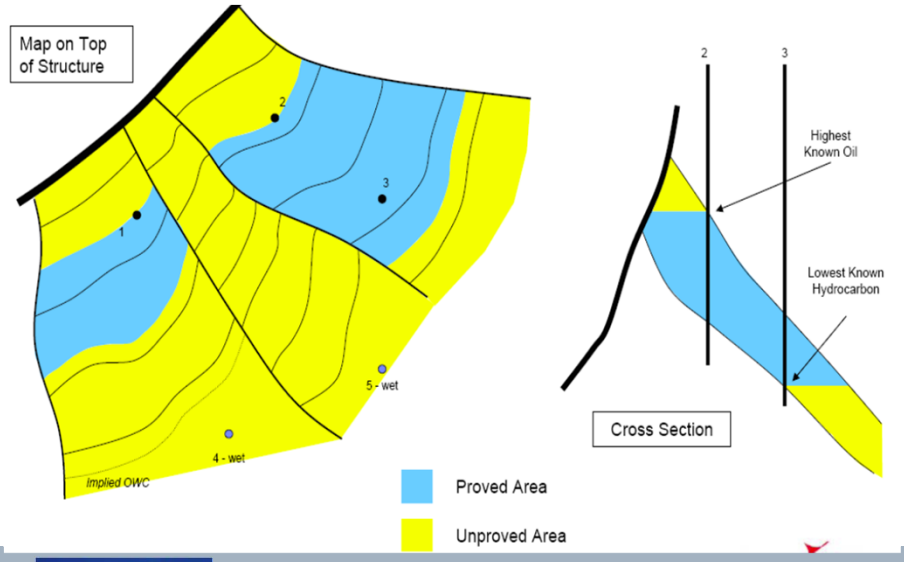
  - Enhanced recovery possibilities

2018 SPE PRMS – Stand-alone Possible reserves

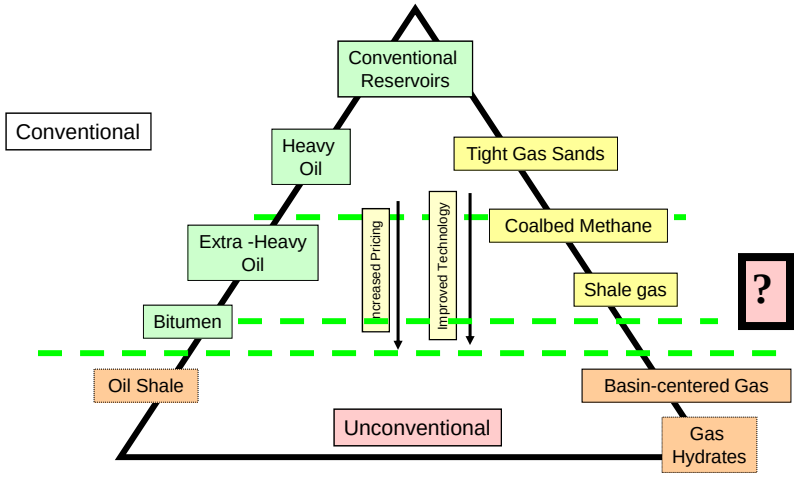
- What are “stand-alone” Possible reserves?
- ✓ Reserves in a project that does not have any Proved or Probable reserves – either in the operator’s or any nearby industry projects.
- Why no “stand-alone” Possible?
- ✓ Since reserves are shown economic based on 2P values, any stand-alone Possible project will have no 2P, thus, be uneconomic.

POP QUIZ

POP QUIZ



SPE-PRMS Unconventional Resources



(Modified from Holditch, JPT Nov. 2002)
(SPE Oil and Gas Reserves Committee)

Unconventional Resources

- Pervasive throughout a large area
- In many cases, commerciality is still not determined and usually requires specialized extraction technology or processing and higher prices.
- Typically reserves are only attributed after a successful pilot, and proof of commercial sustainability with current technology, otherwise
- Volumes remain in the Contingent Resource category

Draft of Guidelines for Application of the PRMS. Chapter 8 p. 118

SPE-PRMS
3.1 Commercial Evaluations

- Commerciality includes:
  1. Commitment to Develop
  2. Technical Viability
  3. Assumptions of Financial Conditions
  4. Marketing
  5. Legal
  6. Environmental
  7. Social
  8. Governmental
  9. Economic Project

SPE-PRMS
3.1.1 Cash Flow Based Resource Evaluation

- Cash Flow Input Parameters – Project Based
  - Production Profile
  - Estimated Capital Costs
  - Estimated Operating Expenses
  - Estimated Environmental Liabilities (Safety, Abandonment)
  - Entity Forecast Conditions (Prices, inflation, etc.)
  - Estimated Revenues
  - Project Life Less Than Entitlement Period
  - Application of Appropriate Discount Rates to Estimate NPV
    - Future price conditions must be based on "reliable data"

PRMS
3.3.3 Contract Extensions or Renewals

- *"Reserves should not be claimed for those volumes that will be produced beyond the end date of the current agreement unless there is a **reasonable expectation** that an extension, a renewal, or a new contract will be granted."*
- Reasonable expectation may be based on historical treatment of similar agreements by the license issuing jurisdiction.
- Otherwise, production beyond the current agreement should be classified as a Contingent Resource.

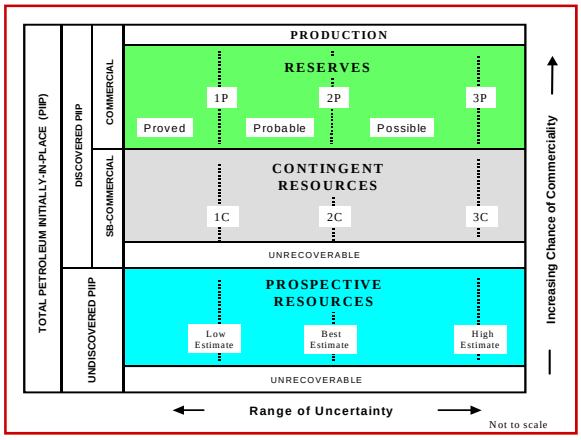
SPE-PRMS
4.0 Estimation of Recoverable Quantities

Acceptable Analytical Procedures

- Analogy
- Volumetric Estimates
- Performance Based
  - Material Balance Reservoir
  - Simulation Modeling
  - Production Decline Analysis
  - Ratios vs.. Cumulative

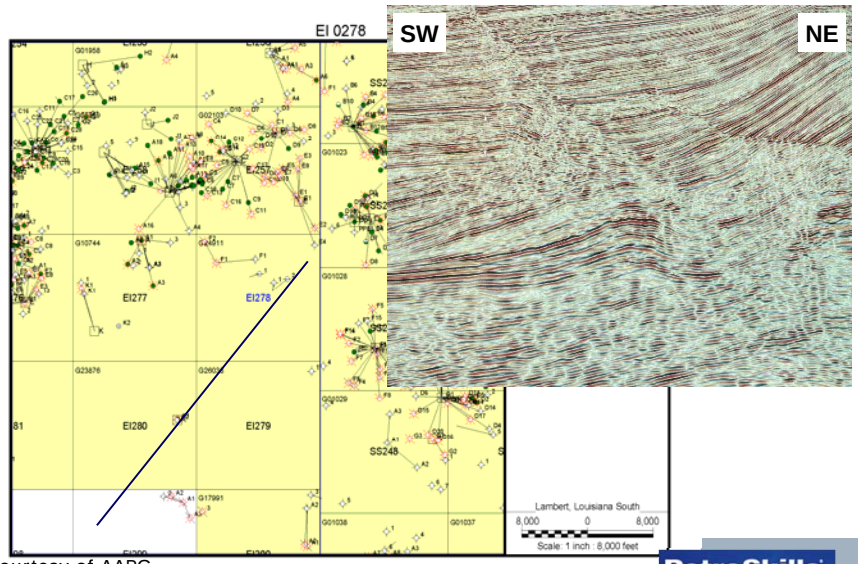
SPR-PRMS LET's REVIEW OUR RESOURCE CLASSIFICATIONS

- Example Courtesy of AAPG by
  - John Hodgin & Ron Harrell



Courtesy of AAPG

Now What SPE-PRMS Class is This?



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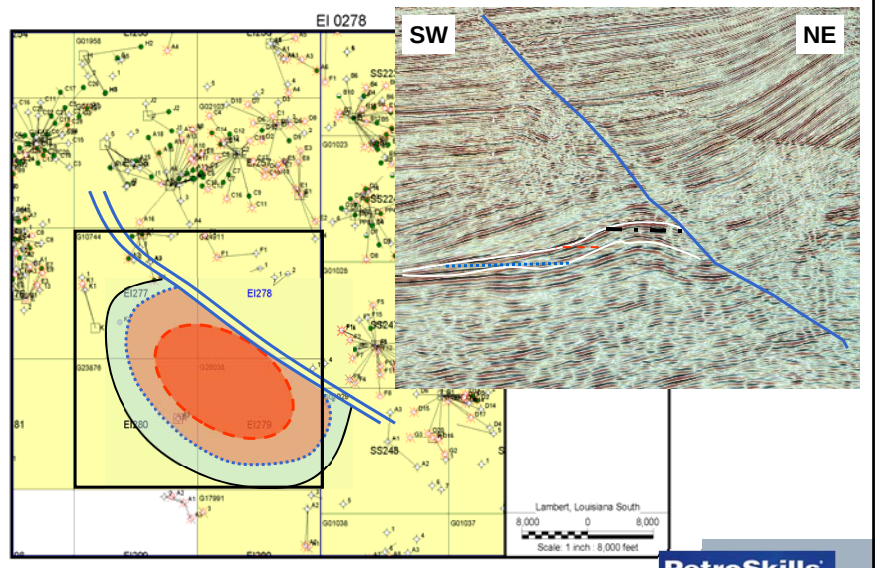
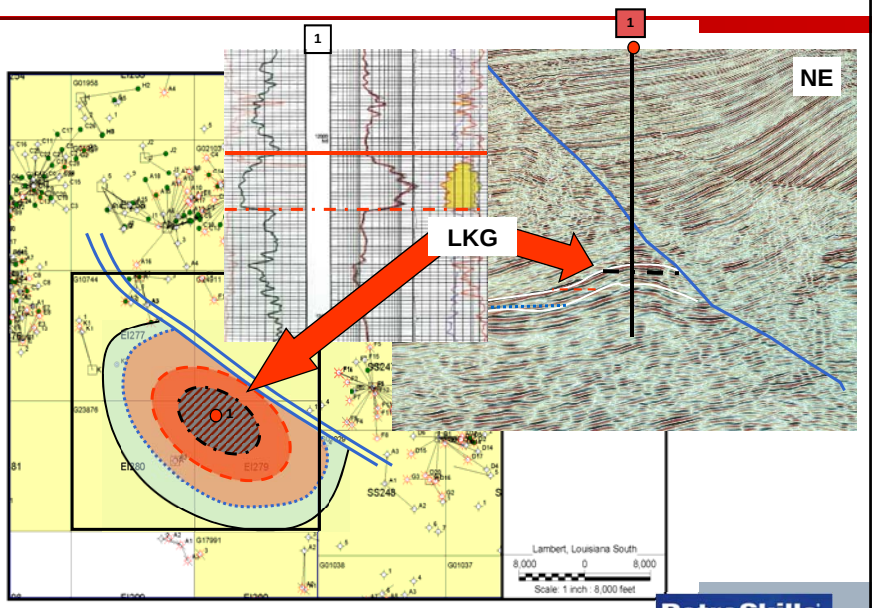
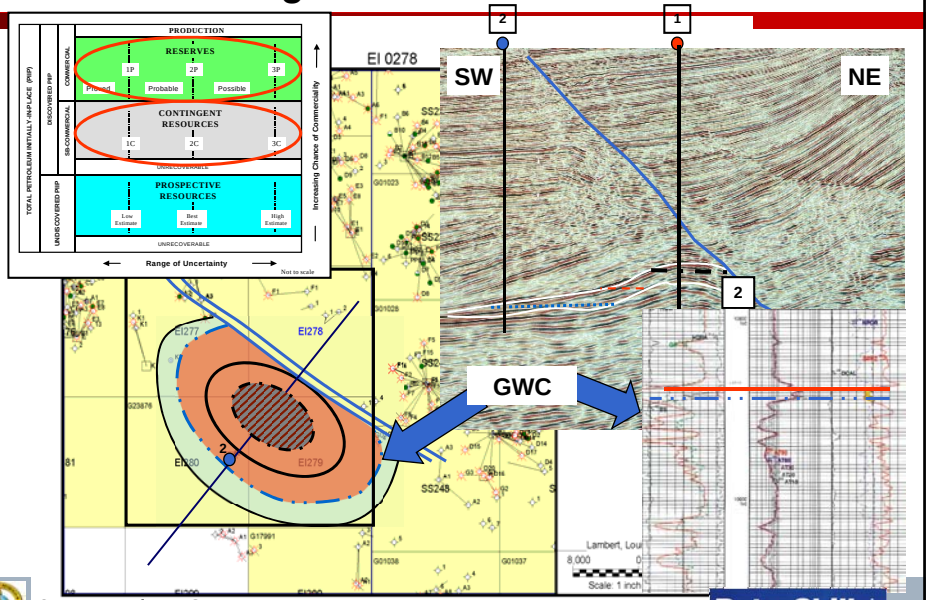


Now What Class?

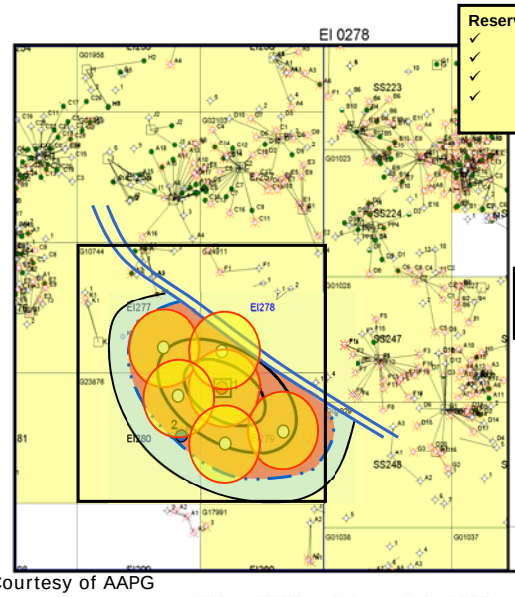


We Drill an Appraisal Well
Have We Changed Class Yet?



Courtesy of AAPG

We Have a Development Project
What Do We Need To Book Reserves?



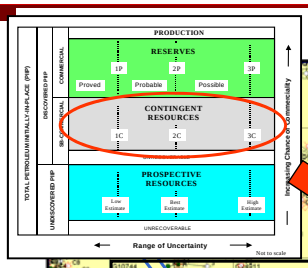
Reserves Must Satisfy Four Criteria, they must be:
- ✓ Discovered
- ✓ Recoverable
- ✓ Commercial
- ✓ Remaining in projects applied

•Wells to hold each lease
•Establish technical drainage area/well

Test Economic Viability & Commerciality

Courtesy of AAPG

We Have a Development Project
Are We There Yet?



3 Well Development Plan
Does not meet governmental requirements
- ✓Develops 70% of total resources
- ✓**Does meet company ROR requirements** by reducing CAPEX by 50% for fewer wells

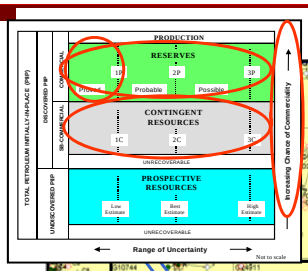
6 Well Development Plan
- ✓Meets governmental requirements to hold leases
- ✓Develops 90% of total resources

Does not meet company ROR requirements

Apply for MMS Exception to Hold Leases
•Same partners & ownership each in each block

Courtesy of AAPG

Field Development Plan



Reserves
✓**Proved reserves for 3 development wells**

Reserves & Contingent Resources

✓**Proved for 3 development wells**

✓**Contingent resources for remaining volumes IF case for larger drainage area cannot be justified**

✓ **But Probable and/or Possible if case is justified**

MMS GRANTS EXCEPTION

Courtesy of AAPG

Summary

- Proved reserves
  - 'Reasonable certainty' clarified
  - Much more likely than not; 90% probability
- Probable reserves
  - As likely as not; 50% probability
- Possible reserves
  - Possible, but not likely; 10% probability

POSS	POSS	POSS	POSS	POSS	POSS	POSS
POSS	PROB	PROB	PROB	PROB	PROB	POSS
POSS	PROB	PUD	PUD	PUD	PROB	POSS
POSS	PROB	PUD	☆	PUD	PROB	POSS
POSS	PROB	PUD	PUD	PUD	PROB	POSS
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