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)
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)
SPE-PRMS
1.1 Resources Classification Framework

- **Resources Classification Framework**
  - Categorize estimates based on uncertainty of sales volumes.

- **E&P Life Cycle of a Project**
  - **Reserves**
    - Proved (P1)
    - Probable (P2)
    - Possible (P3)
  - **Contingent Resources**
    - Probable (P1C)
    - Possible (P2C)
    - Commercial (P3C)

- **Prospective Resources**
  - High (3P)
  - Medium (2P)
  - Low (1P)

- **TOTAL PETROLEUM INITIALLY-IN-PLACE (PIIP)**
  - **Discoverable PIIP**
  - **Undiscoverable PIIP**

- **Increasing Chance of Commerciality**

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

Two Risk Hurdles

- Reserves
- Commercial – What does it take to become commercial?
- Contingent Resources
- Discovered – What does it take to claim a discovery?
- Prospective Resources

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."
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:

- 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 are or will be made available
- Evidence that legal, contractual, social, environmental, and economic concerns will be met.

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.

<table>
<thead>
<tr>
<th></th>
<th>Deterministic</th>
<th>Probabilistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proved</td>
<td>Reasonable Certainty</td>
<td>At least 90% probability</td>
</tr>
<tr>
<td>Probable</td>
<td>More likely than not</td>
<td>At least 50% probability for sum of proved plus probable</td>
</tr>
<tr>
<td>Possible</td>
<td>Less likely than not</td>
<td>At least 10% probability for sum of proved plus probable plus possible</td>
</tr>
</tbody>
</table>

SPE-PRMS
2.2.1 RANGE of UNCERTAINTY

Deterministic View

- 1P scenario – high degree of confidence
- 2P scenario – more likely than not
- 3P scenario - unlikely

Probabilistic View

- P10
- P50
- P90
- EUR

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
“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.”

“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

* While “Reliable Technology” is an official SEC term, the concept of a reliable technology is common with the SPE definitions.

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.
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.

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**

- Log of Production Rate vs. Time
- Log of WOR vs. Cumulative Oil Production

[Graphs showing different performance interpretations with labeled sections for past, future, and ultimate phases.]
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

Conventional
Reservoirs
Tight Gas Sands
Coalbed Methane
Gas
Hydrates
Heavy
Oil
Bitumen
Oil Shale
Unconventional
Conventional
Reservoirs
Tight Gas Sands
Coalbed Methane
Shale gas
Basin-centered Gas
Gas Hydrates
Unconventional

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

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
Now What SPE-PRMS Class is This?

What SPE-PRMS Class is This?
Now What Class?

We Drill an Appraisal Well
Have We Changed Class Yet?
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

---

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

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

6 Well Development Plan
- Meets governmental requirements to hold leases
- Develops 90% of total resources
- Does not meet company ROR requirements
**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

**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