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Guidelines for Application of the Petroleum Resources Management System

- 2022 -

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Presented by
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SPEE
SOCIETY OF PETROLEUM EVALUATION ENGINEERS

Collaborative Effort

- Update was spearheaded by SPE
- Co-sponsoring organizations were:

Special Thanks

- SPEE Reserves Definitions Committee

  Rawdon Seager – Chair

  Jorge Faz

  Shane Hattingh

  John Lee

  Rod Sidle

  Tim Smith

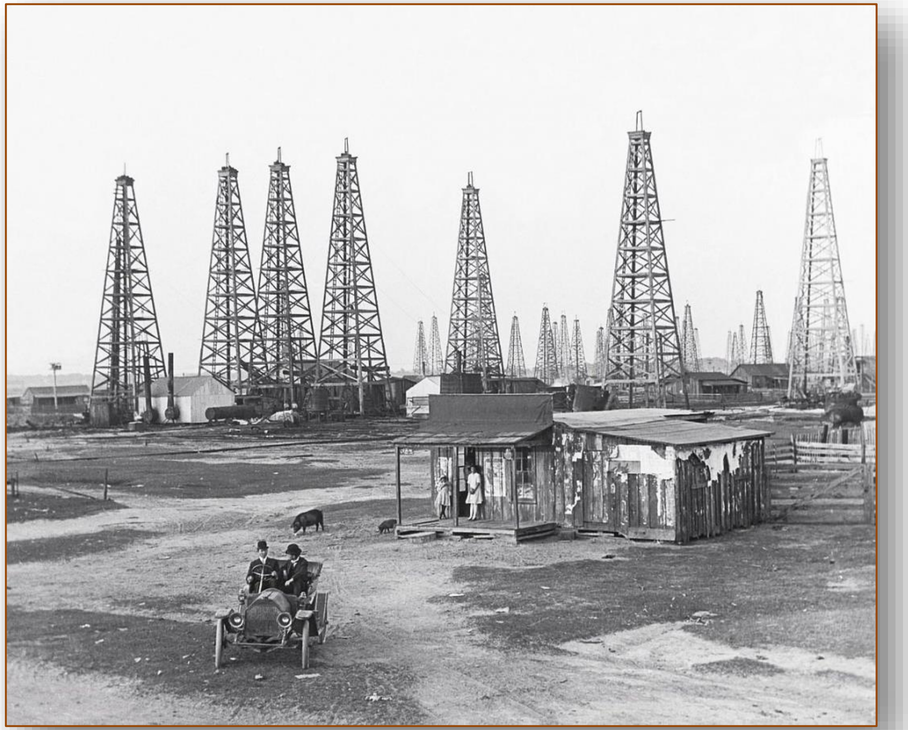
Outline

- History
- The New PRMS
- The Updated Application Guidelines
- Content of Updated Application Guidelines
- Emphasis:
  - Examples
  - Integration
  - Utility
- Way Forward
- Acknowledgments

History

- Reserves definitions first appeared in 1937 with the API
  - Purpose: annual studies of Proved oil reserves

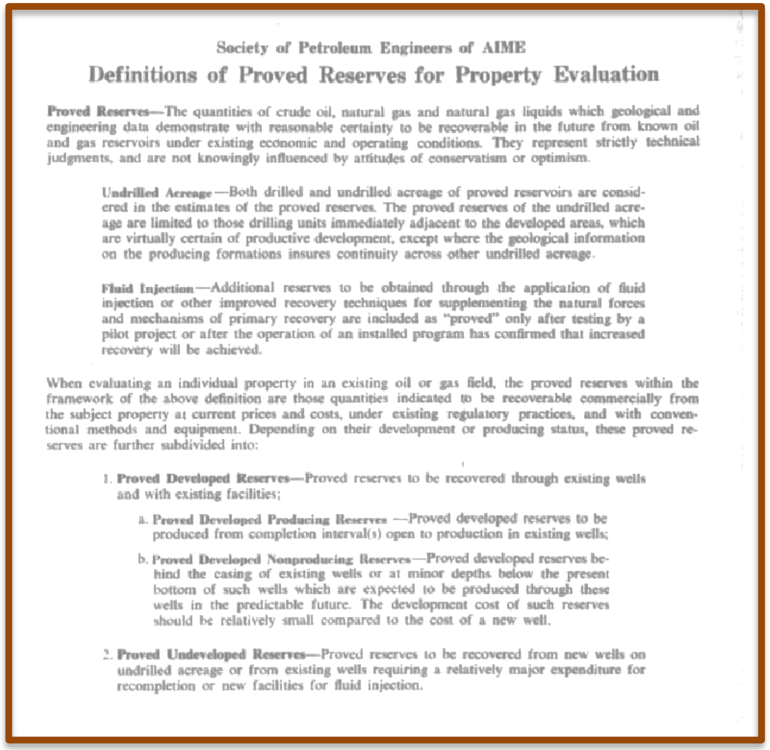
- Gas Proved reserves definitions appear in 1961
  - API combined definitions with AGA



History (continued)

- SPE modifies these & publishes their first definitions in 1965
  - July 1965 JPT p. 815

- SPE further updated definitions in
  - 1981
  - 1987
  - 1997
  - 2000
    - *2000 definitions were 4 pages!*



Society of Petroleum Engineers of AIME

Definitions of Proved Reserves for Property Evaluation

Proved Reserves—The quantities of crude oil, natural gas and natural gas liquids which geological and engineering data demonstrate with reasonable certainty to be recoverable in the future from known oil and gas reservoirs under existing economic and operating conditions. They represent strictly technical judgments, and are not knowingly influenced by attitudes of conservatism or optimism.

Undrilled Acreage—Both drilled and undrilled acreage of proved reservoirs are considered in the estimates of the proved reserves. The proved reserves of the undrilled acreage are limited to those drilling units immediately adjacent to the developed areas, which are virtually certain of productive development, except where the geological information on the producing formations insures continuity across other undrilled acreage.

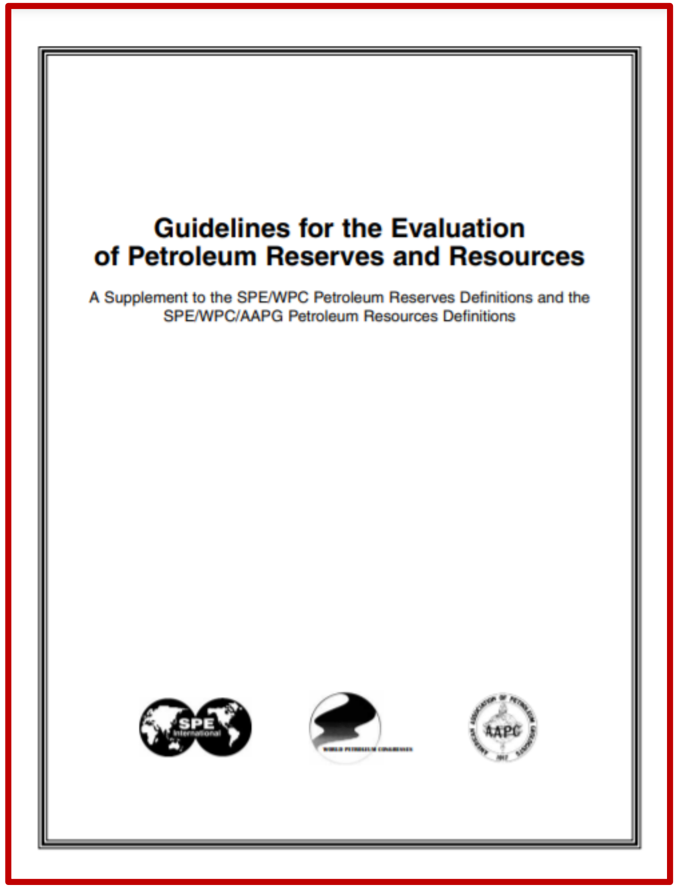
Fluid Injection—Additional reserves to be obtained through the application of fluid injection or other improved recovery techniques for supplementing the natural forces and mechanisms of primary recovery are included as "proved" only after testing by a pilot project or after the operation of an installed program has confirmed that increased recovery will be achieved.

When evaluating an individual property in an existing oil or gas field, the proved reserves within the framework of the above definition are those quantities indicated to be recoverable commercially from the subject property at current prices and costs, under existing regulatory practices, and with conventional methods and equipment. Depending on their development or producing status, these proved reserves are further subdivided into:

1. **Proved Developed Reserves**—Proved reserves to be recovered through existing wells and with existing facilities;
   a. **Proved Developed Producing Reserves** —Proved developed reserves to be produced from completion interval(s) open to production in existing wells;
   b. **Proved Developed Nonproducing Reserves**—Proved developed reserves behind the casing of existing wells or at minor depths below the present bottom of such wells which are expected to be produced through these wells in the predictable future. The development cost of such reserves should be relatively small compared to the cost of a new well.
2. **Proved Undeveloped Reserves**—Proved reserves to be recovered from new wells on undrilled acreage or from existing wells requiring a relatively major expenditure for recompletion or new facilities for fluid injection.

History (continued)

- No guidelines for application of these reserves definitions appeared until 2001
- "Guidelines for the Evaluation of Petroleum Reserves and Resources" was co-sponsored by the WPC and AAPG
- Intended to complement use of 2000 SPE/WPC/AAPG documents
- 139 pages


Guidelines for the Evaluation of Petroleum Reserves and Resources

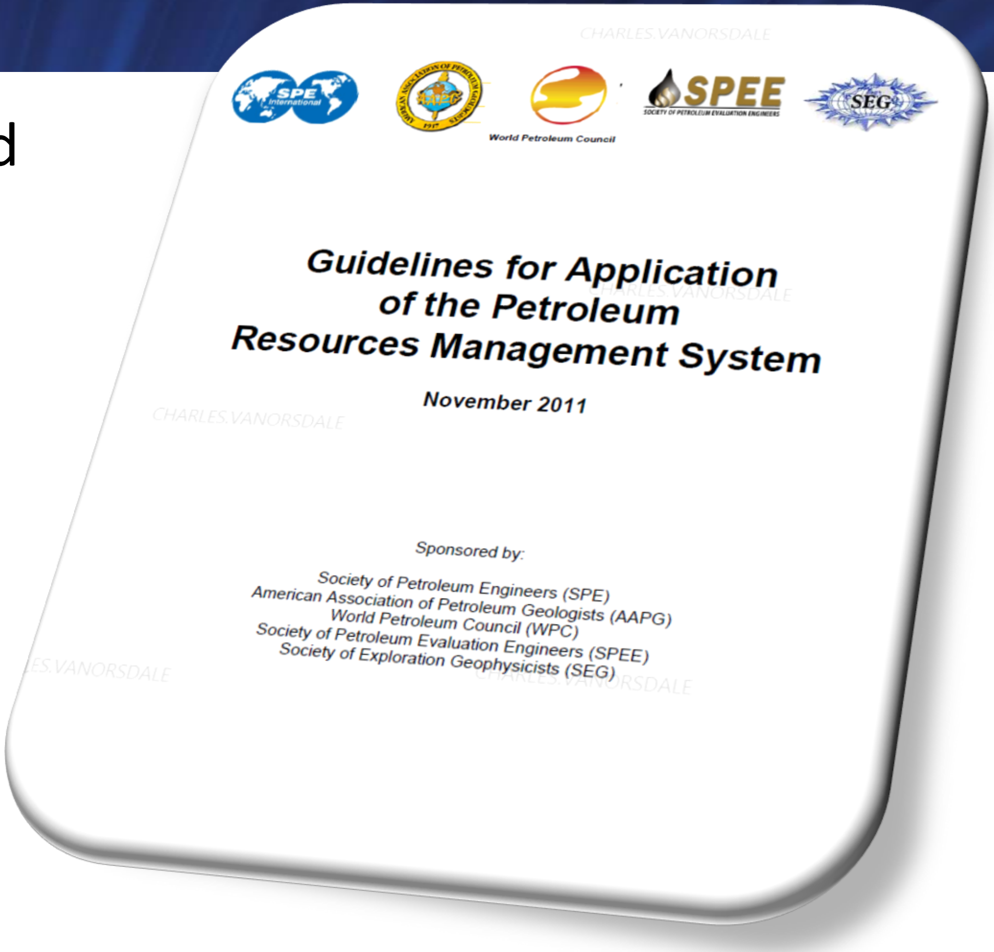
A Supplement to the SPE/WPC Petroleum Reserves Definitions and the SPE/WPC/AAPG Petroleum Resources Definitions

History (continued)

- In 2007, first "Petroleum Resources Management System" (PRMS) released
- Major step forward – 49 pages
- Industry feedback requested further clarification & amplification of PRMS principles

History (continued)

- Consequently, the 2001 “Guidelines” were updated to reflect the new PRMS
- New “Guidelines for Application of the PRMS” was published in 2011
- PRMS co-sponsors SPE, AAPG, WPC, and SPEE joined by SEG



History (continued)

- The 2011 version had two new chapters

2001 Document
139 Pages

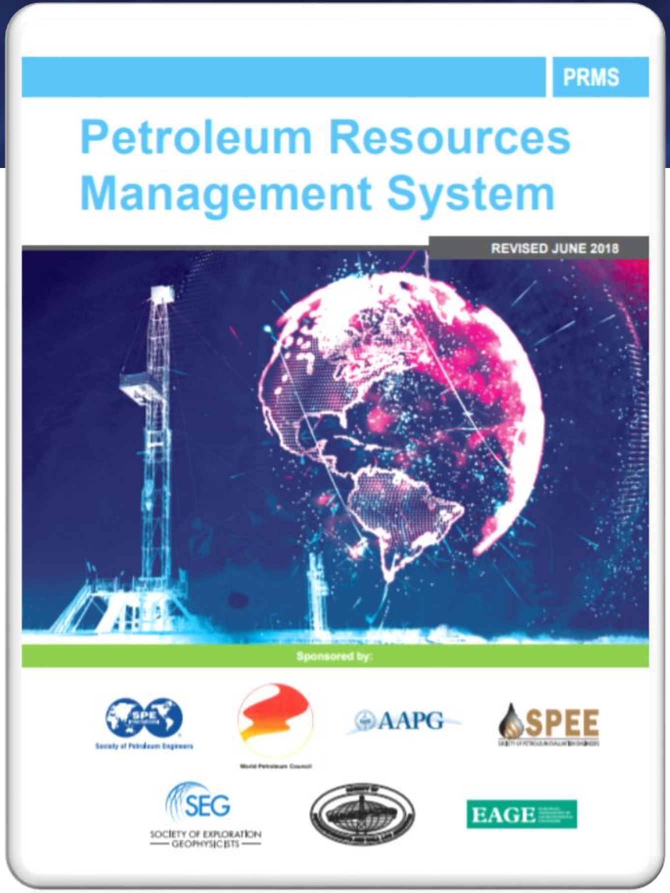
Table of Contents

2011 Document
221 Pages

Table of Contents

The New PRMS

- Major industry changes required updating the 2007 PRMS
- New PRMS was released in June 2018
  - Version 1.01 released shortly after with some corrections
- Notable additions due to surge in unconventional resources



Updated "Application Guidelines"

- In early 2019, discussions began to update the "Application Guidelines" (AG)
  - Reflect 2018 PRMS
  - Overhaul 2011 chapter on Unconventional Resources

JPT Sept. 30, 2014 https://jpt.spe.org/shale-evolution-zipper-fracture-takes-hold

Content - Updated "Application Guidelines"

- Chapters:
  1. Introduction
  2. Petroleum Resources Definitions, Classification & Categorization
  3. Seismic Applications
  4. Assessment of Petroleum Resources Using Deterministic Procedures
  5. Petrophysics
  6. Reservoir Simulation
  7. Probabilistic Resources Estimation
  8. Aggregation of Reserves and Resources
  9. Evaluation of Petroleum Reserves and Resources
  10. Unconventional Resources Estimation
  11. Production Measurement and Operational Issues
  12. Resources Entitlement and Recognition

  Glossary and References

New Chapters

2022 AG will be about twice as many pages as 2011.

Content - Updated "Application Guidelines" (cont'd)

- Chapter 5 Petrophysics added to address PRMS-2018 first definition of "Net Pay"

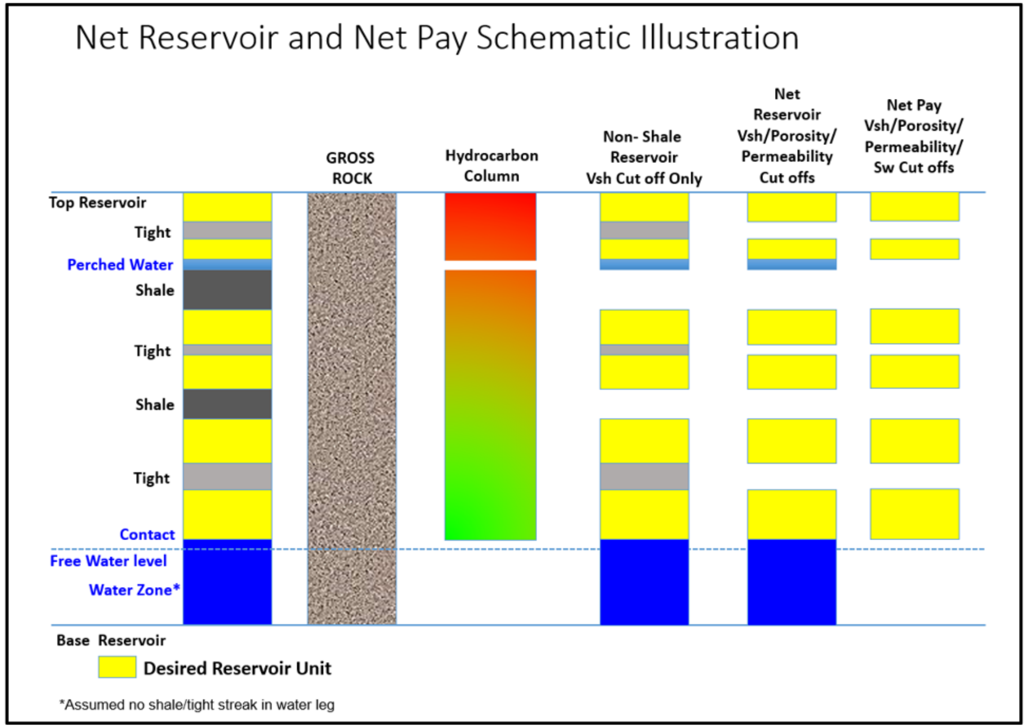


Fig. 5.2: Net reservoir and net pay description (Modified from Worthington and Cosentino, SPE-84387-PA, 2003).

Net Pay:
The portion (after applying cutoffs) of the thickness of a reservoir from which petroleum can be produced or extracted. Value is referenced to a true vertical thickness measured.

Content - Updated “Application Guidelines” (cont’d)

- Chapter 6 Reservoir Simulation added to assist with principles in modeling of recoverable resources and development scenarios

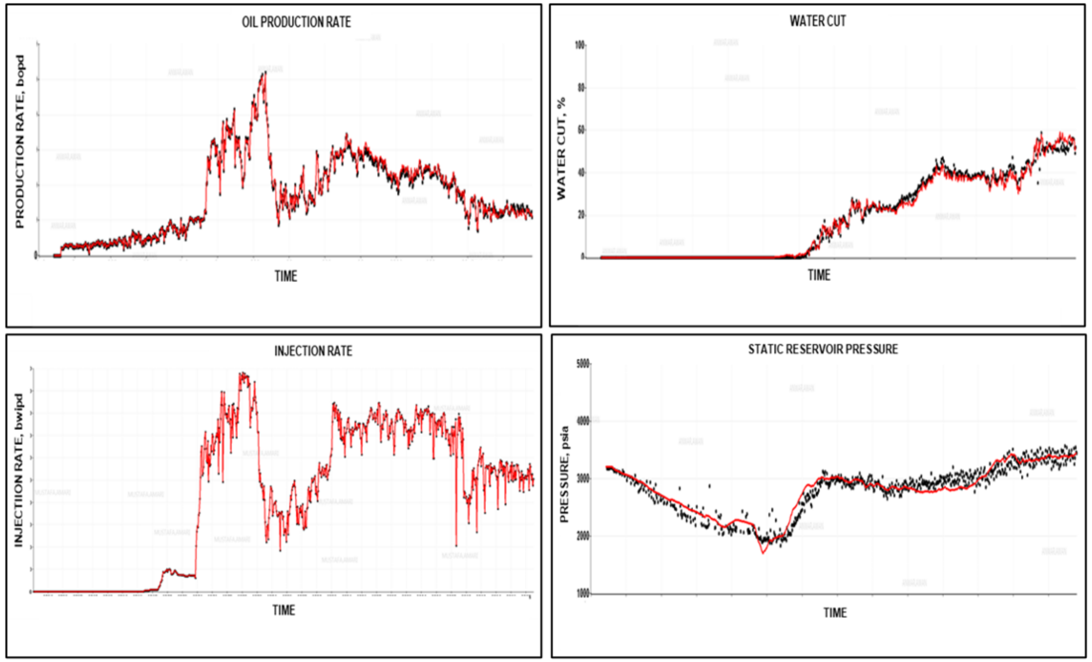


Fig. 6.2b- Common Suite of History Matching Plots

Reservoir Simulation:

… a more rigorous form of material balance analysis. While such modeling can be a reliable predictor of reservoir behavior under a defined development program, the reliability of input rock properties, reservoir geometry, relative permeability functions, fluid properties, and constraints (e.g., wells, facilities, and export) are critical. Predictive models are most reliable in estimating recoverable quantities when there is sufficient production history to validate the model through history matching. (PRMS § 4.1.3.2)

Emphasis: on *Examples*

- 2011 AG had limited number of example PRMS interpretation situations

- A main focus of the 2022 update was inclusion of multiple examples in all chapters

2.11 A Case Study in the Application of Commercial Maturity Sub-classes

Five coalbed methane exploration/appraisal wells were drilled in the southern part of a European license block in 2014. In 2015, a production pilot using these wells commenced with the commissioning of flowlines and a compression station selling gas to pressurized-gas filling stations in the vicinity under a 15-year gas contract.

In early 2016, five ne
completed in the northern p
km from the pilot area (Fig
as evaluated from logs were
southern pilot wells. A d
acquire core data. The prod
complete these wells due to
geology, but without testin
the gas from all 5 wells wer
units and flowlines were inc
of the business plan.

However, development
opposition from the commu
area close to a National Pa
occurred and a complaint s
filed with the local council.

Nevertheless, the compa
part of a Phase II developm
six to be drilled in 2018.
2017 wells showed
petrophysical properties si
southern pilot wells. It was
the wells but to complete t
As of the 12/31/2017 evalu
are ready for production.

Fifteen-year sales co
negotiated securing gas sale
wells from Phase II. The we
to several gas filling stati
stations have been approve
end of 2018 to take gas fro
wells.

The following question
above scenario reference
duplicated from PRMS Figu

Can the entity claim any Reserves from the five southern area (pilot) wells? This development project is curre
contract to an existing market. Assuming the entity would n
wells without having satisfied all commerciality criteria,
Production) may be assigned for the 15-year contract durat

Seismic Surveillance Example D:

Monitor water and gas sweep efficiency

In this third example, an Angolan deepwater field consists of an unconsolidated turbiditic sand systems (Berthet et al., 2015). Understanding heterogeneities within these systems is essential to locate infill wells. Oil is produc
The primary purpose of the 4D s
However, because the reservoir
the bubble point. This resulted
surveys, delineating areas of the

Fig. 3.22.a shows the 4D respo
reservoir. The spatial limits of t
and sedimentological limits s
incorporated into the reservoir m
history match in the dynamic
model 4D velocity change (**Fig.**

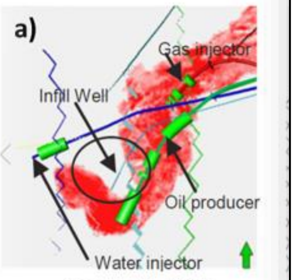


Fig. 3.22 - a) 4D seismic respo
surveys as a result of gas exso
reservoir simulation model, an
Green bars indicate perforated

12.6.3.1 Example: Reserves estimates with unitization of accumulation in two concession areas after a Unitization Agreement. SUN OIL Co and MOON OIL Co entered into an onshore concession contract with a local government to explore, develop and produce hydrocarbons in Block 36. Each company has 50% interest in the block. After a 2-year exploration period which included two exploratory wells and the acquisition of seismic data, they discovered oil in commercial quantities and that the accumulation extended to Block 37, recently leased from the local government by STAR OIL Co (80% WI) and COMET OIL Co (20% WI), as shown in **Fig. 12.16**. According to government regulations, the companies in Blocks 36 and 37 are responsible to pay cash payments termed royalties to the government, which have production-tax characteristics. Those cash payments are calculated as 10% of all produced oil and gas, multiplied by a tax price established by the government. In this simplified example case, SUN OIL Co oil and gas forecast sales prices are 50 USD/STB and 8 USD/MCF for all future years, and forecast royalty prices are 55 USD/STB and 10 USD/MCF for all future years.

Fig. 12.16 - Accumulation that extends across Block 36 and Block 37

As the accumulation straddles the concession contract boundaries, after negotiation, all companies signed a Unitization Agreement (UA) in which they defined the tract participation (TP) based on estimated total PIIP of a P50 model of the accumulation in each lease area, with a possibility of future redetermination. The resulting TP was 70% (Block 36) and 30% (Block 37). Unit Interests (UI) are obtained by multiplying each company´s WI in the Block by the Block TP, as shown in **Table 12.8**.

Block	Company	WI (%)	TP (%)	UI (%)
36	SUN OIL Co	50%	70%	35%
	MOON OIL Co	50%		35%
37	STAR OIL Co	80%	30%	24%
	COMET OIL Co	20%		6%
Total			**100%**	**100%**

Table 12.8 - Tract participation and unit participation for the accumulation

Emphasis: on *Integration*

- 2011 AG chapters were primarily standalone
- The 2022 update emphasized cross-reference and consistency of messages

9.4.7 Legal/Contract/Fiscal Terms. The revenue and costs components of any term described above (including all other relevant economic and commercial terms) may be defined differently from country to country due to the fiscal arrangements made between companies and host governments, which allocate the rights to develop and operate specific oil and gas businesses. Common forms of international fiscal arrangements are concessions (through royalties and/or taxes), PSCs and risk service contracts (see Chapter 12 h…
between the …
of these gov…

2.5 Methods for Estimating the Range of Uncertainty in Recoverable Quantities

There are several different methods commonly used to estimate the range of uncertainty in recoverable quantities for a project. While the objective of the exercise is to estimate at least three outcomes (Low, Best, and High estimates of recoverable quantities) that reflect the range of uncertainty, it is important to recognize that the underlying philosophy must be the same, regardless of the approach used. In this context "deterministic" methods rely on a single set of discrete parameters (gross rock volume, average porosity, etc.) that represent a physically realizable and realistic combination in order to derive a single, specific estimate of recoverable quantities (e.g., a combination of parameters represents a specific scenario).

Evaluators may choose to apply more than one method to a specific project, especially for more complex developments. For example, three deterministic scenarios may be selected after reviewing a Monte Carlo analysis of the same project. The following terminology is recommended for the primary methods in current use. These methods are discussed in more detail in subsequent chapters of these *Guidelines* (see Ch. 4 – Assessment of Petroleum Resources Using Deterministic Procedures, and Ch. 7 – Probabilistic Reserves Estimation).

Deterministic "scenario" method. In this method, three discrete scenarios are developed that

Emphasis: on *Utility*

- Document includes a “Glossary and References” section for many important terms

- Glossary consistent with PRMS definitions and includes terms not found within PRMS

Glossary and References

This Glossary provides further definition of terms used within the *Guidelines for Application of the PRMS* and the Chapter and subsections in which they appear (e.g., 12.4.2 refers to section 4.2 in Chapter 12). References in numerous chapters are identified as “General”, while multiple references within a given chapter may be identified as “Ch. X – General”.

TERM	USED IN THESE GUIDELINES	DEFINITION
1C	2.1	Denotes low estimate scenario of Contingent Resources.
2C	2.1	Denotes best estimate scenario of Contingent Resources.
3C	2.1	Denotes high estimate scenario of Contingent Resources.
1P	2.1	Denotes low estimate of Reserves (i.e., Proved Reserves). Equal to P1.
2P	2.1	Denotes best estimate of Reserves. The sum of Proved plus Probable Reserves.
3P	2.1	Denotes high estimate of reserves. The sum of Proved plus Probable plus Possible Reserves.
1U	2.1	Denotes the unrisked low estimate qualifying as Prospective Resources.
2U	2.1	Denotes the unrisked best estimate qualifying as Prospective Resources.
3U	2.1	Denotes the unrisked high estimate qualifying as Prospective Resources.
Abandonment, Decommissioning, and Restoration (ADR)	9.3.2	The process (and associated costs) of returning part or all of a project to a safe and environmentally compliant condition when operations cease. Examples include, but are not limited to, the removal of surface facilities, wellbore plugging procedures, and environmental remediation. In some instances, there may be salvage value associated with the equipment removed from the project. ADR costs are presumed to be without consideration of any salvage value, unless presented as “ADR net of salvage.”

Way Forward

- SPE Technical Editor's work completed
- Plan to have SPE Board consider approval at next meeting (mid-July)
  - In event of delay, next Board meeting late-September (before ATCE)
- Once approved, co-sponsors will review/concur
- New "AG" release should occur in 4th Quarter

Way Forward (continued)

- As with PRMS, AG will be “evergreen” document

- Anticipate versioning and/or FAQs available on SPE website

Acknowledgments

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  - SPE OGRC
    - Chairmen Steve McCants (2018 – 2020), Dan Olds (2020-2022)
    - Steering Committee
  - Co-sponsoring Organizations
    - SPEE, AAPG, SEG, SPWLA, EAGE, WPC

Questions?

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