American Association of Petroleum Geologists
Committee on Resource Evaluation (CORE)
Subcommittee to Review the United States Onshore Continuous (Unconventional) Gas Assessment Methodology Used by the USGS

Report Submitted by

John Curtis (Colorado School of Mines), Naresh Kumar (Growth Oil and Gas), Pulak Ray (Minerals Management Service), Rusty Riese (BP Americas, Inc) and John Ritter (Texaco)

Recommendations

1. The subcommittee recommends that the full Committee on Resource Evaluation (CORE) endorse the general methodology being used for assessing unconventional gas resources by the United States Geological Survey in its ongoing National Oil and Gas Assessment. If the Committee approves this recommendation, then we recommend that the Executive Committee also endorse this approval.
2. Because of its national and international significance, and the potential usefulness of the products coming out of this project, we recommend that the Committee ask the AAPG Executive Committee to support publicity for the project in the *AAPG Explorer*.
3. Due to the fact that this assessment is ongoing, we consider this to be a progress report. Based on the current schedule, assessment activity will continue until 2004, when final review of the last of the 25-targeted basins will be complete. We recommend the Committee consider at least one additional review during the course of the evaluation and prior to issuance of any final report. This revisit is necessary because some of the procedures are still being refined/clarified.

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Background

At the CORE meeting held at the offices of the Oklahoma Geological Survey in Norman, Oklahoma on November 8-9, 2000, the USGS, through CORE member Tom Ahlbrandt, requested a review of the methodology used by the USGS to estimate unconventional gas resources in the United States. This assessment is part of the ongoing National Oil and Gas Assessment currently being carried out by the USGS. John Ritter was asked to form a subcommittee to meet with USGS personnel to review the assessment methodology. Formation of this subcommittee follows two previous subcommittee activities, chaired by Richard Nehring and Naresh Kumar respectively, to review both the ANWR and World Energy Project assessment methodologies. In both of these previous cases, the methodology was found by CORE to be technically and scientifically sound. The AAPG Executive Committee later endorsed the USGS methodology in both instances.

The National Oil and Gas Assessment is another major resource assessment project being carried out by the USGS. The last major national assessment performed by the USGS was released in 1995. This assessment varies significantly from that previous assessment in both methodology and review areas. In particular, the 1995 study was based on assessment of 72 individual provinces while the current study focuses on 25 major basins. Therefore, the USGS wanted an industry panel to review the methodology being utilized and provide comments and suggestions to the assessment team. Because of the importance of this type of project to the AAPG membership, CORE approved its involvement.

John Ritter initially met with the USGS team, headed by Chris Schenk, at the Survey's offices in Denver, on December 11, 2000. The full subcommittee, consisting of John Curtis (Colorado School of Mines), Naresh Kumar (Growth Oil and Gas), Pulak Ray (Minerals Management Service), Rusty Riese (BP Americas, Inc.), and John Ritter (Texaco) met for a detailed review of the project on February 26, 2001. This report summarizes the committee's observations, comments and recommendations.

National Oil and Gas Assessment

For the current project, which was initiated in 1999, the USGS is concentrating on 25 major US basins. A timeline depicting the planned evaluation process is included as Attachment 1. These basins cover approximately 96% of the producing, and/or prospective, hydrocarbon accumulations in the onshore United States. These basins are subdivided initially into Total Petroleum Systems, or mappable entities encompassing genetically related petroleum deposits, whether discovered or undiscovered. Further subdivisions break these total petroleum systems into Assessment Units (AU), or mappable volumes of rock within the systems that encompass accumulations (discovered or undiscovered) which share similar geologic traits and socio-economic factors. In some cases, an AU may equate to a Total Petroleum system. These AUs are themselves broken into cells, subdivisions or areas related to the drainage area of individual wells. Expanded definitions for Total Petroleum System, Assessment Unit and cell are included in the glossary (Attachment 2), which also contains definitions for other terms used by the USGS team in the course of the assessment.

For each of these basins, the USGS is evaluating both conventional (or discrete) and unconventional continuous deposits. While the National Assessment includes both oil and gas, the primary driver is the estimation of natural gas resources with the focus of the CORE review being the methodology underpinning the assessment of the continuous deposits. Continuous deposits are defined as petroleum accumulations that are pervasive throughout a large area and are not significantly affected by hydrodynamic influences. Characteristics of continuous deposits include some, but not necessarily all, of the following for any given accumulation:

- Lack of well-defined downdip water contact;
- Lack of obvious seal or trap;
- Large areal extent;
- Abnormal pressures;
- Close association with source rocks;
- Low recovery factors.

Typical examples include coalbed methane, low permeability reservoirs, shale gas/oil, basin-centered gas and gas hydrates.

The USGS has assembled a team consisting of more than 50 Survey employees to undertake this project. A senior Survey scientist, in this instance Chris Schenk, acts as the project chief and review team leader. Included in the 6-person assessment review team is a production engineer, employed to bring balance to the overall evaluation. A list of the assessment review team members is included in Attachment 3.

Sources of Information and Data Bases

Data used for this evaluation are additive to the data used in the 1995 assessment. Considerable new data and additional data, particularly production data, have been accumulated since the last evaluation. This type of information is of prime importance to the evaluation process; particularly considering the increased attention the industry has given to the exploitation of continuous resources since 1995. For example, the Gas Research Institute estimates that US annual production from coal-bed methane has risen from 538 BCF in 1992 to over 1.1 TCF by 1997 (Gas Research Institute, North American

Coalbed Methane Resource Map, 1999), indicating dramatic increases in production from continuous accumulations.

Evaluation of individual basins involves designation of a geologic project team that then undertakes a two-year or longer evaluation phase, during which time data relating to the hydrocarbon resource base of the basin is examined in detail. The project team relies on a number of databases to assist in the accumulation of relevant data, as follows:

- Petroleum Information (PI) Well History
- Petroleum Information (PI) Production
- Nehring Significant Fields of US and Canada
- Geomark Research Inc.'s (Geochemical)
- Petroconsultants
- Oil and gas Integrated Field Files (OGIFF - DOE) - proprietary

When combined with the detailed geologic knowledge of specific US basins possessed by many of the Survey scientists, significant volumes of data can be incorporated into the study. Addition of a reservoir engineer to the evaluation staff, absent for the 1995 assessment, has allowed the production data to be more fully utilized to define assessment criteria.

The Assessment Methodology

The assessment of continuous deposits begins with the geologic framework and with the definition of one or more "Total Petroleum Systems", as previously discussed. These systems are defined for each of the 25-targeted basins. For each of the Total Petroleum Systems, one or more "Assessment Units" have been mapped. The form used to capture these data is included as Attachment 4.

Assessment Units are next defined for a particular Total Petroleum System. Estimation of resources within an Assessment Unit is then based on an analytical probabilistic and spreadsheet software system called Analytic Cell-based Continuous Energy Spreadsheet System (ACCESS). The ACCESS method is based upon mathematical equations derived from probability theory with the final ACCESS spreadsheet used to calculate estimates of undeveloped oil, gas and NGL (natural gas liquids) resources in a continuous-type assessment unit. Calculation of recoverable volumes for each assessment unit can therefore be seen to follow three distinct steps: First, the geological assessment model is defined; second, the analytic probabilistic method is derived; and third, the ACCESS spreadsheet is described.

The ACCESS system allows definition of a subset of the Assessment Unit referred to as a cell, the size of which is related to the drainage area of a well. Definition of the cells has been handled in such a way that for each assessment unit, the probability of hydrocarbon accumulation for all cells (discovered and undiscovered) is assigned a single probability for charge, rocks (reservoir, trap and seal), timing of geologic events, and accessibility. An assessment unit in which there is existing production has a unit probability of one, whereas those with no known accumulations are hypothetical units with varying degrees of probabilities for hosting undiscovered fields. Geologic analogs across province and region boundaries are used for assessing areas of no known discoveries.

Based on all the literature and data available, the assessment geologist for each of the assessment units defines a set of nine variables, including Assessment Unit area, percentage of Assessment Unit that is untested, percentage of untested area with the potential to add reserves, area per cell, recovery per cell, coproduct ratios, and percent of unit allocated either onshore or offshore. Of these, Assessment Unit area, percentage of assessment unit area that is untested, percentage of untested area with the potential to add reserves, and area per cell are used to determine the potential number of cells remaining to be tested. Finally, three descriptive parameters for each of the nine variables, representing Minimum (F100), Median (F50) and Maximum (F0), are assigned. Following assignment, the geologic assessment model, called the FORSPAN model, is considered complete.

The ACCESS system is then applied to the FORSPAN model. The ACCESS system utilizes the descriptive parameters defined in the FORSPAN model for each of the nine variables to produce probability distributions. Distribution shapes are set for each independent variable; with considerable effort having been expended on determining the probability function that would best depict the sizes and numbers of undiscovered fields. The team has experimented with normal, lognormal, shifted lognormal and triangular distribution functions. After much trial and error and experimentation, either truncated, shifted lognormal or triangular distributions were used, with all but recovery per cell being defined by median-based triangular distributions. ACCESS then relates the parameters, computing means, standard deviations, minimums and maximums.

The ACCESS system then feeds a spreadsheet consisting of 54 separate panels, consolidated into four worksheets. Conditional (unrisked) and unconditional (risked) estimates of undeveloped petroleum resources are developed for the assessment unit, including mean, standard deviation, F95 and F5. A more detailed review of the ACCESS methodology is described in USGS Open File Report 00-044.

Because our task has been to review the methodology, specific numbers for any of the areas were neither requested by us nor presented during our discussions.

Concerns and Suggestions

1. During our discussion, we did not have enough time to query the USGS personnel on how they subdivide a Total Petroleum System into Assessment Units (AU's). We suggest that the final document clearly describe the rationale by which Assessment Units are defined. The assumptions used in defining hypothetical Assessment Units also need to be clearly specified. Additionally, we are concerned that some AUs may be erroneously called "continuous" while the problem may be lack of data.

2. It should be clearly stated that this methodology does not deal with in-place resources and does not assign a recovery factor. The methodology assigns a range of

producible hydrocarbons from a cell and determines the final resource by aggregating all the "successful" cells.

3. USGS currently believes that at the cell level, cell size and EUR are probably highly correlated. However, the assessment analysis is at the (aggregate) assessment unit level, and at this level the variables of cell size and EUR are not as highly correlated. The issue of dependency needs to be further investigated. Is it possible to treat that as a range when the two are fully dependent to when they are fully independent?

4. The term "societal relevance" suggests pre-screening *before* an assessment has been made. Perhaps the untruncated and truncated EURs should be reported so that the filters used and their impacts can be clearly seen. The idea of a 30-year time frame is reasonable. Perhaps, USGS could just define the Assessment Units as those areas that contribute within that time frame.

5. Our subcommittee lauds the inclusion of an engineer to the assessment team. However, we recommend that besides analyzing the decline curves, the engineer on the team utilize pressure data and material balance calculations wherever possible. At the minimum, a few cases of comparison between decline-curve analysis and material-balance calculations should be made.

6. The distribution of EURs from cells attempts to capture the possibility of "sweet spots" within the Assessment Units (AU). In real life, geology would demand that these sweet spots would be clustered within various parts of the AU. Does treating the EUR as an independent variable capture the possibility of clustering of the sweet spots?

7. There is strong concern that the use of a triangular distribution for input variables other than EUR will yield results that are too optimistic. The USGS should carry out sensitivity testing with other types of distributions and see if changing the shape of the distribution makes a significant difference to the estimated resources. If there is an overestimation, and we believe there will be, this can be reduced by redefining the types of distributions that underpin the evaluation.

8. Because this methodology does not have a "success ratio", there is no accounting for "dry holes". In a typical economic analysis, the project bears the cost of dry holes out of the successful ones until a positive cash flow is achieved. In the current methodology, USGS is using a variable cell size with variable EURs to distinguish highly productive cells from "dry" cells. It may work for assessing the "technically recoverable" but it is not clear how the economically recoverable volumes will be determined using this methodology. Some clarification is needed at this time.

Summary and Conclusions

Our committee believes that the methodology being used by the United States Geological Survey is sound and despite our comments and suggestions above, is an improvement over the past methods. However, as the evaluations become more sophisticated, so also they become more complex. Small changes in definitions of distributions could have significant impact on final results, hence the need for rigorous sensitivity testing. Additionally, because we did not review the economic analysis part of this assessment, we can recommend in advance that that (portion) of the assessment is as robust as the geological assessment. Finally, the geological assessment and the economic analysis have to be mutually compatible and linked.

Our committee believes that with a detailed discussion of assumptions used and distributions utilized, the cell-based assessment of continuous deposits will provide supportable results. With "full disclosure" of assumptions, other assessors can make their own estimates by incorporating their own assumptions.

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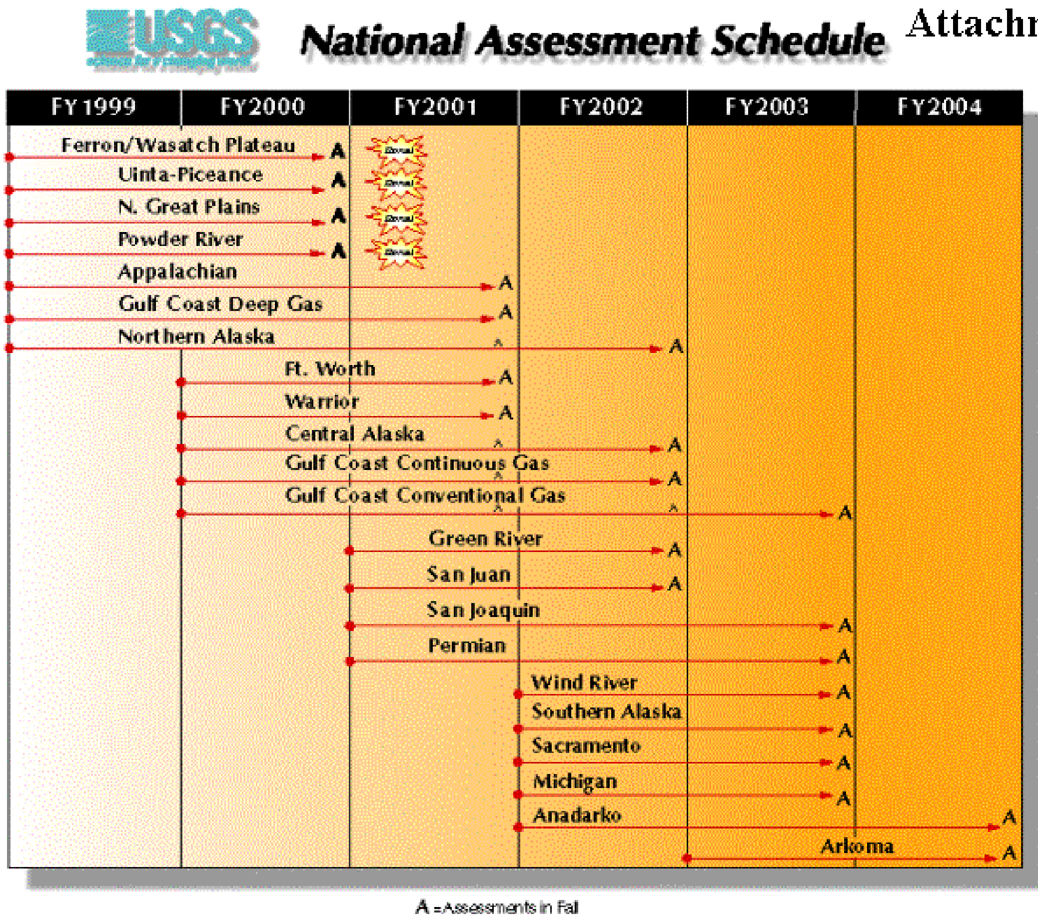
Attachment 1



Attachment 2

Glossary

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and Gregory F. Ulmishek

Selected terms of particular importance to the USGS assessment of undiscovered resources in total petroleum systems are defined here. The definitions are intended to be generally explanatory rather than strictly technical. No attempt has been made to include a detailed listing of common industry definitions.

Access Probability: The probability, expressed as a decimal fraction, of sufficient access (political and physical) to a particular assessment unit within a given time frame for the activities necessary to find a accumulation of minimum size and to add its volume to proved reserves. The time frame for this assessment is 30 years.

Accumulation: Two types of accumulations are recognized, conventional and continuous. A conventional accumulation is an individual producing unit consisting of a single pool or multiple pools of petroleum grouped on, or related to, a single structural or stratigraphic feature. A continuous accumulation is also an individual producing unit but having an areally extensive pool or pools of petroleum not necessarily related to structural or stratigraphic features.

Assessment Unit (AU): A mappable volume of rock within the total petroleum system that encompasses accumulations (discovered and undiscovered), which share similar geologic traits and socio-economic factors. The accumulations within an assessment unit should constitute a sufficiently homogeneous population that the chosen methodology of resource assessment is applicable. A total petroleum system might equate to a single assessment unit. If necessary, a total petroleum system can be subdivided into two or more assessment units in order that each unit is sufficiently homogeneous to assess individually. An assessment unit may be identified as conventional if it contains conventional accumulations or as continuous if it contains continuous-type accumulations.

Assessment Unit Probability: The assessment unit probability, expressed as a decimal fraction, represents the likelihood that, in the assessment unit, at least one undiscovered accumulation of the minimum size exists that has the potential for its volume to be added to proved reserves in a given time frame. The assessment unit probability is the product of the probabilities of the three geologic attributes (charge, rocks, and timing) and the probability of access.

Associated/Dissolved Gas: Natural gas that occurs in an oil accumulation, either as a free gas cap or in solution; synonymous with gas in oil accumulations.

Barrels of Oil Equivalent (BOE): A unit of petroleum volume in which the gas portion is expressed in terms of its energy equivalent in barrels of oil. For this assessment, 6,000 cubic feet of gas equals 1 barrel of oil equivalent (BOE).

Cell: A subdivision or area within an assessment unit having dimensions related to the drainage areas of wells (not to be confused with finite-element cells). Three categories of cells are recognized, cells tested by drilling, untested cells, and untested cells having potential to provide additions to reserves within the forecast span of the assessment. A continuous-type assessment unit is a collection of petroleum-containing cells.

Composite Total Petroleum System: A mappable entity encompassing all or a portion of two or more total petroleum systems. Composite total petroleum systems are used when accumulations within an assessment unit are assumed to be charged by more than one source rock.

Continuous-Type Accumulation: A petroleum accumulation that is pervasive throughout a large area, that is not significantly affected by hydrodynamic influences, and for which the chosen methodology for assessment of sizes and number of discrete accumulations is not appropriate. Continuous-type accumulations lack well-defined downdip water contacts. The terms continuous-type accumulation and continuous accumulation are used interchangeably.

Conventional Accumulation: A discrete accumulation, commonly bounded by a downdip water contact, which is significantly affected by the buoyancy of petroleum in water. This geologic definition does not involve factors such as water depth, regulatory status, or engineering techniques.

Cumulative Petroleum Production: Reported cumulative volume of petroleum that has been produced. Cumulative oil, cumulative gas, and cumulative production are sometimes used as abbreviated forms of this term.

Estimated Ultimate Recovery (EUR): The total expected recoverable volume of oil, gas, and natural gas liquids production from a well, lease, or field under present economic and engineering conditions; synonymous with total recovery.

Field: A production unit consisting of a collection of oil and gas pools that when projected to the surface form an approximately contiguous area that can be circumscribed.

Field Growth: The increases in known petroleum volume that commonly occur as oil and gas fields are developed and produced. The terms field growth and reserve growth are used interchangeably throughout this report.

Forecast Span: A specified future time span in which petroleum accumulations have the potential to provide additions to reserves. A 30-year time forecast span is used in this assessment and affects (1) the minimum undiscovered accumulation size, (2) the number of years in the future that reserve growth is estimated, (3) economic assessments, (4) the accumulations that are chosen to be considered in this assessment, and (5) the risking structure as represented by access risk.

Gas Accumulation: A accumulation with a gas to oil ratio of 20,000 cubic feet/barrel or greater.

Gas in Gas Accumulations: Gas volumes in gas accumulations.

Gas in Oil Accumulations: Gas volumes in oil accumulations.

Gas to Oil Ratio (GOR): Ratio of gas to oil (in cubic feet/barrel) in a accumulation. In this assessment, GOR is calculated using known gas and oil volumes at surface conditions.

Geologic Province: A USGS-defined area having characteristic dimensions of perhaps hundreds to thousands of kilometers encompassing a natural geologic entity (for example, sedimentary basin, thrust belt, delta) or some combination of contiguous geologic entities.

Grown Petroleum Volume: Known petroleum volume adjusted upward to account for future reserve growth. For this assessment, 30 years of reserve growth is considered.

Known Petroleum Volume: The sum of cumulative production and remaining reserves as reported in the databases used in this assessment. Also called estimated total recoverable volume (sometimes called "ultimate recoverable reserves" or "estimated ultimate recovery").

Liquids to Gas Ratio (LGR): Ratio of total petroleum liquids (including oil, condensate, and natural gas liquids) to gas (in barrels/million cubic feet) in a gas accumulation. The LGR is calculated using known petroleum liquids and gas volumes at surface conditions. This ratio is used to assess the liquid coproducts associated with undiscovered gas in gas accumulations.

Minimum Accumulation Size: The smallest accumulation size (volume of oil in oil accumulations or volume of gas in gas accumulations) that is considered in the assessment process for conventional accumulations.

Minimum Total Recovery per Cell: The smallest total recovery per cell (volume of oil or gas) in that is considered in the assessment process for continuous-type accumulations.

Minimum Petroleum System: The mappable part of a total petroleum system for which the presence of essential elements has been proved by discoveries of petroleum shows, seeps, and accumulations.

Natural Gas Liquids (NGL): Petroleum that occurs naturally as a gas in the reservoir, but as a liquid under surface conditions. Natural gas liquids are typically reported separately from crude oil.

Natural Gas Liquids to Gas Ratio (for oil accumulations): Ratio of natural gas liquids to gas (in barrels/million cubic feet) in an oil accumulation, calculated using known natural gas liquids and gas volumes at surface conditions. This ratio is used to assess the natural gas liquids associated with undiscovered gas in oil accumulations.

Nonassociated Gas: Natural gas that occurs in a gas accumulation; synonymous with gas in gas accumulations.

Oil Accumulation: An accumulation with a GOR less than 20,000 (in cubic feet/barrel).

Oil in Gas Accumulations: Oil volumes in gas accumulations. For this assessment, oil in gas accumulations was calculated along with other liquids rather than separately.

Oil in Oil Accumulations: Oil volumes in oil accumulations.

Petroleum: A collective term for oil, gas, natural gas liquids, and tar.

Play: A set of known or postulated oil and gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration pathway, timing, trapping mechanism, and hydrocarbon type. A play differs from an assessment unit; an assessment unit can include one or more plays.

Remaining Petroleum Reserves: Volume of petroleum in discovered accumulations that has not yet been produced. For this assessment, remaining reserves were calculated by subtracting cumulative production from known volumes. Remaining reserves is sometimes used as an abbreviated form of this term.

Reserve Growth: The increases in known petroleum volume that commonly occur as oil and gas accumulations are developed and produced. The terms reserve growth and field growth are used interchangeably throughout this report.

Subsurface Allocation: An allocation of potential additions to reserves to land entities based on subsurface ownership of mineral rights.

Surface Allocation: An allocation of potential additions to reserves to land entities based on surface ownership.

Sweet Spot: An area within a continuous-type deposit where production characteristics are relatively more favorable.

Total Petroleum System (TPS): A mappable entity encompassing genetically related petroleum that occurs in seeps, shows, and accumulations (discovered or undiscovered) that have been generated by a pod or by closely related pods of mature source rock, together with the essential mappable geologic elements (source, reservoir, seal, and overburden rocks) that controlled fundamental processes of generation, migration, entrapment, and preservation of petroleum.

Total Recovery: The total expected recoverable volume of oil, gas, and natural gas liquids production from a well, lease, or field under present economic and engineering conditions; synonymous with estimated ultimate recovery.

Undeveloped Petroleum Resources: Assessed resources in continuous-type accumulations as opposed to reserve growth or undiscovered conventional accumulations.

Undiscovered Petroleum Resources: Resources postulated from geologic information and theory to exist outside of known oil and gas accumulations.

USGS Assessed Petroleum Volumes: The quantities of oil, gas, and natural gas liquids that have the potential to be added to reserves within some future time frame. For this assessment, the time frame is 30 years. The USGS assessed petroleum volumes include those from undiscovered accumulations, whose sizes are greater than or equal to the stated minimum accumulation size, and from the reserve growth of fields already discovered.

Attachment 3

Assessment Review Team

- Ron Charpentier
- Troy Cook
- Bob Crovelli
- Tim Klett
- Chris Schenk
- Jim Schmoker

Attachment 4

FORSPAN ASSESSMENT MODEL FOR CONTINUOUS ACCUMULATIONS--BASIC INPUT DATA FORM (NOGA, Version 6, 12-30-00)

IDENTIFICATION INFORMATION

Assessment Geologist:… __________ Date: ______
Region:…………………… __________ Number: ______
Province:………………… __________ Number: ______
Total Petroleum System:. __________ Number: ______
Assessment Unit:………. __________ Number: ______
Based on Data as of:…… __________
Notes from Assessor….. __________

CHARACTERISTICS OF ASSESSMENT UNIT

Assessment-Unit type: **Oil** (<20,000 cfg/bo) **or** **Gas** (≥20,000 cfg/bo) ______
What is the minimum total recovery per cell?… ______ (mmbo for oil A.U.; bcfg for gas A.U.)
Number of tested cells:………… ______
Number of tested cells with total recovery per cell ≥ minimum: ……... ______
Established (>24 cells ≥ min.) ______ Frontier (1-24 cells) ______ Hypothetical (no cells) ______
Median total recovery per cell (for cells ≥ min.): (mmbo for oil A.U.; bcfg for gas A.U.)
1st 3rd discovered ______ 2nd 3rd ______ 3rd 3rd ______

Assessment-Unit Probabilities:
Attribute — Probability of occurrence (0-1.0)
1. **CHARGE:** Adequate petroleum charge for an untested cell with total recovery ≥ minimum …… ______
2. **ROCKS:** Adequate reservoirs, traps, seals for an untested cell with total recovery ≥ minimum. ______
3. **TIMING:** Favorable geologic timing for an untested cell with total recovery ≥ minimum……….. ______

Assessment-Unit GEOLOGIC Probability (Product of 1, 2, and 3):……….......… ______

4. **ACCESS:** Adequate location for necessary petroleum-related activities for an untested cell with total recovery ≥ minimum ……………………………………………………………… ______

NO. OF UNTESTED CELLS WITH POTENTIAL FOR ADDITIONS TO RESERVES IN THE NEXT 30 YEARS

1. Total assessment-unit area (acres): (uncertainty of a fixed value)
minimum ______ median ______ maximum ______

2. Area per cell of untested cells having potential for additions to reserves in next 30 years (acres):
(values are inherently variable) minimum__________ median_________ maximum____________

3. Percentage of total assessment-unit area that is untested (%): (uncertainty of a fixed value)
minimum__________ median_________ maximum____________

4. Percentage of untested assessment-unit area that has potential for additions to reserves in next 30 years (%): (a necessary criterion is that total recovery per cell $\geq$ minimum)
(uncertainty of a fixed value) minimum__________ median_________ maximum____________

Assessment Unit (name, no.)

____

TOTAL RECOVERY PER CELL

Total recovery per cell for untested cells having potential for additions to reserves in next 30 years:
(values are inherently variable)
(mmbo for oil A.U.; bcfg for gas A.U.) minimum__________ median_________ maximum____________

AVERAGE COPRODUCT RATIOS FOR UNTESTED CELLS, TO ASSESS COPRODUCTS

(uncertainty of fixed but unknown values)

Oil assessment unit:	minimum	median	maximum
Gas/oil ratio (cfg/bo)………………………...……	__________	_________	____________
NGL/gas ratio (bngl/mmcfg)……………………..….	__________	_________	____________
Gas assessment unit:			
Liquids/gas ratio (bliq/mmcfg)….…………..……	__________	_________	____________

SELECTED ANCILLARY DATA FOR UNTESTED CELLS

(values are inherently variable)

Oil assessment unit:	minimum	median	maximum
API gravity of oil (degrees)…………….……….	__________	_________	____________
Sulfur content of oil (%)……………………...….	__________	_________	____________
Drilling depth (m) ……………...……………..…….	__________	_________	____________
Depth (m) of water (if applicable)……………….	__________	_________	____________
Gas assessment unit:			
Inert-gas content (%)………………………......	__________	_________	____________
CO_2 content (%)………………………………..…..	__________	_________	____________
Hydrogen-sulfide content (%)……………..…….	__________	_________	____________
Drilling depth (m)………………………………….	__________	_________	____________
Depth (m) of water (if applicable)……………….	__________	_________	____________

Assessment Unit (name, no.)

____

ALLOCATIONS OF POTENTIAL ADDITIONS TO RESERVES TO LAND ENTITIES
Surface Allocations (uncertainty of a fixed value)

1. Federal Lands ______ represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______
Gas in gas assessment unit:			
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

2. Private Lands ______ represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______
Gas in gas assessment unit:			
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

3. Tribal Lands ______ represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______
Gas in gas assessment unit:			
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

4. State Lands 1 ______ represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______
Gas in gas assessment unit:			
Volume % in entity..................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

Assessment Unit (name, no.) ____________________

5. State Lands 2 represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity…………………………………	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

Gas in gas assessment unit:			
Volume % in entity…………………………………	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

6. State Total 1 represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity…………………………………	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

Gas in gas assessment unit:			
Volume % in entity…………………………………	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

7. State Total 2 represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity…………………………………	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

Gas in gas assessment unit:			
Volume % in entity…………………………………	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

Assessment Unit (name, no.) ____________________

ALLOCATIONS OF POTENTIAL ADDITIONS TO RESERVES TO LAND ENTITIES

Subsurface Allocations (uncertainty of a fixed value)

Based on Data as of: ____________________

1. All Federal Subsurface represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity...................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

Gas in gas assessment unit:			
Volume % in entity...................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

2. Other Subsurface represents ______ areal % of the assessment unit

Oil in oil assessment unit:	minimum	median	maximum
Volume % in entity...................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______

Gas in gas assessment unit:			
Volume % in entity...................................	______	______	______
Portion of volume % that is offshore (0-100%).	______	______	______