Gaffney, Cline & Associates

GCA do Brasil Consultores Ltda.

Av República do Chile, 330, Torre Oeste, Sl. 2801,
Rio de Janeiro, RJ
CEP 20031-170
Brasil

www.gaffney-cline.com

January 8, 2020

ENEVA S.A.
Praia de Botafogo, 501 | Torre Corcovado | 4º andar
Rio de Janeiro | 22250-040
Rio de Janeiro
Brazil

Natural Gas Reserves Audit Report for ENEVA Participating Interest Fields in Parnaiba and Amazonas Basins, Brazil as of December 31, 2019

This reserves statement has been prepared by Gaffney, Cline & Associates (GCA) and issued on January 8, 2020 at the request of ENEVA S.A. (ENEVA or "the Client"). This report is intended solely for ENEVA's internal use and is not to be distributed to any third parties without GCA's prior written consent.

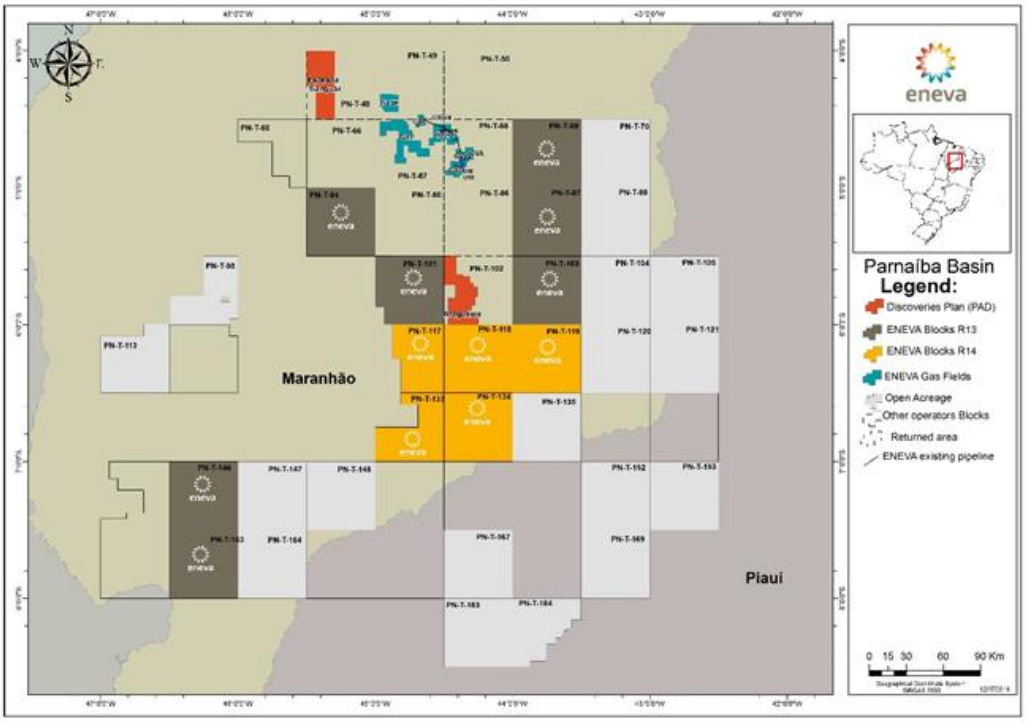
ENEVA is the operator of and has 100% interest participation in several gas properties located onshore in the Parnaiba and Amazonas basin, Brazil as presented in Figure 1. ENEVA is a Brazilian fully integrated energy company, with businesses in power generation, energy commercialization, and oil & gas exploration and production.

GCA performed periodic reserves audit examinations of the mentioned fields from 2013 to 2019. The last GCA issued report titled "Natural Gas Reserves Audit Report for ENEVA Participating Interest Fields in Parnaiba and Amazonas Basins, Brazil" was dated on January 9, 2019.

This report relates specifically and solely to the subject matter as defined in the scope of work in the Proposal for Services and subsequently agreed upon revisions and is conditional upon the assumptions described herein. The report must be considered in its entirety and must only be used for the purpose for which it was intended.

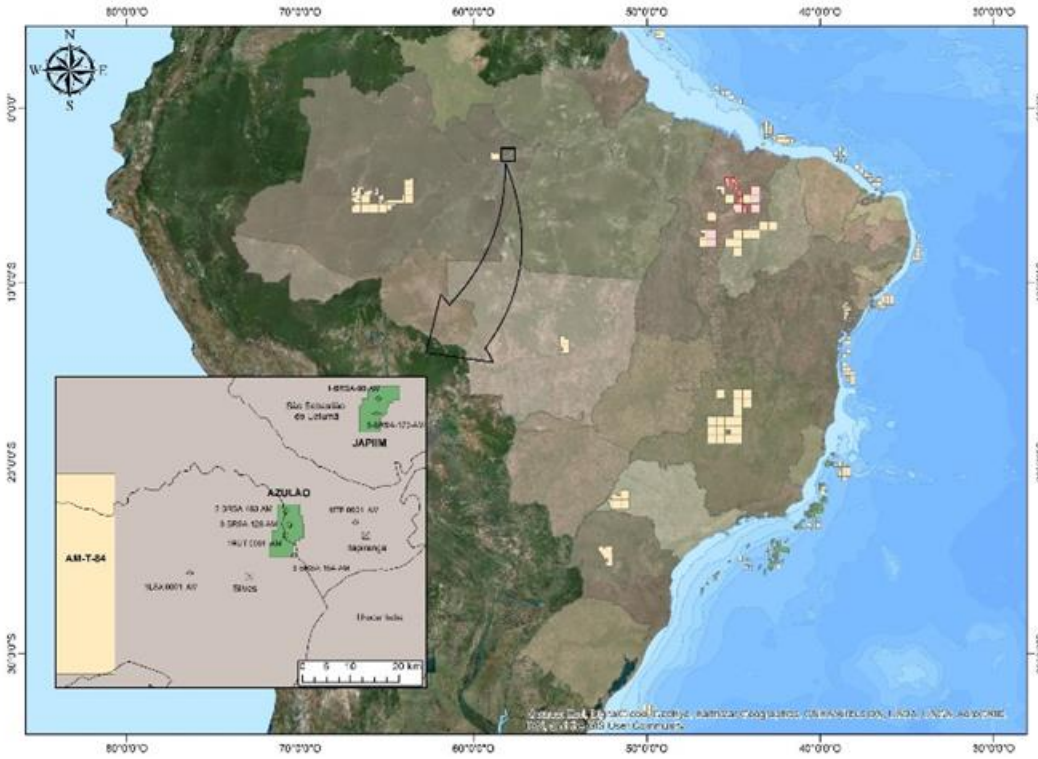
Figure 1 presents the location of the nine fields located in the Parnaiba basin and Figure 2 presents the location of the Azulão field located in the Amazonas basin.

Figure 1: Location Map of the ENEVA Areas in the Parnaiba and Amazonas Basin



Source: ENEVA S.A.

Figure 2: Location Map of the Azulao Field in the Amazonas Basin



Source: ENEVA S.A.

As shown in Figure 1, the following are the nine ENEVA fields located in the Parnaiba basin considered in this report:

- Gavião Real (GVR)
- Gavião Azul (GVA)
- Gavião Branco (GVB) plus Gavião Branco Sudeste (GBSE)
- Gavião Branco Norte (GVBN)
- Gavião Caboclo (GVC)
- Gavião Vermelho (GVV)
- Gavião Preto (GVP)
- Gavião Tesoura GVTE
- Araguaína (Gavião Carijó field)

Additionally, the Azulão field (AZU) located in the Amazonas Basin has been included in this report.

GCA reviewed ENEVA's re-evaluation of some of the field's sizes where new information from drilling and pressure evolution indicated variation of the original in-place gas volumes. ENEVA performed new reservoir simulations for each field obtaining new estimates of recovery factors and production profiles that were also reviewed by GCA. On the basis of technical and other information made available to GCA concerning these property units, GCA hereby provides the reserves statement in Table 1.

Table 1: Statement of Natural Gas Reserves Volumes
Nine Fields in the Parnaiba Basin and One in the Amazonas Basin
as of December 31, 2019

Reserves Category	Gross Field Gas Volumes (100% WI) (Bm^3)	ENEVA Gas Reserves (100% WI) (Bm^3)
Proved		
Developed	13.1	12.8
Undeveloped	11.8	11.5
Total (1P)	**24.8**	**24.4**
2P	28.2	27.7
3P	31.9	31.2

Table 2 presents the reserves statement for the nine fields located in the Parnaiba Basin.

Table 2: Statement of Natural Gas Reserves Volumes
Nine Fields in the Parnaiba Basin
as of December 31, 2019

Reserves Category	Gross Field Gas Volumes (100% WI) (Bm^3)	ENEVA Gas Reserves (100% WI) (Bm^3)
Proved		
Developed	13.1	12.8
Undeveloped	8.8	8.6
Total (1P)	**21.8**	**21.4**
2P	24.6	24.1
3P	27.4	26.9

Table 3 presents the reserves statement for the Azulão field located in the Amazonas Basin.

Table 3: Statement of Natural Gas Reserves Volumes
Azulão Field in the Amazonas Basin
as of December 31, 2019

Reserves Category	Gross Field Gas Volumes (100% WI) (Bm^3)	ENEVA Gas Reserves (100% WI) (Bm^3)
Proved		
Developed	0.0	0.0
Undeveloped	3.0	3.0
Total (1P)	**3.0**	**3.0**
2P	3.7	3.6
3P	4.4	4.4

Natural gas volumes have been reported in billion (10^9) cubic meters at standard conditions of 1 Atmosphere and 15.6 °C. Reserves volumes correspond to sales gas, after an allocation has been made for fuel and consumption estimated as 2% of total gas production.

Hydrocarbon liquid volumes to be recovered during field separation represent minor quantities and are not reported.

Gas sales volumes are based on firm and existing gas contracts.

Article 47 of the Brazilian Petroleum Law states that "…royalties are to be paid on a monthly basis, in national currency …" and, therefore, royalties (10%) are treated as cash deductions rather than a reduction to volumes.

Field Description

The following is a description of the wells and facilities of each field included in this report:

- Six developed gas fields:
  - Gavião Real: Twenty-eight producing wells. Estimated cumulative gas production is 6.830 Bm^3 as of December 31, 2019
  - Gavião Vermelho: Six producing wells, compression and booster system installed in GTU. Estimated cumulative gas production is 1.065 Bm^3 as of December 31, 2019
  - Gavião Branco: Eight producing wells in the Main area and four wells in the West Area; drilled two new wells (end of 2019), Compression and Booster (2021). Estimated cumulative gas production is 1.491 Bm^3 as of December 31, 2019
  - Gavião Branco Sudeste: Five producing wells. Compression in and Booster in 2021. Estimated cumulative gas production is 0.770 Bm^3 as of December 31, 2019
  - Gavião Azul: Five producing wells, plus one well to be drilled in 2020, compression and booster installed in GTU; estimated cumulative gas production is 0.074 Bm^3 as of December 31, 2019
  - Gavião Caboclo: Nine producing wells, production station in 2021, booster in 2021. Estimated cumulative gas production is 1.070 Bm^3 as of December 31, 2019
- Five gas fields under development:
  - Gavião Preto: Seven producing wells plus five wells to be drilled between in 2020, production station in 2021, booster in 2023
  - Gavião Branco Norte: One producing well, facilities to be installed in 2021
  - Gavião Tesoura: Three producing wells, and one to be drilled in 2023, facilities construction in 2023. Booster in 2023. Initial gas production in 2024
  - Araguaína Five existing well drilled and five wells to be drilled until 2025. Facilities construction. Initial gas production Jan 2025.
  - Azulão Two existing producing wells. Drilling one additional well in 2020. Facilities construction in 2021. Initial gas production Jan-2022

As of December 31, 2019, all of these fields have been declared commercial and estimated total cumulative production as of December 31, 2019 is 11.299 Bm^3.

Table 4 shows the original gas in place by field.

Table 4: Original Gas in Place as of December 31, 2019

Field	GIIP (MMm^3)		
	1P	2P	3P
GVR	10,780	11,000	11,220
GVA	2,453	2,950	3,440
GVB	5,260	5,680	6,054
GBSE	2,264	2,522	2,841
GVBN	348	389	434
GVV	2,520	2,653	2,786
GVC	4,914	5,173	5,495
GVT	1,550	1,750	1,970
AZU	3,740	4,550	5,490
ARAG	2,250	3,000	3,750
GVP	7,185	7,983	8,781

Note: summation differences are due to rounding

GCA estimated the recovery factors to be expected for each reserves category, based upon reservoir simulation results and depletion considerations. They are shown in Table 5.

Table 5: Estimated Recovery Factors as of December 31, 2019

Field	Recovery Factors (%)		
	1P	2P	3P
GVR	89%	89%	89%
GVA	66%	66%	66%
GVB	86%	86%	86%
GBSE	90%	90%	90%
GVBN	45%	50%	55%
GVV	86%	88%	90%
GVC	91%	91%	91%
GVT	82%	82%	82%
AZU	81%	81%	81%
ARAG	43%	43%	43%
GVP	89%	89%	89%

Reserves Assessment

GCA obtained the expected gross field remaining volumes from the previously mentioned in-place values and recovery factors, applying a deterministic calculation and taking into account the previously mentioned cumulative production of the active fields at the as of date.

Gross field reserves were estimated as the gross field volumes limited by the expiry of the gas contracts at the end of 2036 net of 2% consumption and subjected to Economic Limit Test (ELT) considerations. ENEVA working interest is 100%. These results are shown in Table 6.

Table 6: Statement of Natural Gas Reserve Volumes per Field as of December 31, 2019

Field	Gross Field Volumes (Bm^3)				ENEVA Reserves (Bm^3)			
	PD	1P	2P	3P	PD	1P	2P	3P
GVR	2.710	2.710	2.905	3.099	2.656	2.656	2.847	3.037
GVA	1.545	1.545	1.873	2.196	1.514	1.514	1.835	2.152
GVB	3.033	3.033	3.394	3.716	2.972	2.972	3.326	3.641
GBSE	1.268	1.268	1.500	1.787	1.243	1.243	1.470	1.752
GVBN	0.000	0.157	0.194	0.239	0.000	0.153	0.191	0.234
GVV	1.109	1.109	1.270	1.436	1.087	1.087	1.245	1.407
GVC	3.402	3.402	3.638	3.931	3.334	3.334	3.565	3.852
GVT	0.000	1.271	1.435	1.615	0.000	1.246	1.406	1.583
AZU	0.000	3.029	3.685	4.447	0.000	2.969	3.612	4.358
ARAG	0.000	0.967	1.290	1.612	0.000	0.948	1.264	1.580
GVP	0.000	6.358	7.065	7.771	0.000	6.231	6.924	7.616
Total	**13.067**	**24.850**	**28.249**	**31.850**	**12.805**	**24.353**	**27.684**	**31.213**

Note: summation differences are due to rounding

This audit examination was based on reserves estimates and other information provided by ENEVA to GCA through December 15, 2019 and included such tests, procedures and adjustments as were considered necessary. All questions that arose during the audit process were resolved to GCA's satisfaction.

The economic tests for the December 31, 2019 reserves volumes were based on gas prices provided by ENEVA that are based on internal transfer prices and ANP reference price estimates.

The future production forecast is dependent on demand. The operational gas plant maximum capacity is of 8.4 MMm^3/d and GCA estimated that the average yearly demand would reach 60% of that capacity, based on recent demand history. The revenue of ENEVA is composed of gas sales at US$0.08/MMBtu and a revenue for the existing production capacity consisting of a fixed yearly amount of US$68.7 million and a variable amount of US$2.19/MMBtu.

Future capital costs were derived from development plans prepared by ENEVA for the fields audited. Recent historical operating expense data were used as the basis for operating cost projections. Adjustments for dollar inflation were applied to prices and costs. GCA has found

that ENEVA has projected sufficient capital investments and operating expenses to economically produce the projected volumes.

In the preparation of this report, GCA has used definitions contained within the Petroleum Resources Management System (PRMS), which was approved by the Society of Petroleum Engineers, the World Petroleum Council, the American Association of Petroleum Geologists, the Society of Petroleum Evaluation Engineers, the Society of Exploration Geophysicists, the Society of Petrophysicists and Well Log Analysts, and the European Association of Geoscientists and Engineers in June 2018 Version 1.01 (see Appendix I).

GCA concludes that the methodologies employed by ENEVA in the derivation of the reserves estimates are appropriate, and that the quality of the data relied upon and the depth and thoroughness of the reserves estimation process is adequate.

Basis of Opinion

This document reflects GCA's informed professional judgment based on accepted standards of professional investigation and, as applicable, the data and information provided by the Client, the limited scope of engagement and the time permitted to conduct the evaluation.

In line with those accepted standards, this document does not in any way constitute or make a guarantee or prediction of results, and no warranty is implied or expressed that actual outcome will conform to the outcomes presented herein. GCA has not independently verified any information provided by, or at the direction of, the Client. and has accepted the accuracy and completeness of this data. GCA has no reason to believe that any material facts have been withheld but does not warrant that its inquiries have revealed all of the matters that a more extensive examination might otherwise disclose.

The opinions expressed herein are subject to and fully qualified by the generally accepted uncertainties associated with the interpretation of geoscience and engineering data and do not reflect the totality of circumstances, scenarios and information that could potentially affect decisions made by the report's recipients and/or actual results. The opinions and statements contained in this report are made in good faith and in the belief that such opinions and statements are representative of prevailing physical and economic circumstances.

There are numerous uncertainties inherent in estimating reserves and resources and in projecting future production, development expenditures, operating expenses and cash flows. Oil and gas resources assessments must be recognized as a subjective process of estimating subsurface accumulations of oil and gas that cannot be measured in an exact way. Estimates of oil and gas resources prepared by other parties may differ, perhaps materially, from those contained within this report.

The accuracy of any resource estimate is a function of the quality of the available data and of engineering and geological interpretation. Results of drilling, testing and production that post-date the preparation of the estimates may justify revisions, some or all of which may be material. Accordingly, resource estimates are often different from the quantities of oil and gas that are ultimately recovered, and the timing and cost of those volumes that are recovered may vary from that assumed.

GCA's review and audit involved reviewing pertinent facts, interpretations and assumptions made by the Client or others in preparing estimates of reserves and resources. GCA performed

procedures necessary to enable it to render an opinion on the appropriateness of the methodologies employed, adequacy and quality of the data relied on, depth and thoroughness of the reserves and resources estimation process, classification and categorization of reserves and resources appropriate to the relevant definitions used and reasonableness of the estimates.

Definition of Reserves and Resources

Reserves are those quantities of petroleum that are anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions. Reserves must further satisfy four criteria, based on the development project(s) applied: discovered, recoverable, commercial and remaining (as of the evaluation date).

GCA is not aware of any potential changes in regulations applicable to these fields that could affect the ability of the Client to produce the estimated reserves.

Reserves are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by development and production status. All categories of reserves volumes quoted herein have been derived within the context of an economic limit test (ELT) assessment (pre-tax and exclusive of accumulated depreciation amounts) prior to any Net Present Value (NPV) analysis.

GCA has not undertaken a site visit or inspection because it was not considered relevant for the purpose of this report. As such, GCA is not in a position to comment on the operations or facilities in place, their appropriateness and condition or whether they are in compliance with the regulations pertaining to such operations. Further, GCA is not in a position to comment on any aspect of health, safety or environment of such operation.

This report has been prepared based on GCA's understanding of the effects of petroleum legislation and other regulations that currently apply to these properties. However, GCA is not in a position to attest to property title or rights, conditions of these rights (including environmental and abandonment obligations), or any necessary licenses and consents (including planning permission, financial interest relationships or encumbrances thereon for any part of the appraised properties).

Qualifications

In performing this study, GCA is not aware that any conflict of interest has existed. As an independent consultancy, GCA is providing impartial technical, commercial and strategic advice within the energy sector. GCA's remuneration was not in any way contingent on the contents of this report.

In the preparation of this document, GCA has maintained, and continues to maintain, a strict independent consultant-client relationship with the Client. Furthermore, the management and employees of GCA have no interest in any of the assets evaluated or related with the analysis performed as part of this report.

Staff members who prepared this report hold appropriate professional and educational qualifications and have the necessary levels of experience and expertise to perform the work.

Notice

This document is confidential and has been prepared for the exclusive use of the Client or parties named herein. It may not be distributed or made available, in whole or in part, to any other company or person without the prior knowledge and written consent of Gaffney, Cline & Associates (GCA). No person or company other than those for whom it is intended may directly or indirectly rely upon its contents. GCA is acting in an advisory capacity only, and to the fullest extent permitted by law disclaims all liability for actions or losses derived from any actual or purported reliance on this document (or any other statements or opinions of GCA) by the Client or by any other person or entity.

Yours sincerely.

Gaffney. Cline & Associates

Project Manager
Cesar Guzzetti. Principal Advisor – Reservoir Engineer

Reviewed by
Roberto Wainhaus – Technical Director

Appendices

Appendix I	PRMS Definitions
Appendix II	Glossary

Appendix I
PRMS Definitions

**Society of Petroleum Engineers, World Petroleum Council,
American Association of Petroleum Geologists, Society of Petroleum Evaluation Engineers,
Society of Exploration Geophysicists, Society of Petrophysicists and Well Log Analysts,
and European Association of Geoscientists & Engineers**

Petroleum Resources Management System

Definitions and Guidelines ([1])

(Revised June 2018)

Table 1—Recoverable Resources Classes and Sub-Classes

Class/Sub-Class	Definition	Guidelines
Reserves	Reserves are those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions.	Reserves must satisfy four criteria: discovered, recoverable, commercial, and remaining based on the development project(s) applied. Reserves are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by the development and production status. To be included in the Reserves class, a project must be sufficiently defined to establish its commercial viability (see Section 2.1.2, Determination of Commerciality). This includes the requirement that there is evidence of firm intention to proceed with development within a reasonable time-frame. 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 where, for example, development of an economic project is deferred at the option of the producer for, among other things, market-related reasons or to meet contractual or strategic objectives. In all cases, the justification for classification as Reserves should be clearly documented. To be included in the Reserves class, there must be a high confidence in the commercial maturity and economic 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.

[1] These Definitions and Guidelines are extracted from the full Petroleum Resources Management System (revised June 2018) document.

Class/Sub-Class	Definition	Guidelines
On Production	The development project is currently producing or capable of producing and selling petroleum to market.	The key criterion is that the project is receiving income from sales, rather than that the approved development project is necessarily complete. Includes Developed Producing Reserves. The project decision gate is the decision to initiate or continue economic production from the project.
Approved for Development	All necessary approvals have been obtained, capital funds have been committed, and implementation of the development project is ready to begin or is under way.	At this point, it must be certain that the development project is going ahead. The project must not be subject to any contingencies, such as outstanding regulatory approvals or sales contracts. Forecast capital expenditures should be included in the reporting entity's current or following year's approved budget. The project decision gate is the decision to start investing capital in the construction of production facilities and/or drilling development wells.
Justified for Development	Implementation of the development project is justified on the basis of reasonable forecast commercial conditions at the time of reporting, and there are reasonable expectations that all necessary approvals/contracts will be obtained.	To move to this level of project maturity, and hence have Reserves associated with it, the development project must be commercially viable at the time of reporting (see Section 2.1.2, Determination of Commerciality) and the specific circumstances of the project. All participating entities have agreed and there is evidence of a committed project (firm intention to proceed with development within a reasonable time-frame}) There must be no known contingencies that could preclude the development from proceeding (see Reserves class). The project decision gate is the decision by the reporting entity and its partners, if any, that the project has reached a level of technical and commercial maturity sufficient to justify proceeding with development at that point in time.
Contingent Resources	Those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations by application of development projects, but which are not currently considered to be commercially recoverable owing to one or more contingencies.	Contingent Resources may include, for example, projects for which there are currently no viable markets, where commercial recovery is dependent on technology under development, where evaluation of the accumulation is insufficient to clearly assess commerciality, where the development plan is not yet approved, or where regulatory or social acceptance issues may exist. Contingent Resources are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by the economic status.

Class/Sub-Class	Definition	Guidelines
Development Pending	A discovered accumulation where project activities are ongoing to justify commercial development in the foreseeable future.	The project is seen to have reasonable potential for eventual commercial development, to the extent that further data acquisition (e.g., drilling, seismic data) and/or evaluations are currently ongoing with a view to confirming that the project is commercially viable and providing the basis for selection of an appropriate development plan. The critical contingencies have been identified and are reasonably expected to be resolved within a reasonable time-frame. Note that disappointing appraisal/evaluation results could lead to a reclassification of the project to On Hold or Not Viable status. The project decision gate is the decision to undertake further data acquisition and/or studies designed to move the project to a level of technical and commercial maturity at which a decision can be made to proceed with development and production.
Development on Hold	A discovered accumulation where project activities are on hold and/or where justification as a commercial development may be subject to significant delay.	The project is seen to have potential for commercial development. Development may be subject to a significant time delay. Note that a change in circumstances, such that there is no longer a probable chance that a critical contingency can be removed in the foreseeable future, could lead to a reclassification of the project to Not Viable status. The project decision gate is the decision to either proceed with additional evaluation designed to clarify the potential for eventual commercial development or to temporarily suspend or delay further activities pending resolution of external contingencies.
Development Unclarified	A discovered accumulation where project activities are under evaluation and where justification as a commercial development is unknown based on available information.	The project is seen to have potential for eventual commercial development, but further appraisal/evaluation activities are ongoing to clarify the potential for eventual commercial development. This sub-class requires active appraisal or evaluation and should not be maintained without a plan for future evaluation. The sub-class should reflect the actions required to move a project toward commercial maturity and economic production.
Development Not Viable	A discovered accumulation for which there are no current plans to develop or to acquire additional data at the time because of limited production potential.	The project is not seen to have potential for eventual commercial development at the time of reporting, but the theoretically recoverable quantities are recorded so that the potential opportunity will be recognized in the event of a major change in technology or commercial conditions. The project decision gate is the decision not to undertake further data acquisition or studies on the project for the foreseeable future.

Class/Sub-Class	Definition	Guidelines
Prospective Resources	Those quantities of petroleum that are estimated, as of a given date, to be potentially recoverable from undiscovered accumulations.	Potential accumulations are evaluated according to the chance of geologic discovery and, assuming a discovery, the estimated quantities that would be recoverable under defined development projects. It is recognized that the development programs will be of significantly less detail and depend more heavily on analog developments in the earlier phases of exploration.
Prospect	A project associated with a potential accumulation that is sufficiently well defined to represent a viable drilling target.	Project activities are focused on assessing the chance of geologic discovery and, assuming discovery, the range of potential recoverable quantities under a commercial development program.
Lead	A project associated with a potential accumulation that is currently poorly defined and requires more data acquisition and/or evaluation to be classified as a Prospect.	Project activities are focused on acquiring additional data and/or undertaking further evaluation designed to confirm whether or not the Lead can be matured into a Prospect. Such evaluation includes the assessment of the chance of geologic discovery and, assuming discovery, the range of potential recovery under feasible development scenarios.
Play	A project associated with a prospective trend of potential prospects, but that requires more data acquisition and/or evaluation to define specific Leads or Prospects.	Project activities are focused on acquiring additional data and/or undertaking further evaluation designed to define specific Leads or Prospects for more detailed analysis of their chance of geologic discovery and, assuming discovery, the range of potential recovery under hypothetical development scenarios.

Table 2—Reserves Status Definitions and Guidelines

Status	Definition	Guidelines
Developed Reserves	Expected quantities to be recovered from existing wells and facilities.	Reserves are considered developed only after the necessary equipment has been installed, or when the costs to do so are relatively minor compared to the cost of a well. Where required facilities become unavailable, it may be necessary to reclassify Developed Reserves as Undeveloped. Developed Reserves may be further sub-classified as Producing or Non-producing.
Developed Producing Reserves	Expected quantities to be recovered from completion intervals that are open and producing at the effective date of the estimate.	Improved recovery Reserves are considered producing only after the improved recovery project is in operation.
Developed Non-Producing Reserves	Shut-in and behind-pipe Reserves.	Shut-in Reserves are expected to be recovered from (1) completion intervals that are open at the time of the estimate but which have not yet started producing, (2) wells which were shut-in for market conditions or pipeline connections, or (3) wells not capable of production for mechanical reasons. Behind-pipe Reserves are expected to be recovered from zones in existing wells that will require additional completion work or future re-completion before start of production with minor cost to access these reserves. In all cases, production can be initiated or restored with relatively low expenditure compared to the cost of drilling a new well.
Undeveloped Reserves	Quantities expected to be recovered through future significant investments.	Undeveloped Reserves are to be produced (1) from new wells on undrilled acreage in known accumulations, (2) from deepening existing wells to a different (but known) reservoir, (3) from infill wells that will increase recovery, or (4) where a relatively large expenditure (e.g., when compared to the cost of drilling a new well) is required to (a) recomplete an existing well or (b) install production or transportation facilities for primary or improved recovery projects.

Table 3—Reserves Category Definitions and Guidelines

Category	Definition	Guidelines
Proved Reserves	Those quantities of petroleum that, 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.	If deterministic methods are used, the term "reasonable certainty" is intended to express a high degree of confidence that the quantities will be recovered. If probabilistic methods are used, there should be at least a 90% probability (P90) that the quantities actually recovered will equal or exceed the estimate. The area of the reservoir considered as Proved includes (1) the area delineated by drilling and defined by fluid contacts, if any, and (2) adjacent undrilled portions of the reservoir that can reasonably be judged as continuous with it and commercially productive on the basis of available geoscience and engineering data. In the absence of data on fluid contacts, Proved quantities in a reservoir are limited by the 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 in undeveloped locations may be classified as Proved provided that: A. The locations are in undrilled areas of the reservoir that can be judged with reasonable certainty to be commercially mature and economically productive. B. Interpretations of available geoscience and engineering data indicate with reasonable certainty that the objective formation is laterally continuous with drilled Proved locations. For Proved Reserves, the recovery efficiency applied to these reservoirs should be defined based on a range of possibilities supported by analogs and sound engineering judgment considering the characteristics of the Proved area and the applied development program.
Probable Reserves	Those additional Reserves that analysis of geoscience and engineering data indicates are less likely to be recovered than Proved Reserves but more certain to be recovered than Possible Reserves.	It is equally likely that actual remaining quantities recovered will be greater than or less than the sum of the estimated Proved plus Probable Reserves (2P). In this context, when probabilistic methods are used, there should be at least a 50% probability that the actual quantities recovered will equal or exceed the 2P estimate. Probable Reserves may be assigned to areas of a reservoir adjacent to Proved where data control or interpretations of available data are less certain. The interpreted reservoir continuity may not meet the reasonable certainty criteria. Probable estimates also include incremental recoveries associated with project recovery efficiencies beyond that assumed for Proved.

Category	Definition	Guidelines
Possible Reserves	Those additional reserves that analysis of geoscience and engineering data indicates are less likely to be recoverable than Probable Reserves.	The total quantities ultimately recovered from the project have a low probability to exceed the sum of Proved plus Probable plus Possible (3P), which is equivalent to the high-estimate scenario. When probabilistic methods are used, there should be at least a 10% probability (P10) that the actual quantities recovered will equal or exceed the 3P estimate. Possible Reserves may be assigned to areas of a reservoir adjacent to Probable where data control and interpretations of available data are progressively less certain. Frequently, this may be in areas where geoscience and engineering data are unable to clearly define the area and vertical reservoir limits of economic production from the reservoir by a defined, commercially mature project. Possible estimates also include incremental quantities associated with project recovery efficiencies beyond that assumed for Probable.
Probable and Possible Reserves	See above for separate criteria for Probable Reserves and Possible Reserves.	The 2P and 3P estimates may be based on reasonable alternative technical interpretations within the reservoir and/ or subject project that are clearly documented, including comparisons to results in successful similar projects. In conventional accumulations, Probable and/or Possible Reserves may be assigned where geoscience and engineering data identify directly adjacent portions of a reservoir within the same accumulation that may be separated from Proved areas by minor faulting or other geological discontinuities and have not been penetrated by a wellbore but are interpreted to be in communication with the known (Proved) reservoir. Probable or Possible Reserves may be assigned to areas that are structurally higher than the Proved area. Possible (and in some cases, Probable) Reserves may be assigned to areas that are structurally lower than the adjacent Proved or 2P area. Caution should be exercised in assigning Reserves to adjacent reservoirs isolated by major, potentially sealing faults until this reservoir is penetrated and evaluated as commercially mature and economically productive. Justification for assigning Reserves in such cases should be clearly documented. Reserves should not be assigned to areas that are clearly separated from a known accumulation by non-productive reservoir (i.e., absence of reservoir, structurally low reservoir, or negative test results); such areas may contain Prospective Resources. In conventional accumulations, where drilling has defined a highest known oil elevation and there exists the potential for an associated gas cap, Proved Reserves of oil should only be assigned in the structurally higher portions of the reservoir if there is reasonable certainty that such portions are initially above bubble point pressure based on documented engineering analyses. Reservoir portions that do not meet this certainty may be assigned as Probable and Possible oil and/or gas based on reservoir fluid properties and pressure gradient interpretations.

Figure 1.1—RESOURCES CLASSIFICATION FRAMEWORK

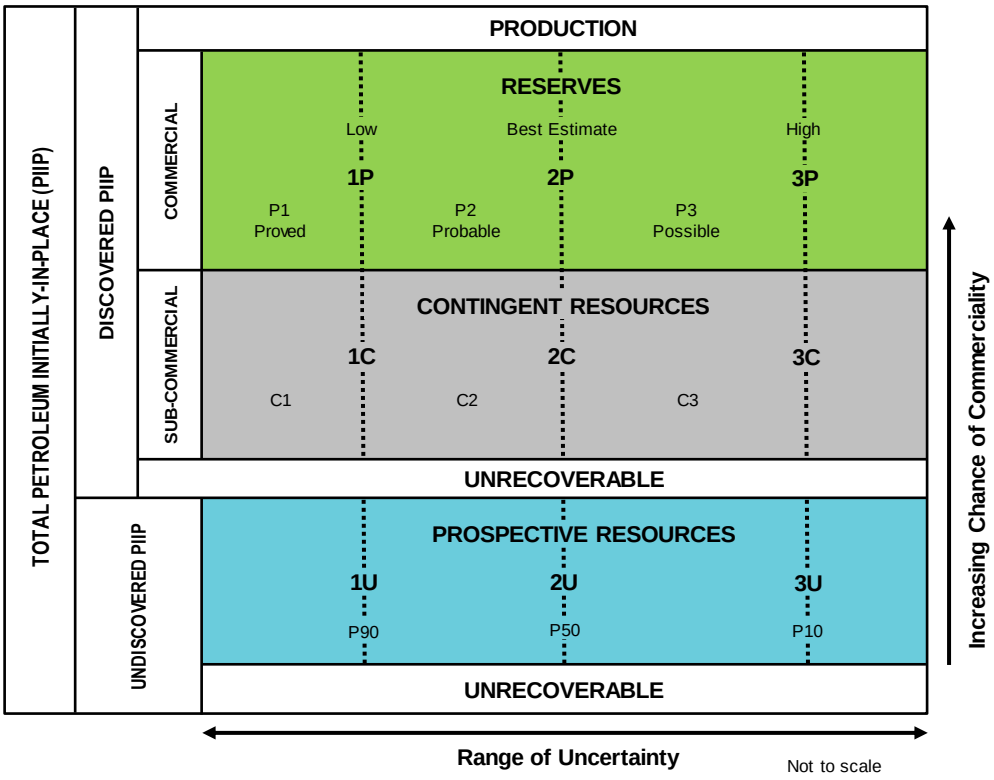
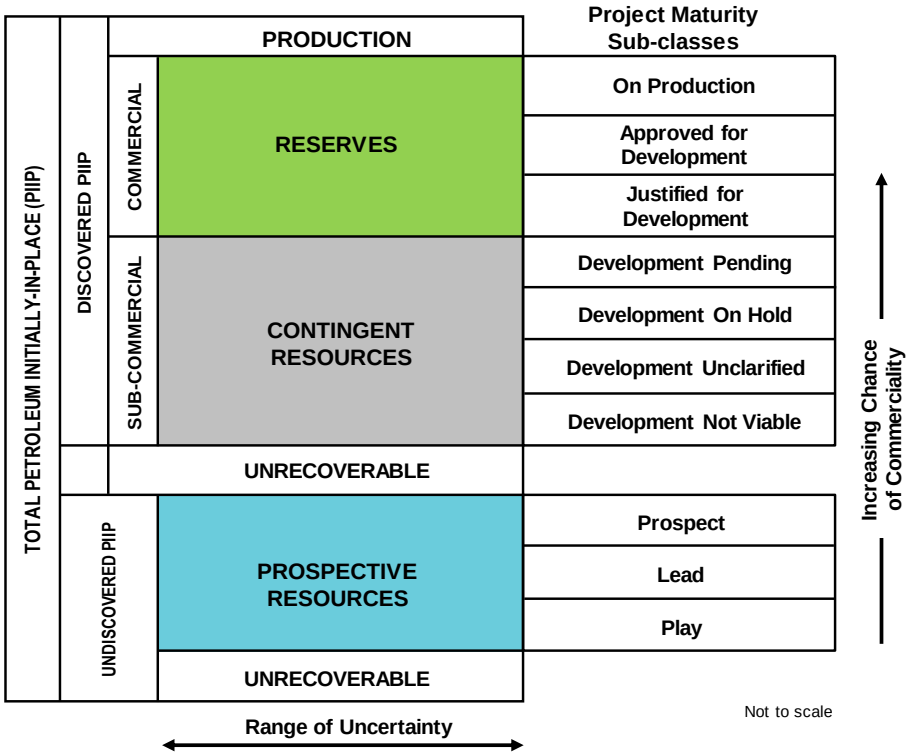


Figure 2.1—SUB-CLASSES BASED ON PROJECT MATURITY



Appendix II
Glossary

Gaffney, Cline & Associates

GLOSARIO
Lista de Términos y Abreviaturas Estándar de la Industria Petrolera

ABEX	Abandonment Expenditure	Gastos de Abandono
ACQ	Annual Contract Quantity	Volúmen Anual del Contrato
^{o}API	Degrees API (American Petroleum Institute)	Grados API (American Petroleum Institute)
AAPG	American Association of Petroleum Geologists	American Association of Petroleum Geologists
AVO	Amplitude versus Offset	Amplitud versus Desplazamiento
A$	Australian Dollars	Dólares Australianos
B	Billion (10^9)	Billones (10^9)
Bbl	Barrels	Barriles
/Bbl	per barrel	Por Barril
BBbl	Billion Barrels	Billones de Barriles
BHA	Bottom Hole Assembly	Conjunto de Fondo de Pozo
BHC	Bottom Hole Compensated	Fondo de Pozo Compensado
Bscf or Bcf	Billion standard cubic feet	Billones de pies cúbicos estándar
Bscfd or Bcfd	Billion standard cubic feet per day	Billones de pies cúbicos estándar por día
Bm^3	Billion cubic metres	Billones de metros cúbicos
bcpd	Barrels of condensate per day	Barriles de condensado por día
BHP	Bottom Hole Pressure	Presión de Fondo de Pozo
blpd	Barrels of liquid per day	Barriles de fluído por día
bpd	Barrels per day	Barriles por día
boe	Barrels of oil equivalent @ 6 Mcf/Bbl	Barriles de petróleo equivalente a 6 Mcf/Bbl
boepd	Barrels of oil equivalent per day @ 6 Mcf/Bbl	Barriles de petróleo equivalente por día a 6 Mcf/Bbl
BOP	Blow Out Preventer	Armadura de Control
bopd	Barrels oil per day	Barriles de petróleo por día
bwpd	Barrels of water per day	Barriles de agua por día
BS&W	Bottom sediment and water	Sedimentos de fondo y agua
BTU	British Thermal Units	Unidades Térmicas Británicas
CBM	Coal Bed Methane	Metano de yacimientos de carbono
CO_2	Carbon Dioxide	Dióxido de Carbono
CAPEX	Capital Expenditure	Gastos de capital
CCGT	Combined Cycle Gas Turbine	Turbina de gas de ciclo combinado
cm	centimetres	Centímetros
CMM	Coal Mine Methane	Metano de minas de carbón
CNG	Compressed Natural Gas	Gas natural comprimido
Cp	Centipoise (a measure of viscosity)	Centipoise (unidad de medida de viscosidad)
CSG	Coal Seam Gas	Gas de veta de carbón
CT	Corporation Tax	Impuesto de sociedades
DCQ	Daily Contract Quantity	Volúmen Diario del Contrato
Deg C	Degrees Celsius	Grados Celsius
Deg F	Degrees Fahrenheit	Grados Fahrenheit
DHI	Direct Hydrocarbon Indicator	Indicador Directo de Hidrocarburos
DST	Drill Stem Test	Ensayos de presión a través de sondeo
DWT	Dead-weight ton	Tonelada de peso muerto
E&A	Exploration & Appraisal	Exploración y Evaluación
E&P	Exploration and Production	Exploración y Producción
EBIT	Earnings before Interest and Tax	Ganancias antes de intereses e impuestos
EBITDA	Earnings before interest, tax, depreciation and amortisation	Ganancias antes de intereses, impuestos, depreciación y amortización
EI	Entitlement Interest	Intereses de Participación

EIA	Environmental Impact Assessment	Evaluación de Impacto Ambiental
EMV	Expected Monetary Value	Valor Monetario Previsto
EOR	Enhanced Oil Recovery	Recuperación Mejorada de Petróleo
EUR	Estimated Ultimate Recovery	Recuperación Final Estimada
FDP	Field Development Plan	Plan de Desarrollo de Campo
FEED	Front End Engineering and Design	Ingeniería y Diseño Inicial
FPSO	Floating Production, Storage and Offloading	Plataforma offshore de producción, almacenamiento y despacho.
FSO	Floating Storage and Offloading	Plataforma offshore de almacenamiento y despacho.
ft	Foot/feet	Pie / Pies
Fx	Foreign Exchange Rate	Tipo de Cambio de Divisas Extranjeras
g	gram	gramo
g/cc	grams per cubic centimetre	gramos por centímetro cúbico
gal	gallon	galón
gal/d	gallons per day	galones por día
G&A	General and Administrative costs	Gastos generales y administrativos
GBP	Pounds Sterling	Libra Esterlina
GDT	Gas Down to	Profundidad comprobada de gas
GIIP	Gas initially in place	Volúmen de gas original in-situ
GJ	Gigajoules (one billion Joules)	Gigajoules (mil millones de Joules)
GOR	Gas Oil Ratio	Relación Gas-Petróleo
GTL	Gas to Liquids	Gas a Líquidos
GWC	Gas water contact	Contacto agua-gas
HDT	Hydrocarbons Down to	Profundidad comprobada de hidrocarburos
HSE	Health, Safety and Environment	Salud, Seguridad y Medioambiente
HSFO	High Sulphur Fuel Oil	Combustible con alto contenido de azufre
H_2S	Hydrogen Sulphide	Ácido sulfhídrico
IOR	Improved Oil Recovery	Recuperación Mejorada de Petróleo
IPP	Independent Power Producer	Productor de Energía Independiente
IRR	Internal Rate of Return	Tasa Interna de Retorno
J	Joule (Metric measurement of energy) I kilojoule = 0.9478 BTU)	Joule (unidad de medida de la energía) 1 kilojoule = 0,9478 BTU)
k	Permeability	Permeabilidad
KJ	Kilojoules (one Thousand Joules)	Kilojoules (Mil Joules)
kl	Kilolitres	Kilolitros
km	Kilometres	Kilómetros
km^2	Square kilometres	Kilómetros Cuadrados
kPa	Thousands of Pascals (measurement of pressure)	Miles de Pascales (medición de la presión)
KW	Kilowatt	Kilovatio
KWh	Kilowatt hour	Kilovatio hora
LKG	Lowest Known Gas	Máxima profundidad de gas conocida
LKH	Lowest Known Hydrocarbons	Máxima profundidad de hidrocarburos conocida
LKO	Lowest Known Oil	Máxima profundidad de petróleo conocida
LNG	Liquefied Natural Gas	Gas Natural Licuado
LoF	Life of Field	Vida de Campo
LPG	Liquefied Petroleum Gas	Gas de Petróleo Licuado
LTI	Lost Time Injury	Tiempo Perdido por Lesiones
LWD	Logging while drilling	Registro de perfiles durante la perforación
m	Metres	Metros
M	Thousand	Mil
m^3	Cubic metres	Metros Cúbicos

Mcf or Mscf	Thousand standard cubic feet	Miles de pies cúbicos estándar
MCM	Management Committee Meeting	Reunión del Comité de Gestión
MMcf or MMscf	Million standard cubic feet	Millones de pies cúbicos estándar
m^3d	Cubic metres per day	Metros Cúbicos por día
mD	Measure of Permeability in millidarcies	Medida de permeabilidad en milidarcies
MD	Measured Depth	Profundidad medida
MDT	Modular Dynamic Tester	Medidor Dinámico Modular
Mean	Arithmetic average of a set of numbers	Promedio aritmético de un conjunto de números
Median	Middle value in a set of values	Valor medio en un conjunto de valores
MFT	Multi Formation Tester	Medidor de Formación Múltiple
mg/l	milligrams per litre	miligramos por litro
MJ	Megajoules (One Million Joules)	Megajoules (Un Millón de Joules)
Mm^3	Thousand Cubic metres	Miles de metros cúbicos
Mm^3d	Thousand Cubic metres per day	Miles de metros cúbicos por día
MM	Million	Millón
MMBbl	Millions of barrels	Millones de barriles
MMBTU	Millions of British Thermal Units	Millones de Unidades Térmicas Británicas
Mode	Value that exists most frequently in a set of values = most likely	Valor que existe más frecuentemente en un conjunto de valores = más probable
Mscfd	Thousand standard cubic feet per day	Miles de pies cúbicos estándar por día
MMscfd	Million standard cubic feet per day	Millones de pies cúbicos estándar por día
MW	Megawatt	Megavatio
MWD	Measuring While Drilling	Medición durante la perforación
MWh	Megawatt hour	Megavatio hora
mya	Million years ago	Hace un millón de años
NGL	Natural Gas Liquids	Líquidos del Gas Natural
N_2	Nitrogen	Nitrógeno
NPV	Net Present Value	Valor Actual Neto
OBM	Oil Based Mud	Lodo a base de petróleo
OCM	Operating Committee Meeting	Reunión del Comité de Operaciones
ODT	Oil down to	Profundidad de petróleo comprobada
OPEX	Operating Expenditure	Gastos de Operación
OWC	Oil Water Contact	Contacto agua-crudo
p.a.	Per annum	Anualmente
Pa	Pascals (metric measurement of pressure)	Pascales (medición métrica de la presión)
P&A	Plugged and Abandoned	Tapón de abandono
PDP	Proved Developed Producing	Probadas desarrolladas en producción
PI	Productivity Index	Índice de Productividad
PJ	Petajoules (10^{15} Joules)	Petajoules (10^{15} Joules)
PSDM	Post Stack Depth Migration	Migración en profundidad post apilamiento
psi	Pounds per square inch	Libras por pulgada cuadrada
psia	Pounds per square inch absolute	Libras por pulgada cuadrada absoluta
PUD	Proved Undeveloped	Probado sin desarrollar
PVT	Pressure volume temperature	Temperatura del volumen de presión
P10	10% Probability	10% de probabilidad
P50	50% Probability	50% de probabilidad
P90	90% Probability	90% de probabilidad
Rf	Recovery factor	Factor de recuperación
RFT	Repeat Formation Tester	RFT
RT	Rotary Table	Mesa rotativa
R_w	Resistivity of water	Resistividad del agua
SCAL	Special core analysis	Análisis de núcleo especial

cf or scf	Standard Cubic Feet	Pies cúbicos estándar
cfd or scfd	Standard Cubic Feet per day	Pies cúbicos estándar por día
scf/ton	Standard cubic foot per ton	Pies cúbicos estándar por tonelada
SL	Straight line (for depreciation)	Línea recta (para depreciación)
s_o	Oil Saturation	Saturación de crudo
SPE	Society of Petroleum Engineers	Society of Petroleum Engineers
SPEE	Society of Petroleum Evaluation Engineers	Society of Petroleum Evaluation Engineers
ss	Subsea	Submarino
stb	Stock tank barrel	Barril de crudo almacenado
STOIIP	Stock tank oil initially in place	Petróleo original in-situ en condiciones estándar
s_w	Water Saturation	Saturación de agua
T	Tonnes	Toneladas
TD	Total Depth	Profundidad total
Te	Tonnes equivalent	Toneladas equivalentes
THP	Tubing Head Pressure	Presión de cabeza de tubería
TJ	Terajoules (10^{12} Joules)	Terajoules (10^{12} Joules)
Tscf or Tcf	Trillion standard cubic feet	Trillón de pies cúbicos estándar
TCM	Technical Committee Meeting	Reunión del Comité Técnico
TOC	Total Organic Carbon	Carbono orgánico total
TOP	Take or Pay	Toma o paga
Tpd	Tonnes per day	Toneladas por día
TVD	True Vertical Depth	Profundidad vertical verdadera
TVDss	True Vertical Depth Subsea	Profundidad vertical verdadera submarina
USGS	United States Geological Survey	Encuesta Geológica de los Estados Unidos
US$	United States Dollar	Dólar Americano
VSP	Vertical Seismic Profiling	Perfiles sísmicos verticales
WC	Water Cut	Corte de agua
WI	Working Interest	Participación
WPC	World Petroleum Council	World Petroleum Council
WTI	West Texas Intermediate	West Texas Intermediate
wt%	Weight percent	Porcentaje de peso
1H05	First half (6 months) of 2005 (example of date)	Primer semestre (6 meses) de 2005 (ejemplo de fecha)
2Q06	Second quarter (3 months) of 2006 (example of date)	Segundo trimestre (3 meses) de 2006 (ejemplo de fecha)
2D	Two dimensional	Bidimensional
3D	Three dimensional	Tridimensional
4D	Four dimensional	Cuatro dimensiones
1P	Proved Reserves	Reservas probadas
2P	Proved plus Probable Reserves	Reservas Probadas más Probables
3P	Proved plus Probable plus Possible Reserves	Reservas Probados más Probables más Posibles
%	Percentage	Porcentaje