

Statistical Considerations

Sampling Plan

The goal was a sample that would provide estimates of reserves and production of crude oil, natural gas, and lease condensate for the United States. A stratified sample using a single stage and systematic selection with probability proportional to size was designed. The measure of size was the volume of production for crude oil, natural gas, and lease condensate by State by company in 2006. There were two strata: companies selected with certainty and companies selected under the systematic probability proportional to size design.

Operators of crude oil and natural gas wells were selected as the appropriate respondent population because they have access to the most current and detailed information, and therefore, presumably have better reserve estimates than do other possible classes of respondents, such as working interest or royalty owners. EIA conducts extensive frame maintenance activities each year to identify all current operators of crude oil and natural gas wells in the country. While large operators are quite well known, they comprise only a small portion of all operators. The small operators are not well known and are difficult to identify because they go into and out of business, alter their corporate identities, and change addresses frequently.

Sample Design

To meet survey objectives, while minimizing respondent burden, a sampling strategy has been used since 1977. EIA publishes data on reserves and production for crude oil, natural gas, and lease condensate by State for most States, and by subdivision for the States of California, Louisiana, New Mexico, and Texas. The total volume of production varies among the State/subdivisions. To meet the survey objectives while controlling total respondent burden, EIA selected the following target sampling error for the 2007 survey for each product class.

Each operator is asked to report production and reserves for crude oil, natural gas, and lease condensate for each State/subdivision in which he operates. The term State/subdivision refers to an individual subdivision within a State or an individual State that is not subdivided.

EIA selected the following target sampling error for the 2006 survey for each product class.

- 1.0 percent for National estimates and for each of the States having subdivisions: Alaska, California, Louisiana, New Mexico, and Texas.
- 2.5 percent for each State having 1 percent or more of estimated lower 48 States reserves or production in 2006 for any product class.
- 4 percent for each State/subdivision having less than 1 percent of estimated U.S. reserves or production in 2006 (lower 48 States) for all 3 product class.
- 8 percent for States not published separately.

Certainty Stratum

There are three components to the certainty stratum Category I, Category II, and certain Category III Small Operators.

- **Category I - Large Operators:** Operators who produced a total of 1.5 million barrels or more of crude, or 15 billion cubic feet or more of natural gas, or both in 2006.
- **Category II - Intermediate Operators:** Operators who produced a total of at least 400,000 barrels of crude oil or 2 billion cubic feet of natural gas, or both, but less than Category I operators in 2006, and additionally, all coalbed methane and Federal Offshore operators.
- **Category III - Small Operators:** Operators who produced less than the Category II operators in 2006.

Small operators were further subdivided into certainty and noncertainty strata. Small operators who satisfied any of the following criteria based upon their production shown in the operator frame are certainty operators:

- All other operators with production or reserves in a State/subdivision that exceed selected cutoff levels.
- The largest operator in each State/subdivision regardless of level of production or reserves.
- Operators with production or reserves of oil or gas for six or more State/subdivisions.

Table F1. 2007 EIA–23 Initial Number of Operators in Survey Sample

State and Subdivision	Number of Certainty Operators	Number of Multi–State Operators	Number of Noncertainty Operators	Target Error	
				Oil	Gas
Alabama Onshore	36	1	10	0.040	0.025
Alaska	8	0	0		
Arkansas	62	9	15	0.040	0.025
California - Coastal Region Onshore	15	1	2	0.080	0.080
California - Los Angeles Basin Onshore	17	5	2	0.010	0.010
California - San Joaquin Basin Onshore	41	3	5	0.025	0.040
Colorado	116	3	24	0.025	0.010
Florida	4	0	0	0.025	0.025
Illinois	33	29	24	0.040	0.040
Indiana	35	18	22	0.040	0.080
Kansas	163	86	70	0.040	0.080
Kentucky	40	21	13	0.025	0.010
Louisiana-North	114	18	31	0.040	0.040
Louisiana-South Onshore	200	25	30	0.010	0.010
Michigan	34	5	6	0.010	0.010
Mississippi	77	2	15	0.040	0.040
Montana	65	1	9	0.040	0.040
Nebraska	16	1	12	0.040	0.040
New Mexico - East	150	5	36	0.040	0.080
New Mexico - West	53	8	6	0.025	0.025
New York	16	4	4	0.025	0.010
North Dakota	64	0	6	0.080	0.040
Ohio	27	37	8	0.040	0.040
Oklahoma	258	66	105	0.040	0.040
Pennsylvania	42	10	7	0.025	0.025
Texas - RRC District 1	128	5	37	0.040	0.040
Texas - RRC District 2 Onshore	192	3	39	0.025	0.025
Texas - RRC District 3 Onshore	248	4	49	0.040	0.025
Texas - RRC District 4 Onshore	202	7	33	0.025	0.025
Texas - RRC District 5	105	4	22	0.040	0.010
Texas - RRC District 6	173	7	43	0.040	0.010
Texas - RRC District 7B	148	30	91	0.025	0.010
Texas - RRC District 7C	161	5	54	0.025	0.025
Texas - RRC District 8	190	1	47	0.040	0.025
Texas - RRC District 8A	170	0	53	0.010	0.010
Texas - RRC District 9	149	25	84	0.010	0.040
Texas - RRC District 10	142	32	45	0.025	0.025
Utah	54	0	6	0.040	0.010
Virginia	20	0	0	0.040	0.025
West Virginia	32	15	5	0.080	0.040
Wyoming	148	10	16	0.040	0.025
Offshore Areas	334	0	2	0.025	0.025
Other States ^a	50	5	1	0.080	0.080
Total	^b964	511	^b404	0.010	0.010

^aIncludes Arizona, Idaho, Iowa, Maryland, Missouri, Nevada, Oregon, South Dakota, Tennessee, and Washington.

^bNonduplicative count of operators by States.

Note: Sampling rate was 10 percent except in Alaska, Florida Onshore, Virginia, and Offshore areas where sampling rate was 100 percent.

Source: Energy Information Administration, Office of Oil and Gas.

Noncertainty Stratum

Small operators not in the certainty stratum were classified in the noncertainty stratum. They were systematically sampled with probability proportional to size. Only the operators in the following 6 states were included in the noncertainty sample: Illinois, Indiana, Kentucky, Pennsylvania, Tennessee, and West Virginia. All other States were treated as certainty stratum.

-In each State/subdivision the balance between the number of operators and the sample size was determined in an iterative procedure designed to minimize the number of total respondents. The iteration for each State/subdivision began with only the Category I and Category II operators in the certainty stratum. The size of the sample of small operators required to meet the target variance was calculated based on the variance of the volumes of those operators. For a number of State/subdivisions with high correlations between frame values across pairs of consecutive years, an adjusted target variance was calculated, that utilized the information about the correlations. This allowed the selection of a smaller sample that still met the target sampling error criteria. Independent samples of single location operators (operators who, according to the sampling frame, operate in only one State/subdivision) were selected from each State/subdivision using systematic random sampling.

State/subdivision volume estimates are calculated as the sum of the certainty strata and all of the estimates for the sampling strata in that region. The sampling variance of the estimated total is the sum of the sampling variances for the sampling strata. There is no sampling error associated with the certainty stratum. The square root of the sampling variance is the standard error. It can be used to provide confidence intervals for the State/subdivision totals.

For the States in which subdivision volume estimates are published, the State total is the sum of the individual volume estimates for the subdivisions. The U.S. total is the sum of the State estimates. A sampling variance is calculated for each State/subdivision and for the U.S. Total. **Table F1** shows sampling rates.

Total U.S. Reserve Estimates

Conceptually, the estimates of U.S. reserves and production can be thought of as the sum of the estimates for the individual States. Correspondingly, the estimates for the four States for which estimates are published separately by subdivision (California, Louisiana, New Mexico, and Texas) can be thought of as the sum of the estimates by subdivision. The

remaining States are not subdivided and may be considered as a single subdivision.

The estimates of year-end proved reserves and annual production for any State/subdivision is the sum of the volumes in the State/subdivision reported by the certainty stratum operators and an estimate of the total volume in the State/subdivision by the noncertainty stratum operators. The total volume of certainty operators in the State/subdivision is simply the sum of individual operator's volumes. The estimated total volume of noncertainty operators in the State/subdivision is the weighted sum of the reports of the noncertainty sample operators.

In many State/subdivisions, the accuracy of the oil and gas estimates was improved by using the probability proportional to size procedure. This procedure took advantage of the correlation between year-to-year production reports. The weights used for estimating the oil production were different from the weights used for estimating the gas production.

The weight used for the estimation is the reciprocal of the probability of selection for the stratum from which the sample operator was selected. In making estimates for a State/ subdivision, separate weights are applied as appropriate for noncertainty operators shown in the frame as having had production in only the State/subdivision, for those shown as having had production in that State/subdivision and up to four other State/ subdivisions, and for operators with no previous record of production in the State/subdivision. National totals were then obtained by summation of the component totals.

Imputation and Estimation for Reserves Data

There were 439 operators sampled proportional to size (Table E2) that responded as Category III noncertainty operators. Only 50 of these, located in 6 states, had their data weighted and used to estimate the production and reserves of the operators that were not sampled in those states. The remaining 389 noncertainty sampled operators were treated as certainty sampled operators with a weight of 1 and were used in states where the bulk of the operator production data was obtained from auxiliary State data (Table F2-F5).

The data reported by operator category on Form EIA-23 and data imputed and estimated for report year 2007 are summarized in **Tables F2, F3, F4, and F5**. The reported data in **Table F2** shows that those responding operators accounted for 93.7 percent of the published production for wet natural gas and 95.7 percent of the reserves shown in **Table 9**. Data shown in **Table F3**

indicate that those responding operators accounted for 94.5 percent of the nonassociated natural gas production and 95.6 percent of the reserves published in **Table 10**. The reported data shown in **Table F4** indicate that those responding operators accounted for 79.5 percent of published crude oil production and 93.8 percent of the reserves shown in **Table 6**. Additionally, **Table F5** indicates that those responding operators accounted for 92.3 percent of the published production and 84.8 percent of the published proved reserves for lease condensate shown in **Table 15**.

In order to estimate reserve balances for National and State/subdivision levels, a series of imputation and estimation steps at the operator level must be carried out.

- Year-end reserves for operators who provided production data only were imputed on the basis of their production volumes.
- Imputation was also applied to the small and intermediate operators as necessary to provide data on each of the reserve balance categories (i.e., revisions, extensions, or new discoveries).
- Imputation was required for the natural gas data of the small operators to estimate their volumes of associated-dissolved and nonassociated natural gas.
- Adjustments to maintain reserves balance.

Methods used are discussed in the following sections.

Imputation of Year-End Proved Reserves

Category I operators were required to submit year-end estimates of proved reserves. Category II and Category III operators were required to provide year-end estimates of proved reserves only if such estimates existed in their records. Some of these respondents provided estimates for all of their operated properties, others provided estimates for only a portion of their properties, and still others provided no estimates for any of their properties. All respondents did, however, provide annual production data.

A year-end proved reserves estimate was imputed from reported production data in each case where an estimate was not provided by the respondent. A R/P function was derived and used to calculate a reserves-to-production (R/P) ratio, based on operator size and the geographic region where the operator's properties were located. The R/P function has the following functional form for each geographic region:

$$\text{Calculated } P/[P+R] = \text{Beta} * \text{EXP}(\text{Alpha} * \ln(1 + \text{MOS}))$$

- *Alpha, Beta* = Regional Coefficients (calculated)
- *MOS* = *Measure of size* for a respondent, which is equal to the barrel oil equivalent volume of a respondent's 2006 production.

Table F6 lists the coefficients used for each region and the number of observations on which it was based. The regional areas used are similar to the National Petroleum Council Regions (**Figure F1**). These regions generally follow the boundaries of geologic provinces wherein the stage of resource development tends to be somewhat similar.

Once the R/P ratio was obtained for an operator, it could be multiplied by the reported or estimated production to give a proved reserves estimate. Operators that had production plus end of year reserves equal to zero were excluded from the respondents selected to calculate the R/P coefficients.

Rather than rely on a weighted sample, the R/P function was used to estimate the proved reserves of all noncertainty operators in these States. This technique improved the correlation of EIA data with State and commercial production data, and reduced the burden of reporting and analysis on both EIA and the noncertainty operators in these States.

Imputation of Changes to Proved Reserves by Component of Change

Category II and Category III operators that do not keep reserves data were not asked to provide estimates of beginning-of-year reserves or annual changes to proved reserves by component of change, i.e., revisions, extensions, and discoveries. When they did not provide estimates, these volumes were estimated by either:

- applying an algebraic allocation scheme which preserved the relative relationships between these items within each State/subdivision, as reported by Category I and Category II operators, or
- applying a modified version of the R/P function to each separate component of change, calculated with its own set of geographically dependent coefficients. This method was used in all four states where the R/P Function was applied to calculate end of year reserves.

Table F2. Summary of Form EIA-23 Reported, Imputed, and Estimated Natural Gas Data for 2007, Wet after Lease Separation (million cubic feet at 14.73 psia and 60° Fahrenheit)

Level of Reporting	Operator Category					Total
	I	II	Certainty III	Noncertainty III	Auxillary State Data	
Reported						
Number of Operators	156	497	288	439	9,324	10,704
Proved Reserves as of 12/31/06	192,939,286	17,390,372	275,120	0	0	210,604,778
(+) Revision Increases	27,892,861	4,242,700	22,252	0	0	32,157,813
(-) Revision Decreases	13,574,786	2,927,766	19,440	0	0	16,521,992
(-) Sales	13,084,210	2,226,057	201,468	0	0	15,511,735
(+) Acquisitions	9,867,217	6,059,406	16,780	0	0	15,943,403
(+) Extensions	22,660,941	4,352,000	60,283	0	0	27,073,224
(+) New Field Discoveries	589,968	211,047	0	0	0	801,015
(+) New Reservoirs in Old Fields	941,482	252,811	0	0	0	1,194,293
(-) Production With						
Proved Reserves Reported	16,671,585	2,047,865	4,062	0	0	18,723,512
(-) Production Without						
Proved Reserves Reported	0	249,676	3,797	0	0	253,473
Proved Reserves as of 12/31/07	211,561,394	25,320,441	149,465	0	0	237,031,300
Imputed and Estimated						
Number of Operators	-	-	-	3,070	-	3,070
Proved Reserves as of 12/31/06	-	-	-	-	-	-
(+) Revision Increases	0	0	0	0	1,247,943	1,247,943
(-) Revision Decreases	0	0	0	0	945,370	945,370
(-) Sales	0	0	0	0	0	0
(+) Acquisitions	0	0	0	0	28,542	28,542
(+) Extensions	0	0	0	0	1,182,840	1,182,840
(+) New Field Discoveries	0	0	0	0	15,450	15,450
(+) New Reservoirs in Old Fields	0	0	0	0	51,906	51,906
(-) Production With						
Proved Reserves Reported	0	0	0	0	88,184	88,184
(-) Production Without						
Proved Reserves Reported	0	157,392	123,941	281,333	690,920	1,253,586
Proved Reserves as of 12/31/07	0	1,642,214	1,079,609	2,721,823	5,319,393	10,763,039
Total						
Number of Operators	156	497	288	3,509	9,324	13,774
Proved Reserves as of 12/31/06	192,939,286	17,390,372	275,120	0	0	210,604,778
(+) Revision Increases	27,892,861	4,242,700	22,252	0	1,247,943	33,405,756
(-) Revision Decreases	13,574,786	2,927,766	19,440	0	945,370	17,467,362
(-) Sales	13,084,210	2,226,057	201,468	0	0	15,511,735
(+) Acquisitions	9,867,217	6,059,406	16,780	0	28,542	15,971,945
(+) Extensions	22,660,941	4,352,000	60,283	0	1,182,840	28,256,064
(+) New Field Discoveries	589,968	211,047	0	0	15,450	816,465
(+) New Reservoirs in Old Fields	941,482	252,811	0	0	51,906	1,246,199
(-) Production With						
Proved Reserves Reported	16,671,585	2,047,865	4,062	0	88,184	18,811,696
(-) Production Without						
Proved Reserves Reported	0	407,068	127,738	281,333	690,920	1,507,059
Proved Reserves as of 12/31/07	211,561,394	26,962,655	1,229,074	2,721,823	5,319,393	247,794,339
Summary						
Total Number of Operators	156	497	288	3,509	9,324	13,774
Percent of Total	1.1%	3.6%	2.1%	25.5%	67.7%	100.0%
Total Production in 2007	16,671,585	2,454,933	131,800	281,333	779,104	20,318,755
Percent of Total	82.1%	12.1%	0.6%	1.4%	3.8%	100.0%
Total Proved Reserves 12/31/07	211,561,394	26,962,655	1,229,074	2,721,823	5,319,393	247,794,339
Percent of Total	85.4%	10.9%	0.5%	1.1%	2.1%	100.0%

^aThere were 439 noncertainty responses, 50 were used with their sample weights and 389 were treated as Certainty III operators.
 - = Not applicable.

Notes: Table 9 totals include imputed and estimated wet natural gas proved reserves rounded at the State/subdivision level. Field level data are reported volumes and may not balance due to submission of incomplete reserve component records.

Source: Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," 2007.

Table F3. Summary of Form EIA-23 Reported, Imputed, and Estimated Nonassociated Natural Gas Data for 2007, Wet after Lease Separation (million cubic feet at 14.73 psia and 60° Fahrenheit)

Level of Reporting	Operator Category					Total
	I	II	Certainty III	Noncertainty III	Auxillary State Data	
Reported						
Number of Operators	156	497	288	439	9,324	10,704
Proved Reserves as of 12/31/06	166,185,699	15,722,876	228,829	0	0	182,137,404
(+) Revision Increases	23,291,549	3,669,234	15,646	0	0	26,976,429
(-) Revision Decreases	12,258,754	2,710,398	12,994	0	0	14,982,146
(-) Sales	12,064,119	2,132,407	201,468	0	0	14,397,994
(+) Acquisitions	9,037,696	5,541,141	12,706	0	0	14,591,543
(+) Extensions	21,809,567	4,184,924	59,418	0	0	26,053,909
(+) New Field Discoveries	548,812	205,006	0	0	0	753,818
(+) New Reservoirs in Old Fields	875,444	246,155	0	0	0	1,121,599
(-) Production With						
Proved Reserves Reported	14,800,167	1,837,184	3,293	0	0	16,640,644
(-) Production Without						
Proved Reserves Reported	17	385,015	7,643	0	0	392,675
Proved Reserves as of 12/31/07	182,625,749	22,902,263	98,844	0	0	205,626,856
Imputed and Estimated						
Number of Operators	-	-	-	3,070	-	3,070
Proved Reserves as of 12/31/06	-	-	-	-	-	-
(+) Revision Increases	0	0	0	0	1,028,107	1,028,107
(-) Revision Decreases	0	0	0	0	683,341	683,341
(-) Sales	0	0	0	0	0	0
(+) Acquisitions	0	0	0	0	28,542	28,542
(+) Extensions	0	0	0	0	1,105,078	1,105,078
(+) New Field Discoveries	0	0	0	0	15,075	15,075
(+) New Reservoirs in Old Fields	0	0	0	0	50,585	50,585
(-) Production With						
Proved Reserves Reported	0	0	0	0	81,611	81,611
(-) Production Without						
Proved Reserves Reported	0	151,681	114,007	265,688	375,469	906,845
Proved Reserves as of 12/31/07	0	1,586,236	990,703	2,576,939	4,342,044	9,495,922
Total						
Number of Operators	156	497	288	3,509	9,324	13,774
Proved Reserves as of 12/31/06	166,185,699	15,722,876	228,829	0	0	182,137,404
(+) Revision Increases	23,291,549	3,669,234	15,646	0	1,028,107	28,004,536
(-) Revision Decreases	12,258,754	2,710,398	12,994	0	683,341	15,665,487
(-) Sales	12,064,119	2,132,407	201,468	0	0	14,397,994
(+) Acquisitions	9,037,696	5,541,141	12,706	0	28,542	14,620,085
(+) Extensions	21,809,567	4,184,924	59,418	0	1,105,078	27,158,987
(+) New Field Discoveries	548,812	205,006	0	0	15,075	768,893
(+) New Reservoirs in Old Fields	875,444	246,155	0	0	50,585	1,172,184
(-) Production With						
Proved Reserves Reported	14,800,167	1,837,184	3,293	0	81,611	16,722,255
(-) Production Without						
Proved Reserves Reported	17	536,696	121,650	265,688	375,469	1,299,520
Proved Reserves as of 12/31/07	182,625,749	24,488,499	1,089,547	2,576,939	4,342,044	215,122,778
Summary						
Total Number of Operators	156	497	288	3,509	9,324	13,774
Percent of Total	1.1%	3.6%	2.1%	25.5%	67.7%	100.0%
Total Production in 2007	14,800,184	2,373,880	124,943	265,688	457,080	18,021,775
Percent of Total	82.1%	13.2%	0.7%	1.5%	2.5%	100.0%
Total Proved Reserves 12/31/07	182,625,749	24,488,499	1,089,547	2,576,939	4,342,044	215,122,778
Percent of Total	84.9%	11.4%	0.5%	1.2%	2.0%	100.0%

^aThere were 439 noncertainty responses, 50 were used with their sample weights and 389 were treated as Certainty III operators.

- = Not applicable.

Notes: Table 10 totals include imputed and estimated nonassociated wet natural gas proved reserves rounded at the State/subdivision level. Field level data are reported volumes and may not balance due to submission of incomplete reserve component records.

Source: Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," 2007.

Table F4. Summary of Form EIA-23 Reported, Imputed, and Estimated Crude Oil Data for 2007,
(thousand barrels of 42 U.S. gallons)

Level of Reporting	Operator Category					Total
	I	II	Certainty III	Noncertainty III	Auxillary State Data	
Reported						
Number of Operators	156	497	288	439	9,324	10,704
Proved Reserves as of 12/31/06	18,191,093	1,436,722	9,468	0	0	19,637,283
(+) Revision Increases	1,902,879	218,892	2,831	0	0	2,124,602
(-) Revision Decreases	876,019	127,187	2,947	0	0	1,006,153
(-) Sales	725,908	83,677	0	0	0	809,585
(+) Acquisitions	469,951	318,256	6,370	0	0	794,577
(+) Extensions	558,787	52,974	366	0	0	612,127
(+) New Field Discoveries	65,440	1,594	0	0	0	67,034
(+) New Reservoirs in Old Fields	61,864	10,465	0	0	0	72,329
(-) Production With						
Proved Reserves Reported	1,360,438	126,833	753	0	0	1,488,024
(-) Production Without						
Proved Reserves Reported	7	14,592	444	0	0	15,043
Proved Reserves as of 12/31/07	18,287,661	1,701,490	15,335	0	0	20,004,486
Imputed and Estimated						
Number of Operators	-	-	-	3,070	-	3,070
Proved Reserves as of 12/31/06	-	-	-	-	-	-
(+) Revision Increases	0	0	0	0	152,032	152,032
(-) Revision Decreases	0	0	0	0	72,065	72,065
(-) Sales	0	0	0	0	0	0
(+) Acquisitions	0	0	0	0	0	0
(+) Extensions	0	0	0	0	43,635	43,635
(+) New Field Discoveries	0	0	0	0	718	718
(+) New Reservoirs in Old Fields	0	0	0	0	3,305	3,305
(-) Production With						
Proved Reserves Reported	0	0	0	0	20,428	20,428
(-) Production Without						
Proved Reserves Reported	0	17,618	18,996	36,614	95,948	169,176
Proved Reserves as of 12/31/07	0	138,291	191,696	329,987	647,767	1,307,741
Total						
Number of Operators	156	497	288	3,509	9,324	13,774
Proved Reserves as of 12/31/06	18,191,093	1,436,722	9,468	0	0	19,637,283
(+) Revision Increases	1,902,879	218,892	2,831	0	152,032	2,276,634
(-) Revision Decreases	876,019	127,187	2,947	0	72,065	1,078,218
(-) Sales	725,908	83,677	0	0	0	809,585
(+) Acquisitions	469,951	318,256	6,370	0	0	794,577
(+) Extensions	558,787	52,974	366	0	43,635	655,762
(+) New Field Discoveries	65,440	1,594	0	0	718	67,752
(+) New Reservoirs in Old Fields	61,864	10,465	0	0	3,305	75,634
(-) Production With						
Proved Reserves Reported	1,360,438	126,833	753	0	20,428	1,508,452
(-) Production Without						
Proved Reserves Reported	7	32,210	19,440	36,614	95,948	184,219
Proved Reserves as of 12/31/07	18,287,661	1,839,781	207,031	329,987	647,767	21,312,227
Summary						
Total Number of Operators	156	497	288	3,509	9,324	13,774
Percent of Total	1.1%	3.6%	2.1%	25.5%	67.7%	100.0%
Total Production in 2007	1,360,445	159,043	20,193	36,614	116,376	1,692,671
Percent of Total	80.4%	9.4%	1.2%	2.2%	6.9%	100.0%
Total Proved Reserves 12/31/07	18,287,661	1,839,781	207,031	329,987	647,767	21,312,227
Percent of Total	85.8%	8.6%	1.0%	1.5%	3.0%	100.0%

^aThere were 439 noncertainty responses, 50 were used with their sample weights and 389 were treated as Certainty III operators.
- = Not applicable.

Notes: Table 6 totals include imputed and estimated crude oil proved reserves rounded at the State/subdivision level. Field level data are reported volumes and may not balance due to submission of incomplete reserve component records.

Source: Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," 2007.

Table F5. Summary of Form EIA-23 Reported, Imputed, and Estimated Lease Condensate Data for 2007,
(thousand barrels of 42 U.S. gallons)

Level of Reporting	Operator Category					Total
	I	II	Certainty III	Noncertainty III	Auxiliary State Data	
Reported						
Number of Operators	156	497	288	439	9,324	10,704
Proved Reserves as of 12/31/06	965,527	231,313	193	0	0	1,197,033
(+) Revision Increases	183,570	63,391	47	0	0	247,008
(-) Revision Decreases	149,518	55,065	31	0	0	204,614
(-) Sales	152,665	17,784	0	0	0	170,449
(+) Acquisitions	132,420	33,364	0	0	0	165,784
(+) Extensions	128,187	43,584	0	0	0	171,771
(+) New Field Discoveries	3,496	3,815	0	0	0	7,311
(+) New Reservoirs in Old Fields	10,875	8,570	0	0	0	19,445
(-) Production With						
Proved Reserves Reported	134,695	31,231	88	0	0	166,014
(-) Production Without						
Proved Reserves Reported	30	673	0	0	0	703
Proved Reserves as of 12/31/07	987,311	280,052	190	0	0	1,267,553
Imputed and Estimated						
Number of Operators	-	-	-	3,070	-	3,070
Proved Reserves as of 12/31/06	-	-	-	-	-	-
(+) Revision Increases	0	0	0	0	36,233	36,233
(-) Revision Decreases	0	0	0	0	811	811
(-) Sales	0	0	0	0	0	0
(+) Acquisitions	0	0	0	0	15,894	15,894
(+) Extensions	0	0	0	0	42,527	42,527
(+) New Field Discoveries	0	0	0	0	8,136	8,136
(+) New Reservoirs in Old Fields	0	0	0	0	-4,537	-4,537
(-) Production With						
Proved Reserves Reported	0	0	0	0	4,434	4,434
(-) Production Without						
Proved Reserves Reported	0	374	1,552	1,926	7,377	11,229
Proved Reserves as of 12/31/07	0	2,231	8,729	10,960	207,507	229,427
Total						
Number of Operators	156	497	288	3,509	9,324	13,774
Proved Reserves as of 12/31/06	965,527	231,313	193	0	0	1,239,957
(+) Revision Increases	183,570	63,391	47	0	36,233	283,241
(-) Revision Decreases	149,518	55,065	31	0	811	205,425
(-) Sales	152,665	17,784	0	0	0	170,449
(+) Acquisitions	132,420	33,364	0	0	15,894	181,678
(+) Extensions	128,187	43,584	0	0	42,527	214,298
(+) New Field Discoveries	3,496	3,815	0	0	8,136	15,447
(+) New Reservoirs in Old Fields	10,875	8,570	0	0	-4,537	14,908
(-) Production With						
Proved Reserves Reported	134,695	31,231	88	0	4,434	170,448
(-) Production Without						
Proved Reserves Reported	30	1,047	1,552	1,926	7,377	11,932
Proved Reserves as of 12/31/07	987,311	282,283	8,919	10,960	207,507	1,496,980
Summary						
Total Number of Operators	156	497	288	3,509	9,324	13,774
Percent of Total	1.1%	3.6%	2.1%	25.5%	67.7%	100.0%
Total Production in 2007	134,725	32,278	1,640	1,926	11,811	182,380
Percent of Total	73.9%	17.7%	0.9%	1.1%	6.5%	100.0%
Total Proved Reserves 12/31/07	987,311	282,283	8,919	10,960	207,507	1,496,980
Percent of Total	66.0%	18.9%	0.6%	0.7%	13.9%	100.0%

^aThere were 439 noncertainty responses, 50 were used with their sample weights and 389 were treated as Certainty III operators.

- = Not applicable.

Notes: Table 15 totals include imputed and estimated lease condensate proved reserves rounded at the State/subdivision level. Field level data are reported volumes and may not balance due to submission of incomplete reserve component records.

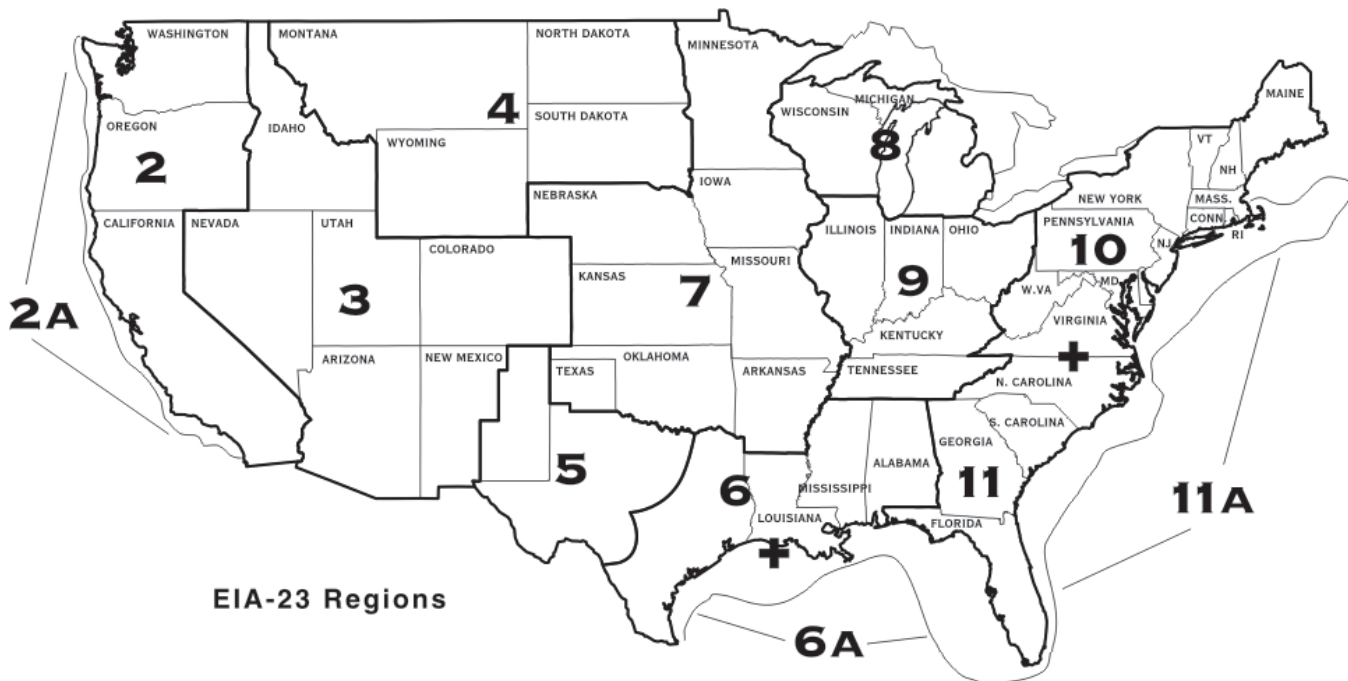
Source: Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," 2007.

Table F6. Statistical Parameters of Reserves Estimation Equation by Region for 2007

Region Number	Region	Number of Nonzero R/P Pairs			Equation Coefficients					
		Oil	Gas	LC	Oil Alpha	Oil Beta	Gas Alpha	Gas Beta	LC Alpha	LC Beta
1	Alaska	7	10	0	-0.1206	0.2625	-0.1328	0.6229	0.0000	0.0000
2	Pacific Coast States	46	55	4	-0.1206	0.2488	-0.1328	0.3327	-0.1267	0.4425
2A	Federal Offshore Pacific	7	7	-	-0.1206	0.1907	-0.1328	0.1994	0.0000	0.0000
3	Western Rocky Mountains	87	142	58	-0.1206	0.1741	-0.1328	0.2729	-0.1267	0.3035
4	Northern Rocky Mountains	168	173	47	-0.1206	0.2445	-0.1328	0.3063	-0.1267	0.2291
5	West Texas and East New Mexico	465	489	174	-0.1206	0.2092	-0.1328	0.3122	-0.1267	0.4342
6	Western Gulf Basin	500	827	542	-0.1206	0.2887	-0.1328	0.3724	-0.1267	0.5177
6A	Gulf of Mexico	70	136	110	-0.1206	0.4535	-0.1328	0.7084	-0.1267	0.7487
7	Mid-Continent	283	369	138	-0.1206	0.4728	-0.1328	0.3223	-0.1267	0.3325
8 + 9	Michigan Basin and Eastern Interior	80	56	11	-0.1206	0.1807	-0.1328	0.1379	-0.1267	0.2064
10 + 11	Appalachians	26	74	10	-0.1206	0.2177	-0.1328	0.1497	-0.1267	0.3731
	United States	1,739	2,338	1,094	-0.1206	0.2857	-0.1328	0.3406	-0.1267	0.4596

Source: Based on data filed on Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves, 2007".

Figure F1. Form EIA-23 Regional Boundaries



Source: Energy Information Administration, Office of Oil and Gas.

Both methods preserved an exact annual reserves balance of the following form:

Published Proved Reserves at End of Previous Report Year
+ Adjustments
+ Revision Increases
- Revision Decreases
- Sales
+ Acquisitions
+ Extensions
+ New Field Discoveries
+ New Reservoir Discoveries in Old Fields
- Report Year Production
= Published Proved Reserves at End of Report Year

Proved Reserves at End of Previous Year
+ Revision Increases
- Revision Decreases
- Sales
+ Acquisitions
+ Extensions
+ New Field Discoveries
+ New Reservoir Discoveries in Old Fields
- Report Year Production
= Proved Reserves at End of Report Year

The algebraic allocation method used for all but six states in the 2007 survey worked as follows: A ratio was calculated as the sum of the annual production and year-end proved reserves of those respondents who did not provide the reserves balance components, divided by the sum of year-end proved reserves and annual production of those respondents of similar size who did provide these quantities. This ratio was then multiplied by each of the reserves balance components reported by Category I and some Category II operators, to obtain imputed volumes for the reserves balances of the other Category II operators and certainty and noncertainty operators. These were then added to the State/subdivision totals.

Imputation of Natural Gas Volumes

Small operators in the certainty and noncertainty strata were not asked to segregate their natural gas volumes by type of natural gas, i.e., nonassociated natural gas (NA) and associated-dissolved natural gas (AD). The total estimated year-end proved reserves of natural gas and the total annual production of natural gas reported by, or imputed to, operators in the State/subdivision certainty and noncertainty strata were, therefore, subdivided into the NA and AD categories, by State/subdivision, in the same proportion as was reported by large and intermediate operators in the same area.

Adjustments

The instructions for Schedule A of Form EIA-23 specify that, when reporting reserves balance data, the following arithmetic equation must hold:

Any remaining difference in the State/subdivision annual reserves balance between the published previous year-end proved reserves and current year-end proved reserves not accounted for by the imputed reserves changes was included in the adjustments for the area. One of the primary reasons that adjustments are necessary is the instability of the noncertainty operators sampled each year. There is no guarantee that in the smaller producing States/subdivision the same number of small operators will be selected each year, or that the operators selected will be of comparable sizes when paired with operators selected in a prior year. Thus, some instability of this stratum from year to year is unavoidable, resulting in minor adjustments.

Some of the adjustments are, however, more substantial, and could be required for any one or more of the following reasons:

- The frame coverage may or may not have improved between survey years, such that more or fewer certainty operators were included in 2007 than in 2006.
- One or more operators may have reported data incorrectly on Schedule A in 2007 or 2006, but not both, and the error was not detected by edit processing.
- Operation of properties was transferred during 2007 from operators not in the frame or noncertainty operators not selected for the sample to certainty operators or noncertainty operators selected for the sample.
- Respondent changed classification of natural gas from NA to AD or vice versa.
- The trend in reserve changes imputed for the small operators, which was based on the trend reported by the large operators, did not reflect the actual trend for the small operators.

- noncertainty operators, who have grown substantially in size since they were added to the frame, occasionally cause a larger standard error than expected.
- The noncertainty sample for either year in a state may have been an unusual one.

The causes of adjustments are known for some but not all areas. The only problems whose effects cannot be expected to balance over a period of several years are those associated with an inadequate frame or those associated with any actual trend in reserves changes for small operators not being the same as those for large operators. EIA continues to attempt to improve sources of operator data to resolve problems in frame completeness.

Sampling Reliability of the Estimates

The sample of noncertainty operators selected is only one of the large number of possible samples that could have been selected and each would have resulted in different estimates. The standard error or sampling error of the estimates provides a measure of this variability. When probability sampling methods are used, as in the EIA-23 survey, the sampling error of estimates can also be estimated from the survey data.

The estimated sampling error can be used to compute a confidence interval around the survey estimate, with a prescribed degree of confidence that the interval covers the value that would have been obtained if all operators in the frame had been surveyed. If the estimated volume is denoted by V_s and its sampling error by $S.E.(V_s)$, the confidence interval can be expressed as:

$$V_s \pm k S.E.(V_s)$$

where k is a multiple selected to provide the desired level of confidence. For this survey, k was taken equal to 2. Then there is approximately 95 percent confidence that the interval:

$$V_s \pm 2 S.E.(V_s)$$

includes the universe value, for both the estimates of reserves and production volumes. Correspondingly, for approximately 95 percent of the estimates in this report, the difference between the published estimate and the value that would be found from a complete survey of all operators is expected to be less than twice the sampling error of the estimate. **Tables F7 and F8** provide estimates for $2S.E.(V_s)$ by product. These estimates are directly applicable for constructing approximate 95 percent confidence intervals. For example, the 95 percent confidence interval for dry natural gas proved reserves is 237,726 \pm 359 billion

cubic feet. The sampling error of V_s is equal to the sampling error of the noncertainty estimate V_{sr} , because the certainty total is not subject to sampling error. The estimated sampling error of a noncertainty estimate is the square root of its estimated sampling variance.

Sources of Errors

The EIA maintains an evaluation program to assess the accuracy and quality of proved reserve estimates gathered on Form EIA-23. Field teams consisting of petroleum engineers from EIA's Reserves and Production Division conduct technical reviews of reserve estimates and independently estimate the proved reserves of a selected sample of operator properties. The results of these reviews are used to evaluate the accuracy of reported reserve estimates. Operators are apprised of the team's findings to assist them in completing future filings. The magnitude of errors due to differences between reserve volumes submitted by operators on the Form EIA-23 and those estimated by EIA petroleum engineers on their field trips were generally within accepted professional engineering standards. Several sources of possible error, apart from sampling error, are associated with the Form EIA-23 survey:

- Operator nonresponse
- Respondent estimation errors
- Reporting errors and data processing errors
- Inadequate frame coverage
- Errors associated with statistical estimates.

Imputation for Operator Nonresponse

The nonresponse rate for certainty operators for the 2007 survey (Appendix E, Table E2) was 2.1 percent and for the noncertainty operators 8.9 percent. An imputation was made for the production and reserves for the 39 nonresponding operators.

Respondent Estimation Errors

The principal data elements of the Form EIA-23 survey consist of respondent estimates of proved reserves of crude oil, natural gas, and lease condensate. Unavoidably, the respondents are bound to make some estimation errors, i.e., until a particular reservoir has been fully produced to its economic limit and abandoned, its reserves are not subject to direct measurement but must be inferred from limited, imperfect, or indirect evidence. A more complete discussion of the several techniques of estimating proved reserves, and the many problems inherent in the task, appears in Appendix G.

Table F7. Factors for Confidence Intervals (2S.E.) for Crude Oil Proved Reserves and Production, 2007
(million barrels of 42 U.S. gallons)

State and Subdivision	2007 Reserves	2007 Production	State and Subdivision	2007 Reserves	2007 Production
United States	7	1	Montana ^b	0	0
Alabama ^b	0	0	Nebraska	0	0
Alaska ^a	0	0	New Mexico ^b	0	0
Arkansas ^b	0	0	North Dakota ^b	0	0
California ^b	0	0	Ohio ^b	0	0
Colorado ^b	0	0	Oklahoma ^b	0	0
Florida ^a	0	0	Pennsylvania	0	0
Illinois	0	0	Texas ^b	0	0
Indiana	0	0	Utah ^b	0	0
Kansas ^b	0	0	Virginia ^a	0	0
Kentucky	0	0	West Virginia	0	0
Louisiana ^b	0	0	Wyoming ^b	0	0
Michigan ^b	0	0	Federal Offshore ^a	0	0
Mississippi ^b	0	0	Miscellaneous ^c	2	0

^aSampling rate was 100 percent in Alaska, Florida Onshore, Virginia, and Offshore areas.

^bSampling was not used. Estimates for each operator were made using an imputation function.

^cIncludes Arizona, Missouri, Nevada, South Dakota, Tennessee, and Virginia.

Notes: Confidence intervals are associated with Table 6 reserves and production data.

Factors for confidence intervals for each State and the United States are independently estimated and do not add.

Source: Factor estimates based on data filed on Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," 2007.

Table F8. Factors for Confidence Intervals (2S.E.) for Natural Gas Proved Reserves and Production, Wet After Lease Separation, 2007 (billion cubic feet at 14.73 psia and 60° Fahrenheit)

State and Subdivision	2007 Reserves	2007 Production	State and Subdivision	2007 Reserves	2007 Production
United States	359	28	New Mexico ^b	0	0
Alabama ^b	0	0	New York ^b	0	0
Alaska ^a	0	0	North Dakota ^b	0	0
Arkansas ^b	0	0	Ohio ^b	0	0
California ^b	0	0	Oklahoma ^b	0	0
Colorado ^b	0	0	Pennsylvania	52	4
Florida ^a	0	0	Texas ^b	0	0
Kansas ^b	0	0	Utah ^b	0	0
Kentucky	0	0	Virginia ^a	0	0
Louisiana ^b	0	0	West Virginia	6	0
Michigan ^b	0	0	Wyoming ^b	0	0
Mississippi ^b	0	0	Federal Offshore ^{a,c}	0	0
Montana ^b	0	0	Miscellaneous ^d	4	0

^aSampling rate was 100 percent in Alaska, Florida Onshore, Virginia, and Offshore areas.

^bSampling was not used. Estimates for each operator were made using an imputation function.

^cIncludes Federal offshore Alabama.

^dIncludes Arizona, Illinois, Indiana, Maryland, Missouri, Nebraska, Nevada, Oregon, South Dakota, and Tennessee.

Notes: Confidence intervals are associated with Table 8 reserves and production data.

Factors for confidence intervals for each State and the United States are independently estimated and do not add.

Source: Factor estimates based on data filed on Form EIA-23, "Annual Survey of Domestic Oil and Gas Reserves," 2007.

Reporting and Data Processing Errors

Reporting errors on the part of respondents are of definite concern in a survey of the magnitude and complexity of the Form EIA-23 program. Several steps were taken by EIA to minimize and detect such problems. The survey instrument itself was carefully developed, and included a detailed set of instructions for filing data, subject to a common set of definitions similar to those already used by the industry. Editing software is continually developed to detect different kinds of probable reporting errors and flag them for resolution by analysts, either through confirmation of the data by the respondent or through submission of amendments to the filed data. Data processing errors, consisting primarily of random keypunch errors, are detected by the same software.

Frame Coverage Errors

Of all the sources of controllable error connected with the Form EIA-23 survey, errors in the operator frame were expected to be the most important. If the frame does not list all operators in a given State, the sample selected from the frame for the State will not represent the entire operator population, a condition called under coverage. Under coverage is a problem with certain States, but it does not appear to be a problem with respect to the National proved reserve estimates for either crude oil or natural gas. While it is relatively straightforward to use existing sources to identify large operators and find addresses for them, such is not the case for small operators. A frame such as that used in the 2007 survey is particularly likely to be deficient in States where a large portion of total reserves and production is accounted for by small operators. EIA is continuing to work to remedy the under coverage problem in those States where it occurred.

Imputation Errors

Some error, generally expected to be small, is an inevitable result of the various estimations outlined. These imputation errors have not yet been completely addressed by EIA and it is possible that estimation methods may be altered in future surveys. Nationally, 6.1 percent of the crude oil proved reserve estimates, 4.9 percent of the wet natural gas proved reserve estimates, and 15.3 percent of the lease condensate proved reserve estimates resulted from the imputation and estimation of reserves for those certainty and noncertainty operators who did not provide estimates for all of their properties, in combination with the expansion of the sample of noncertainty operators to the full population. Errors for the latter were quantitatively calculated, as discussed in the previous section. Standard errors, for the former, would tend to

cancel each other from operator to operator, and are, therefore, expected to be negligible, especially at the National level of aggregation. In States where a large share of total reserves is accounted for by Category III and smaller Category II operators, the errors are expected to be somewhat larger than in States where a large share of total reserves is accounted for by Category I and larger Category II operators.

Calculation of Reserves of Natural Gas Liquids and Dry Natural Gas

Natural Gas Liquids Reserve Balance

The published reserves, production, and reserves change statistics for crude oil, lease condensate, and natural gas, wet after lease separation, were derived from the data reported on Form EIA-23 and the application of the imputation methods discussed previously. The information collected on Form EIA-64A was then utilized in converting the estimates of the wet natural gas reserves into two components: plant liquids reserve data and dry natural gas reserve data. The total natural gas liquids reserve estimates presented in **Table 14** were computed as the sum of plant liquids estimates (**Table 15**) and lease condensate (**Table 16**) estimates.

To generate estimates for each element in the reserves balance for plant liquids in a given producing area, the first step was to group all natural gas processing plants that reported this area as an area-of-origin on their Form EIA-64A, and then sum the liquids production attributed to this area over all respondents. Next, the ratio of the liquids production to the total wet natural gas production for the area was determined. This ratio represented the percentage of the wet natural gas that was recovered as natural gas liquids. Finally, it was assumed that this ratio was applicable to the reserves and each component of reserve changes (except adjustments), as well as production. Therefore, each element in the wet natural gas reserves balance was multiplied by this recovery factor to yield the corresponding estimate for plant liquids. Adjustments of natural gas liquids were set equal to the difference between the end of previous year reserve estimates, based upon the current report year Form EIA-23 and Form EIA-64A surveys, and the end of current year reserve estimates published in the preceding year's annual reserves report.

Natural Gas Reserve Balance

This procedure involved downward adjustments of the natural gas data, wet after lease separation, in estimating the volumes of natural gas on a fully dry basis. These reductions were based on estimates of the gaseous equivalents of the liquids removed (in the case of production), or expected to be removed (in the case of reserves), from the natural gas stream at natural gas processing plants. Form EIA-64A collected the volumetric reduction, or shrinkage, of the input natural gas stream that resulted from the removal of the NGL at each natural gas processing plant.

The shrinkage volume was then allocated to the plant's reported area or areas of origin. Because shrinkage is, by definition, roughly in proportion to the NGL recovered, i.e. the NGL produced, the allocation was in proportion to the reported NGL volumes for each area of origin. However, these derived shrinkage volumes were rejected if the ratio between the shrinkage and the NGL production (gas equivalents ratio) fell outside certain limits of physical accuracy. The ratio was expected to range between 1.558 MMCF per thousand barrels (where NGL consists primarily of ethane) and 0.940 MMCF per thousand barrels (where NGL consists primarily of natural gasolines). When the computed gas equivalents ratio fell outside these limits, an imputed ratio was utilized to estimate the plant's natural gas shrinkage allocation to each reported area of origin.

This imputed ratio was that calculated for the aggregate of all other plants reporting production and shrinkage, and having a gas equivalent ratio within the aforesaid limits, from the area in question. The imputed area ratio was applied only if there were at least five plants on which to base its computation. If there were less than five plants, the imputed ratio was calculated based on all plants in the survey whose

individual gas equivalents ratio was within the acceptable limits. Less than one percent of the liquids production was associated with shrinkage volumes imputed in this manner. Based on the 2007 Form EIA-64A survey, the national weighted average gas equivalents ratio was computed to be 1,413 cubic feet of natural gas shrinkage per barrel of NGL recovered. The total shrinkage volume (reported plus imputed) for all plants reporting a given area of origin was then subtracted from the estimated value of natural gas production, wet after lease separation, yielding dry natural gas production for the area. The amount of the reduction in the wet natural gas production was then expressed as a percentage of the wet natural gas production. Dry natural gas reserves and reserve changes were determined by reducing the wet natural gas reserves and reserve changes by the same percentage reduction factor.

A further refinement of the estimation process was used to generate an estimate of the natural gas liquids reserves in those States with coalbed methane fields. The States where this procedure was applied were Alabama, Colorado, Kansas, New Mexico, Oklahoma, Pennsylvania, Utah, Virginia, West Virginia, and Wyoming. The first step in the process was to identify all Form EIA-23 reported coalbed methane fields. Coalbed methane fields contain no extractable natural gas liquids. Therefore, when the normal shrinkage procedure was applied to the wet gas volume reserve components, the estimate of State coalbed methane volumes were excluded and were not reduced for liquid extraction. Following the computation for shrinkage, each coalbed field gas volume reserve components was added back to each of the dry gas volume reserve components in a State. The effect of this is that the large increases in reserves in some States from coalbed methane fields did not cause corresponding increases in the State natural gas liquids proved reserves.