B. Collection of Information Employing Statistical Methods

1. Form EIA-23

Survey Methodology

The Form EIA-23 survey is designed to provide reliable estimates of the proved reserves and production of crude oil, natural gas, and lease condensate for the United States. 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 proved reserve estimates than do other possible classes of respondents, such as working interest or royalty owners.

While the larger 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 more easily, frequently alter their corporate identities, and often change addresses. As a result, EIA conducts extensive annual frame maintenance activities to identify all current operators of crude oil and natural gas wells in the country.

The survey methodology used in prior years will not change over the requested clearance period.

Sampling Methodology

EIA estimates and publishes data on proved reserves and production for crude oil, natural gas, and lease condensate by State for most States, and by State subdivision for the States of Alaska, California, Louisiana, New Mexico, and Texas. To meet the survey objectives, while minimizing respondent burden, a random sampling strategy has been used since 1977. Each operator reporting on the survey is asked to report production for crude oil, natural gas, and lease condensate for each State/subdivision in which it operates. Hereafter the term "State/subdivision" refers to either an individual subdivision within a State or an individual State that is not subdivided.

The volume of production varies greatly among the State/subdivisions. To meet the survey objectives while controlling total respondent burden, EIA selected the following target sampling error for the survey for each product class.

- 1.0 percent for National estimates.
- 1.0 percent for each of the 5 States having subdivisions: Alaska, California, Louisiana, New Mexico, and Texas. For selected subdivisions within these States, targets of 1.0 percent or 1.5 percent as required to meet the State target.
- 2.5 percent for each State/subdivision having 1 percent or more of estimated U.S. reserves or production (lower 48 States) for any product class.
- 4 percent for each State/subdivision having less than 1 percent of estimated U.S. reserves or production (lower 48 States) for all 3 product classes.

- 8 percent for States not published separately. The combined production from these States was less than 0.2 percent of the U.S. total for crude oil and for natural gas.

The volume of production defining the Certainty stratum, referred to as the cutoff, varies by product or State/subdivision. The Certainty stratum has three components.

- Category I - Large Operators: Operators with annual production of 1.5 million barrels or more of crude, or 15 billion cubic feet or more of natural gas, or both.
- Category II - Intermediate Operators: Operators with annual production of at least 400,000 barrels of crude oil or 2 billion cubic feet of natural gas, or both, but less than 1.5 million barrels of crude oil.
- Category III - Small Operators: Operators with annual production less than the Category II operators, but which were selected with certainty. Category III operators were subdivided into operators sampled with certainty (Certainty) and operators that were randomly sampled (Noncertainty).

  Certainty - Small operators who satisfied any of the following criteria based upon their production shown in the operator frame:

  - Operators with annual crude oil production of 200 thousand barrels or more, but less than 400,000 barrels of crude oil or reserves of 4 million barrels or more; or annual natural gas production of 1 billion cubic feet or more, or reserves of 20 billion cubic feet or more.
  - All other operators with production or reserves in a State/subdivision that exceed selected cutoff levels for that State/subdivision.
  - 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.

  Noncertainty - Small operators not in the certainty stratum were classified in a noncertainty stratum and sampled at a rate of 3 percent.

In each State/subdivision the balance between the number of small certainty 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. With each iteration, a small operator, beginning with the largest of the Category III operators, was added to the certainty group and the required sample size was again calculated. The procedure of adding one operator at a time stopped when the proportion of operators to be sampled at random satisfied the 3 percent threshold. 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.

An additional complexity is introduced because some small operators selected for the sample in another region or regions, sometimes report production volumes in a region in which EIA has no previous record of production.

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, State, and for the U.S. total.

Total U.S. Proved Reserve Estimates

Conceptually, the estimates of U.S. proved 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 (Alaska, 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.

In many State/subdivisions, the accuracy of the oil and gas estimates was improved by using the probability proportional to size procedure for selecting operators in the noncertainty strata. This procedure took advantage of the correlation between year-to-year production reports. The weights used for estimating the oil production for a State/subdivision 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 for Operator Nonresponse

In 2005, the response rate for Category I operators was 99.0 percent, for Category II operators it was 95 percent, and for Category III operators it was approximately 96.6 percent. Production for nonrespondents was based on research of publicly available information as well as imputation. Reserves of nonrespondents were estimated using production information and an algorithm developed by EIA.

Imputation and Estimation for Proved Reserves Data

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 proved 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 proved reserve balance categories (i.e., revisions, extensions, or new discoveries). Finally, imputation was required for the natural gas data of the small operators to estimate their volumes of associated-dissolved and nonassociated natural gas. The final manipulation of the data adjusts for the differences caused by different sample frames from year to year. Each of these imputations generate only a small percentage of the total estimates.

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. The production reported by Noncertainty sample operators and the corresponding imputed reserves were weighted to estimate the full Noncertainty stratum when calculating proved reserves and production as previously described in the section Total U.S. Reserves.

A year-end proved reserves estimate was imputed from reported production data in each case where an estimate was not provided by the respondent. The reported annual production was multiplied by a proved reserves-to-production (R/P) ratio characteristic of operators of similar size in the region where the properties were located. The regional R/P ratios in this report are averages calculated by dividing the mean of reported proved reserves by the mean of reported production for selected respondents of similar size who did report estimated reserves. A cutoff level for each region was determined based upon the largest Certainty operator that reported production, but did not provide a proved reserve estimate. Data from respondents whose production in a region exceeded the regional cutoff level was excluded from the R/P ratio calculation for that region. In addition, operators that had R/P ratios that exceeded 25 to 1 and Category I operators were excluded from the respondents selected to calculate the characteristic

regional R/P ratio. All other respondents who reported both production and proved reserves were used to calculate the regional R/P ratio characteristic.

The R/P ratio varied significantly from region to region. This variation was presumably in response to variation in geologic conditions and the degree of development of crude oil and natural gas resources in each area. The average R/P ratio was computed for regional areas similar to the National Petroleum Council regional units. These units generally follow the boundaries of geologic provinces wherein the stage of resource development tends to be somewhat similar.

The regional R/P ratio is determined primarily to provide a factor that can be applied to the production reported by operators without proved reserves estimates to provide an estimate of the proved reserves of these operators when aggregated to the regional level. The average R/P ratio, when multiplied by each individual production in the distribution of R,P pairs used to calculate it, will exactly reproduce the sum of the reported proved reserves in the distribution.

An improved reserves estimation approach different from the one described above was invoked for the Category III operators of selected States beginning with the 1999 survey. In the States of Texas, New Mexico, California, and Louisiana the Category III operator sample was selected as described in the sampling methodology above, but not surveyed. Instead, production data for the selected operators were obtained from State records and edited for error by EIA. This provided EIA with a reliable estimate of these operators' production without actually having to survey them. Their proved reserves were then estimated using representative reserve-to-production ratios scaled by size of production.

Imputation of Annual Changes to Proved Reserves by Component of Change

Category II and Category III operators that do not keep proved reserves data were not asked to provide estimates of beginning-of-year proved 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 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, and also preserved an exact annual proved reserves balance of the following form:

A ratio was calculated as the sum of the annual production and year-end proved reserves of those respondents who did not provide the proved 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 proved reserves balance components reported by Category I and some Category II operators, to obtain imputed volumes for the proved 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 Type Volumes

Operators in the State/subdivision 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 Category I and Category II operators in the same area.

Adjustments

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

Proved Reserves at End of Previous Report 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

Any remaining difference in the State/subdivision annual proved reserves balance between the published previous year-end proved reserves and current year-end proved reserves not accounted for by the imputed proved 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. About 24 percent of the Noncertainty stratum operators sampled in 2001 were sampled again in 2002. 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 the report year than the previous year.
- One or more operators may have reported data incorrectly on Schedule A in one report year or the next, but not both, and the error was not detected by edit processing.

- Operation of properties was transferred during the report year from operators not in the frame or Noncertainty operators not selected for the sample to Certainty operators or Noncertainty operators selected for the sample.
- Operation of properties was transferred during the report year to an operator with a different evaluation of the proved reserves associated with the properties than that of the previous year's operator.
- Respondent changed classification of natural gas from NA to AD or vice versa.
- The trend in reserve changes imputed for the small operators that 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 reserve 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. The estimated volume, its sampling error, and a confidence interval are calculated.

Nonsampling Errors

Several sources of possible error, apart from sampling error, are associated with the Form EIA-23 survey. These include bias due to nonresponse of operators in the sample, proved reserve estimation errors, and reporting errors on the part of the respondents to the survey. On the part of EIA, possible errors include inadequate frame coverage, data processing error, and errors associated with statistical estimates. Each of these sources is discussed below. An estimate of the bias from nonresponse is presented in the section on adjustment for operator nonresponse.

Assessing the Accuracy of the Reserve Data

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 Dallas Field Office conduct technical reviews of reserve estimates and independently estimate the proved reserves of a statistically selected sample of operator properties. The results of these reviews are used to evaluate the accuracy of reported proved 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 proved 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.

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 proved 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 the publication of the OGRS surveys.

Reporting Errors 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.

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. In 2005, nationally, 5.9 percent of the crude oil proved reserves estimates, 6.1 percent of the natural gas proved reserves estimates, and 0.7 percent of the lease condensate proved reserves 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 proved 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 proved reserves is accounted for by Category I and larger Category II operators.

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 undercoverage. Undercoverage is a problem with certain States, but it does not appear to be a problem with respect to the National proved reserves 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 2005 survey is particularly likely to be deficient in States where a large portion of total proved reserves and production is accounted for by small operators. These States are not likely to allocate sufficient resources to keep track of all operators on a current basis. Some undercoverage of this type seems to exist, particularly, with reference to natural gas operators. EIA is continuing to work to remedy the undercoverage problem in those States where it occurred.

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.

To generate estimates for each element in the proved 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 proved reserve estimates, based upon the current report year Form EIA-23 and Form EIA-64A surveys, and the end of current year proved 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 volume is, by definition, roughly in proportion to the NGL recovered, i.e. the volume of NGL produced, the allocation was in proportion to the reported production of 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 cubic feet per barrel (where NGL consists primarily of ethane) and 900 cubic feet per barrel (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 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 other plants reporting NGL production in a producing area to base its computation on. If there were less than five other 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 Form EIA-64A survey, the national weighted average gas equivalents ratio was computed to be 1,404 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 proved reserves and proved 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. The assumption was made that coalbed methane fields contained little or 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 proved reserves in some States from coalbed methane fields did not cause corresponding increases in the EIA-64A derived estimates of State natural gas liquids proved reserves.

Adjustments of dry natural gas were set equal to the difference between the end of previous year reserves 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.

Each estimate of end of year proved reserves and report year production has associated with it an estimated sampling error. The standard errors for dry natural gas were computed by multiplying the wet natural gas standard errors by these same percentage reduction factors.

1.C Form EIA-64A

Sample Frame

The Form EIA-64A plant frame contains data on all known active and inactive natural gas processing plants in the United States. The plant frame is compared to listings of natural gas processing plants from the Form EIA-816, the *LPG Almanac*, and the *Oil and Gas Journal*. A list of possible additions to the plant frame is compiled. Telephone calls to the newly identified plants were conducted to verify their status. Additions identified during the frame maintenance are coordinated with the Form EIA-816 Program Office.

Collection Methods

Each year the EIA mails forms to all known natural gas processing plant operators as of December 31 of the report year. In addition, plant operators whose plants were shut down or dismantled during the report year are required to complete forms for that portion of the report year the plants were operated.

Sampling

The EIA-64A is a census survey of natural gas processing plants. All natural gas processing plant operators were requested to file a Form EIA-64A for each of their plants. For report year 2005, 489 plants were requested to report natural gas liquids production by the area of origin of the natural gas processed. The majority of the plant operators reported only one area of origin for the natural gas, which was processed by the plant. The State or area of origin reported is generally also the plant location.

Estimation and Imputation

Production data collected on Form EIA-64A from gas processing plants were combined with the lease condensate production data reported on Form EIA-23 to estimate the Nation's total NGL production by geographic area, as presented in the annual report. NGL recovery rates, as calculated from data supplied on Form EIA-64A, were applied to proved reserves of natural gas estimated from data collected on Form EIA-23 to derive dry natural gas proved reserves data. When plants fail to report data, their production data from the form EIA-816 are used and an estimate based on past data for shrinkage is imputed for that plant.

2. Maximizing the Response Rate

The EIA will use standard procedures to conduct the data collections. An introductory letter signed by a responsible EIA official will be sent to each company. Follow-up procedures consist of: (1) a reminder letter to all companies that do not return a completed survey form by the due date and (2) a round of calls to companies that do not respond by the due date, specified in the cover letter and instructions. Response rates for the most recent surveys were:

EIA-23L (field version)	97%
EIA-23S (summary version)	97%
EIA-64A	100%

3. Tests of Procedures

There are no significant changes in the forms so no tests were necessary.

4. Questions

Questions regarding this request may be directed to John Wood of the Department of Energy, Energy Information Administration, at (214) 720-6150. The EIA Clearance Officer is Kara Norman at (202) 287-1902.