

Appendix A

Technical Notes

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Note 1: EIA-821: Annual Fuel Oil and Kerosene Sales Report, 1996

Background

The EIA-821, "Annual Fuel Oil and Kerosene Sales Report" survey was implemented to meet Energy Information Administration (EIA) legislative mandates and data user needs. Form EIA-821 is used to gather data on the sales to end users of distillate fuel oil, residual fuel oil, and kerosene. The data are used to determine the level of demand by end-use category and product at the State, regional, and national levels. This mandatory report is authorized by the Federal Energy Administration Act of 1974 (P. L. 93-275).

The predecessor survey to the EIA-821 was the EIA-172, "Sales Report of Fuel Oil and Kerosene" survey. The EIA-172 was conducted for reference years 1979 through 1982. Due to a serious deterioration in the sample of respondents during the 4-year period, the Form EIA-172 data were not collected for 1983. Instead, estimates for 1983 were published and a new sample of respondents was designed and selected from an improved sampling frame. The EIA-821 survey commenced with reference year 1984.

Discussion of Sampling Frame

The target population for the fuel oil and kerosene sales survey is the universe of companies that sell fuel oil and kerosene to end users.

The EIA-863 data base provided the sampling frame for the 1996 EIA-821 survey. The EIA-863, "Petroleum Product Sales Identification Survey," was mailed to approximately 30,000 companies in January 1995 to collect 1994 State-level sales volume data for No. 2 distillate, residual fuel, motor gasoline, and propane. Companies also indicated if they sold kerosene. The No. 2 distillate data were further identified by residential and nonresidential end use, and non-end-use sales; the residual data were identified by end use and non-end-use; motor gasoline was identified by end use and non-end use and by conventional and oxygenated and/or reformulated; and propane was identified by residential, nonresidential, and non-end-use sales. The mailing list for the EIA-863 survey was constructed by

merging and unduplicating the 1991 frame file and more than 50 State and commercial lists. In addition, company/ State-level volumes for distillate fuel, residual fuel, motor gasoline, and propane from the 1994 EIA-821 survey were merged with the EIA-863 to yield a combined data file. The transformed and edited version of the frame was then used to design and select the 1995 EIA-821 sample.

It should be noted that truck stops selling No. 2 diesel fuel were not specifically included in the EIA-863 survey. Therefore, the EIA-821 survey does not include all sales of No. 2 distillate through retail truck stops. However, to compensate for this shortage in coverage, data from the Federal Highway Administration are presented in the tables for on-highway diesel sales.

The sampling frame also lacked full coverage of kerosene retailers, many of whom are hardware stores and service stations. To account for all kerosene volumes supplied to the marketplace, aggregate reported kerosene volumes are set equal to the products supplied volumes published in the *Petroleum Supply Annual*.

Discussion of the Sample Design

The purpose of the EIA-821 sample design was to produce State-level estimates of total sales for the following five target variables: (1) residential No. 2 distillate, (2) other retail No. 2 distillate, (3) wholesale No. 2 distillate, (4) retail residual, and (5) wholesale residual. A separate sample was initially designed for each target variable.

Companies were divided into two basic types of strata: certainty and noncertainty. Companies selected with certainty were:

- all refiners and gas plant operators
- companies doing business in four or more States
- companies accounting for 5 percent or more of the distillate or residual fuel oil volume for any target variable or particular end-use category sold in a State.
- companies accounting for 5 percent or more of the kerosene volume sold in a State in an earlier EIA-821 survey.

- augmented frame units, e.g., vessel bunkering, for which no attribute data were available.

Firms determined not to be selling distillate or residual fuel oil or kerosene were removed from the frame file. Volumes for nonrespondents to the EIA-863 who had reported in the previous frame survey or in a sample survey were imputed. The imputed nonrespondents and the noncertainty companies were stratified by sales volume for each target variable. Strata boundaries were determined using the Dalenius-Hodges procedures, allowing the number of strata and the strata boundaries to vary by State. Nonrespondents for whom no previous information was available were classified in a separate stratum and sampled with reduced probabilities of selection.

Neyman allocation was used to allocate the number of companies required for each strata to obtain the required levels of accuracy: a 2.5 percent coefficient of variation for residual fuel oil and a 5 percent coefficient of variation for distillate fuel oil. Sample selections were then performed simultaneously from the same random list for the five samples to produce a final linked sample of approximately 4,700 companies. This method reduced the total survey sample size while improving volume estimates. Selected companies were asked to report sales by end-use categories for distillate and residual fuel oil and kerosene.

Imputation and Estimation

Survey data gathered from the respondents may contain incomplete reporting, total nonresponse, or values that fail editing. Missing data are estimated, or implicitly imputed for, using the strata means and treated the same as reported data. The weighted estimate is defined as follows:

$$\hat{V} = \sum_h N_h \left(\sum_i W_{hi} V_{hi} / \sum_i W_{hi} \right)$$

where:

- \hat{V} = total estimated volume
- \sum_h = denotes summation over strata
- N_h = stratum population for stratum h
- \sum_i = denotes summation over units within stratum h
- V_{hi} = volume reported for unit i in stratum h
- W_{hi} = weight attached to unit i in stratum h.

where: W_{hi} is inversely proportional to the probability of inclusion in the linked sample.

The degree of imputation by product and end use at the U.S. total level ranged as follows for the 1996 EIA-821 data: distillate, 0.07 percent for oil company use to 15.8 percent for off-highway use; residual fuel oil, 0.01 percent for all other uses to 3.0 percent for military use; and kerosene, 0.7 percent for farm use to 4.1 percent for residential use.

Collection Methods

The EIA-821 form was mailed in January 1997 to all companies selected for participation in the 1996 reference year survey. The completed form was due to EIA on March 3, 1997. A second request was sent by certified mail to nonrespondents approximately 1 month after the filing deadline. Follow-up telephone calls were made to collect outstanding data and to verify reported data. Late submissions and resubmissions were processed when received.

Data Processing

As EIA-821 forms were received, they were logged into an automated Survey Control File that maintains company identification and survey form status information for each company selected to participate in the survey. The data were reviewed manually, entered onto the computer files, and then processed through an automated edit program which detected missing data and outlying values. Data that failed the edits were resolved through telephone calls to the data reporters and corrections were entered onto the computer files. Preliminary estimates were generated and processed through a series of validation procedures to flag and rectify potential misreporting of data. Statistical reports, including publication tables, were produced using only acceptable and verified data.

Note 2: Reliability of the Data

Two types of errors are associated with data produced from a sample survey---sampling errors and nonsampling errors. Sampling errors occur because the estimates are based on a sample rather than on a census. The particular sample used for the EIA-821 survey is one of a large number of samples of equal size which could have been selected from the sampling frame using the same sample design. Each of these samples would produce a different estimate. If the estimates were averaged over all possible samples, the result would be the same as the estimate derived from a census of the sampling frame. The sampling error is a measure of variability among the estimates from all possible samples and, thus, is a measure of the

precision with which an estimate from a particular sample approximates the results of a census.

Nonsampling errors and possibly biases can arise from a number of sources: (1) inability to obtain information about all cases in the sample, (2) response errors, (3) differences in the interpretation of questions or definitions, (4) mistakes in recording or coding of the data obtained, and (5) other errors of collection, response, coverage, and estimation for missing data. Bias is the difference between the average of the estimates over all possible samples of the same size and design, and the true value being estimated. It is not possible to estimate bias using the results of one sample.

Data obtained from alternate sources are not subject to sampling errors, but may be subject to nonsampling errors, the magnitudes of which are unknown. Nonsampling errors for survey estimates and estimates adjusted to alternate sources cannot be determined, but attempts are made throughout survey processing to minimize this type of error.

Data in Tables 1 through 12 are based on survey data which are subject to sampling errors. Coefficients of variation, which are estimates of sampling errors, are presented for the retail target variables in the following table for the 1995 survey. The coefficients of variation (CV) were estimated by:

$$CV(\hat{V}) = \frac{\sqrt{VAR(\hat{V})}}{\hat{V}}$$

where:

$$VAR(\hat{V}) = \sum_h n_h \left(1 - \frac{n_h}{N_h}\right) S_h^2$$

$$S_h^2 = \frac{\sum_{i=1}^{n_h} W_i^2 V_i^2 + \bar{V}_h^2 \sum_{i=1}^{n_h} W_i^2 - 2 \bar{V}_h \sum_{i=1}^{n_h} W_i^2 V_i}{n_h - 1}$$

$$\bar{V}_h = \frac{\sum_{i=1}^{n_h} W_i V_i}{\sum_{i=1}^{n_h} W_i}$$

- \hat{V} = total estimated volume,
- N_h = stratum population for stratum h,
- n_h = number of sample units in stratum h,
- V_i = volume for unit i,
- W_i = weight for unit i.

Response rates also offer some indication of the reliability and comprehensiveness of survey results. For the 1996 EIA-821 survey, the overall response rate (the number of submissions received, divided by the number of submissions solicited and expected, times 100) was 93.1 percent.

Coefficients of Variation for Sales of Fuel Oil, 1996

Geographic Area	Residential Distillate Fuel Oil	Non-Residential Retail Distillate Fuel Oil	Retail Residual Fuel Oil
U.S. Average	1.7	2.8	0.1
PAD District I Average	2.0	1.4	0.1
Subdistrict IA Average	3.2	1.8	0.1
Connecticut	4.7	3.5	0.0
Maine	13.2	3.9	0.0
Massachusetts	5.4	3.6	0.1
New Hampshire	6.4	3.5	0.0
Rhode Island	5.5	5.7	0.0
Vermont	3.2	3.8	0.0
Subdistrict IB Average	3.0	2.6	0.1
Delaware	3.2	5.9	0.0
District of Columbia	0.6	0.3	0.0
Maryland	3.7	3.4	0.0
New Jersey	4.7	3.6	0.0
New York	5.8	6.3	0.1
Pennsylvania	5.0	4.4	0.0
Subdistrict IC Average	3.3	2.0	0.1
Florida	10.7	2.6	0.0
Georgia	15.3	4.2	0.0
North Carolina	5.0	6.3	0.3
South Carolina	6.4	7.4	0.0
Virginia	5.5	5.1	0.0
West Virginia	7.8	3.0	0.0
PAD District II Average	2.9	1.3	0.1
Illinois	6.5	6.7	0.0
Indiana	6.4	2.6	0.0
Iowa	8.8	3.9	0.0
Kansas	15.8	6.9	1.3
Kentucky	7.4	3.2	0.0
Michigan	7.4	4.2	0.0
Minnesota	8.1	7.8	0.0
Missouri	5.8	4.6	0.0
Nebraska	15.3	3.8	0.0
North Dakota	7.7	3.8	0.0
Ohio	7.3	2.9	0.0
Oklahoma	62.3	5.8	0.0
South Dakota	9.8	4.5	0.0
Tennessee	17.4	2.5	0.0
Wisconsin	7.9	4.4	0.0
PAD District III Average	5.9	13.1	0.1
Alabama	7.6	6.2	0.1
Arkansas	42.3	4.1	0.0
Louisiana	41.0	8.6	0.0
Mississippi	4.5	4.7	0.0
New Mexico	2.8	4.5	0.0
Texas	0.0	23.6	0.0
PAD District IV Average	14.8	1.8	0.1
Colorado	66.4	3.5	0.0
Idaho	10.7	4.0	0.0
Montana	35.7	6.6	0.1
Utah	14.1	4.4	0.0
Wyoming	5.2	2.7	0.0
PAD District V Average	2.0	2.2	0.1
Alaska	2.9	1.4	0.0
Arizona	22.4	3.0	0.0
California	9.3	4.5	0.0
Hawaii	0.0	4.1	0.0
Nevada	1.7	3.9	0.0
Oregon	4.3	4.0	0.0
Washington	3.6	4.2	0.1

Note: Coefficients of variation that are less than 0.1 and greater than zero are displayed as 0.1.

Sources: • Energy Information Administration Form EIA-821, "Annual Fuel Oil and Kerosene Sales Report," for 1996.

Note 3: Data Adjustments

Alternate Source Data

After all preliminary tabulations were verified, comparisons were made between the survey results and available alternate source data. The following end-use categories were replaced by alternate source data at the U.S., Petroleum Administration for Defense (PAD) district, or State level:

Tables 1 through 12:

On-Highway Diesel. Distillate fuel oil by State was calculated from the Federal Highway Administration data on highway use of special fuels. Of the 1992 through 1996 special fuels, more than 98 percent is diesel.

Tables 13 through 24:

Electric Utility. National-level distillate and residual fuel oil sales for electric utility use were calculated from annual aggregations of data collected on forms EIA-759, "Monthly Power Plant Report," and FERC-423, "Monthly Report of Cost and Quality of Fuels for Electric Plants." Form EIA-759 consumption data for light oils include No. 2 fuel oil, kerosene, and jet fuel; the heavy oils include No. 4 fuel oil, residual fuel oil, and crude oil. Using receipt data from Form FERC-423, the No. 4 fuel oil receipts were deleted from the heavy oil consumption data and added to the light oil consumption data. The resultant distillate (light oils) and residual (heavy oils) consumption data were added to the stock change of light oils and heavy oils, respectively, from Form EIA-759 to obtain the estimate of sales. Allocations at the State level were based on the EIA-821 survey.

On-Highway Diesel. Distillate fuel oil by State was calculated from the Federal Highway Administration data on highway use of special fuels. Of the 1992 through 1996 special fuels, more than 98 percent is diesel.

1992 through 1996 Adjustments

Kerosene volumes in Tables 1 through 24 are adjusted at the national level to equal products supplied volumes as published in the "Detailed Statistics" section

of the *Petroleum Supply Annual* (PSA). The 1996 survey resulted in 812,140 thousand gallons of kerosene at the national level. The products supplied volume at the national level for kerosene was 948,990 thousand gallons. Hence, the adjustment factor at the national level for 1996 was 1.17.

Volumes of distillate fuel oil in Tables 13 through 24 were adjusted at the PAD district level to equal products supplied volumes. The adjustment factors at the PAD district level for 1996 are as follows:

Distillate Fuel Oil

- PAD District I: .98
- PAD District II: .98
- PAD District III: .85
- PAD District IV: 1.30
- PAD District V: .66

For Tables 13 through 24, total sales at the PAD district level equal the products supplied volumes as reported in the PSA, 1992 through 1996. For example, the 1996 survey yielded a volume for distillate residential use in PAD District II of 903,197 thousand gallons. The total distillate volume for PAD District II was 6,488,200 from the survey, after subtracting the volume coming from alternate sources. The product supplied total distillate volume for PAD District II was 6,359,193 after removing alternate source volume. Hence, the adjusted 1996 estimate of distillate for residential use in PAD District II was $(6,359,193/6,488,200) \times 903,197 = 885,239$.

For distillate fuel oil in Tables 13 through 24, the PAD district adjustments were made to each State and product-use category except on-highway diesel use, and electric utility use.

Volumes of residual fuel oil in Tables 13 through 24 were adjusted at the national level to equal the products supplied estimate. The 1996 survey yielded 13,256,998 thousand gallons of residual fuel oil, while the products supplied volume at the national level was 13,041,042 thousand gallons. Thus, the adjustment factor at the national level for 1996 was 1.02, after subtracting the volumes coming from alternate sources. For residual fuel oil, the adjustments were made to each State and end-use category except electric utility use.

Note 4: End-Use Descriptions and Petroleum Product Definitions

End-Use Descriptions

Residential Use. Includes sales for use in private households for space heating, water heating, cooking, etc. Sales to farm houses are reported under "Farm Use."

Commercial Use. Includes sales for use in nonmanufacturing establishments such as motels, apartment buildings, restaurants, retail stores, institutions, government buildings, schools, and laundries for space heating, water heating, and cooking.

Industrial Use. Includes sales to mines, smelters, and plants engaged in producing manufactured products, processing and assembling goods, etc. Also includes space heating. Excludes oil company use, as defined below.

Oil Company Use. Includes sales to drilling companies, pipelines or other related oil companies not engaged in the selling of petroleum products. Includes fuel oil that was purchased or produced and used by company facilities for the operation of drilling equipment, other field or refinery operations, and space heating at petroleum refineries, pipeline companies, and oil-drilling companies. Oil used to bunker vessels is counted under vessel bunkering. Sales to other oil companies for field use are included, but sales for use as refinery charging stocks are excluded.

Farm Use. Includes sales for use in tractors, irrigation pumps and other agricultural machinery, as well as that used for crop drying, smudge pot fuel, space heating of buildings (including farm houses), cooking, and any other use by the agriculture industry.

Electric Utility Companies. Includes sales to electric utility companies, including that used for the generation of electricity. Volumes imported and used directly by electric utility companies are also included.

Railroad Use. Includes sales to railroads, for any use, including that used for heating buildings operated by railroads.

Vessel Bunkering. Includes sales for the fueling of commercial or private boats, such as pleasure craft, fishing boats, tugboats, and ocean-going vessels, including vessels operated by oil companies. Excluded are volumes sold to the U.S. Armed Forces.

On-Highway Diesel Use. Includes sales for use in motor vehicles. Volumes used by companies in the marketing and distribution of petroleum products are also included.

Military Use. Includes sales to the Armed Forces, including volumes sold to the Defense Fuel Supply Center (DFSC) for use by all branches of the Department of Defense (DOD).

Off-Highway Use. Includes sales for use in:

1. **Construction.** Construction equipment including earthmoving equipment, cranes, stationary generators, air compressors, etc.
2. **Other.** Sales for off-highway uses other than construction. Sales for logging are included in this category. Volumes for off-highway use by the agriculture industry are reported under "Farm Use."

All Other Uses. Sales for all other uses not included in any other end-use category are reported here.

Definitions of Petroleum Products and Other Related Terms

ASTM. The acronym for the American Society for Testing and Materials.

Distillate Fuel Oil. A general classification for one of the petroleum fractions produced in conventional distillation operations. It is used primarily for space heating, on- and off-highway diesel engine fuel (including railroad engine fuel and fuel for agricultural machinery), and electric power generation. Included are products known as No. 1, No. 2, and No. 4 fuel oils and No. 1, No. 2, and No. 4 diesel fuels.

1. **No. 1 Distillate.** A petroleum distillate which meets the specifications for No. 1 heating or fuel oil as defined in ASTM D 396 and/or the specifications for No. 1 diesel fuel as defined in ASTM Specification D 975.
 - a. **No. 1 Diesel Fuel.** A volatile distillate fuel oil with a boiling range between 300 and 575 degrees Fahrenheit and used in high-speed diesel engines generally operated under wide variations in speed and load. Includes type C-B diesel fuel used for city buses and similar operations. Properties are defined in ASTM Specification D 975.
 - b. **No. 1 Fuel Oil.** A light distillate fuel oil intended for use in vaporizing pot-type

burners. ASTM Specification D 396 specifies for this grade maximum distillation temperatures of 400 degrees Fahrenheit at the 10-percent point and 550 degrees Fahrenheit at the 90-percent point, and kinematic viscosities between 1.4 and 2.2 centistokes at 100 degrees Fahrenheit.

2. **No. 2 Distillate.** A petroleum distillate which meets the specifications for No. 2 heating oil or fuel oil as defined in ASTM D 396 and/or the specifications for No. 2 diesel fuel as defined in ASTM Specification D 975.

a. **No. 2 Diesel Fuel.** A gas oil type distillate of lower volatility with distillation temperatures at the 90-percent point between 540 and 640 degrees Fahrenheit for use in high speed diesel engines generally operated under uniform speed and load conditions. Includes Type R-R diesel fuel used for railroad locomotive engines, and Type T-T for diesel-engine trucks. Properties are defined in ASTM Specification D 975.

(1) **No. 2 Diesel \leq .05% Sulfur.** The sulfur level does not exceed 0.05 percent by weight.

(2) **No. 2 Diesel $>$.05% Sulfur.** The sulfur level is above 0.05 percent by weight.

b. **No. 2 Fuel Oil.** A distillate fuel oil for use in atomizing type burners for domestic heating or for moderate capacity commercial-industrial burner units. ASTM Specification D 396 specifies for this grade distillation temperatures at the 90-percent point between 540 and 640 degrees Fahrenheit, and kinematic viscosities between 2.0 and 3.6 centistokes at 100 degrees Fahrenheit.

3. **No. 4 Fuel.** A fuel oil for commercial burner installations not equipped for preheating facilities. It is used extensively in industrial plants. This grade is a blend of distillate fuel oil and residual fuel oil stocks that conforms to ASTM Specification D 396 or Federal Specification VV-F-815C; its kinematic viscosity is between 5.8 and 26.4 centistokes at 100 degrees Fahrenheit. Also included is No. 4-D, a fuel oil for low- and medium-speed diesel engines that conforms to ASTM Specification D 975.

Kerosene. A petroleum distillate that boils at a temperature between 300 and 550 degrees Fahrenheit, that has a flash point higher than 100 degrees Fahrenheit by ASTM Method D 56, that has a gravity range from 40 to 46 degrees API, and that has a burning point

in the range of 150 degrees to 175 degrees Fahrenheit. Included are the two classifications recognized by ASTM Specification D 3699: No. 1-K and No. 2-K, and all grades of kerosene called range or stove oil which have properties similar to No. 1 fuel oil, but with a gravity of about 43 degrees API and a maximum end-point of 625 degrees Fahrenheit. Kerosene is used in space heaters, cook stoves, and water heaters and is suitable for use as an illuminant when burned in wick lamps. **NOTE:** Respondents to the EIA-821 survey were instructed to report all volumes in accordance with what the product was sold as, regardless of the actual specifications of that product. For example, if a No. 2 distillate was sold as a heating oil or fuel oil, the volume would be reported in the category "No. 2 Fuel Oil" even if the product conformed to the higher specifications of a diesel fuel.

PAD District. Petroleum Administration for Defense Districts

PAD District I:

Subdistrict IA. Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont

Subdistrict IB. Delaware, District of Columbia, Maryland, New Jersey, New York, and Pennsylvania

Subdistrict IC. Florida, Georgia, North Carolina, South Carolina, Virginia, and West Virginia

PAD District II:

Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Ohio, Oklahoma, Tennessee, and Wisconsin

PAD District III:

Alabama, Arkansas, Louisiana, Mississippi, New Mexico, and Texas

PAD District IV:

Colorado, Idaho, Montana, Utah, and Wyoming

PAD District V:

Alaska, Arizona, California, Hawaii, Nevada, Oregon, and Washington

Residual Fuel Oils. The topped crude of refinery operations, which includes No. 5 and No. 6 fuel oils, as defined in ASTM Specification D 396 and Federal Specification, VV-F-815C; Navy Special fuel oil as

defined in Military Specification MIL-F-859E including Amendment 2 (NATO symbol F-77); and Bunker C fuel oil. Residual fuel oil is used for the production of electric power, space heating, vessel bunkering, and various industrial purposes.

United States. The 50 States and the District of Columbia.