Appendix A

How the Survey Was Conducted

Introduction

The Federal Buildings Supplemental Survey (FBSS) conducted by the Energy Information Administration (EIA) of the U.S. Department of Energy (DOE), in conjunction with the Office of Federal Energy Management Programs (OFEMP) of DOE was a supplement to the Commercial Buildings Energy Consumption Survey (CBECS). The FBSS was conducted to assist in the implementation of the Energy Policy Act of 1992 (EPACT) by focusing a modified version of the CBECS exclusively on Federally owned and operated buildings. The CBECS, a triennial commercial buildings survey conducted by EIA, is the only source of national-level data on both commercial buildings' characteristics and related energy consumption and expenditures. Federally owned commercial buildings are one of three types of government-owned commercial buildings that are included in the CBECS sample. However, because the CBECS sample size is relatively small (6,500 sample commercial buildings of an estimated 4.8 million commercial buildings)and yields an even smaller number of federally owned government buildings, in-depth examination of energy use and characteristics of these buildings was not possible using the CBECS data. To obtain energy-related building characteristics and consumption and expenditures data for Federal commercial buildings, a sample survey of approximately 900 Federally owned and operated buildings was conducted in Federal Regions 3, 6, and 9 (See Appendix C for the Federal regions map). The FBSS sample selection procedures are described in the "Sample Design" section of this appendix. As with the CBECS, the "building" was the basic unit for the FBSS since the building is the energy-consuming unit. FBSS data are at the building level and data presented in this report represent the 881 responding buildings and cannot be used to generalize about Federal buildings in each region.

EIA used a computer-assisted telephone interview (CATI) to conduct voluntary interviews with the Federal building energy manager or designated person. CATI was used as a test as opposed to the usual in-person data collection method to see if building owners/managers could provide the technical information over the telephone. Under EIA's direction, a survey research firm conducted the FBSS CATI at their telephone center.

At a Glance - Differences Between 1992 CBECS and 1993 FBSS

The CBECS consists of two major data collection stages--a building characteristics survey, which is an in-person interview with the building respondent, and an energy suppliers survey which is mailed to the energy suppliers. The FBSS survey design included only one major data collection stage -- collecting both building characteristics and consumption data from the building respondent, because the Federal building respondent was thought to have consumption data available to them. Respondents were asked to provide consumption and expenditures data for electricity, natural gas, fuel oil, and district sources (steam, hot water, and chilled water). For these major fuels, the following data were requested: (1) quantity consumed or delivered; (2) cost; and (3) unit of measure. The units of measure were as follows: electricity--kilowatt (kW) demand; natural gas including transportation gas--therms, cubic feet or 1,000 cubic feet; fuel oil--fuel-tank data; and district heating and cooling--the entire district or system. Respondents could Fax completed worksheets that were mailed to them in advance. If building respondents could not obtain these data, they were asked to provide the name, address, telephone and Fax number of the person who would most likely be able to provide the data. The data were requested for the Federal Fiscal Year 1993; that is, from October 1992 to September 1993.

These data were collected on the Building Questionnaire, a modified version of the CBECS form tailored to include specific questions relating to the Federal Energy Management Program (FEMP); such as, questions on motors, retrofitting equipment, energy conservation program sponsorship, and availability of energy audits. Additionally, wording and structural changes to the 1992 CBECS questionnaire were incorporated into the 1993 FBSS questionnaire to facilitate the CATI mode of data collection.

Questions Asked in 1993 FBSS and Not 1992 CBECS

- Equipment Age for: heating (each type present), central chillers, refrigeration, water heating, motors 10 or more horsepower (each type present)
- Sponsorship of Retrofit/Purchase and Type of Assistance (included FEMP and Federal Energy Efficiency Fund (FEEF)) for: special energy technologies, heating equipment (each type present), central chillers, refrigeration, water-heating equipment, lighting
- FBSS asked if Electronic Ballasts were present in the building
- Motors - 10 or more horsepower: number, age, approximate number of energy-efficient motors, approximate number of motors rewound, age when rewound, general behavior when motor fails -- rewind or replace. Specifically asked for the following equipment:

Chillers	Heat Pumps
Fans	Air Compressors
Water Pumps	Elevators
Escalators	Refrigeration

- Questions asked of the interviewer to assess the respondents ability to answer the motor questions and the questionnaire in general

1992 CBECS Questions Not Asked in 1993 FBSS

- Physical Characteristics: Number of below-ground-level floors, building shape, ground-level length/width of square and rectangular buildings, attachment to other structures, renovations and demolitions
- Ownership and Occupancy Characteristics: Building owner and occupant of building, number businesses and organizations that occupy buildings, percent vacant three consecutive months, additional operating hours when equipment in use
- Conservation and Energy Management: Special space functions, opening and closing windows

This appendix has three sections: "Sample Design," "Survey of Building Characteristics and Consumption Data," and "Public-Use Data Preparation." These sections focus on components of the sample, the procedures for data collection and processing, data difficulties encountered, and procedures for handling unit and item nonresponse.

Target Population

The OFEMP requested that the FBSS provide building-level energy-related characteristics for a special sample of commercial buildings owned by the Federal Government. To meet OFEMP's requests, the FBSS target population consisted of federally owned commercial buildings: (1) operated by either GSA, some agency other than GSA, or a contract facility; and (2) in Federal Regions 3, 6, or 9 that:

- Met the CBECS definition of a building--a structure intended for human access and totally enclosed by walls extending from the foundation to the roof

- Were primarily used for some commercial purpose--more than 50 percent of the floorspace devoted to activities that are neither residential, industrial, agricultural nor warehouse/storage

- Measured 10,000 square feet or larger -- this was increased from the CBECS 1,001 square feet size criterion because smaller buildings form a large, inherently ill-defined, group of marginal structures.

All agencies in Federal Regions 3, 6, and 9 were in the FBSS target population.[3]

Determining Building Eligibility

During the development of the facility and building sample lists for the FBSS frame, somewhat looser criteria were applied to prevent inaccurate exclusion of eligible buildings based on inaccurate list information. During the interview with the building owner or manager, building eligibility was determined according to the criteria listed above to allow a knowledgeable respondent to ultimately screen eligible buildings. Once the interview began, initial screening questions instructed the interviewer to terminate the interview if the respondent indicated that the building size was less than 10,000 square feet or if 50 percent or more of the square footage was used for residential, industrial, agricultural, or warehouse/storage purposes.

Sample Design

Although a comprehensive list of all Federal buildings in the target population (3 Federal regions) does not exist, there is a list of most Federal facilities. Under the direction of the OFEMP, a data base was developed, which contained energy management information on all Federally owned facilities in the United States. As of June 1994, 19,237 Federal facilities were represented in the data base. Therefore, the FBSS sample design was based upon sampling from a national list of Federal facilities created from the data base.

Two-Stage Systematic Probability-Proportional-to-Size (PPS) Sample

The sample design of the FBSS was a two-stage systematic probability-proportional-to-size (PPS) design and the two-stages of the design were: (1) Selecting Facilities and (2) Selecting Buildings. Facility selection was conducted using the FEMP data base. For each facility selected in stage one, a list of buildings on the selected facility was obtained from the facility energy manager. For stage two, buildings were selected. PPS sampling is commonly used to take advantage of existing knowledge about the sample units to improve the reliability of survey estimates. For quantities roughly proportional to certain measures of size (MOS's), estimates based on PPS sampling have lower variances than estimates based on equal-probability sampling. The total square footage of a facility or building was used as a MOS since building size is well correlated with commercial activity and energy consumption, which indicates size is a good choice not only for PPS sampling, but also for ordering in the systematic selection.

[3]For a detailed discussion of CBECS criteria, see Appendix A, "How the Survey was Conducted" in the *Commercial Buildings Energy Consumption and Expenditures 1992*, DOE/EIA-0318(92), Energy Information Administration (Washington, D.C., Government Printing Office, April 1995).

First Stage -- Selecting Facilities

To prepare for the first-stage of the PPS sample, all Federal facilities listed in Regions 3, 6, and 9 were divided into Department of Defense (DOD) and non-DOD facilities based on agency designation, to ensure appropriate selection of DOD facilities. Next, within the DOD facilities, eight strata were formed by grouping adjacent States. Adjacent States were assumed to be similar in average temperatures and main fuel used; and, therefore, similar in energy-related characteristics. Similarly, the non-DOD facilities were grouped into eight strata by the same grouping of adjacent States. From the 15 States in Regions 3, 6, and 9 the States were grouped as follows: (1) West Virginia and Virginia, (2) Delaware and Pennsylvania, (3) Maryland and District of Columbia, (4) Oklahoma and Texas, (5) New Mexico, (6) Louisiana and Arkansas, (7) Hawaii and California, and (8) Arizona and Nevada. These groupings resulted in the listed Federal facilities being divided in a total of 16 strata--8 DOD strata and 8 non-DOD strata. From each of the 16 strata an independent systematic PPS sample of facilities was conducted; such that N_i buildings were selected (with replacement). N_i represents the number of buildings assigned to stratum I based on the ratio of the square feet of stratum I to the square feet of all facilities. A modified proportional allocation of the sample to stratum was used; 10 percent from the 8 DOD strata, 90 percent from the 8 non-DOD strata, resulting in separate proportional allocation within each of these two sets of strata. Table A1 below lists the adjacent States contained in each stratum along with square footage and sample sizes for each stratum.

Table A1. Stratum Sample Size

Strata #	Strata Type	Federal Region	States	Square Feet	Number of Facilities	Number of Buildings	N_i	R_i
1	DOD	3	WV, VA	62,361,720	85	7,070	28	2,227,204
2	DOD	3	DE, PA	29,160,956	109	2,702	13	2,243,150
3	DOD	3	MD, DC	53,219,624	53	5,164	24	2,217,484
7	DOD	6	OK, TX	85,299,041	138	10,876	38	2,244,712
8	DOD	6	NM	12,952,851	12	2,165	6	2,158,809
9	DOD	6	LA, AR	18,895,368	49	3,408	9	2,099,485
13	DOD	9	HI, CA	164,757,998	186	19,659	74	2,226,459
14	DOD	9	AZ, NV	18,348,119	29	3,230	8	2,293,515
4	Non-DOD	3	WV, VA	31,238,568	172	1,681	218	143,296
5	Non-DOD	3	DE, PA	23,271,681	199	1,099	162	143,653
6	Non-DOD	3	MD, DC	74,381,176	167	1,759	518	143,593
10	Non-DOD	6	OK, TX	35,509,436	460	1,815	247	143,763
11	Non-DOD	6	NM	14,218,734	64	1,646	99	143,624
12	Non-DOD	6	LA, AR	13,621,885	134	463	95	143,388
15	non-DOD	9	HI, CA	56,847,625	429	4,368	396	143,555
16	non-DOD	9	AZ, NV	9,348,882	134	959	65	143,829

N_i = Stratum sample size or the number of buildings assigned to stratum I.
R_i = Ratio of stratum square feet to stratum sample size.
Source: Energy Information Administration, Office of Energy Markets and End Use, 1993 Federal Buildings Supplemental Survey.

Second Stage -- Selecting Buildings

In the second stage, the selected multibuilding facilities were screened for eligible buildings. Each facility was sampled independently. Once the frame of buildings for each facility was verified for accuracy, it provided the correct MOS for each eligible building and, consequently, an update for the facility MOS. The frame of buildings for each facility was then ordered by building square footage and sampled systematically with PPS.

Projected Sampling Results

The core sample size was 1,000 buildings, since 90 percent of 1,000 would provide the targeted sample size of 900 buildings. An additional sample of 1,000 buildings was selected for reserve use for ineligible buildings, nonresponse, and any replication that may have been needed. The 2,000 buildings were randomly divided into the core and reserve samples, Panel I and Panel II, respectively.

Actual Sample Selected

To achieve the FBSS sampling goal, the actual sample selected included the core (Panel I) and reserve (Panel II) buildings of which 963 buildings were from Region 3, 494 buildings were from Region 6, and 543 were from Region 9.

Actual Sampling Results

These procedures resulted in 881 completed interviews, only 19 short of the targeted goal of 900. Of the 881 completed interviews; 310 (35.2 percent) were from Region 3; 245 (27.8 percent) were from Region 6; and 326 (37.0 percent) were from Region 9 (See Table A2). The overall response rate for this survey was 75 percent. The regional response rates are provided below.

Table A2. Regional Response Rates in Panel I and Panel II

	Panel I Selection			Panel II Selection			Total		
	Eligible	Completed Interviews	Percent	Eligible	Completed Interviews	Percent	Eligible	Completed Interviews	Percent
Region 3 . . .	383	283	73.89	40	27	67.50	423	310	73.29
Region 6 . . .	228	207	90.79	43	38	88.37	271	245	90.41
Region 9 . . .	288	210	72.92	195	116	59.49	483	326	67.49
Total	899	700	77.86	278	181	65.11	1,177	881	74.85

Source: Energy Information Administration, Office of Energy Markets and End Use, 1993 Federal Buildings Supplemental Survey.

Survey of Building Characteristics and Consumption Data

Data Collection

FBSS data collection involved many phases and began with the redesign of the 1992 CBECS Building Questionnaire to not only assist in the implementation of the 1992 EPACT but also to accommodate the CATI system. After the questionnaire redesign, the data collection phases continued with minimizing nonresponse to ensure quality data, training supervisors and interviewers, interviewing building respondents, and concluded with processing the FBSS data. Survey interviewing began July 1994 (pretests were conducted) and ended December 31, 1994. A survey contractor performed the data collection under the direction of EIA. The data were collected by the survey contractor's telephone center staff.

Minimizing Nonresponse

Prior to and throughout data collection, EIA worked closely with the three Federal regions employing several approaches to increase cooperation and participation and to ensure that respondent burden and nonresponse was minimized. There were telephone callbacks; establishment of an 800 number to address respondents' concerns or questions; and direct EIA response to customer concerns. Respondents were encouraged to call either EIA or the 800 number if they had any questions. Additionally, letters of notification and/or FBSS materials were sent to the following:

- Federal Interagency Management Task Force
- General Services Administration (GSA) and Department of Energy (DOE) regional offices
- Facility managers of facilities selected to participate in FBSS
- Building managers of the buildings selected to participate in the FBSS.

For more discussion on the efforts taken to minimize nonresponse and respondent burden as well as examples of letters sent and addressees receiving those respective letters, see Appendix E, “Outreach Efforts.”

Training Supervisors and Interviewers

Because the 1993 FBSS was a CATI-administered, shortened version of the 1992 CBECS Building Questionnaire, only a shortened version of training was needed. The survey contractor conducted both the half-day supervisor training session and the one-day interviewer training session at the survey contractor's telephone center. The supervisor training session covered the in-depth FBSS subject-matter information, which included a component on monitoring the interview and providing feedback. The interviewer training session conducted on August 11, 1994, included FBSS background, key concepts related to energy use, several hours of interviewer self-study, several hours of practice interview, and administrative information. EIA personnel observed the interviewer training session and were available for assistance. From August 12 through August 15, 1994, interviewers received intense monitoring. On August 16, an interviewer debriefing was held. Monitoring also continued throughout the data collection process.

Interviewing the Building Respondent

Each interview began with a series of screening questions designed to verify the building's address and eligibility for the survey. The completed building interview lasted an average of 39 minutes. This included the time for the interviewer to ask all questions on energy-related building characteristics as well as the consumption and expenditure data.

Data Preparation for Report

EIA data analysts reviewed and processed the data for the final data tape. Crosstabulations were run to check for internal

consistency of the data. Because commercial building consumption and expenditure data are complex and interrelated, the EIA review was extensive. EIA performed data imputations and in July 1995, prepared a final data tape. Statistical tables of aggregated data were then produced and analyzed. The report text was based on these tables, which are presented both in the text and in Chapter 3, of this report.

Processing the FBSS Data

Because FBSS used CATI as the mode of data collection, most data editing occurred during the interview. The CATI system checked for completeness, inconsistencies or ambiguities in the data, accuracy of questionnaire skip patterns, and checked that only allowable values or codes were entered. After the interviews, data editing occurred during review of data frequencies and crosstabulations. These were reviewed to search for outlying values and inconsistencies that the CATI edits may not have identified. When CATI edits failed to resolve data problems, especially when the energy sources or heating and cooling equipment were involved, EIA personnel provided technical guidance, and when necessary, the survey contractor contacted the respondent by telephone for clarification. Telephone data retrieval was conducted for edit failures involving nonprogrammed-CATI edits. After having inconsistencies corrected by the contractor, EIA began the data preparation for the report. Any changes made to any questionnaire response as a result of data editing were documented.

Data Editing/Data Adjustments

Adjustments for unit nonresponse were performed. Cases missing all or part of calendar year 1993 consumption or expenditures were considered as particular kinds of item nonresponse. Adjustments for these cases were made as described under "Annual Consumption and Expenditures" in the "Nonsampling and Sampling Errors" section. For cases where the consumption data covered more than the one sampled building, the EIA implemented a special adjustment procedure--disaggregation to compute building-specific annualized consumption and expenditures.

Disaggregation. Disaggregation was generally necessary when either the building respondent reported that the energy bill for a source included more than the sampled building. In a limited number of cases, the preliminary data reviewer designated a case for disaggregation, even if the building respondent had not. A disaggregation "factor" was calculated based on the square footage of the buildings involved.

Imputations

Nonresponse to several items in otherwise completed questionnaires was treated by a technique known as hot-deck imputation. In hot-decking, when a certain response is missing for a given building, another building, called a "donor" is randomly chosen to furnish its reported value for that missing item. That value is then assigned to the building with item nonresponse (the nonrespondent, or "receiver"). To serve as a donor, a building had to be similar to the nonrespondent in characteristics correlated with the missing item. This procedure was used to reduce the bias caused by different nonresponse rates for a particular item among different types of buildings. The characteristics used to define "similar" depended on the nature of the item to be imputed. The most frequently used characteristics were: principal building activity, floorspace category, year constructed category, and Federal region. To hot-deck values for a particular item, all buildings were first grouped according to the values of the matching characteristics specified for that item. Within each group defined by the matching variables, donor buildings were assigned randomly to receiver buildings. For the FBSS, only data items considered critical for predicting energy consumption were imputed. These data items were: square footage, year constructed, principal building activity, energy sources used, end uses performed, major and minor fuel end uses, percent of floorspace heated and cooled, presence of refrigeration equipment, months the building was in use, operating hours, and number of workers.

The general approach taken for imputing annual consumption or expenditures for a particular fuel was to use respondent cases to develop multiple linear regression equations, and then use these equations to provide imputed values for cases in which the data were missing.

Public-Use Data Preparation

In addition to the publication of this 1993 FBSS service report, the basic survey data at the microlevel were provided to the public on public-use data diskettes. These public-use diskettes are available to the public through the National Technical Information Service (NTIS) and the Office of Scientific and Technical Information (OSTI). (See Appendix F for ordering information.)