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ENERGY USE IN OFFICE BUILDINGS

Analysis of 1977 Office Building Energy Use as Reported in the
Building Owners and Managers Association Data Base

Volume 1

August 29, 1980

Work Performed Under Contract No. AC01-79CS20189

General Electric Company
Energy Analysis
Washington, D. C.

U. S. DEPARTMENT OF ENERGY

Division of Industrial Energy Conservation

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General Electric Company
Energy Analysis
777 14th Street, N.W.
Washington, DC 20005

PREFACE

This is the report on Task IA, Analysis of the 1977 BOMA Data Base, of the General Electric Company's Energy Use in Office Buildings project, work conducted under a cost sharing contract with the Department of Energy. The analysis and calculations in this volume were performed by G.E.'s Energy Analysis Section of the Power Systems Strategic Planning and Development Operation. The report was prepared for the Department of Energy's Division of Buildings and Community Systems, Office of Conservation and Solar.

The project was undertaken in the hope of filling a major gap in the available data on energy consumption. Survey and census data that can be used for estimating energy consumption are published regularly for the residential and industrial sectors of the economy. Similar data do not yet exist for the commercial sector, and it will probably be several years before all of the data from a major DOE/EIA commercial sector energy survey which is currently in process will have been published and analyzed.

General Electric's earlier efforts in this area, the Commercial Sector Energy Consumption Data Base Development Project, developed estimates on the square feet of commercial space and assembled existing data on the energy consumption characteristics of the space. Also in that earlier project, an initial effort was made to provide greater detail on energy consumption in office buildings. Three reports were produced:

- o Commercial Buildings Inventory, General Electric, Center for Energy Systems, Volume I, DOE Contract EC-77-C-01-2161, June 1978.
- o Survey of Available Energy Use Data, General Electric, Center for Energy Systems, Volume II, DOE Contract EC-77-C-01-2161, April 1978.
- o Analysis of Energy Consumption in Office Buildings, General Electric, Center for Energy Systems, Volume III, DOE Contract EC-77-C-01-2161, April 1978.

The current project, Energy Use in Office Buildings, builds on the information developed in the initial project. The work is focused on office buildings, which are a major and complex energy consuming subsector of the Commercial Sector. As currently defined the contract has three major outputs.

- o The verification and tabular presentation of data from the 1977 commercial office building data base of the Building Owners and Managers Association (BOMA).
- o A tabular and regression analysis of a new and significantly expanded 20 city office building data base recently developed by BOMA.
- o A review and analysis of a 400 building supplementary survey conducted by BOMA.

This volume presents the results of the analysis of the 1977 BOMA data base. When the project has been completed it is expected that the information on office building energy use and the factors which drive energy use will have been substantially improved.

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SUMMARY

This report presents the results of Task IA of the Energy Use in Office Buildings Project: An analysis in tabular form of the 1977 office building energy use data base of the Building Owners and Managers Association (BOMA).¹⁾ BOMA's approximately 4000 members directly manage over 500 million square feet of commercial office space, which is approximately 16% of total commercial office building space. BOMA annually collects data on office building characteristics and operating performance for presentation in its Experience Exchange Report. Data are collected from BOMA member and non-member buildings electing to participate in the reporting process; and, in addition, a number of Federal, state, and local government buildings have been participating since 1977. Summaries of the data are published by BOMA on an aggregate basis; the summaries, which are developed on a city or regional basis, provide a benchmark for use by building managers in comparing the results of specific building operations with the industry's aggregate experience.

The BOMA Experience Exchange Report data base is believed to be the most comprehensive commercial office building data base available. It is, however, subject to some constraints. The buildings which participate in the survey are believed to be better maintained and more professionally managed than the average commercial office building; i.e., the data base is largely composed of prime office space. To the degree that non-prime space is under represented, there may be a bias in extrapolating the results to office buildings in general. There is no information available, however, about the amount of non-prime office space in the office building population; some information on this is being developed under a separate task of the Energy Use in Office Buildings Project. Second, since the Experience Exchange Report is a voluntary report, the data are probably less accurate than those which would be obtained from a mandatory report.

¹⁾ The Energy Use in Office Buildings Project was conducted under a cost sharing contract with the Department of Energy, DOE DE-AC01-79CS 20189.

Access to the 1977 BOMA data base was obtained under a subcontract with BOMA. Data for 1342 buildings -- 1059 commercial office buildings and 283 government office buildings in the United States and Canada -- were delivered. Of the 1059 commercial office buildings, 999 were located in the United States. A total of 233 Federal, state, and local government operated buildings located in the United States were also in the data base.

Prior to analysis the data were subjected to an intensive review. Questions were referred to the BOMA staff for explanation or correction. In some cases the BOMA staff were able to verify or correct a data item from existing records. In other cases it was necessary for the BOMA staff to contact individual building managers. In some cases it was impossible for a building manager to verify or correct a data item, and in other cases BOMA could not reach the appropriate person. A number of buildings were, therefore, eliminated from the energy analysis.

After the Canadian buildings and the buildings with questionable data had been eliminated, a sample consisting of 889 commercial and 216 government office buildings for which data had been verified was finally developed from the data furnished by BOMA. The sample of buildings will be referred to in this report as the "1977 data base", to distinguish it from the somewhat larger data base from which it was obtained, the 1977 Experience Exchange Report.

Energy use data were reported by BOMA in terms of kwh of electricity, cubic feet of gas, gallons of oil, and pounds of steam. The data were converted to British thermal units (Btu's), and all building energy measures were expressed in terms of Btu/Sq. Ft.

Section II of the report presents the analysis for commercial office buildings, and Section III presents the analysis for government office buildings.

On the basis of data previously developed from the F.W. Dodge "Dodge Construction Potentials" and presented in Commercial Buildings Inventory, it was found that the commercial office buildings in the data base were reasonably representative of the stock of commercial office buildings in terms of location and age.¹⁾ Tables summarizing electric consumption and fuel consumption by fuel and census division, downtown/suburban location, height, age, electrical billing policy, of management, computer space, and air conditioning were developed.

¹⁾ General Electric Company, Center for Energy Systems, Commercial Buildings Inventory, June 1978.

As measured by square feet of space 15% of the commercial buildings were electrically heated, 35% were gas heated, 7% were oil heated, and 42% were steam heated. Electrically heated buildings used the least energy per square foot in 1977 in comparison to other types of buildings. Steam heated buildings were the second most energy efficient, followed by oil heated buildings. Gas heated buildings were the least energy efficient. (The data are summarized in Table II-5). Both electricity and fuel were found to vary by census division. Fuel consumption tended to be higher in cold regions, and electric consumption tended to be higher in warm regions (Tables II-8 through II-12).

There was found to be a difference in energy use between downtown and suburban office buildings: on an aggregate basis downtown buildings were found to use more energy per square foot than suburban buildings (Tables II-13 and II-14).

In examining energy use by height there was no clear energy use trend in the case of fuel use, but buildings in excess of 9 stories used more electricity per square foot than did lower buildings (Tables II-15 and II-16). This may be due to relatively greater elevator and air handling needs in the taller buildings.

Energy use was found to be a function of building age (Tables II-17 and II-18). Energy use is relatively low in new buildings, probably as the result of the buildings having heating, ventilating, and air conditioning equipment which is in good operating condition. Energy use is higher for buildings in the 10-19 years old range, possibly due to older and less efficient equipment. Energy use then tapers off to a low level for buildings through the 30-39 years age range, as the quality of the space declines. Buildings in the 40+ years old range have generally been remodeled, and their energy use reflects that the space is again high quality, prime space. Relatively low energy use in the 50+ years old buildings probably is due to the construction practices of the 1920's and to the use of steam for heating.

Charges for electricity are usually included in the building rent, and an escalator clause typically provides for the pass-through of increased energy charges for a building in proportion to the space rented by each tenant. Under these circumstances the tenant has little control over the charge to him for electricity. In some buildings, however, the tenant is metered by the building or by the electric utility for some of his electric use -- such as lighting, computer, and general office uses -- and can lower his electric bill through decreased electric use. It was found that in cases in which tenants were metered for their electric use and could directly benefit financially from conservation, the buildings tended to use less electricity (Table II-19).

The existence of computer or data processing facilities in a building was found to have an effect on building energy use: buildings without computer space used more fuel and less electricity on average than did buildings with computer space (Tables II-20 and II-21). A possible explanation of this would be that large amounts of electricity are used to power the computer equipment and that the waste heat subsequently filters through the rest of the building, reducing some of the need for heating fuel use. Given the zoning of many commercial buildings, however, it appears that general building usage patterns rather than waste heat recovery may also be an important factor in explaining energy use in this case.

Data on energy use and air conditioning were also developed (Tables II-22 through II-25). Electric consumption for buildings with non-electric air conditioning (steam absorption, gas, etc.) was significantly less than for buildings with electric air conditioning.

Section III presents the office building energy use analysis for government office buildings, defined to be buildings owned and operated by a government agency. There were 216 government office buildings in the 1977 data base. The buildings were not, however, typical of government office buildings in general in terms of location or age. In terms of heating fuel, 5% of the space was electrically heated, 36% was gas heated, 8% was oil heated, and 51% was steam heated. In contrast to the commercial office buildings in the 1977 data base, the government buildings tended to fall in the middle age ranges: there were fewer old (50 years +) or younger (1-9 years) buildings.

Government office buildings were found to use less energy than do commercial office buildings (Tables III-5 through III-11). Differences in building construction and building usage could account for the lower energy consumption. The government architectural style results in building design which is structurally more massive than commercial space and probably has better thermal characteristics. In addition, building managers for government buildings have frequently received directions to operate the buildings at comfort levels for lighting, heating, and cooling which are below those maintained in the private sector. Commercial building managers in providing space conditioning have to maintain a level of tenant satisfaction and comfort that will enhance the marketability of the space. In contrast, government building managers in some instances operate the buildings pursuant to government conservation policies.

An attempt was made to compare energy use between downtown and suburban government office buildings (Table III-12). There is some evidence that suburban government gas and oil heated buildings use more energy than do downtown government buildings. However, since most government buildings are located downtown, the data are too limited to permit definite conclusions.

Table III-13 presents energy use by building height; there did not appear to be any significant trend in the case of government buildings, in contrast to the findings for commercial office buildings, as presented in Tables II-15 and II-16.

It was found that energy consumption varied by building age (Tables III-14 and III-15). A pattern similar to that found in the case of commercial office buildings emerged.

As was the case with commercial office buildings, government office buildings with computer space tended to use more electricity and less "other fuels", (Tables III-16 and III-17).

Data on energy use in terms of type of air conditioning were developed (Tables III-18 through III-21). Electric air conditioning was present in 164 of the buildings in comparison to steam absorption in 17 buildings.

The data presented in this report should be a useful input to models for the forecasting of energy consumption. However, it should be recognized that the data in this report do not provide a cause and effect explanation of what factors drive energy consumption, nor do the data present energy consumption by end use. A 20 city data base which is being obtained under a different subtask of this project will be subjected to regression analysis under a subsequent task of the project in an effort to obtain insight on what factors cause energy use to vary. No data are gathered for energy use by end use, and it will not be possible, therefore, to develop information on energy use by end use in the regression analysis.

Building energy use simulation programs, such as the DOE II, etc., are typically used to simulate building energy use by end use -- heating, cooling, lighting, hot water, fans, pumps, etc. The programs model energy use as a function of the building shell, the building equipment, and building age. It is currently necessary to rely on these types of programs for end use data, for submetering by function is still not practiced to any significant degree in the commercial office building sector.

The major objective of the Energy Use in Office Buildings subtask presented in this report was to develop the tabular data. As the data were developed two major additional interesting conclusions emerged: there was a decline in office buildings' energy use between 1975 and 1977, based on the comparison of the data in this report with the data from a previous report, and there is a difference in energy use patterns between commercial and government office buildings.

ENERGY USE IN OFFICE BUILDINGS: ANALYSIS OF THE 1977 BOMA DATA BASE

INTRODUCTION

Energy analysis and projections are generally conducted in terms of four major energy consuming sectors: residential, commercial, industrial, and transportation. Substantial amounts of detailed data are available for the industrial and transportation sectors; however, data for the residential and commercial sectors have historically been more limited, being available only on a combined basis. The commercial sector is an energy consuming sector which contributes value-added to the GNP. In contrast, the residential sector is an energy consuming sector which consumes the value-added of the GNP. The factors affecting energy consumption by these two sectors are different, for the sectors themselves are different. The work presented in this report is a part of General Electric's efforts over the last 6 years to obtain a better understanding of the factors driving energy consumption in the commercial sector, of which the office building subsector is an important component. This report presents the results of Task IA, Analysis of the 1977 BOMA Data Base, of the Energy Use in Office Buildings Project, work conducted under a cost sharing contract with DOE.

In a previous study, the Commercial Sector Energy Consumption Data Base Development Project, the commercial sector was defined in terms of the activity occurring in 15 major types of space: Store and Other Mercantile Buildings, Warehouses (Excluding Manufacturer Owned), Office and Bank Buildings, Commercial Garages and Auto Service Stations, Schools and College Classroom Buildings, Laboratories (Excluding Manufacturer Owned), Libraries and Museums, Hospitals and Other Health Treatment Buildings, Government Administration Buildings, Other Government Service Buildings, Houses of Worship, Other Religious Buildings, Amusement/Social/Recreational Buildings, Miscellaneous Non-Residential Buildings, and Non-Housekeeping Residential Buildings.¹⁾ Commercial

¹⁾General Electric Company, Center for Energy Systems, Commercial Sector Energy Consumption Data Base Development Project, DOE Contract EC-77-C-01-2161. Three major reports resulted from this work: Commercial Buildings Inventory, June 1978; Survey of Available Energy Use Data, April 1978; and Analysis of Energy Consumption in Office Buildings, April 1978.

sector energy use results from the conduct of economic transactions in a building. The amounts of space, the types of space, the characteristics of the space, and the usage of the space will determine the level of commercial sector energy use. The objectives of the previous contract were the estimation of the inventory of the square feet of 15 types of commercial sector space at the national and regional level, and the assembling of existing information on the energy consumption characteristics of the space. An inventory of commercial space by building type was derived from the F. W. Dodge "Dodge Construction Potentials" for the years 1925-76, and the distribution of the space among the 173 Business Economic Areas (BEA) and building types was derived for 1976. Data for energy consumption by building type were, however, found to be limited: very little information was available for commercial sector energy consumption.

After a broad survey of available information on commercial energy consumption had been conducted, the project focused on energy use in commercial office buildings, which are an important and energy intensive part of the commercial sector. The 1975 data base of the Building Owners and Managers Association International (BOMA) was analyzed. Tables which present office building energy use as a function of such building characteristics as size, location, height, and age were developed, and a regression analysis presenting energy use as a function of building characteristics was conducted.

The current report presents an analysis of the 1977 BOMA data base. A total of 889 commercial office and 216 government office buildings were analyzed in comparison to the 371 buildings in the 1975 data base. A number of data items, such as information on computer space and air conditioning, which were previously unavailable, are examined.

I. THE BOMA ORGANIZATION AND DATA BASE

The BOMA membership numbers approximately 3800 members in the United States and Canada, with approximately 100 additional members throughout the world. Member buildings account for over 500 million square feet of commercial office space, or about 16% of total office building space. As the trade association for the commercial office building industry BOMA has a Washington office and staff, and affiliated regional organizations with full or part time staffs are located in approximately 70 U.S. and Canadian cities. The association's work is conducted through a number of committees which deal with such subjects as accounting, energy, marketing, lease content, space measurement, insurance, rehabilitation, planning services, special use buildings, operating methods, urban affairs, etc. The Building Owners and Managers Institute (BOMI) is an affiliated educational organization offering courses in building management; a certification program for the title of Real Property Administrator (RPA) has been developed.

A building manager is responsible on behalf of the owners for the day-to-day operations and maintenance of a building. A typical major commercial office building may be 20 stories tall with 10,000 square feet per floor and may require 75 employees to handle maintenance, renovation, and cleaning. Some managers are also involved in the leasing of the building. Market conditions vary from city to city, but in general newer office space currently rents for \$12-\$18 per square foot per year, and older space is in the \$11-\$14 range.

BOMA annually collects data on office building characteristics and operating performance. Data are collected from BOMA member and non-member buildings electing to participate in the reporting process; and, in addition, a number of federal and state government buildings have been participating since 1976. Summaries of the data are published on an aggregate basis in the annual Experience Exchange Report; the summaries, which are developed on a city or regional basis provide a benchmark for use by building managers in comparing the results of specific building operations with the industry's aggregate experience. The Experience Exchange Report is a management tool which has been developed to assist building managers in evaluating the cost performance of specific buildings in comparison to overall industry average performance. A copy of the form used by BOMA for data collection is presented in Appendix 1.

The Experience Exchange Report is believed to be the most comprehensive commercial office building data base available; there are, however, some problems associated with it. BOMA undertakes an initial examination of the data for reasonableness, but no extensive verification of the data is performed. In some cases the data are incomplete or inaccurate. In addition, the buildings which participate in the Experience Exchange Report may not be representative of the inventory of all commercial office buildings; the BOMA member buildings are believed to be better maintained and more professionally managed than many commercial office buildings. BOMA has indicated some of the limitations of the data.¹⁾

"The BOMA Experience Exchange Report is a voluntary report. Consequently, the sample changes from year to year. Moreover, voluntary reporting tends to be less accurate and less complete than mandatory reports. Even though the sample size may be comparable from year to year for a region or city, the building composition of the sample may have changed. For example, the 1978 sample may contain more new buildings than 1977 sample, despite the same number of reports for both years. Consequently, it is important to rely on tables with large samples where possible. Where special circumstances apply, good judgment will be a prerequisite to fruitful use of the BOMA Experience Exchange Report".

¹⁾ Building Owners and Managers Association International, 1979 Downtown and Suburban Office Building Experience Exchange Report, Washington, D.C., 1979, p. 3.

Access to the 1977 BOMA data base was obtained under a subcontract with BOMA. Data for individual buildings excluded building names and street addresses but were otherwise complete. Under the terms of the agreement, General Electric is precluded from releasing any of the specific individual data items furnished by BOMA. General Electric may publish and/or deliver only aggregated data to the Department of Energy. On completion of such use the data base will be returned to BOMA. The characteristics of the BOMA data base, as reported in Acquisition Of The 1977 BOMA Data Base, are presented in Appendix 2.¹⁾

Data for 1342 buildings -- 1059 commercial office buildings and 283 government office buildings -- in the United States and Canada were delivered. Of the 1059 commercial office buildings, 999 were located in the United States, and the remainder were Canadian buildings. A total of 233 U.S. Federal, state, and local government operated buildings were also in the data base; 1977 was the first year for which these buildings had participated. Prior to performing the analysis, a major data verification and interpretation effort was conducted by GE in conjunction with the BOMA staff in order to review all relevant data entries and to correct, modify, or delete data items as appropriate and necessary. This effort was necessary because previous work with the 1975 BOMA data base had uncovered many errors and inconsistencies in the energy use and building characteristics data.

For review purposes, electric and fuel use were converted to a per square foot basis, and these data were reviewed along with other building operating and physical characteristics data for reasonableness and accuracy on a building by building basis.²⁾ Questions were referred to the BOMA staff for explanation or correction. In many cases, the BOMA staff were able to verify or correct a data item from existing records. In a number of cases, it was necessary for the BOMA staff to contact individual building managers; in some cases it was impossible for a building manager to verify or correct a data item, and in other cases BOMA could not reach the appropriate person. A number of buildings were, therefore, eliminated from the energy analysis.

1) General Electric, Center for Energy Systems, Acquisition Of The 1977 BOMA Data Base, work conducted under DOE purchase order EM-78-X-01-5724, Washington, D.C., December 20, 1978.

2) Electricity was converted at 3412 Btu/kwh; gas at 1020 Btu/cu. ft.; #2 Oil at 138,690 Btu/gallon; #6 Oil at 149,690 Btu/gallon; and Steam at 1000 Btu/cu. ft. Where oil type was unavailable it was assumed that #2 Oil was being burned.

Energy use efficiency varies from building to building; however, reports of abnormally high or low energy use were often a result of inaccurate or incomplete reporting. Where data could be obtained from BOMA the necessary corrections were made. Buildings with inadequate data were not used in the energy analysis. Various factors were found to account for the variability of reported building energy use:

- Special use space: Special use space, such as banking, medical, scientific, retail, restaurant, or corporate headquarters results in energy use that is higher than expected.
- Incomplete energy reporting: In some cases an electric utility directly metered the tenant, and the metered energy use in tenant areas was not reported by the building manager. In other cases, buildings supply energy to neighboring buildings; this causes reported energy use to be higher than the actual building use for the supplying building. In the case of buildings which purchased chilled water from adjoining buildings, the data were not adequately reported in 1977. Buildings with chilled water usage were dropped from the analysis; for other buildings, the data were either verified or corrected, or the building was dropped.
- Equipment characteristics: Buildings with steam absorption or steam turbine air conditioning have high fuel use but relatively low electric use. Cases with steam absorption and steam turbine air conditioning were identified to the extent possible. The existence of computer space was identified by whether raised flooring and/or special air conditioning was used for the computer equipment. Cases with abnormal electric use were examined to determine whether equipment characteristics could be an explanatory factor for the abnormal energy use.
- Inaccurate reporting: A number of keypunching and data recording errors were found and corrected.
- Fuel use: Cases in which more than one type of fuel use was reported were examined for accuracy.

The 1977 Data Base: Conclusions

After the Canadian buildings and the buildings with questionable data had been eliminated, a sample consisting of 889 commercial and 216 government office buildings for which data had been verified was finally developed from the data furnished by BOMA. The sample of buildings will be referred to in this report as the "1977 data base", to distinguish it from the somewhat larger data base from which it was obtained, the 1977 Experience Exchange Report. When the 1977 data base is presented in the computer output, it will be denoted as the "1977 BOMA Office Building Sample."

Two analyses were run on the data base: one for the commercial office buildings, and one for the government office buildings. The comments and conclusions for the commercial buildings will be presented in the next section, and the following section will present conclusions for the government buildings.

II. ANALYSIS OF THE 1977 DATA BASE: COMMERCIAL OFFICE BUILDINGS

II-1 Characteristics of the Data Base

The 1977 data base contained data for 889 commercial office buildings. Before analyzing the data, it was desired to determine to what degree the data were representative of commercial office buildings in general. There is a belief that the commercial office buildings from which BOMA collects data are not representative of office buildings in general. Instead, it is believed that BOMA buildings are prime space which is better maintained and managed. However, the 1977 data base does in fact appear to be representative in terms of location and age, on the basis of information obtained from Commercial Buildings Inventory¹⁾ Table II-1 compares the distribution of space by census division of the 1977 data base with the distribution of the population of U.S. commercial office buildings in 1975 (there being no 1977 regional data distribution available).²⁾ With the exception of the East South Central region and -- to a lesser degree New England -- the 1977 data base is roughly proportionally distributed in comparison to the population of commercial office buildings. In comparison to the 1975 data base developed under a previous contract the 1977 regional distribution is greatly improved.³⁾

1) General Electric Company, Center for Energy Systems, Commercial Buildings Inventory, June 1978.

2) The allocation of space by Census Division was based on data in Commercial Buildings Inventory, General Electric, Center for Energy Systems, June 1978.

There are nine census divisions:

New England:	Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut
Middle Atlantic:	New York, New Jersey, Pennsylvania
East North Central:	Ohio, Indiana, Illinois, Michigan, Wisconsin
West North Central:	Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas
South Atlantic:	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida
East South Central:	Kentucky, Tennessee, Alabama, Mississippi
West South Central:	Arkansas, Louisiana, Oklahoma, Texas
Mountain:	Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada
Pacific:	Washington, Oregon, California, Alaska, Hawaii.

3) Throughout this report reference will be made to the 1975 data base, which is presented in Analysis of Energy Consumption in Office Buildings, General Electric Company, Center for Energy Systems, April 1978.

TABLE II-1
PERCENTAGE DISTRIBUTION OF SQUARE FEET OF COMMERCIAL
OFFICE BUILDING SPACE BY CENSUS DIVISION

Census Division	Estimated Distribution of U.S. Commercial Office Building Space for 1975 ¹⁾ (Percent of Total Space by Region)	Distribution of Square Feet of Commercial ²⁾ Space in 1977 Sample (Percent of Sample)	Distribution of Square Feet of Commercial ³⁾ Space in 1975 Sample (Percent of Sample)
NE	6.0%	2.8%	.7%
MA	22.2	21.6	33.7
ENC	18.1	15.6	19.0
WNC	6.7	8.8	9.6
SA	14.5	13.4	5.5
ESC	4.0	1.1	.3
WSC	9.4	14.4	13.8
MTN	4.0	4.8	1.9
PAC	15.2	17.6	15.5

1) Based on Commercial Buildings Inventory of the Commercial Sector Energy Consumption Data Base Development Project, DOE Contract EC-77-01-2161, Center for Energy Systems, General Electric Company, June 1978.

2) Based on the data base developed for this project.

3) Based on the data base presented in Analysis of Energy Consumption in Office Buildings of the Commercial Sector Energy Consumption Data Base Development Project, DOE Contract EC-77-C-01-2161, Center for Energy Systems, General Electric Company, April 1978.

Table II-2 presents the distribution at the national level of commercial office building space by age as developed from data presented in Commercial Building Inventory and compares both the 1977 and the 1975 data bases. With the exception of buildings aged 30-39 years, the 1977 data base is an improvement over the 1975 data base and is not unrepresentative of the population of buildings in general.

The buildings in the 1977 data base can be defined in terms of the type of fuel used for heating: electric, gas, oil, and steam.

<u>Building Fuel Type</u>	<u>Number of Buildings</u>	<u>% of Buildings</u>	<u>Square Feet of Space (10⁶)</u>	<u>% of Space</u>
Electric	172	19.4%	34.2	15.3%
Gas	359	40.4	78.9	35.4
Oil	71	8.0	16.0	7.2
Steam	287	32.3	94.0	42.1
	<u>889</u>			

Table II-3 describes the buildings by fuel type and census division. Approximately 40% of the electrically heated buildings are centered in the South Atlantic division with an additional 26% in the Pacific. Gas heated buildings are relatively evenly distributed throughout the country. The major concentration of oil heated buildings, which are relatively few in number, is in the South Atlantic Division. There are four major concentrations of steam heated buildings: Middle Atlantic, East North Central, West North Central, and Pacific. Steam heated buildings are concentrated in major cities with steam plants.

Most of the buildings for which data are reported in the BOMA Experience Exchange Report are probably prime, well managed space; it is unlikely that data are reported for non-prime space. Since there is no information available at the national level for the mix of prime and non-prime space, however, it is not possible to estimate to what degree the 1977 data base is unrepresentative of buildings in general.

TABLE II-2
PERCENTAGE DISTRIBUTION OF SQUARE FEET OF
COMMERCIAL OFFICE BUILDING SPACE BY AGE

Age	Estimated Distribution of Square Feet of Commercial Office Building Space by Age in 1977 ¹⁾ (Percent of Total Space)	Distribution of Square Feet of Commercial Office Building Space ²⁾ in 1977 Sample (Percent of Sample)	Distribution of Square Feet of Commercial Office Building Space in 1975 Sample ³⁾ (Percent of Sample)
1-9	47.1%	45.7%	42.0%
10-19	24.6	21.8	22.5
20-29	9.5	7.8	4.9
30-39	4.4	.1	4.0
40-49	4.9	9.6	12.0
50+	9.5	14.0	14.6

1) Estimated on the basis of data in Commercial Buildings Inventory of the Commercial Sector Energy Consumption Data Base Development Project, DOE Contract EC-77-C-01-2161, Center for Energy Systems, General Electric Company, June 1978. Based on yearly additions adjusted by removal rate.

2) Based on data developed in this project.

3) Based on data presented in Analysis of Energy Consumption in Office Buildings of the Commercial Sector Energy Consumption Data Base Development Project, DOE Contract EC-77-C-01-2161.

TABLE II-3
THE 1977 BOMA OFFICE BUILDING SAMPLE
BY TYPE OF HEATING FUEL AND REGION
(SQUARE FEET IN MILLIONS)
COMMERCIAL OFFICE BUILDINGS

	ELECTRIC			GAS			OIL			STEAM		
	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)
NEW ENGLAND	0	0.0	0.0	3	0.6	213.1	2	1.0	488.5	5	4.6	923.2
MIDDLE ATLANTIC	1	0.0	4.0	16	2.4	149.3	6	0.9	143.1	84	44.8	532.8
EAST NORTH CENTRAL	16	5.3	329.3	61	16.0	262.7	6	2.7	452.1	52	10.8	207.4
WEST NORTH CENTRAL	11	2.3	206.4	43	7.1	166.2	4	0.6	157.3	42	9.6	229.4
SOUTH ATLANTIC	68	11.4	167.5	38	3.9	103.2	49	9.8	199.4	14	4.9	346.5
EAST SOUTH CENTRAL	3	0.7	224.1	5	0.6	120.6	1	0.7	737.2	4	0.5	126.0
WEST SOUTH CENTRAL	22	4.9	222.9	84	25.2	299.9	1	0.3	286.2	2	1.8	875.5
MOUNTAIN	6	1.3	222.6	41	6.0	147.1	0	0.0	0.0	14	3.3	238.7
PACIFIC	45	8.4	185.8	68	17.0	250.0	2	0.1	29.7	70	13.8	197.1
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TOTAL	172	34.2	198.9	359	78.9	219.9	71	16.0	225.8	287	94.0	327.7

TABLE II-4
HEATING FUEL BY AGE OF BUILDING IN THE 1977 BOMA OFFICE BUILDING SAMPLE
(SQUARE FEET IN MILLIONS)
COMMERCIAL OFFICE BUILDINGS

AGE (YEARS)	HEATING FUEL														
	ELECTRIC			GAS			OIL			STEAM			TOTAL		
	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)
1-9	122	27.9	228.3	121	33.7	278.7	26	7.3	280.7	53	33.2	626.5	322	102.1	317.0
10-19	24	3.4	143.4	98	18.6	190.2	23	5.0	218.6	60	21.6	360.3	205	48.7	237.7
20-29	5	1.0	190.1	43	9.2	215.1	8	1.5	190.7	19	5.7	300.6	75	17.4	232.5
30-39	1	0.0	9.7	8	2.2	269.6	2	0.1	33.0	0	0.0	0.0	11	2.2	203.0
40-49	4	0.7	187.0	16	3.6	226.1	3	1.4	470.3	43	15.6	363.3	66	21.4	324.2
50+	16	1.2	74.9	73	11.5	158.2	9	0.7	78.4	112	17.9	159.7	210	31.3	149.2
TOTAL	172	34.2	198.9	359	78.9	219.9	71	16.0	225.8	287	94.0	327.7	889	223.2	251.1

Table II-4 presents data on fuel type and building age. 71% of the electrically heated buildings are less than 10 years old. In many areas natural gas has been unavailable or subject to uncertain supply for a number of years. Depending on climate, expected usage, and capital costs, it has been cheaper in some instances to rely on electricity than to install an oil/gas dual fuel capability. Installation of electric heating also eliminates problems of fuel availability. Natural gas, however, has continued to be available to some degree: 34% of the natural gas heated buildings are less than 10 years old. Most of the oil heated buildings are less than 20 years old. During the 1960's and early 1970's oil was cheaper than natural gas and captured a significant share of the market in some cities. The steam heated buildings tend to be older than buildings heated by other fuels. District steam plants have existed for many years in some of the large cities.

II-2 Summary of Energy Consumption

Energy consumption in terms of Btu/Sq. Ft. was prepared on a Census Division basis for all fuels together and for electric, gas, oil, and steam buildings separately. The tables -- Tables II-5 through II-12 -- are presented at the end of this section. Btu/Sq. Ft. was calculated on a weighted and unweighted basis for electric use, fuel use, and total energy use. A computation with the Btu/Sq. Ft. for each building weighted by the area of the specific building relative to the total sample places a greater importance on the larger buildings, which are the important ones in terms of the total square feet of building space. In performing an unweighted computation, all buildings are assumed to be of equal importance regardless of size. It is believed that the weighted means and variances are the more important statistics, and the discussions throughout this report will focus on them. Unweighted means and variances will, however, in a number of instances also be presented.

In cases in which both weighted and unweighted means and variances have been prepared the weighted data will be presented in a table with the suffix A. The unweighted data will be presented immediately following in an identically numbered table with the suffix B.

It will be observed that the means of "Electricity" and "Other" fuels in general do not exactly add to equal the "Total" energy use in many of the following tables. The differences are relatively minor and are due to the way in which the data were processed and computed.

1. In the case of electrically heated buildings, the number of buildings in the denominator for "Other" fuel use does not equal the total number of electrically heated buildings. "Other" fuel was computed only for those buildings which in fact had such use.

2. In the case of gas, oil, and steam heated buildings the "Other" fuels heading captures the use of the principal fuel -- gas, oil, or steam -- not total fuel use. However, total fuel use was included in the "Total" energy use column. For example, many oil and steam heated buildings have minor amounts of gas use for restaurant or other purposes, this use was included in the "Total" column but not in the fuel use column. Similarly, some gas heated buildings had significant amounts of oil use -- probably due to interruptible gas supplies. This oil use was included in the "Total" heading but not under the "Other" fuel heading.

3. The number of buildings in the denominator was not always equal in computing "Electricity", "Other" fuel use, and "Total" use. For example, for a few buildings either "Other" or "Electricity" were not reported in the data base, but "Total" energy use was available. In these cases, rather than eliminate a building entirely, the building was only eliminated from that part of the computation for which the data were unavailable. It is, therefore, necessary to note that Table II-3 does not present the exact number of buildings in each computation. Rather, Table II-3 is most useful in examining fuel penetration. The number of buildings in each computation is explicitly presented in Table II-7.

In presenting the results developed from the 1977 data base we will make some comparisons with the 1975 data base, developed under a previous contract. It should be recognized that the 1975 sample was not as large or as well verified as the 1977 sample. For example, in the case of the 1975 data outlying observations -- i.e., energy use observations which appeared to G.E. to be questionable -- were more often eliminated without additional review or correction by BOMA than was the case with the 1977 data base. This probably did not bias the mean, but it

almost certainly caused the computed sample variance to be less than the population variance. As a result, the 1975 data base had significantly fewer buildings, and the data tended to be more clustered about the means. In addition to differences in sample size and possible bias, the regional distribution of the 1975 sample was not as good as that of the 1977 sample.

Table II-5 presents a summary of energy use by type of fuel at the national level during 1975 and 1977. In non-electrically heated buildings the fuel is in general used for building heating and hot water; however, a limited amount of gas and steam air conditioning also accounts for some of the fuel use. The electricity is used for the usual purposes of lighting, fans, etc.; and in most buildings the air conditioning is electric. It would be desirable to have a finer breakout by end use - lighting, heating, hot water, air conditioning, fans, pumps, special equipment, etc. However, most buildings do not meter energy use in this way: the data are, therefore, unavailable. To determine energy use by end use it is currently necessary to use a building simulation program, such as the AXCESS program.

Recognizing that there are limitations to the comparison of 1975 and 1977 data it is, nevertheless, useful to examine the differences between the two years. Total Btu/Sq. Ft. was 152.5 thousand in 1977 in comparison to 159.9 thousand in 1975. With the exception of steam heated buildings commercial office buildings used less energy in 1977 than in 1975.

It was desired to determine on a statistical basis whether energy use per square foot had changed between 1975 and 1977. Recognizing that the computed 1975 standard deviation was unreliable we formed 95% and 99% confidence intervals for the 1977 population mean based on the sample, as is shown in Table II-6. On a total energy use basis the 1975 sample mean did not fall in the 1977 confidence interval for all buildings on a combined basis and for electric, gas, and oil fired buildings. Accordingly, the statement that conservation occurred between 1975 and 1977 is not disproved.

Electrically heated buildings used the least energy per square foot in 1977 in comparison to other types of buildings. Building location may have been an important contributing factor to this difference, for most electric buildings are located in relatively warm climates; therefore, heating requirements would be less than would be the case for other building types. In addition, in the case of electric buildings, energy is measured at the user level, exclusive of generation and transmission losses. There was a substantial decline in Btu/Sq. Ft. use by the electrically heated buildings between 1975 and 1977.

Steam heated buildings were the second most energy efficient in 1977, but 1977 total Btu use was up by approximately nine thousand Btu/Sq. Ft. between 1975 and 1977. As can be seen in Table II-5, the increase was entirely caused by rising electric use, probably due to increased supplemental use of electricity in place of steam for some heating applications. As is the case with electricity, steam use is measured at the building line exclusive of generation and transmission losses: energy use data are measured in this report on the basis of building expenditures. The place of measurement has an effect on the apparent efficiency of utilization: in the case of electric and steam buildings, much of the energy loss occurs before the energy is measured in the tables; in the case of gas and oil use, the tables pick up much of the energy utilization loss.

Gas heated buildings were the least energy efficient, probably due in part to the relatively low cost of gas. Even here, however, there was a decline of twenty thousand Btu/Sq. Ft.

Table II-7 summarizes fuel use on a weighted basis by building type and census division. Tables II-8 through II-12 present the detailed computer output.

Both electricity and fuel use vary by region. For gas, oil, and steam heated buildings less electricity is in general used in colder than in warmer areas of the country, probably as a result of the decreased need for air conditioning. Conversely, more fuel is used in colder areas of the country, probably resulting from the increased need for heating. For electrically heated buildings electric use also appears to vary by climate area, but it is not possible to distinguish between fuel use and air conditioning use. The "other" energy use for electrically heated buildings is largely fuel used for restaurant, decorative, or other process use purposes.

TABLE II-5
ENERGY CONSUMPTION IN THE 1975 AND 1977 COMMERCIAL OFFICE
BUILDING SAMPLES BY TYPE OF HEATING FUEL

(Btu/Sq. Ft. in thousands; Square feet in millions)
Weighted Means

	Heating Fuel								All Buildings	
	Electric		Gas		Oil		Steam		1975	1977
	1975	1977	1975	1977	1975	1977	1975	1977		
Electric Btu/Sq. Ft.	137.2	114.9	94.3	92.4	58.5	75.5	65.5	75.0		
Gas Btu/Sq. Ft.			107.6	86.0						
Oil Btu/Sq. Ft.					154.9	62.3				
Steam Btu/Sq. Ft.							67.1	66.2		
Total Btu/Sq. Ft. ¹⁾	137.2	116.6	201.9	180.1	213.4	152.9	132.6	141.4	159.9	152.5
Total Square Feet	19.7	34.2	39.4	78.9	12.2	16.0	68	94	139.3	223.1
Number of Buildings	41	158	139	333	30	65	161	273	371	829

¹⁾ As is indicated in the text, electric use plus other fuel use do not exactly sum to equal total energy use.

TABLE II-6
CONFIDENCE INTERVALS FOR THE 1977 MEAN
FOR COMMERCIAL OFFICE BUILDINGS
 (Btu/Sq. Ft. in thousands)

<u>Fuel Type</u>	<u>1977 Mean</u>	<u>1975 Mean</u>
Electric	116.6	137.2
95% confidence interval	111.0-122.2	
99% confidence interval	109.3-123.9	
Gas	180.1	201.9
95% confidence interval	167.7-192.5	
99% confidence interval	163.8-196.4	
Oil	152.9	213.4
95% confidence interval	138.2-167.6	
99% confidence interval	133.5-172.3	
Steam	141.4	132.6
95% confidence interval	135.6-147.2	
99% confidence interval	133.8-149.0	
All Buildings	152.5	159.9
95% confidence interval	146.9-158.0	
99% confidence interval	143.2-159.8	

TABLE II-7
SUMMARY OF 1977 COMMERCIAL OFFICE BUILDING ENERGY CONSUMPTION¹⁾
(10³ BTU/SQ. FT.)
WEIGHTED MEANS

Census Division and Type of Building Fuel for Heating	<u>Electricity</u>	<u>Number of Buildings</u>	<u>Other</u>	<u>Number of Buildings</u>	<u>Total</u>	<u>Number of Buildings</u>
New England						
Electric		0	-	0	-	0
Gas	67.9	3	97.3	3	165.1	3
Oil	73.7	2	104.5	2	178.1	2
Steam	64.2	5	103.7	5	167.9	5
All	66.1	10	103.2	10	169.3	10
Middle Atlantic						
Electric	181.7	1	-	0	181.7	1
Gas	104.1	14	105.7	13	197.0	14
Oil	54.3	5	78.6	5	151.5	5
Steam	76.2	77	70.4	75	146.8	77
All	77.3	97	72.2	96	149.4	97
East North Central						
Electric	117.5	14	.1	1	117.5	14
Gas	65.6	56	108.5	56	183.0	56
Oil	60.5	6	80.0	6	168.3	6
Steam	77.7	51	71.0	51	151.1	51
All	76.8	128	94.8	115	162.4	128
West North Central						
Electric	128.6	11	3.5	1	129.4	11
Gas	84.8	37	116.7	39	213.1	39
Oil	64.0	3	42.9	3	143.8	3
Steam	67.9	42	66.1	42	135.3	42
All	81.2	97	93.2	89	164.1	99
South Atlantic						
Electric	106.0	62	9.0	12	107.9	62
Gas	82.0	35	73.3	34	157.6	35
Oil	78.8	46	53.7	45	140.9	46
Steam	75.3	13	68.4	12	147.3	13
All	88.6	159	61.0	106	131.0	159
East South Central						
Electric	102.7	3	4.4	1	103.4	3
Gas	96.7	4	58.8	4	155.5	4
Oil	126.0	1	48.5	1	231.2	1
Steam	100.2	4	38.7	4	140.2	4
All	109.1	12	70.1	10	161.4	12
West South Central						
Electric	119.0	19	0	0	119.0	19
Gas	115.7	80	79.8	80	195.6	80
Oil	-	0	-	0	-	0
Steam	85.5	2	51.0	2	136.5	2
All	114.2	102	77.6	83	180.6	102

¹⁾ See footnote on next page.

TABLE II-7, Continued
SUMMARY OF 1977 COMMERCIAL OFFICE BUILDING ENERGY CONSUMPTION¹⁾
(10³ BTU/SQ. FT.)
WEIGHTED MEANS

Census Division and Type of Building Fuel for Heating	<u>Electricity</u>	<u>Number of Buildings</u>	<u>Other</u>	<u>Number of Buildings</u>	<u>Total</u>	<u>Number of Buildings</u>
Mountain						
Electric	132.4	5	5.8	1	135.9	5
Gas	85.4	38	122.7	38	208.8	38
Oil	-	0	-	0	-	0
Steam	86.5	13	53.6	13	141.0	13
All	92.3	58	93.3	53	179.8	58
Pacific						
Electric	117.7	43	28.8	4	121.8	43
Gas	87.9	64	48.6	62	134.5	64
Oil	37.6	2	67.6	2	105.3	2
Steam	72.4	66	37.8	65	109.5	66
All	87.9	179	43.3	138	123.1	179
National Average						
Electric	114.9	158	9.1	20	116.6	158
Gas	92.4	331	86.0	329	180.1	333
Oil	75.5	65	62.3	64	152.9	65
Steam	75.0	273	66.2	269	141.4	273
All	87.0	842	74.9	700	152.5	844

¹⁾ As is indicated in the text, "Electricity" plus "Other" may not exactly equal "Total" energy use. Similarly, the numbers of electric, gas, oil, and steam buildings do not exactly sum to equal the number of "All" buildings, for some buildings were not included in some computations.

TABLE II - 8A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		OTHER FUELS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	66.1	14.0	103.2	14.4	169.3	16.4
MIDDLE ATLANTIC	77.3	26.0	72.2	36.4	149.4	41.7
EAST NORTH CENTRAL	76.8	32.3	94.8	58.2	162.4	61.1
WEST NORTH CENTRAL	81.2	34.1	93.2	96.1	164.1	89.8
SOUTH ATLANTIC	88.6	36.3	61.0	59.1	131.0	63.6
EAST SOUTH CENTRAL	109.1	22.3	70.1	39.4	161.4	57.5
WEST SOUTH CENTRAL	114.2	48.2	77.6	125.7	180.6	137.8
MOUNTAIN	92.3	34.5	93.3	112.4	179.8	118.4
PACIFIC	87.9	41.7	43.3	43.3	123.1	56.4
NATIONAL AVERAGE	87.0	38.2	74.9	75.2	152.5	81.6

TABLE II - 8B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		OTHER FUELS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	66.5	13.4	103.9	16.0	170.3	17.6
MIDDLE ATLANTIC	75.5	31.8	70.5	35.9	145.3	41.3
EAST NORTH CENTRAL	72.3	35.1	94.8	56.8	157.4	65.8
WEST NORTH CENTRAL	79.9	35.7	94.3	73.5	163.1	75.7
SOUTH ATLANTIC	85.9	34.7	64.2	59.9	128.7	59.3
EAST SOUTH CENTRAL	97.3	31.4	51.3	39.5	140.1	49.5
WEST SOUTH CENTRAL	106.4	48.1	76.0	114.6	168.3	122.7
MOUNTAIN	78.9	36.3	90.4	97.3	161.5	104.2
PACIFIC	76.9	45.2	47.9	45.1	113.9	60.9
NATIONAL AVERAGE	82.0	39.9	74.5	70.0	143.6	77.0

TABLE II - 9A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
ELECTRICALLY HEATED BUILDINGS
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		OTHER		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	181.7	Undefined ¹⁾	0.0	0.0	181.7	Undefined ¹⁾
EAST NORTH CENTRAL	117.5	28.3	0.1	Undefined ¹⁾	117.5	28.3
WEST NORTH CENTRAL	128.6	28.5	3.5	Undefined ¹⁾	129.4	28.1
SOUTH ATLANTIC	106.0	35.4	9.0	10.5 ²⁾	107.9	35.1
EAST SOUTH CENTRAL	102.7	9.3	4.4	Undefined ¹⁾	103.4	9.4
WEST SOUTH CENTRAL	119.0	41.8	0.0	0.0	119.0	41.8
MOUNTAIN	132.4	56.3	5.8	Undefined ¹⁾	135.9	54.8
PACIFIC	117.7	31.8	28.8	24.3 ²⁾	121.8	31.7
NATIONAL AVERAGE	114.9	35.9	9.1	14.9	116.6	35.7

¹⁾ One building.

²⁾ Mean and standard deviation computed only for those buildings having "other" use.

TABLE II - 9B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
ELECTRICALLY HEATED BUILDINGS
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		OTHER		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	181.7	0.0	0.0	0.0	181.7	0.0
EAST NORTH CENTRAL	111.1	46.3	0.1	0.0	111.1	46.3
WEST NORTH CENTRAL	121.8	35.7	3.5	0.0 ¹⁾	122.1	35.6
SOUTH ATLANTIC	102.9	32.7	8.6	10.5 ¹⁾	104.6	32.8
EAST SOUTH CENTRAL	102.5	10.2	4.4	0.0	104.0	10.5
WEST SOUTH CENTRAL	120.0	48.7	0.0	0.0	120.0	48.7
MOUNTAIN	131.5	77.5	5.8	0.0	132.6	77.1
PACIFIC	102.3	40.8	19.6	25.4 ¹⁾	104.1	41.6
NATIONAL AVERAGE	108.2	40.6	9.7	14.0 ¹⁾	109.5	40.7

¹⁾ Mean and standard deviation of "other" computed only for those buildings having "other" use.

TABLE II - 10A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
GAS HEATED BUILDINGS
(BTU/SQ. FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		GAS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	67.9	5.5	97.3	13.1	165.1	14.4
MIDDLE ATLANTIC	104.1	47.9	105.7	29.8	197.0	63.5
EAST NORTH CENTRAL	65.6	27.7	108.5	52.9	183.0	56.6
WEST NORTH CENTRAL	84.8	30.3	116.7	140.3	213.1	125.9
SOUTH ATLANTIC	82.0	28.7	73.3	55.0	157.6	62.8
EAST SOUTH CENTRAL	96.7	43.4	58.8	41.3	155.5	47.1
WEST SOUTH CENTRAL	115.7	50.0	79.8	130.1	195.6	149.8
MOUNTAIN	85.4	24.5	122.7	135.4	208.8	149.2
PACIFIC	87.9	45.1	48.6	55.4	134.5	71.2
NATIONAL AVERAGE	92.4	44.9	86.0	104.5	180.1	115.2

TABLE II - 10B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
GAS HEATED BUILDINGS
(BTU/SQ. FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		GAS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	68.1	6.7	97.3	16.3	165.3	17.9
MIDDLE ATLANTIC	73.7	45.7	98.8	39.9	169.5	63.4
EAST NORTH CENTRAL	63.1	30.1	107.0	50.1	175.6	57.5
WEST NORTH CENTRAL	81.7	31.4	95.8	97.1	187.9	97.9
SOUTH ATLANTIC	72.9	28.8	76.3	63.6	149.7	67.5
EAST SOUTH CENTRAL	89.9	50.4	60.4	48.7	150.3	56.8
WEST SOUTH CENTRAL	104.4	48.0	77.7	116.3	182.1	133.2
MOUNTAIN	72.7	24.4	100.4	109.0	173.4	119.9
PACIFIC	71.9	53.2	52.7	61.5	123.3	83.9
NATIONAL AVERAGE	79.8	42.8	83.4	87.5	164.9	99.9

TABLE II - 11A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
OIL HEATED BUILDINGS
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		OIL		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	73.7	0.2	104.5	14.7	178.1	14.4
MIDDLE ATLANTIC	54.3	19.9	78.6	10.8	151.5	13.7
EAST NORTH CENTRAL	60.5	16.4	80.0	47.5	168.3	74.6
WEST NORTH CENTRAL	64.0	18.9	42.9	14.8	143.8	30.3
SOUTH ATLANTIC	78.8	37.0	53.7	47.0	140.9	58.9
EAST SOUTH CENTRAL	126.0	Undefined ¹⁾	48.5	Undefined ¹⁾	231.2	Undefined ¹⁾
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	0.0	0.0	0.0	0.0	0.0	0.0
PACIFIC	37.6	2.0	67.6	12.6	105.3	14.6
NATIONAL AVERAGE	75.5	33.7	62.3	45.2	152.9	60.5

¹⁾ One building.

TABLE II - 11B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
OIL HEATED BUILDINGS
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		OIL		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	73.6	0.4	107.1	21.1	180.7	20.6
MIDDLE ATLANTIC	62.1	17.8	80.0	12.5	151.6	16.2
EAST NORTH CENTRAL	68.0	22.8	66.2	39.6	155.6	72.0
WEST NORTH CENTRAL	59.4	34.5	33.9	25.9	117.0	39.4
SOUTH ATLANTIC	75.4	36.3	53.9	56.1	139.0	62.6
EAST SOUTH CENTRAL	126.0	0.0	48.5	0.0	231.2	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	0.0	0.0	0.0	0.0	0.0	0.0
PACIFIC	39.1	3.5	77.0	22.2	116.1	25.7
NATIONAL AVERAGE	72.5	33.6	58.5	50.4	142.5	59.1

TABLE II - 12A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
STEAM HEATED BUILDINGS
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		STEAM		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	64.2	15.6	103.7	14.4	167.9	16.4
MIDDLE ATLANTIC	76.2	23.3	70.4	34.1	146.8	33.9
EAST NORTH CENTRAL	77.7	28.7	71.0	48.9	151.1	62.5
WEST NORTH CENTRAL	67.9	27.4	66.1	35.7	135.3	43.3
SOUTH ATLANTIC	75.3	26.6	68.4	32.1	147.3	97.6
EAST SOUTH CENTRAL	100.2	17.1	38.7	18.5	140.2	31.5
WEST SOUTH CENTRAL	85.5	12.4	51.0	8.7	136.5	3.7
MOUNTAIN	86.5	27.2	53.6	33.4	141.0	32.7
PACIFIC	72.4	32.8	37.8	20.0	109.5	40.4
NATIONAL AVERAGE	75.0	26.3	66.2	40.6	141.4	48.7

TABLE II - 12B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
STEAM HEATED BUILDINGS
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		STEAM		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	62.7	18.3	106.5	16.9	169.2	18.8
MIDDLE ATLANTIC	75.4	27.2	64.6	30.4	140.1	36.1
EAST NORTH CENTRAL	71.9	31.5	74.5	58.8	149.7	72.3
WEST NORTH CENTRAL	68.3	32.6	79.7	42.2	150.7	53.0
SOUTH ATLANTIC	81.2	24.7	85.9	68.8	164.9	78.5
EAST SOUTH CENTRAL	93.7	24.6	37.6	20.0	134.2	37.9
WEST SOUTH CENTRAL	89.5	18.4	48.1	13.0	137.6	5.5
MOUNTAIN	72.6	31.1	55.8	31.3	129.8	36.3
PACIFIC	65.7	38.8	42.6	20.1	108.9	42.5
NATIONAL AVERAGE	71.6	30.6	64.3	41.9	137.1	53.3

II-3 Energy Consumption Comparison: Downtown/Suburban Use

Table II-13 summarizes energy use in terms of building location, downtown or suburban, and provides a comparison of 1975 and 1977 energy use. It has been hypothesized that suburban buildings have a different energy use profile from that of downtown buildings, due to such factors as intensity of use and differences in construction patterns.

On the basis of the data one can state that there is a difference in energy use between downtown and suburban buildings, but the difference is less than was previously the case. On an aggregate basis, downtown buildings are less efficient now than suburban buildings, whereas the converse was the case in 1975. Table II-14 provides detailed data by census division on the buildings. It should be noted that suburban buildings are on average approximately one half the size of downtown buildings.

In the case of electrically heated buildings, there is no significant difference between downtown and suburban buildings in terms of energy use. Suburban buildings do use significantly less gas per square foot, and there are lesser differences in the case of oil and steam.

Energy use declined between 1975 and 1977 with large savings being experienced by most building types with the exception of suburban electric buildings and both downtown and suburban steam heated buildings.

TABLE II-13
COMPARISON OF ENERGY CONSUMPTION:
DOWNTOWN AND SUBURBAN COMMERCIAL OFFICE BUILDINGS

	Downtown Buildings				Suburban Buildings			
	# Buildings		10 ³ Btu/Sq. Ft.		# Buildings		10 ³ Btu/Sq. Ft.	
	1975	1977	1975	1977	1975	1977	1975	1977
Electric	24	87	145.5	106.4	17	85	104.7	103.3
Gas	93	235	191.9	172.0	46	124	248.8	157.3
Oil	26	53	217.8	148.1	4	18	181.5	144.0
Steam	158	282	132.6	134.8	3	5	128.9	128.3
Average Across All Fuels	301	657	156.7	144.5	70	232	191.6	135.5

TABLE II - 14A
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

LOCATION OF BUILDINGS	NATIONAL TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	106.4	172.0	148.1	134.8	144.5
STANDARD DEVIATION (000)	51.4	128.0	69.2	56.6	89.7
SQUARE FEET (000,000)	22.5	62.5	12.6	92.7	190.3
NUMBER OF BUILDINGS	87.0	235.0	53.0	282.0	657.0
SQ.FT./BLDG. (000)	259.0	266.0	238.2	328.6	289.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	103.3	157.3	144.0	128.3	135.5
STANDARD DEVIATION (000)	41.8	79.9	52.7	6.7	68.7
SQUARE FEET (000,000)	11.7	16.4	3.4	1.4	32.9
NUMBER OF BUILDINGS	85.0	124.0	18.0	5.0	232.0
SQ.FT./BLDG. (000)	137.3	132.5	189.5	273.3	141.7

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

NEW ENGLAND

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	165.1	166.1	167.9	167.5
STANDARD DEVIATION (000)	0.0	14.4	Undefined ¹⁾	16.4	15.4
SQUARE FEET (000,000)	0.0	0.6	0.6	4.6	5.8
NUMBER OF BUILDINGS	0.0	3.0	1.0	5.0	9.0
SQ.FT./BLDG.(000)	0.0	213.1	574.5	923.2	647.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	0.0	195.3	0.0	195.3
STANDARD DEVIATION (000)	0.0	0.0	Undefined ¹⁾	0.0	0.7
SQUARE FEET (000,000)	0.0	0.0	0.4	0.0	0.4
NUMBER OF BUILDINGS	0.0	0.0	1.0	0.0	1.0
SQ.FT./BLDG.(000)	0.0	0.0	402.6	0.0	402.6

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

MIDDLE ATLANTIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	179.7	132.5	136.7	138.1
STANDARD DEVIATION (000)	0.0	64.0	46.4	53.8	54.6
SQUARE FEET (000,000)	0.0	1.4	0.5	43.4	45.4
NUMBER OF BUILDINGS	0.0	7.0	3.0	80.0	90.0
SQ.FT./BLDG.(000)	0.0	206.8	175.6	542.8	504.5
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	181.7	196.4	156.2	128.9	156.9
STANDARD DEVIATION (000)	Undefined ¹⁾	90.9	16.5	5.6	63.3
SQUARE FEET (000,000)	0.0	0.9	0.3	1.3	2.6
NUMBER OF BUILDINGS	1.0	9.0	3.0	4.0	17.0
SQ.FT./BLDG.(000)	4.0	104.5	110.6	331.8	153.1

¹⁾ One building

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

EAST NORTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	103.5	157.2	168.3	150.1	148.1
STANDARD DEVIATION (000)	46.8	78.9	74.6	63.4	72.0
SQUARE FEET (000,000)	4.4	13.2	2.7	10.8	31.1
NUMBER OF BUILDINGS	9.0	38.0	6.0	52.0	105.0
SQ.FT./BLDG. (000)	488.7	346.4	452.1	207.4	295.8
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	106.0	189.6	0.0	0.0	170.1
STANDARD DEVIATION (000)	41.8	68.8	0.0	0.0	72.7
SQUARE FEET (000,000)	0.9	2.9	0.0	0.0	3.7
NUMBER OF BUILDINGS	7.0	23.0	0.0	0.0	30.0
SQ.FT./BLDG. (000)	124.3	124.4	0.0	0.0	124.4

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

WEST NORTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	134.8	205.3	49.7	135.3	158.9
STANDARD DEVIATION (000)	25.1	136.5	48.0	43.3	94.2
SQUARE FEET (000,000)	1.1	5.9	0.2	9.6	16.8
NUMBER OF BUILDINGS	4.0	27.0	2.0	42.0	75.0
SQ.FT./BLDG. (000)	281.2	216.7	78.8	229.4	223.6
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	124.1	215.4	152.1	0.0	169.2
STANDARD DEVIATION (000)	29.9	87.3	24.8	0.0	75.1
SQUARE FEET (000,000)	1.1	1.3	0.5	0.0	2.9
NUMBER OF BUILDINGS	7.0	16.0	2.0	0.0	25.0
SQ.FT./BLDG. (000)	163.7	80.9	235.8	0.0	116.5

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
SOUTH ATLANTIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	96.5	162.3	140.5	142.4	130.0
STANDARD DEVIATION (000)	45.7	63.3	61.8	100.0	72.1
SQUARE FEET (000,000)	7.0	3.0	7.6	4.8	22.4
NUMBER OF BUILDINGS	31.0	19.0	38.0	13.0	101.0
SQ.FT./BLDG.(000)	226.7	156.5	199.5	370.1	221.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	112.0	121.4	131.1	106.4	118.7
STANDARD DEVIATION (000)	31.7	72.1	58.8	Undefined ¹⁾	48.1
SQUARE FEET (000,000)	4.4	0.9	2.2	0.0	7.5
NUMBER OF BUILDINGS	37.0	19.0	11.0	1.0	68.0
SQ.FT./BLDG.(000)	117.9	49.9	199.4	39.4	110.9

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

EAST SOUTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	96.6	53.7	231.2	140.2	143.1
STANDARD DEVIATION (000)	6.6	68.4	Undefined ¹⁾	31.5	79.5
SQUARE FEET (000,000)	0.4	0.5	0.7	0.5	2.1
NUMBER OF BUILDINGS	2.0	3.0	1.0	4.0	10.0
SQ.FT./BLDG.(000)	194.0	169.2	737.2	126.0	213.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	112.7	203.1	0.0	0.0	135.4
STANDARD DEVIATION (000)	Undefined ¹⁾	38.4	0.0	0.0	43.7
SQUARE FEET (000,000)	0.3	0.1	0.0	0.0	0.4
NUMBER OF BUILDINGS	1.0	2.0	0.0	0.0	3.0
SQ.FT./BLDG.(000)	284.3	47.7	0.0	0.0	126.6

¹⁾ One building.

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

WEST SOUTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	140.5	200.4	0.0	136.5	188.1
STANDARD DEVIATION (000)	40.7	165.5	0.0	3.7	154.2
SQUARE FEET (000,000)	1.9	19.3	0.0	1.8	23.2
NUMBER OF BUILDINGS	7.0	55.0	0.0	2.0	65.0
SQ.FT./BLDG.(000)	276.4	350.2	0.0	875.5	357.4
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	86.5	153.7	0.0	0.0	131.3
STANDARD DEVIATION (000)	48.8	82.0	0.0	0.0	79.3
SQUARE FEET (000,000)	3.0	5.9	0.0	0.0	8.9
NUMBER OF BUILDINGS	15.0	29.0	0.0	0.0	44.0
SQ.FT./BLDG.(000)	198.0	204.5	0.0	0.0	202.2

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

MOUNTAIN

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	137.3	205.6	0.0	134.1	171.3
STANDARD DEVIATION (000)	54.4	162.8	0.0	44.1	126.4
SQUARE FEET (000,000)	1.2	4.9	0.0	3.3	9.4
NUMBER OF BUILDINGS	4.0	30.0	0.0	14.0	48.0
SQ.FT./BLDG.(000)	310.7	162.2	0.0	238.7	196.9
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	16.3	92.7	0.0	0.0	87.0
STANDARD DEVIATION (000)	27.6	65.5	0.0	0.0	66.6
SQUARE FEET (000,000)	0.1	1.2	0.0	0.0	1.3
NUMBER OF BUILDINGS	2.0	11.0	0.0	0.0	13.0
SQ.FT./BLDG.(000)	46.5	105.9	0.0	0.0	96.7

TABLE II - 14A, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
PACIFIC

LOCATION OF BUILDINGS =====	TYPE OF HEATING FUEL =====				AVERAGE ACROSS ALL FUELS =====
	ELECTRIC =====	GAS =====	OIL =====	STEAM =====	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	98.5	126.3	98.0	102.4	111.3
STANDARD DEVIATION (000)	58.7	80.8	Undefined ¹⁾	47.6	66.1
SQUARE FEET (000,000)	6.4	13.8	0.0	13.8	34.1
NUMBER OF BUILDINGS	30.0	53.0	1.0	70.0	154.0
SQ.FT./BLDG.(000)	214.0	260.4	47.5	197.1	221.2
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	98.5	132.8	134.3	0.0	119.9
STANDARD DEVIATION (000)	44.7	45.4	Undefined ¹⁾	0.0	48.1
SQUARE FEET (000,000)	1.9	3.2	0.0	0.0	5.2
NUMBER OF BUILDINGS	15.0	15.0	1.0	0.0	31.0
SQ.FT./BLDG.(000)	129.3	213.4	12.0	0.0	166.2

¹⁾One building.

TABLE II - 148
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
NATIONAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN:					
TOTAL BTU/SQ.FT. (000)	106.1	159.1	126.4	130.6	135.1
STANDARD DEVIATION (000)	51.7	119.2	75.6	60.3	86.7
SQUARE FEET (000,000)	22.5	62.5	12.6	92.7	190.3
NUMBER OF BUILDINGS	87.0	235.0	53.0	282.0	657.0
SQ.FT./BLDG. (000)	259.0	266.0	238.2	320.6	289.7
SUBURBAN:					
TOTAL BTU/SQ.FT. (000)	95.0	152.7	142.2	121.9	130.1
STANDARD DEVIATION (000)	46.2	83.7	45.2	11.3	73.5
SQUARE FEET (000,000)	11.7	16.4	3.4	1.4	32.9
NUMBER OF BUILDINGS	89.0	124.0	16.0	5.0	232.0
SQ.FT./BLDG. (000)	137.3	132.5	189.5	273.3	141.7

TABLE II - 14B, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
NEW ENGLAND

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	165.3	166.1	169.2	167.6
STANDARD DEVIATION (000)	0.0	17.9	0.0	18.8	16.2
SQUARE FEET (000,000)	0.0	0.6	0.6	4.6	5.8
NUMBER OF BUILDINGS	0.0	3.0	1.0	5.0	9.0
SQ.FT./BLDG.(000)	0.0	213.1	574.5	923.2	647.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	0.0	195.3	0.0	195.3
STANDARD DEVIATION (000)	0.0	0.0	0.0	0.0	0.0
SQUARE FEET (000,000)	0.0	0.0	0.4	0.0	0.4
NUMBER OF BUILDINGS	0.0	0.0	1.0	0.0	1.0
SQ.FT./BLDG.(000)	0.0	0.0	402.6	0.0	402.6

TABLE II - 14B, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
MIDDLE ATLANTIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	132.7	102.6	128.5	128.0
STANDARD DEVIATION (000)	0.0	102.9	89.6	53.3	58.7
SQUARE FEET (000,000)	0.0	1.4	0.5	43.4	45.4
NUMBER OF BUILDINGS	0.0	7.0	3.0	80.0	90.0
SQ.FT./BLDG.(000)	0.0	206.8	175.6	542.8	504.5
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	181.7	160.5	150.0	125.8	151.7
STANDARD DEVIATION (000)	0.0	67.1	19.5	8.4	50.8
SQUARE FEET (000,000)	0.0	0.9	0.3	1.3	2.6
NUMBER OF BUILDINGS	1.0	9.0	3.0	4.0	17.0
SQ.FT./BLDG.(000)	4.0	104.5	110.6	331.8	153.1

TABLE II - 14B, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
EAST NORTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	92.8	157.6	155.6	146.8	146.6
STANDARD DEVIATION (000)	65.2	78.0	72.0	74.6	75.9
SQUARE FEET (000,000)	4.4	13.2	2.7	10.8	31.1
NUMBER OF BUILDINGS	9.0	38.0	6.0	52.0	105.0
SQ.FT./BLDG.(000)	488.7	346.4	452.1	207.4	295.8
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	103.0	167.3	0.0	0.0	152.3
STANDARD DEVIATION (000)	50.2	66.4	0.0	0.0	68.1
SQUARE FEET (000,000)	0.9	2.9	0.0	0.0	3.7
NUMBER OF BUILDINGS	7.0	23.0	0.0	0.0	30.0
SQ.FT./BLDG.(000)	124.3	124.4	0.0	0.0	124.4

TABLE II - 14B, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
WEST NORTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	140.1	172.9	48.0	150.7	155.4
STANDARD DEVIATION (000)	30.2	117.4	67.9	53.0	83.3
SQUARE FEET (000,000)	1.1	5.9	0.2	9.6	16.8
NUMBER OF BUILDINGS	4.0	27.0	2.0	42.0	75.0
SQ.FT./BLDG.(000)	281.2	216.7	78.8	229.4	223.6
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	111.8	166.3	127.5	0.0	147.9
STANDARD DEVIATION (000)	36.3	94.3	49.4	0.0	81.4
SQUARE FEET (000,000)	1.1	1.3	0.5	0.0	2.9
NUMBER OF BUILDINGS	7.0	16.0	2.0	0.0	25.0
SQ.FT./BLDG.(000)	163.7	80.9	235.8	0.0	116.5

TABLE II - 148, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
SOUTH ATLANTIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	93.6	136.2	128.1	156.7	122.7
STANDARD DEVIATION (000)	47.2	63.8	73.8	89.9	69.6
SQUARE FEET (000,000)	7.0	3.0	7.6	4.8	22.4
NUMBER OF BUILDINGS	31.0	19.0	38.0	13.0	101.0
SQ.FT./BLDG.(000)	226.7	156.5	199.5	370.1	221.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	96.9	139.6	138.6	106.4	115.7
STANDARD DEVIATION (000)	40.2	89.3	52.9	0.0	62.3
SQUARE FEET (000,000)	4.4	0.9	2.2	0.0	7.5
NUMBER OF BUILDINGS	37.0	19.0	11.0	1.0	68.0
SQ.FT./BLDG.(000)	117.9	49.9	199.4	39.4	110.9

TABLE II - 148, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
EAST SOUTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	99.6	96.0	231.2	134.2	125.5
STANDARD DEVIATION (000)	10.3	89.6	0.0	37.9	63.2
SQUARE FEET (000,000)	0.4	0.5	0.7	0.5	2.1
NUMBER OF BUILDINGS	2.0	3.0	1.0	4.0	10.0
SQ.FT./BLDG.(000)	194.0	169.2	737.2	126.0	213.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	112.7	156.5	0.0	0.0	141.9
STANDARD DEVIATION (000)	0.0	85.4	0.0	0.0	65.5
SQUARE FEET (000,000)	0.3	0.1	0.0	0.0	0.4
NUMBER OF BUILDINGS	1.0	2.0	0.0	0.0	3.0
SQ.FT./BLDG.(000)	284.3	47.7	0.0	0.0	126.6

TABLE II - 148, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
WEST SOUTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	131.7	181.1	0.0	137.6	171.6
STANDARD DEVIATION (000)	60.6	147.4	0.0	5.5	139.3
SQUARE FEET (000,000)	1.9	19.3	0.0	1.8	23.2
NUMBER OF BUILDINGS	7.0	55.0	0.0	2.0	65.0
SQ.FT./BLDG.(000)	276.4	350.2	0.0	875.5	357.4
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	90.6	158.9	0.0	0.0	135.6
STANDARD DEVIATION (000)	59.7	111.0	0.0	0.0	101.3
SQUARE FEET (000,000)	3.0	5.9	0.0	0.0	8.9
NUMBER OF BUILDINGS	15.0	29.0	0.0	0.0	44.0
SQ.FT./BLDG.(000)	198.0	204.5	0.0	0.0	202.2

TABLE II - 148, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
MOUNTAIN

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	150.0	172.0	0.0	120.6	155.2
STANDARD DEVIATION (000)	76.9	139.4	0.0	49.2	116.5
SQUARE FEET (000,000)	1.2	4.9	0.0	3.3	9.4
NUMBER OF BUILDINGS	4.0	30.0	0.0	14.0	48.0
SQ.FT./BLDG.(000)	310.7	162.2	0.0	238.7	196.9
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	31.6	130.0	0.0	0.0	114.8
STANDARD DEVIATION (000)	44.6	61.2	0.0	0.0	68.2
SQUARE FEET (000,000)	0.1	1.2	0.0	0.0	1.3
NUMBER OF BUILDINGS	2.0	11.0	0.0	0.0	13.0
SQ.FT./BLDG.(000)	46.5	105.9	0.0	0.0	96.7

TABLE II - 14B, Continued
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
PACIFIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	106.9	111.6	98.0	102.7	106.6
STANDARD DEVIATION (000)	46.4	94.0	0.0	48.4	67.0
SQUARE FEET (000,000)	6.4	13.8	0.0	13.8	34.1
NUMBER OF BUILDINGS	30.0	53.0	1.0	70.0	154.0
SQ.FT./BLDG.(000)	214.0	260.4	47.5	197.1	221.2
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	84.6	131.9	134.3	0.0	109.1
STANDARD DEVIATION (000)	43.1	51.0	0.0	0.0	51.6
SQUARE FEET (000,000)	1.9	3.2	0.0	0.0	5.2
NUMBER OF BUILDINGS	15.0	15.0	1.0	0.0	31.0
SQ.FT./BLDG.(000)	129.3	213.4	12.0	0.0	166.2

II-4 Energy Consumption by Height

Tables II-15 and II-16 present information on electric, fuel, and total energy use by building height. In general, buildings in excess of 9 stories use more electricity per square foot than do shorter buildings. This may be due to the need for proportionally more elevators and air handling equipment than is the case for shorter buildings. In addition, the taller buildings are located in major cities and may have high energy use activities located within them or may be subject to greater utilization.

There is no clear energy use trend in the case of fuel use, but buildings in the 30-49 story height range tend to use more fuel than do other buildings. Whether these energy patterns are related to the buildings' structural characteristics, to the buildings' usage, or to the choice of heating fuel has not been determined. The relatively low energy consumption figure for very tall buildings is probably accounted for by the existence of steam heated buildings.

TABLE II-15
BUILDING ENERGY CONSUMPTION AND HEIGHT OF BUILDING
COMMERCIAL OFFICE BUILDINGS
WEIGHTED MEANS

Energy Consumption (10 ³ Btu)	Building Height In Stories						
	1-4	5-9	10-19	20-29	30-39	40-49	50+
Electric Btu/sq. ft.							
1977	79.8	79.2	84.7	93.8	89.7	82.7	93.3
1979	84.2	80.2	87.0	82.2	79.0	82.8	83.5
Other Fuels Btu/sq. ft.							
1977	75.9	56.4	70.7	72.4	103.6	98.9	50.1
1979	79.1	84.8	89.9	82.1	102.0	95.0	42.6
Total Btu/sq. ft.							
1977	144.0	126.5	145.1	158.1	180.0	173.8	138.9
1979	163.3	165.1	176.9	164.4	181.0	177.8	126.1
Number of Bldgs.							
1977	120	200	313	115	50	26	18
1979	34	66	133	72	27	19	20

TABLE II-16A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BY BUILDING HEIGHT
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	STORIES						
	1-4	5-9	10-19	20-29	30-39	40-49	50+
ELECTRIC BTU/SQ.FT.(000)							
MEAN	79.8	79.2	84.7	93.8	89.7	82.7	93.3
STANDARD DEVIATION	38.8	38.8	44.4	37.6	34.8	28.7	38.2
OTHER FUELS BTU/SQ.FT.(000)							
MEAN	75.9	56.4	70.7	72.4	103.6	98.9	50.1
STANDARD DEVIATION	62.1	40.0	53.6	101.6	97.6	75.3	43.3
TOTAL BTU/SQ.FT.(000)							
MEAN	144.0	126.5	145.1	158.1	180.0	173.8	138.9
STANDARD DEVIATION	77.3	50.1	65.4	108.4	97.5	88.1	42.0
TOTAL SQUARE FEET(000,000)							
	8.5	27.9	58.1	40.1	30.7	22.3	24.4
NUMBER OF BUILDINGS							
	120.0	200.0	313.0	115.0	50.0	26.0	18.0

TABLE II-16B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BY BUILDING HEIGHT
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	STORIES						
	1-4	5-9	10-19	20-29	30-39	40-49	50+
ELECTRIC BTU/SQ.FT.(000)							
MEAN	78.1	76.7	80.6	94.1	87.5	81.5	98.2
STANDARD DEVIATION	36.4	38.6	42.5	39.0	32.5	31.5	49.8
OTHER FUELS BTU/SQ.FT.(000)							
MEAN	80.8	61.9	72.1	74.7	110.6	95.1	52.6
STANDARD DEVIATION	67.6	38.4	62.5	98.5	108.3	74.5	45.0
TOTAL BTU/SQ.FT.(000)							
MEAN	119.8	125.3	142.2	160.4	181.3	169.3	144.9
STANDARD DEVIATION	74.1	50.9	71.5	106.3	103.1	85.3	49.7
TOTAL SQUARE FEET(000,000)							
	8.5	27.9	58.1	40.1	30.7	22.3	24.4
NUMBER OF BUILDINGS							
	120.0	200.0	313.0	115.0	50.0	26.0	18.0

II-5 Energy Consumption by Building Age

Table II-17 presents data for building energy use by age for the downtown buildings in the 1977 data base and provides data for comparison with 1975.¹⁾ Additional information for 1977 is available in Table II-18. Energy use is relatively low in new buildings. Low energy use probably is the result of the buildings having heating, ventilating, and air conditioning equipment which is in good operating condition, for it is unlikely that the buildings were designed with conservation as an objective: most of the design work would have occurred before the oil embargo. Energy use is higher for buildings in the 10-19 years old range, possibly due to a high level of use coupled with older, less efficient equipment. Energy use then tapers off to a low level for buildings through the 30-39 age range. As buildings approach 40 years old the quality of the space significantly deteriorates. The building generally is in need of renovation, and the space is perceived as being much less desirable than more modern space. Energy use declines due to less intensive use and inoperative equipment. Buildings in the 40+ range have generally been renovated, and energy use rises, reflecting that the space is again high quality, prime space. Relatively low energy use in the 50+ buildings probably is due to design practices of the 1920's, which resulted in buildings with good heat retention, and to the use of steam for heating.

¹⁾ Energy use was analyzed for downtown buildings to achieve compatibility with the available 1975 data.

TABLE II-17
ENERGY CONSUMPTION ON A WEIGHTED BASIS BY BUILDING AGE, 1975 AND 1977
COMMERCIAL OFFICE BUILDINGS, DOWNTOWN BUILDINGS

Energy Use (10 ³ Btu)	Building Age					
	1-9	10-19	20-29	30-39	40-49	50+
Electric Use						
Btu/sq. ft., 1975	99.2	82.4	79.0	32.4	71.9	62.0
Btu/sq. ft., 1977	97.1	87.3	86.1	87.7	76.6	60.9
Other Fuels						
Btu/sq. ft., 1975	51.8	90.7	82.7	53.0	86.1	110.1
Btu/sq. ft., 1977	64.2	92.4	74.1	58.3	81.9	73.0
Total Energy Use						
Btu/sq. ft., 1975	151.0	173.2	161.7	85.4	158.0	172.1
No. of bldgs.	74	56	27	5	59	80
Btu/sq. ft., 1977	146.1	174.1	158.6	145.7	158.1	131.8
No. of bldgs.	302	197	72	12	66	193

TABLE II-18A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE
BUILDING SAMPLE BY BUILDING AGE
DOWNTOWN BUILDINGS
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	1-9 YEARS	10-19 YEARS	20-29 YEARS	30-39 YEARS	40-49 YEARS	50+ YEARS
ELECTRIC BTU/SQ.FT.(000)						
MEAN	97.1	87.3	86.1	87.7	76.6	60.9
STANDARD DEVIATION	39.8	37.4	31.3	28.6	31.1	27.3
OTHER FUELS BTU/SQ.FT.(000)						
MEAN	64.2	92.4	74.1	58.3	81.9	73.0
STANDARD DEVIATION	73.1	102.2	63.8	36.1	45.6	46.8
TOTAL BTU/SQ.FT.(000)						
MEAN	146.1	174.1	158.6	145.7	158.1	131.8
STANDARD DEVIATION	71.4	114.8	82.9	45.7	55.4	53.9
TOTAL SQUARE FEET(000,000)	96.1	46.5	16.6	2.5	21.4	28.7
NUMBER OF BUILDINGS	302.0	197.0	72.0	12.0	66.0	193.0

TABLE II-18B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE
BUILDING SAMPLE BY BUILDING AGE
DOWNTOWN BUILDINGS
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	1-9 YEARS	10-19 YEARS	20-29 YEARS	30-39 YEARS	40-49 YEARS	50+ YEARS
ELECTRIC BTU/SQ.FT.(000)						
MEAN	98.3	86.4	77.8	69.4	73.2	57.2
STANDARD DEVIATION	40.3	36.2	30.2	29.6	39.8	32.8
OTHER FUELS BTU/SQ.FT.(000)						
MEAN	68.2	89.2	74.9	60.1	77.9	66.6
STANDARD DEVIATION	73.8	94.5	60.9	37.9	50.4	40.1
TOTAL BTU/SQ.FT.(000)						
MEAN	142.7	166.1	150.5	124.4	148.8	118.6
STANDARD DEVIATION	72.0	101.3	70.8	54.0	66.1	52.1
TOTAL SQUARE FEET(000,000)	96.1	46.5	16.6	2.5	21.4	28.7
NUMBER OF BUILDINGS	302.0	197.0	72.0	12.0	66.0	193.0

II-6 Electric Billing Policy of Management

Charges for electricity are usually included in the building rent, and an escalator clause typically provides for the pass-through of increased energy charges for a building in proportion to the space rented by each tenant. As Table II-19 indicates, electricity was included in the rent for 532 buildings in the 1977 data base. Since electricity is centrally metered with the charges distributed to the tenants on the basis of occupied space, the tenant typically has little control over his electric bill and little incentive to conserve energy (except in cases where the tenant occupies the entire building).

In 101 cases electricity was sold on a metered basis by the building to the tenant. Typically, the metering would be restricted to lighting and to those parts, if any, of the heating, ventilating, and air conditioning system on a separate circuit. On a metered basis the tenant should benefit from any conservation efforts he makes. The building electricity use reported for the 101 cases presented in Table 19 includes, according to BOMA, both electricity use billed to the tenant directly on the basis of metering and building electricity use for such general purposes as hallway lighting, space conditioning (if not billed to the tenant), and other uses not billed on the basis of metering.

In 24 cases electricity was sold by the building management to the tenant on an estimated basis; i.e., the building management and the tenant negotiated a mutually acceptable payment which, however, was not metered. This type of situation would typically occur when the tenant had installed equipment expected to use large amounts of electricity; the building management attempts to recover part of the cost of the abnormally high electric use through an estimated, projected additional charge. In this case a tenant's control over his electric bill is largely limited to the decision of whether to install the equipment. Usage of the equipment once it is installed will not have an appreciable effect on the bill.

In 39 cases electric use was directly metered by the utility: rather than paying the landlord directly for electricity the tenant pays the utility. According to BOMA, all electric use for the building -- whether metered to the tenant or to the landlord -- is included in the computed Btu/Sq. Ft. for electricity. The tenant can directly affect his electric bill and can benefit from conservation efforts in cases of direct metering.

In cases in which tenants were metered for their electric use and could benefit from conservation, they tended to conserve.

TABLE II-19A

ELECTRIC BILL POLICY OF BUILDING MANAGEMENT IN
1977 BOMA OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	<u>INCLUDED IN RENT</u>	<u>SOLD METERED</u>	<u>SOLD ESTIMATED</u>	<u>METERED BY UTILITY</u>	<u>NO RESPONSE</u>
ELECTRIC BTU/SQ.FT.					
MEAN (000)	88.3	83.3	101.3	64.8	88.7
STANDARD DEVIATION (000)	36.9	38.5	21.6	31.6	44.1
SQUARE FEET (000,000)	133.0	27.1	6.9	10.2	34.6
NUMBER OF BUILDINGS	522.	101.	24.	39.	156.

TABLE II-19B

ELECTRIC BILL POLICY OF BUILDING MANAGEMENT IN
1977 BOMA OFFICE BUILDING SAMPLE
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	<u>INCLUDED IN RENT</u>	<u>SOLD METERED</u>	<u>SOLD ESTIMATED</u>	<u>METERED BY UTILITY</u>	<u>NO RESPONSE</u>
ELECTRIC BTU/SQ.FT.					
MEAN (000)	84.3	70.8	77.0	73.3	84.3
STANDARD DEVIATION (000)	40.5	34.4	39.2	38.1	40.8
SQUARE FEET (000,000)	133.0	27.1	6.9	10.2	34.6
NUMBER OF BUILDINGS	522.	101.	24.	39.	156.

II-7 Energy Consumption and Computer Space

In Analysis of Energy Consumption In Office Buildings it was noted that several studies had found that the existence of computer or data processing facilities could have an effect on building energy use.¹⁾ In the 1977 data base there were 326 buildings that reported the existence of computer space and 604 buildings that did not. Table II-20 presents the data for buildings with computer space, and Table II-21 presents the data for buildings without computer space. At the national level total energy use is equal for both cases. However, buildings without computer space used more fuel and less electricity on average than did buildings with computer space.

The relationship appears also to occur at the regional level. A possible explanation would be that large amounts of electricity are used to power the equipment and that the waste heat subsequently filters throughout the rest of the building, removing some of the need for fuel use. However, given the zoning of many commercial office buildings, it is also possible that the waste heat is removed from the building and is not used to heat the building to any appreciable extent. Differences in energy use could be due to differences in building usage. For example, buildings with computer space may be subject to different usage patterns than buildings without computer space.

A preliminary review of the data obtained under Task IIA of the Energy Use in Office Buildings Project indicates that building managers do not have a good understanding of the amount of computer space in their buildings. Therefore, the conclusions on energy consumption and computer space are not as definitive as one would wish.

¹⁾ Commercial Sector Energy Consumption Data Base Development Project, Analysis of Energy Consumption In Office Buildings, General Electric, Center for Energy Systems, April 1978, pp. 11, 12.

TABLE II-20A

ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH COMPUTER SPACE
(BTU/SQ.FT. 000)

WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS
COMPUTER

	NO. OF BLDGS	SQ. FT. (MILL)	SOFT/ BLDG (000)	SPACE SQ.FT./BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
					MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	3	2.3	781.7	13.6	62.4	14.9	96.3	9.0	158.7	11.1
MIDDLE ATLANTIC	49	25.1	512.8	11.3	82.5	30.9	66.2	37.1	148.6	38.0
EAST NORTH CENTRAL	58	17.6	303.9	4.8	74.2	31.3	87.3	49.8	155.7	59.6
WEST NORTH CENTRAL	46	10.8	234.8	4.2	82.4	30.7	99.7	123.4	170.4	107.6
SOUTH ATLANTIC	52	11.5	220.9	6.2	98.0	36.3	86.7	69.4	156.2	73.8
EAST SOUTH CENTRAL	7	2.1	300.5	6.4	116.0	18.2	86.6	28.2	173.5	60.2
WEST SOUTH CENTRAL	43	15.8	366.8	7.1	123.2	49.1	53.5	60.2	164.9	80.0
MOUNTAIN	15	3.5	231.5	24.9	104.1	51.0	53.4	68.0	149.7	72.5
PACIFIC	53	19.1	361.0	5.2	92.8	31.7	46.1	56.6	131.5	62.9
NATIONAL AVERAGE	326	107.9	330.9	7.3	91.4	38.8	71.0	66.6	153.0	69.0

TABLE II-20B

ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
 BUILDINGS WITH COMPUTER SPACE
 (BTU/SQ.FT. 000)
 UNWEIGHTED MEANS AND STANDARD DEVIATIONS
 COMMERCIAL OFFICE BUILDINGS

	NO. OF BLDGS	SQ. FT. (MILL)	SQFT/ BLDG (000)	COMPUTER SPACE SQ.FT/BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
					MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	3	2.3	781.7	13.6	65.4	16.4	100.6	13.2	166.1	18.5
MIDDLE ATLANTIC	49	25.1	512.8	11.3	81.5	34.1	60.6	31.1	142.1	34.0
EAST NORTH CENTRAL	58	17.6	303.9	4.8	76.6	34.7	93.9	63.4	160.0	74.8
WEST NORTH CENTRAL	46	10.8	234.8	4.2	84.3	32.6	98.4	97.2	172.0	89.6
SOUTH ATLANTIC	52	11.5	220.9	6.2	94.0	38.8	72.3	57.1	140.6	63.4
EAST SOUTH CENTRAL	7	2.1	300.5	6.4	116.1	27.6	63.5	32.6	158.4	60.5
WEST SOUTH CENTRAL	43	15.8	366.8	7.1	121.6	53.8	53.5	47.6	162.1	78.4
MOUNTAIN	15	3.5	231.5	24.9	103.3	57.6	86.0	106.2	175.0	104.0
PACIFIC	53	19.1	361.0	5.2	92.4	38.6	56.1	74.5	135.0	78.8
NATIONAL AVERAGE	326	107.9	330.9	7.3	91.3	41.5	74.8	68.5	152.8	73.4

TABLE II-21A

ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITHOUT COMPUTER SPACE
(BTU/SQ.FT. 000)

WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	NO.OF BLDGS	SQ. FT. (MILL)	SQFT/ BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
				MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	7	3.9	555.3	68.3	12.9	107.3	15.5	175.6	15.7
MIDDLE ATLANTIC	59	22.9	388.6	72.0	18.5	78.2	34.6	150.2	45.0
EAST NORTH CENTRAL	79	18.0	227.2	79.2	33.0	102.2	64.5	168.4	61.9
WEST NORTH CENTRAL	58	9.4	161.8	79.9	37.4	85.6	45.2	156.8	62.5
SOUTH ATLANTIC	136	22.9	168.5	83.2	35.2	47.0	47.1	110.6	51.7
EAST SOUTH CENTRAL	7	0.9	121.6	87.9	20.1	36.6	37.3	124.6	22.7
WEST SOUTH CENTRAL	69	16.9	245.0	106.2	45.9	96.0	155.7	194.8	172.8
MOUNTAIN	49	7.6	155.2	87.7	23.7	106.9	121.1	191.6	130.2
PACIFIC	140	21.5	153.2	83.2	48.7	40.5	23.7	115.3	48.3
NATIONAL AVERAGE	604	123.9	205.1	83.2	37.3	78.3	81.8	152.0	91.1

TABLE II-21B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITHOUT COMPUTER SPACE
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	NO.OF BLDGS	SQ. FT. (MILL)	SQFT/ BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
				MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	7	3.9	555.3	67.0	13.3	105.2	17.9	172.2	18.3
MIDDLE ATLANTIC	59	22.9	388.6	70.5	29.1	79.0	37.8	148.0	46.7
EAST NORTH CENTRAL	79	18.0	227.2	69.1	35.3	95.4	52.1	155.5	58.9
WEST NORTH CENTRAL	58	9.4	161.8	76.7	37.8	90.9	47.0	156.2	63.0
SOUTH ATLANTIC	136	22.9	168.5	82.8	32.6	61.2	61.1	124.1	57.2
EAST SOUTH CENTRAL	7	0.9	121.6	78.5	23.5	43.2	44.4	121.8	30.6
WEST SOUTH CENTRAL	69	16.9	245.0	97.8	42.5	87.5	135.7	171.8	142.3
MOUNTAIN	49	7.6	155.2	72.6	25.7	91.4	96.5	158.0	105.1
PACIFIC	140	21.5	153.2	70.9	46.3	44.8	26.5	105.7	50.3
NATIONAL AVERAGE	604	123.9	205.1	77.0	38.2	74.3	70.9	138.6	78.5

II-8 Energy Consumption and Building Air Conditioning

Energy use as a function of type of building air conditioning is presented in Tables II-22 through II-25. There were 610 buildings identified as having electric air conditioning, 55 buildings with steam absorption, 12 buildings with steam turbine, and 8 with gas air conditioning. Electricity consumption was significantly lower for buildings with non-electric air conditioning.

Electric air conditioning occurred throughout the country. Steam air conditioning occurred to some degree in areas with steam plants. Although such air conditioning is less efficient than electric and can be more costly to operate, a major advantage of district steam is the elimination of much of the space requirements for space conditioning equipment in the building. Since building space is valuable in large cities, building managements in the past have viewed such a tradeoff as desirable. The limited amount of gas air conditioning occurred in the West South Central region; natural gas was abundant and relatively cheap in that region.

Chilled water is purchased for air conditioning by a number of buildings in major cities. The water is furnished from a chilling plant at a specific temperature and is then piped through the building and returned to the chilling plant at a higher temperature. The data furnished by building managements for chilled water use appeared in many cases to be inaccurate or uncertain; and, in addition, a conversion factor to obtain Btu's was unavailable. The conversion to Btu's would depend on the entry and exit temperatures of the water, and these numbers were not reported by the building managers to BOMA. Accordingly, buildings utilizing chilled water for air conditioning were dropped from the data base. Approximately 40 buildings were eliminated.

TABLE II-22A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH ELECTRIC AIR CONDITIONING
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	NO.OF BLDGS	ELECTRICITY		OTHER FUELS		TOTAL	
		MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	6.	61.4	12.6	101.8	11.2	163.1	17.0
MIDDLE ATLANTIC	58.	82.3	28.9	53.5	28.4	135.8	29.5
EAST NORTH CENTRAL	105.	80.7	33.1	86.5	45.3	157.0	50.0
WEST NORTH CENTRAL	75.	85.8	32.9	74.7	43.7	152.9	55.8
SOUTH ATLANTIC	95.	92.4	33.5	49.7	31.0	122.0	42.4
EAST SOUTH CENTRAL	12.	109.1	22.3	70.1	39.4	161.4	57.5
WEST SOUTH CENTRAL	85.	113.6	45.7	60.3	115.5	164.1	124.7
MOUNTAIN	41.	94.1	37.8	48.6	43.0	139.1	53.6
PACIFIC	133.	92.8	39.4	40.1	31.9	124.8	47.1
NATIONAL AVERAGE	610.	91.5	38.0	60.8	60.0	143.0	67.6

TABLE II-22B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH ELECTRIC AIR CONDITIONING
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	NO.OF BLDGS	ELECTRICITY		OTHER FUELS		TOTAL	
		MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	6.	66.4	10.9	101.4	14.8	167.7	18.9
MIDDLE ATLANTIC	58.	79.1	32.0	58.6	28.0	137.7	30.1
EAST NORTH CENTRAL	105.	72.3	35.4	86.9	39.6	150.9	53.8
WEST NORTH CENTRAL	75.	82.3	35.3	83.5	40.0	157.0	55.6
SOUTH ATLANTIC	95.	89.7	32.7	62.7	57.0	124.0	51.6
EAST SOUTH CENTRAL	12.	97.3	31.4	51.3	39.5	140.1	49.5
WEST SOUTH CENTRAL	85.	107.3	46.3	53.4	87.9	150.0	100.1
MOUNTAIN	41.	82.5	39.4	61.6	42.4	138.1	51.7
PACIFIC	133.	84.2	39.5	43.3	27.9	117.4	43.3
NATIONAL AVERAGE	610.	85.5	38.6	64.6	50.8	137.9	60.0

TABLE II-23A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH GAS AIR CONDITIONING
(BTU/SQ.FT. 000)

WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		NO. OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST NORTH CENTRAL	45.5	9.1	2.	74.3	15.5	119.8	6.4
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	82.0	14.2	5.	120.6	105.2	202.6	97.1
MOUNTAIN	46.8	Undefined	1.	75.9	Undefined	122.8	Undefined
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	75.8	18.8	8.	112.7	97.3	188.5	93.5

TABLE II-23B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH GAS AIR CONDITIONING
(BTU/SQ.FT. 000)

UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

	ELECTRICITY		NO. OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST NORTH CENTRAL	47.8	13.3	2.	70.4	22.6	118.2	9.3
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	77.4	14.2	5.	215.4	192.9	292.8	184.9
MOUNTAIN	46.8	0.0	1.	75.9	0.0	122.8	0.0
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	66.2	19.5	8.	161.7	163.8	227.9	166.1

TABLE II-24A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM ABSORPTION AIR CONDITIONING
(BTU/SQ.FT. '000)

	WEIGHTED MEANS AND STANDARD DEVIATIONS		COMMERCIAL OFFICE BUILDINGS		ELECTRICITY		OTHER FUELS		TOTAL	
	MEAN	STD.DEV.	NO.OF BLDGS.		MEAN	STD.DEV.	MEAN	STD.DEV.		
NEW ENGLAND	69.8	13.8	4.		104.2	16.4	174.0	14.1		
MIDDLE ATLANTIC	69.3	16.1	14.		91.2	31.9	160.4	42.6		
EAST NORTH CENTRAL	70.6	18.1	8.		153.2	54.4	223.8	52.3		
WEST NORTH CENTRAL	56.0	21.5	11.		153.7	174.8	203.7	161.5		
SOUTH ATLANTIC	74.8	23.1	8.		157.6	84.3	232.4	105.4		
EAST SOUTH CENTRAL	0.0	0.0	0.		0.0	0.0	0.0	0.0		
WEST SOUTH CENTRAL	127.1	74.5	3.		268.7	153.2	395.8	224.7		
MOUNTAIN	96.2	19.0	3.		290.3	83.0	386.5	101.5		
PACIFIC	62.3	24.4	5.		139.7	127.3	201.9	148.5		
NATIONAL AVERAGE	70.0	23.5	56.		129.4	101.0	198.2	108.3		

TABLE II-24B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM ABSORPTION AIR CONDITIONING
(BTU/SQ.FT. '000)

	UNWEIGHTED MEANS AND STANDARD DEVIATIONS		COMMERCIAL OFFICE BUILDINGS		ELECTRICITY		OTHER FUELS		TOTAL	
	MEAN	STD.DEV.	NO.OF BLDGS		MEAN	STD.DEV.	MEAN	STD.DEV.		
NEW ENGLAND	66.7	18.4	4.		107.6	19.4	174.3	17.2		
MIDDLE ATLANTIC	68.4	23.4	14.		95.5	40.1	163.9	57.4		
EAST NORTH CENTRAL	67.8	22.0	8.		159.8	48.7	227.5	50.1		
WEST NORTH CENTRAL	60.4	27.1	11.		178.5	164.5	233.4	155.2		
SOUTH ATLANTIC	67.4	20.0	8.		135.3	77.0	202.7	94.4		
EAST SOUTH CENTRAL	0.0	0.0	0.		0.0	0.0	0.0	0.0		
WEST SOUTH CENTRAL	112.0	86.0	3.		248.1	182.8	360.0	263.9		
MOUNTAIN	88.5	22.5	3.		280.0	114.9	368.6	135.8		
PACIFIC	69.3	37.8	5.		174.5	159.5	243.8	194.0		
NATIONAL AVERAGE	70.1	30.4	56.		152.6	111.9	221.5	126.2		

TABLE II-25A

ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM TURBINE AIR CONDITIONING
(BTU/SQ.FT. 000)

WEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

ELECTRICITY

OTHER FUELS

TOTAL

	MEAN	STD.DEV.	NO.OF BLDGS	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	73.6	25.5	9.	103.6	23.7	177.1	41.8
EAST NORTH CENTRAL	50.6	15.0	2.	92.2	129.9	142.8	144.9
WEST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	60.6	Undefined	1.	258.8	Undefined	319.4	Undefined
MOUNTAIN	0.0	0.0	0.	0.0	0.0	0.0	0.0
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	70.8	25.4	12.	104.0	52.0	174.8	67.2

TABLE II-25B

ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM TURBINE AIR CONDITIONING
(BTU/SQ.FT. 000)

UNWEIGHTED MEANS AND STANDARD DEVIATIONS
COMMERCIAL OFFICE BUILDINGS

ELECTRICITY

OTHER FUELS

TOTAL

	MEAN	STD.DEV.	NO.OF BLDGS	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	74.4	28.9	9.	91.2	30.3	165.7	53.9
EAST NORTH CENTRAL	67.0	31.4	2.	234.6	272.5	301.6	304.0
WEST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	60.6	0.0	1.	258.8	0.0	319.4	0.0
MOUNTAIN	0.0	0.0	0.	0.0	0.0	0.0	0.0
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	72.0	26.8	12.	129.1	110.2	201.1	121.0

II-9 Conclusions on Commercial Office Building Energy Consumption

The 1977 data base developed from the 1977 BOMA Experience Exchange Report was generally representative of office buildings in terms of location and age. No data are available to classify buildings in terms of prime and non-prime space; it is, therefore, impossible to determine to what degree the 1977 data base was representative in terms of quality of space. It is believed, however, that the commercial office buildings represented in the Experience Exchange Report are better managed than are office buildings in general. Therefore, it is likely that the 1977 data base is unrepresentative of office buildings in general in terms of the prime/non-prime classification.

The tables developed summarize energy use but do not provide explanations of the causes of the variation in energy use by fuel type, building usage, or location. In presenting the major conclusions on building energy use we will offer some comments on variations in energy use; these explanations were developed on the basis of discussions with the BOMA staff. A regression analysis will be developed under Task IC of this project in an attempt to explain some of the energy consumption variations in terms of building characteristics and use.

- o Electrically and steam heated buildings use less energy than do buildings heated with gas and oil.
- o In the cases of gas, oil, and steam heated buildings, electric use per square foot is greater for gas than for oil and steam buildings. It is not known why there is this variation. One possibility is that the variation is related to the heating, ventilating, air conditioning system configuration and to the use of energy for reheat.
- o Both electric and fuel use are related to climate.
- o Downtown buildings are less energy efficient than are suburban buildings in the case of oil and gas heated buildings. There is however, no difference for electric and steam heated buildings.

- o Buildings 10 stories or higher tend to use more electricity than do lower buildings. This is probably due to increased elevator and air handling requirements. There is no clear trend in terms of fuel use by building height.
- o Energy use is a function of building age. Middle aged buildings -- most likely to be approaching the non-prime space category -- use less energy than do younger buildings or older buildings, which have in general been renovated.
- o Building electric use is lower in cases in which the tenant is metered for his use.
- o The presence of computer space has an impact on building energy consumption. Buildings with computer space use more electricity but less fuel than do buildings without computer space; the overall level of energy is, however, the same between the two types of buildings.
- o Most buildings air condition with electricity. In cities with district steam there is some steam air conditioning. Although the operating cost of steam air conditioning is more expensive than that of electric air conditioning, buildings which heat and cool with steam are able to utilize space for commercial purposes which would otherwise be devoted to boiler rooms. In some cities such a space/cost tradeoff has been advantageous. In addition, the choice of steam where available relieves the building manager of fuel availability and handling problems.

III. ANALYSIS OF THE 1977 DATA BASE: GOVERNMENT OFFICE BUILDINGS

III-1. Characteristics of the Data Base

The 1977 BOMA Experience Exchange Report contained data for 233 Federal, state, and local government office buildings. Government office buildings were defined to be office buildings owned and operated by a government agency. Buildings privately owned and leased to the government were classified elsewhere as commercial buildings. After the data had been subjected to a verification and correction process identical to that for the commercial office buildings, there were 216 government office buildings which remained in the 1977 data base.

The government buildings in the 1977 data base were not typical of government buildings in general either in terms of location or in terms of age. The regional distribution of government administration buildings in 1975 was computed on the basis of data in Commercial Buildings Inventory.¹⁾ As is indicated in Table III-1 the square feet of government office space in the 1977 data base are not distributed in a pattern similar to the overall distribution of all government administration space in 1975 (data for the 1977 census division distribution of space have not been developed). Table III-2 presents the age distribution of government office space in 1977; in comparison, the buildings in the 1977 data base are under represented in the 1-9, 20-29, and 50+ age categories, and are over represented in the 10-19 and 40-49 categories. The age distribution of the government buildings in the 1977 data base in comparison to the age distribution of government administration buildings in general is not as bad as the geographic distribution.

The government buildings in the 1977 data base can be classified in terms of the type of fuel used for heating: electric, gas, oil, and steam.

Building Fuel Type	Number of Buildings	% of Buildings	Square Feet of Space (10^6)	% of Space
Electric	8	3.7%	2.4	4.6%
Gas	124	57.4	19.0	36.3
Oil	26	12.0	4.1	7.8
Steam	58	26.9	26.8	51.2

¹⁾ General Electric Company, Center for Energy Systems, Commercial Buildings Inventory, June 1978.

Table III-3 describes the government buildings in the 1977 data base by fuel type and census division. There are relatively few electric buildings, and the buildings are significantly larger than the gas or oil heated buildings. There are 124 gas heated buildings, and most census divisions have a sample of at least 10 buildings. The 26 oil heated buildings are relatively evenly distributed among census divisions, and the steam heated buildings are predominantly located in the East North Central and West North Central divisions. In comparison to the commercial office buildings (Table II-3) the gas and oil heated government office buildings are smaller, and the steam heated buildings are larger.

Table III-4 tabulates the building inventory by age. In contrast to commercial office buildings in the 1977 data base, government buildings tend to fall in the middle age ranges; there are fewer old (50+) or young (1-9) buildings.

Percent of Buildings in Age Category
(By Square Feet)

Age	Commercial	Government
1-9	45.7%	26.0
10-19	21.8	37.7
20-29	7.8	6.5
30-39	1.0	7.3
40-49	9.6	13.0
50+	14.0	9.6

TABLE III-1
Percentage Distribution of Square Feet of Government
Office Building Space by Census Division

Census Division	Estimated Distribution of Government Office Building Space for 1975 ¹⁾ (Percent of Total Space by Region)	Distribution of Square Feet of Government Space in 1977 Data Base ²⁾ (Percent of Sample)
NE	4.8%	3.2
MA	18.8	12.1
ENC	17.0	3.2
WNC	7.4	23.7
SA	17.5	4.2
ESC	4.7	8.9
WSC	8.2	14.2
MTN	4.6	20.5
PAC	17.0	10.0

1) Based on information in Commercial Buildings Inventory, General Electric, Center for Energy Systems, June 1978; includes federal, state, and local space.

2) Based on information obtained from BOMA; includes federal, state, and local space.

TABLE III-2
PERCENTAGE DISTRIBUTION OF SQUARE FEET OF
GOVERNMENT OFFICE BUILDING SPACE BY AGE

Age	Estimated Distribution of Square Feet of Government Office Building Space by Age in 1977 ¹⁾ (Percent of Total Space)	Distribution of Square Feet of Government Building Space in 1977 Data Base ²⁾ (Percent of Sample)
1-9	32.8%	26.0%
10-19	28.0	37.7
20-29	10.3	6.5
30-39	7.4	7.3
40-49	9.1	13.0
50+	12.4	9.6

¹⁾ Based on information developed in Commercial Building's Inventory, General Electric, Center for Energy Systems, June 1978.

²⁾ Does not total 100% due to rounding.

III-2. Summary of Energy Consumption

Table III-5 compares energy use between commercial and government office buildings. With the exception of steam heated buildings, government office buildings use less energy than do commercial office buildings; discussions with BOMA suggested that differences in building construction and building usage could account for this difference in energy consumption. The government architectural style results in building design which is structurally more massive than commercial space and probably has better thermal characteristics. In addition, building managers for government buildings have frequently received directions to operate the buildings at comfort levels for lighting, heating, and cooling which are below those frequently maintained in the private sector. Commercial building managers in providing space conditioning have to maintain a level of tenant satisfaction and comfort that will enhance the marketability of the space. In contrast, government building managers operate the buildings pursuant to the instructions resulting from government conservation policies. The immediate satisfaction of the building tenants is of less importance than is the case in the commercial sector.

Table III-6 summarizes government office building energy use on a regional basis, and Tables III-7 through III-11 provide detailed statistical information by census division. Table III-7 provides the data for all buildings combined by fuel type. Table III-8 provides data for electrically heated buildings; since the number of buildings is very limited it is probably not appropriate to use these data at other than the national level. Table III-9 presents data for gas heated buildings. In comparison to commercial office buildings (Table II-10), fuel use is generally less in all census divisions. In some divisions (Middle Atlantic, sample size 6; South Atlantic, sample size 8; West South Central, sample size 15; Mountain, sample size 30) it is significantly lower and, in view of the adequate sample sizes, the deviation is probably due to factors other than random statistical error. For gas heated buildings the electric use is also lower than is the case for commercial buildings, with particularly dramatic reductions in the case of the South Atlantic and Pacific divisions.

Table III-10 presents data for oil heated buildings. In comparison to commercial office buildings (Table II-11) government office buildings used more electricity but less oil. It is not known why this is the case. A possible explanation might, however, be that the buildings are major regional government installations with data processing and/or other high usage applications.

Table III-11 presents the data for steam heated buildings. In comparison to commercial office buildings (Table II-12) government office buildings use slightly less electricity but more steam. Higher steam use is particularly noticeable in the cases of West North Central, South Atlantic, and Pacific. Again, the causes of the higher use are unknown.

TABLE III - 3
THE 1977 BOMA OFFICE BUILDING SAMPLE
BY TYPE OF HEATING FUEL AND REGION
(SQUARE FEET IN MILLIONS)
GOVERNMENT OFFICE BUILDINGS

	ELECTRIC			GAS			OIL			STEAM		
	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)	NUMBER OF BLDGS	SQ. FT.	SQFT/BLDG (000)
NEW ENGLAND	1	0.7	676.2	4	0.6	152.3	2	0.1	29.5	3	0.9	287.2
MIDDLE ATLANTIC	1	0.3	299.5	6	2.3	380.0	3	0.6	194.9	3	1.4	483.0
EAST NORTH CENTRAL	2	0.8	411.6	11	0.6	53.3	4	0.1	35.0	7	2.1	305.4
WEST NORTH CENTRAL	1	0.1	148.1	23	4.5	197.2	5	1.2	244.0	10	4.4	436.1
SOUTH ATLANTIC	0	0.0	0.0	8	0.8	101.6	5	1.3	262.3	29	16.2	560.0
EAST SOUTH CENTRAL	0	0.0	0.0	10	1.7	173.9	1	0.3	347.6	0	0.0	0.0
WEST SOUTH CENTRAL	0	0.0	0.0	18	2.7	149.9	0	0.0	0.0	0	0.0	0.0
MOUNTAIN	1	0.2	232.4	30	3.9	129.1	2	0.1	59.0	1	0.6	610.0
PACIFIC	2	0.2	116.7	14	1.9	136.2	4	0.3	72.6	5	1.1	223.1
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TOTAL	8	2.4	301.6	124	19.0	153.6	26	4.1	156.6	58	26.8	461.6

TABLE III - 4
HEATING FUEL BY AGE OF BUILDING IN THE 1977 BOMA OFFICE BUILDING SAMPLE
(SQUARE FEET IN MILLIONS)
GOVERNMENT OFFICE BUILDINGS

AGE (YEARS)	HEATING FUEL														
	ELECTRIC			GAS			OIL			STEAM			TOTAL		
	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)	NO.OF BLDGS	SQ. FT.	SQ.FT./ BLDG (000)
1-9	4	1.4	338.8	27	5.3	197.0	7	1.1	150.2	11	5.9	532.8	49	13.6	277.3
10-19	3	0.9	303.2	35	9.3	266.1	6	1.2	194.9	17	8.3	488.0	61	19.7	322.8
20-29	0	0.0	0.0	8	1.8	230.6	2	0.2	116.8	1	1.3	1316.6	11	3.4	308.6
30-39	0	0.0	0.0	2	0.3	162.8	1	1.1	1062.0	6	2.4	400.0	9	3.8	420.9
40-49	1	0.1	148.1	20	0.9	44.0	4	0.2	57.8	13	5.6	427.4	38	6.8	179.4
50+	0	0.0	0.0	32	1.4	42.4	6	0.3	54.0	10	3.3	334.7	48	5.0	104.8
TOTAL	8	2.4	301.6	124	19.0	153.6	26	4.1	156.6	58	26.8	461.6	216	52.3	242.1

TABLE III-5

Comparison of 1977 Energy Consumption Between the Commercial
And Government Office Buildings by Type of Heating Fuel¹⁾
(Btu/Sq. Ft. in thousands; Square feet in millions)
Weighted Means
1977

	Heating Fuel								All Buildings	
	Electric		Gas		Oil		Steam		C	G
	C	G	C	G	C	G	C	G		
Electric Btu/Sq. Ft.	114.9	78.0	92.4	54.3	75.5	91.1	75.0	72.6		
Gas Btu/Sq. Ft.			86.0	48.7						
Oil Btu/Sq. Ft.					62.3	40.8				
Steam Btu/Sq. Ft.							66.2	80.0		
Total Btu/Sq. Ft.	116.6	82.4	180.1	109.6	152.9	139.3	141.4	153.1	152.5	132.9
Total Square Feet	34.2	2.4	78.9	19	16.0	4.1	94	26.8	223.1	52.3
Number of Buildings	158	8	333	122	65	26	273	57	829	214

1) Commercial office building headings are denoted by "C", and government office building headings are denoted by "G".

TABLE III-6¹⁾
SUMMARY OF 1977 GOVERNMENT OFFICE BUILDING ENERGY USE
(Btu/Sq. Ft. in thousands)

Census Division and Type of Building Fuel for Heating	<u>Electricity</u>	<u>Number of Buildings</u>	<u>Other Energy Use</u>	<u>Number of Buildings</u>	<u>Total Energy Use</u>	<u>Number of Buildings</u>
New England						
Electric	39.3	1	-	0	39.3	1
Gas	51.7	4	78.6	4	138.5	4
Oil	18.5	2	63.5	2	89.4	2
Steam	56.1	3	90.5	3	146.6	3
All	48.7	10	88.3	9	109.9	10
Middle Atlantic						
Electric	87.1	1	-	0	87.1	1
Gas	111.8	6	26.9	6	171.3	6
Oil	48.0	3	73.3	3	122.9	3
Steam	57.4	3	71.9	3	129.7	3
All	85.0	13	65.9	12	146.7	13
East North Central						
Electric	116.9	2	.1	1	116.9	2
Gas	41.1	11	86.9	11	137.9	11
Oil	34.2	4	71.2	4	126.2	4
Steam	47.0	7	50.9	7	100.4	7
All	61.1	24	59.7	23	111.1	24
West North Central						
Electric	178.2	1	-	0	178.2	1
Gas	42.7	23	60.4	23	108.7	23
Oil	66.6	5	22.1	5	99.2	5
Steam	69.4	10	100.2	10	170.2	10
All	58.8	39	77.0	38	134.7	39

¹⁾ See footnote at end of table.

TABLE III-6, CONTINUED¹⁾
SUMMARY OF 1977 GOVERNMENT OFFICE BUILDING ENERGY USE
(Btu/Sq. Ft. in thousands)

Census Division and Type of Building Fuel for Heating	<u>Electricity</u>	<u>Number of Buildings</u>	<u>Other Energy Use</u>	<u>Number of Buildings</u>	<u>Total Energy Use</u>	<u>Number of Buildings</u>
South Atlantic						
Electric	-	0	-	0	-	0
Gas	31.8	8	28.1	8	59.9	8
Oil	164.7	5	27.5	4	203.3	5
Steam	80.2	29	80.5	29	161.0	29
All	84.1	42	75.4	42	159.5	42
East South Central						
Electric	-	0	-	0	-	0
Gas	59.8	10	46.7	10	110.7	10
Oil	49.2	1	37.5	1	87.5	1
Steam	-	0	-	0	-	0
All	58.1	11	48.8	11	106.8	11
West South Central						
Electric	-	0	-	0	-	0
Gas	52.0	18	39.6	18	92.3	18
Oil	-	0	-	0	-	0
Steam	-	0	-	0	-	0
All	52.0	18	40.3	18	92.3	18
Mountain						
Electric	18.0	1	-	0	18.0	1
Gas	48.4	30	48.1	30	97.0	30
Oil	60.3	2	68.2	2	128.5	2
Steam	68.8	1	11.2	1	80.0	1
All	49.8	35	44.0	34	91.7	35

¹⁾See footnote at end of table.

TABLE III-6, CONTINUED¹⁾
SUMMARY OF 1977 GOVERNMENT OFFICE BUILDING ENERGY USE
(Btu/Sq. Ft. in thousands)

Census Division and Type of Building Fuel for Heating	<u>Electricity</u>	<u>Number of Buildings</u>	<u>Other Energy Use</u>	<u>Number of Buildings</u>	<u>Total Energy Use</u>	<u>Number of Buildings</u>
Pacific						
Electric	37.2	2	49.3	1	82.5	2
Gas	36.5	12	50.5	12	88.3	12
Oil	52.8	4	82.7	4	135.5	4
Steam	56.1	4	90.6	4	146.7	4
All	43.5	22	65.3	21	108.4	22
National Average						
Electric	78.0	8	24.5	2	82.4	8
Gas	54.3	122	48.7	122	109.6	122
Oil	91.1	26	40.8	25	139.3	26
Steam	72.6	57	80.0	57	153.1	57
All	67.6	214	67.8	208	132.9	214

¹⁾ As is indicated in the text, "Electricity" plus "Other" may not exactly equal "Total" energy use. Similarly, the numbers of electric, gas, oil, and steam buildings do not exactly sum to equal the number of "All" buildings, for some buildings were not included in some computations.

TABLE III - 7A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		OTHER FUELS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	48.7	11.4	88.3	19.9	109.9	52.2
MIDDLE ATLANTIC	85.0	38.9	65.9	25.6	146.7	45.8
EAST NORTH CENTRAL	61.1	37.5	59.7	31.7	111.1	33.7
WEST NORTH CENTRAL	58.8	36.7	77.0	46.7	134.7	60.7
SOUTH ATLANTIC	84.1	47.9	75.4	102.1	159.5	126.9
EAST SOUTH CENTRAL	58.1	26.8	48.8	25.0	106.8	47.1
WEST SOUTH CENTRAL	52.0	8.1	40.3	40.7	92.3	36.9
MOUNTAIN	49.8	39.6	44.0	48.7	91.7	71.2
PACIFIC	43.5	16.8	65.3	58.6	108.4	56.2
NATIONAL AVERAGE	67.6	41.8	67.8	71.6	132.9	90.9

TABLE III - 7B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		OTHER FUELS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	44.8	18.8	86.7	38.7	122.8	57.0
MIDDLE ATLANTIC	50.7	32.3	72.8	41.7	117.9	48.0
EAST NORTH CENTRAL	48.2	28.0	76.8	43.4	121.8	47.2
WEST NORTH CENTRAL	50.6	35.5	79.4	51.7	128.0	58.6
SOUTH ATLANTIC	65.8	45.4	59.9	69.7	125.7	96.5
EAST SOUTH CENTRAL	47.5	26.0	39.9	20.5	87.5	41.8
WEST SOUTH CENTRAL	43.0	10.1	64.1	49.2	107.1	48.8
MOUNTAIN	48.9	57.2	69.8	46.5	116.8	72.5
PACIFIC	43.5	20.2	54.6	51.9	95.7	51.8
NATIONAL AVERAGE	51.2	38.0	67.6	52.3	117.0	66.6

TABLE III -8A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
ELECTRICALLY HEATED BUILDINGS
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		OTHER		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	39.3	Undefined	0.0	0.0	39.3	Undefined
MIDDLE ATLANTIC	87.1	Undefined	0.0	0.0	87.1	Undefined
EAST NORTH CENTRAL	116.9	21.9	0.1	Undefined	116.9	21.9
WEST NORTH CENTRAL	178.2	Undefined	0.0	0.0	178.2	Undefined
SOUTH ATLANTIC	0.0	0.0	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	18.0	Undefined	0.0	0.0	18.0	Undefined
PACIFIC	37.2	17.1	49.3	Undefined	82.5	3.6
NATIONAL AVERAGE	78.0	47.6	24.5	24.6	82.4	45.3

TABLE III - 8B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
ELECTRICALLY HEATED BUILDINGS
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		OTHER		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	39.3	0.0	0.0	0.0	39.3	0.0
MIDDLE ATLANTIC	87.1	0.0	0.0	0.0	87.1	0.0
EAST NORTH CENTRAL	105.2	35.1	0.1	0.0	105.2	35.1
WEST NORTH CENTRAL	178.2	0.0	0.0	0.0	178.2	0.0
SOUTH ATLANTIC	0.0	0.0	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	18.0	0.0	0.0	0.0	18.0	0.0
PACIFIC	63.2	44.0	49.3	0.0	87.9	9.2
NATIONAL AVERAGE	82.4	53.6	24.7	34.8	88.6	49.7

TABLE III - 9A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
GAS HEATED BUILDINGS
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		GAS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	51.7	11.4	78.6	28.8	138.5	21.7
MIDDLE ATLANTIC	111.8	38.7	26.9	19.8	171.3	45.9
EAST NORTH CENTRAL	41.1	13.7	86.9	37.9	137.9	42.0
WEST NORTH CENTRAL	42.7	22.4	60.4	50.9	108.7	52.5
SOUTH ATLANTIC	31.8	13.1	28.1	26.0	59.9	27.9
EAST SOUTH CENTRAL	59.8	29.1	46.7	26.0	110.7	50.7
WEST SOUTH CENTRAL	52.0	8.1	39.6	39.4	92.3	36.9
MOUNTAIN	48.4	42.8	48.1	50.8	97.0	76.9
PACIFIC	36.5	7.0	50.5	39.2	88.3	40.3
NATIONAL AVERAGE	54.3	35.8	48.7	43.8	109.6	59.6

TABLE III - 9B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
GAS HEATED BUILDINGS
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		GAS		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	56.1	17.5	84.0	62.4	158.4	51.6
MIDDLE ATLANTIC	45.5	46.1	50.0	33.5	102.6	53.2
EAST NORTH CENTRAL	44.7	20.5	90.3	50.2	140.1	55.4
WEST NORTH CENTRAL	44.1	26.6	73.4	57.3	126.6	61.5
SOUTH ATLANTIC	37.7	18.9	29.1	34.9	66.8	34.6
EAST SOUTH CENTRAL	47.3	27.4	38.0	20.1	87.4	44.0
WEST SOUTH CENTRAL	43.0	10.1	62.6	47.8	107.1	48.8
MOUNTAIN	49.4	61.5	72.9	47.4	123.7	74.5
PACIFIC	36.4	14.2	38.8	32.8	75.9	33.3
NATIONAL AVERAGE	44.9	36.0	63.2	48.2	112.0	60.4

TABLE III - 10A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
OIL HEATED BUILDINGS
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		OIL		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	18.5	3.8	63.5	38.7	89.4	49.1
MIDDLE ATLANTIC	48.0	5.0	73.3	32.1	122.9	26.9
EAST NORTH CENTRAL	34.2	11.1	71.2	8.4	126.2	32.9
WEST NORTH CENTRAL	66.6	26.1	22.1	13.9	99.2	21.8
SOUTH ATLANTIC	164.7	59.2	27.5	9.0	203.3	64.5
EAST SOUTH CENTRAL	49.3	Undefined	37.5	Undefined	87.5	Undefined
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	60.3	8.7	68.2	8.0	128.5	16.7
PACIFIC	52.8	19.0	82.7	32.6	135.5	51.1
NATIONAL AVERAGE	91.1	63.5	40.8	29.1	139.3	63.0

TABLE III - 10B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
OIL HEATED BUILDINGS
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		OIL		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	18.7	5.3	65.6	54.8	91.9	69.5
MIDDLE ATLANTIC	43.2	9.1	97.3	66.9	142.8	56.1
EAST NORTH CENTRAL	39.6	15.6	71.0	8.3	124.7	32.6
WEST NORTH CENTRAL	48.8	32.3	29.6	24.3	88.7	19.7
SOUTH ATLANTIC	71.2	68.8	35.7	18.3	103.8	75.1
EAST SOUTH CENTRAL	49.3	0.0	37.5	0.0	87.5	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	51.4	17.5	60.2	16.0	111.6	33.5
PACIFIC	44.3	19.4	62.8	39.3	107.6	57.2
NATIONAL AVERAGE	48.3	34.8	56.3	36.7	108.3	47.8

TABLE III - 11A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
STEAM HEATED BUILDINGS
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		STEAM		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	56.1	6.8	90.5	21.0	146.6	24.6
MIDDLE ATLANTIC	57.4	1.7	71.9	30.6	129.7	29.3
EAST NORTH CENTRAL	47.0	25.0	50.9	13.4	100.4	29.7
WEST NORTH CENTRAL	69.4	39.7	100.2	32.6	170.2	57.2
SOUTH ATLANTIC	80.2	40.3	80.5	106.9	161.0	131.0
EAST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	68.8	Undefined	11.2	Undefined	80.0	Undefined
PACIFIC	56.1	20.5	90.6	85.6	146.7	67.5
NATIONAL AVERAGE	72.6	37.9	80.0	88.0	153.1	108.6

TABLE III - 11B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
STEAM HEATED BUILDINGS
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		STEAM		TOTAL	
	MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	49.1	11.7	74.7	33.2	123.8	35.1
MIDDLE ATLANTIC	56.5	2.7	76.4	35.1	133.8	33.4
EAST NORTH CENTRAL	42.2	28.1	50.8	14.7	96.1	35.0
WEST NORTH CENTRAL	53.6	34.9	91.7	41.3	145.7	60.0
SOUTH ATLANTIC	72.6	44.4	72.8	78.2	145.7	105.0
EAST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.0	0.0	0.0	0.0
MOUNTAIN	68.8	0.0	11.3	0.0	80.0	0.0
PACIFIC	54.2	22.2	92.9	95.7	147.2	78.0
NATIONAL AVERAGE	62.1	37.9	74.0	64.4	136.8	83.5

III-3 Energy Use Comparison: Downtown/Suburban

Table III-12 compares energy use between downtown and suburban government office buildings on both a national and a regional basis. Most government buildings are located downtown, and the data are too limited to permit definitive conclusions. There is some evidence that suburban government gas and oil heated buildings use more energy than do downtown government buildings; this may be due to building construction practices. For example, suburban government building construction probably is less typically governmental in style and may not have the thermal retention properties of the governmental style. Only the weighted data are presented in Table III-12 since the comparison appears to be of limited value.

TABLE III - 12.1
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

LOCATION OF BUILDINGS	NATIONAL TYPE OF HEATING FUEL				
	ELECTRIC	GAS	OIL	STEAM	AVERAGE ACROSS ALL FUELS
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	73.5	107.0	95.5	153.5	133.1
STANDARD DEVIATION (000)	39.9	55.6	25.4	110.1	94.8
SQUARE FEET (000,000)	1.6	13.8	2.1	26.1	43.5
NUMBER OF BUILDINGS	6.0	111.0	20.0	57.0	194.0
SQ.FT./BLDG.(000)	262.5	124.1	103.7	457.1	224.1
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	98.9	113.5	184.9	89.2	126.3
STANDARD DEVIATION (000)	50.1	70.1	57.8	Undefined	70.6
SQUARE FEET (000,000)	0.8	5.3	2.0	0.7	8.8
NUMBER OF BUILDINGS	2.0	13.0	6.0	1.0	22.0
SQ.FT./BLDG.(000)	418.9	405.3	332.8	718.9	401.0

TABLE III - 12.2
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
NEW ENGLAND

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	39.3	141.5	89.4	146.6	109.8
STANDARD DEVIATION (000)	Undefined	21.1	49.1	24.6	53.0
SQUARE FEET (000,000)	0.7	0.5	0.1	0.9	2.1
NUMBER OF BUILDINGS	1.0	3.0	2.0	3.0	9.0
SQ.FT./BLDG.(000)	676.2	180.5	29.5	287.2	237.6
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	114.5	0.0	0.0	114.5
STANDARD DEVIATION (000)	0.0	Undefined	0.0	0.0	Undefined
SQUARE FEET (000,000)	0.0	0.1	0.0	0.0	0.1
NUMBER OF BUILDINGS	0.0	1.0	0.0	0.0	1.0
SQ.FT./BLDG.(000)	0.0	67.8	0.0	0.0	67.8

TABLE III - 12.3
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
MIDDLE ATLANTIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	87.1	86.1	122.9	129.7	116.4
STANDARD DEVIATION (000)	Undefined	30.8	26.9	29.3	33.2
SQUARE FEET (000,000)	0.3	0.5	0.6	1.4	2.8
NUMBER OF BUILDINGS	1.0	5.0	3.0	3.0	12.0
SQ.FT./BLDG.(000)	299.5	94.8	194.9	483.0	233.9
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	193.7	0.0	0.0	193.7
STANDARD DEVIATION (000)	0.0	Undefined	0.0	0.0	Undefined
SQUARE FEET (000,000)	0.0	1.8	0.0	0.0	1.8
NUMBER OF BUILDINGS	0.0	1.0	0.0	0.0	1.0
SQ.FT./BLDG.(000)	0.0	1806.2	0.0	0.0	1806.2

TABLE III - 12.4
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
EAST NORTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	80.4	136.2	103.6	100.4	105.9
STANDARD DEVIATION (000)	Undefined	40.5	18.6	29.7	34.5
SQUARE FEET (000,000)	0.2	0.6	0.1	2.1	3.0
NUMBER OF BUILDINGS	1.0	10.0	3.0	7.0	21.0
SQ.FT./BLDG.(000)	217.7	57.5	29.4	305.4	143.8
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	130.0	227.3	164.5	0.0	134.3
STANDARD DEVIATION (000)	Undefined	Undefined	Undefined	0.0	15.2
SQUARE FEET (000,000)	0.6	0.0	0.1	0.0	0.7
NUMBER OF BUILDINGS	1.0	1.0	1.0	0.0	3.0
SQ.FT./BLDG.(000)	605.4	11.0	52.0	0.0	222.8

TABLE III - 12.5
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
WEST NORTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	178.2	116.1	79.8	170.2	143.5
STANDARD DEVIATION (000)	Undefined	58.0	4.6	57.2	63.2
SQUARE FEET (000,000)	0.1	2.9	0.7	4.4	8.1
NUMBER OF BUILDINGS	1.0	19.0	4.0	10.0	34.0
SQ.FT./BLDG.(000)	148.1	151.3	168.5	436.1	237.0
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	96.1	123.1	0.0	102.7
STANDARD DEVIATION (000)	0.0	38.3	Undefined	0.0	35.2
SQUARE FEET (000,000)	0.0	1.7	0.5	0.0	2.2
NUMBER OF BUILDINGS	0.0	4.0	1.0	0.0	5.0
SQ.FT./BLDG.(000)	0.0	415.5	546.2	0.0	441.7

TABLE III - 12.6
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
SOUTH ATLANTIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	59.9	82.3	164.3	158.4
STANDARD DEVIATION (000)	0.0	27.9	16.7	133.1	131.5
SQUARE FEET (000,000)	0.0	0.8	0.1	15.5	16.5
NUMBER OF BUILDINGS	0.0	8.0	3.0	28.0	39.0
SQ.FT./BLDG.(000)	0.0	101.6	48.8	554.3	422.6
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	0.0	218.5	89.2	169.1
STANDARD DEVIATION (000)	0.0	0.0	50.8	Undefined	74.4
SQUARE FEET (000,000)	0.0	0.0	1.2	0.7	1.9
NUMBER OF BUILDINGS	0.0	0.0	2.0	1.0	3.0
SQ.FT./BLDG.(000)	0.0	0.0	582.5	718.9	627.9

TABLE III - 12.7
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

EAST SOUTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	110.7	87.5	0.0	106.8
STANDARD DEVIATION (000)	0.0	50.7	Undefined	0.0	47.1
SQUARE FEET (000,000)	0.0	1.7	0.3	0.0	2.1
NUMBER OF BUILDINGS	0.0	10.0	1.0	0.0	11.0
SQ.FT./BLDG.(000)	0.0	173.9	347.6	0.0	189.7
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	0.0	0.0	0.0	0.0
STANDARD DEVIATION (000)	0.0	0.0	0.0	0.0	0.0
SQUARE FEET (000,000)	0.0	0.0	0.0	0.0	0.0
NUMBER OF BUILDINGS	0.0	0.0	0.0	0.0	0.0
SQ.FT./BLDG.(000)	0.0	0.0	0.0	0.0	0.0

TABLE III - 12.8
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
WEST SOUTH CENTRAL

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	92.3	0.0	0.0	92.3
STANDARD DEVIATION (000)	0.0	36.9	0.0	0.0	36.9
SQUARE FEET (000,000)	0.0	2.7	0.0	0.0	2.7
NUMBER OF BUILDINGS	0.0	18.0	0.0	0.0	18.0
SQ.FT./BLDG. (000)	0.0	149.9	0.0	0.0	149.9
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	0.0	0.0	0.0	0.0
STANDARD DEVIATION (000)	0.0	0.0	0.0	0.0	0.0
SQUARE FEET (000,000)	0.0	0.0	0.0	0.0	0.0
NUMBER OF BUILDINGS	0.0	0.0	0.0	0.0	0.0
SQ.FT./BLDG. (000)	0.0	0.0	0.0	0.0	0.0

TABLE III - 12.9
DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
MOUNTAIN

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	0.0	138.2	87.9	80.0	125.2
STANDARD DEVIATION (000)	0.0	73.0	Undefined	Undefined	68.6
SQUARE FEET (000,000)	0.0	2.2	0.0	0.6	2.8
NUMBER OF BUILDINGS	0.0	24.0	1.0	1.0	26.0
SQ.FT./BLDG. (000)	0.0	89.6	17.0	610.0	106.9
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	18.0	45.4	135.3	0.0	46.7
STANDARD DEVIATION (000)	0.1	43.3	Undefined	0.0	45.3
SQUARE FEET (000,000)	0.2	1.7	0.1	0.0	2.1
NUMBER OF BUILDINGS	Undefined	6.0	1.0	0.0	8.0
SQ.FT./BLDG. (000)	232.4	287.0	100.9	0.0	256.9

TABLE III - 12.10

DOWNTOWN AND SUBURBAN BUILDINGS IN THE 1977 BOMA
OFFICE BUILDING SAMPLE
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS
PACIFIC

LOCATION OF BUILDINGS	TYPE OF HEATING FUEL				AVERAGE ACROSS ALL FUELS
	ELECTRIC	GAS	OIL	STEAM	
DOWNTOWN					
TOTAL BTU/SQ.FT. (000)	82.5	82.1	89.3	116.5	93.7
STANDARD DEVIATION (000	3.6	44.9	11.2	84.5	61.0
SQUARE FEET (000,000)	0.2	1.9	0.2	1.1	3.4
NUMBER OF BUILDINGS	2.0	14.0	3.0	5.0	24.0
SQ.FT./BLDG.(000)	116.7	136.2	52.5	223.1	142.2
SUBURBAN					
TOTAL BTU/SQ.FT. (000)	0.0	0.0	190.4	0.0	190.4
STANDARD DEVIATION (000	0.0	0.0	Undefined	0.0	Undefined
SQUARE FEET (000,000)	0.0	0.0	0.1	0.0	0.1
NUMBER OF BUILDINGS	0.0	0.0	1.0	0.0	1.0
SQ.FT./BLDG.(000)	0.0	0.0	132.8	0.0	132.8

III-4 Energy Consumption by Building Height

Table III-13 presents energy use by building height. Most government buildings are less than 20 stories in height, and there does not appear to be any significant trend in energy use where only height is considered; energy use is lower for buildings in the 5-9 story category than for those in the 1-4 or 10-19 category.

TABLE III-13A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BY BUILDING HEIGHT
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	STORIES						
	1-4	5-9	10-19	20-29	30-39	40-49	50+
ELECTRIC BTU/SQ.FT.(000)							
MEAN	71.3	65.6	67.4	86.7	59.0	56.1	0.0
STANDARD DEVIATION	63.3	37.4	39.3	38.1	13.9	0.2	0.0
OTHER FUELS BTU/SQ.FT.(000)							
MEAN	62.6	53.6	89.1	78.6	39.1	121.7	0.0
STANDARD DEVIATION	41.5	32.6	120.6	29.1	44.4	0.1	0.0
TOTAL BTU/SQ.FT.(000)							
MEAN	131.6	119.2	146.4	165.3	98.1	177.9	0.0
STANDARD DEVIATION	73.2	56.2	137.4	61.4	31.8	Undefined	0.0
TOTAL SQUARE FEET(000,000)	6.7	24.5	15.3	2.9	0.9	1.6	0.0
NUMBER OF BUILDINGS	97.0	72.0	37.0	4.0	3.0	1.0	0.0

TABLE III-13B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BY BUILDING HEIGHT
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	STORIES						
	1-4	5-9	10-19	20-29	30-39	40-49	50+
ELECTRIC BTU/SQ.FT.(000)							
MEAN	44.0	54.4	61.0	81.3	47.6	56.1	0.0
STANDARD DEVIATION	41.2	32.0	39.2	41.1	18.8	0.0	0.0
OTHER FUELS BTU/SQ.FT.(000)							
MEAN	69.4	60.8	73.1	75.5	87.8	121.7	0.0
STANDARD DEVIATION	46.9	38.8	84.4	34.0	81.8	0.0	0.0
TOTAL BTU/SQ.FT.(000)							
MEAN	112.0	115.2	126.1	156.8	135.4	177.9	0.0
STANDARD DEVIATION	61.5	56.2	93.9	67.8	65.0	0.0	0.0
TOTAL SQUARE FEET(000,000)	6.7	24.5	15.3	2.9	0.9	1.6	0.0
NUMBER OF BUILDINGS	97.0	72.0	37.0	4.0	3.0	1.0	0.0

III-5 Energy Consumption by Building Age

Table III-14 presents a comparison between commercial and government office buildings of energy consumption by building age. The decline in energy use is continuously downward through age 30 for government buildings. Energy use then rises above age 30, probably as a result of building renovation.

Table III-15 presents detailed data for government buildings. Trends in energy use probably can be explained in terms of equipment and usage. The newer buildings tend to have equipment that is more energy intensive than do the older buildings and are probably used to a greater degree. In addition, this newer equipment is probably in operation to a greater degree than older equipment, thereby causing energy consumption to be higher. In the 30-40 year age range, buildings that survive are typically remodeled; as is the case with the commercial sector this causes energy consumption to rise, for the buildings are then again used more intensively.

TABLE III-14
Comparison of Energy Use by Age in Commercial and Government
Office Buildings

(Btu in thousands; square feet in millions)
Age

	1-9	10-19	20-29	30-39	40-49	50+
Electric Use-Btu/Sq. Ft.						
Commercial Buildings	97.1	87.3	86.1	87.7	76.6	60.9
Government Buildings	69.8	73.0	45.8	97.3	58.7	45.2
Other Fuels-Btu/Sq. Ft.						
Commercial Buildings	64.2	92.4	74.1	58.3	81.9	73.0
Government Buildings	87.3	61.6	37.5	62.4	69.8	65.9
Total Use-Btu/Sq. Ft.						
Commercial Buildings	146.1	174.1	158.6	145.7	158.1	131.8
Government Buildings	149.7	132.3	83.4	159.7	126.9	111.1
Square Feet						
Commercial Buildings	96.1	46.5	16.6	2.5	21.4	28.7
Government Buildings	13.4	19.7	3.4	3.8	6.8	4.9
Number of Buildings						
Commercial Buildings	302	197	72	12	66	193
Government Buildings	48	61	12	9	37	47

TABLE III - 15A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE
BUILDING SAMPLE BY BUILDING AGE
DOWNTOWN BUILDINGS
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	1-9 YEARS	10-19 YEARS	20-29 YEARS	30-39 YEARS	40-49 YEARS	50+ YEARS
ELECTRIC BTU/SQ.FT.(000)						
MEAN	69.8	73.0	45.8	97.3	58.7	45.2
STANDARD DEVIATION	41.6	40.7	13.2	67.9	30.0	21.5
OTHER FUELS BTU/SQ.FT.(000)						
MEAN	87.3	61.6	37.5	62.4	69.8	65.9
STANDARD DEVIATION	126.5	39.1	26.0	28.5	37.0	40.5
TOTAL BTU/SQ.FT.(000)						
MEAN	149.7	132.3	83.4	159.7	126.9	111.1
STANDARD DEVIATION	147.2	62.6	28.0	70.9	42.4	47.5
TOTAL SQUARE FEET(000,000)	13.4	19.7	3.4	3.8	6.8	4.9
NUMBER OF BUILDINGS	48.0	61.0	12.0	9.0	37.0	47.0

TABLE III - 15B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE
BUILDING SAMPLE BY BUILDING AGE
DOWNTOWN BUILDINGS
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	1-9 YEARS	10-19 YEARS	20-29 YEARS	30-39 YEARS	40-49 YEARS	50+ YEARS
ELECTRIC BTU/SQ.FT.(000)						
MEAN	58.9	65.4	45.2	68.9	38.7	33.0
STANDARD DEVIATION	28.3	50.9	15.0	60.0	29.7	15.9
OTHER FUELS BTU/SQ.FT.(000)						
MEAN	76.9	58.9	48.4	72.4	72.2	70.2
STANDARD DEVIATION	80.1	39.7	42.3	34.2	40.3	44.9
TOTAL BTU/SQ.FT.(000)						
MEAN	131.0	122.4	93.6	141.3	109.0	103.2
STANDARD DEVIATION	90.9	68.3	46.3	71.8	42.6	49.0
TOTAL SQUARE FEET(000,000)	13.4	19.7	3.4	3.8	6.8	4.9
NUMBER OF BUILDINGS	48.0	61.0	12.0	9.0	37.0	47.0

III-6 Energy Consumption and Computer Space

Tables III-16 and III-17 present energy consumption for government buildings with and without computer space. As was the case with commercial office buildings, government buildings with computer space tended to use more electricity and less "other" fuels. It is possible that the increased energy use for electricity could be directly due to the installed machinery. However, another possible explanation would be that the increased building usage associated with a computer installation was responsible for the higher electric use and that the waste heat from increased levels of lighting and other building equipment resulted in a decreased need for building heating. This latter explanation appears to be more likely given the heat transfer characteristics of buildings. The recapture of waste heat from a specific source such as a computer room is probably relatively rare and, accordingly, it is likely that waste heat from computer operations is exhausted in many cases to the outside of the building rather than to other locations within the building for heating purposes. However, it is likely that a number of heat generating sources in the building in addition to the computer space are in operation to a greater than normal degree in order to accommodate the personnel involved with the computer operations. Therefore, the heat associated with lighting and office equipment in the other areas may also contribute to the reduced heating needs.

TABLE III - 16A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH COMPUTER SPACE
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	NO.OF BLDGS	SQ. FT. (MILL)	SQFT/ BLDG (000)	COMPUTER SPACE SQ.FT/BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
					MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	1	0.7	668.5	1.0	59.3	0.0	99.8	0.0	159.1	0.0
MIDDLE ATLANTIC	4	2.7	676.2	47.8	106.2	35.4	58.6	14.6	164.8	42.7
EAST NORTH CENTRAL	2	0.1	26.2	0.8	36.0	13.6	78.2	7.2	114.2	6.4
WEST NORTH CENTRAL	11	3.2	293.5	8.8	87.1	42.0	68.6	33.1	155.7	67.0
SOUTH ATLANTIC	11	7.4	672.4	10.3	76.1	37.4	40.9	23.3	117.0	52.0
EAST SOUTH CENTRAL	4	1.0	256.0	35.5	49.4	5.4	58.2	15.6	107.6	18.4
WEST SOUTH CENTRAL	3	1.2	401.8	3.2	50.0	3.6	49.6	22.6	99.6	19.3
MOUNTAIN	5	1.0	191.7	4.0	50.9	9.9	22.0	36.4	72.9	32.7
PACIFIC	10	2.1	210.0	50.6	44.5	15.5	53.5	39.6	97.5	34.5
NATIONAL AVERAGE	51	19.3	379.2	21.2	74.2	37.6	52.0	30.3	126.1	54.7

TABLE III - 16B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH COMPUTER SPACE
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	NO.OF BLDGS	SQ. FT. (MILL)	SOFT/ BLDG (000)	COMPUTER SPACE SQ.FT/BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
					MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	1	0.7	668.5	1.0	59.3	0.0	99.8	0.0	159.1	0.0
MIDDLE ATLANTIC	4	2.7	676.2	47.8	72.5	39.4	63.2	25.1	135.7	45.7
EAST NORTH CENTRAL	2	0.1	26.2	0.8	32.6	19.9	80.0	10.4	112.5	9.4
WEST NORTH CENTRAL	11	3.2	293.5	8.8	68.3	37.2	61.8	31.2	130.0	55.7
SOUTH ATLANTIC	11	7.4	672.4	10.3	71.3	37.9	48.3	28.7	119.6	60.2
EAST SOUTH CENTRAL	4	1.0	256.0	35.5	36.7	16.5	45.3	16.7	82.1	30.1
WEST SOUTH CENTRAL	3	1.2	401.8	3.2	42.1	8.0	71.2	46.7	113.3	44.3
MOUNTAIN	5	1.0	191.7	4.0	46.2	21.0	49.4	46.1	95.7	43.3
PACIFIC	10	2.1	210.0	50.6	48.1	22.6	53.1	40.3	94.5	34.1
NATIONAL AVERAGE	51	19.3	379.2	21.2	57.9	31.9	57.0	32.3	113.8	48.3

TABLE III - 17A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITHOUT COMPUTER SPACE
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	NO.OF BLDGS	SQ. FT. (MILL)	SQFT/ BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
				MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	9	1.5	170.9	44.1	10.9	79.3	22.7	88.6	49.0
MIDDLE ATLANTIC	9	1.9	212.1	55.0	18.6	78.1	34.1	120.9	36.6
EAST NORTH CENTRAL	22	3.6	165.2	61.5	37.6	59.4	31.9	111.0	33.9
WEST NORTH CENTRAL	28	7.0	251.3	45.9	24.9	80.9	51.4	125.1	54.9
SOUTH ATLANTIC	31	11.0	353.8	89.4	53.1	98.7	125.5	188.1	152.0
EAST SOUTH CENTRAL	7	1.1	151.7	66.4	35.3	39.7	28.8	106.1	63.4
WEST SOUTH CENTRAL	15	1.5	99.6	53.6	10.1	32.9	49.5	86.5	45.6
MOUNTAIN	30	3.9	129.6	49.5	43.9	49.8	49.9	96.4	77.2
PACIFIC	15	1.4	96.4	42.2	18.2	81.1	74.1	123.3	73.8
NATIONAL AVERAGE	166	33.0	198.7	63.9	43.6	77.5	86.4	136.8	106.2

TABLE III - 17B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITHOUT COMPUTER SPACE
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	NO.OF BLDGS	SQ. FT. (MILL)	SQFT/ BLDG (000)	ELECTRICITY		OTHER FUELS		TOTAL	
				MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	9	1.5	170.9	43.2	19.2	85.0	41.0	118.8	58.9
MIDDLE ATLANTIC	9	1.9	212.1	41.0	25.3	77.5	48.8	109.9	49.4
EAST NORTH CENTRAL	22	3.6	165.2	49.6	28.6	76.5	45.5	122.6	49.3
WEST NORTH CENTRAL	28	7.0	251.3	43.6	33.0	86.6	57.0	127.2	60.7
SOUTH ATLANTIC	31	11.0	353.8	63.8	48.2	64.0	79.3	127.9	107.2
EAST SOUTH CENTRAL	7	1.1	151.7	53.7	29.6	36.9	23.1	90.5	49.2
WEST SOUTH CENTRAL	15	1.5	99.6	43.2	10.7	62.6	51.2	105.8	51.0
MOUNTAIN	30	3.9	129.6	49.4	61.5	73.3	46.4	120.3	76.3
PACIFIC	15	1.4	96.4	41.0	19.2	55.4	58.2	96.4	60.9
NATIONAL AVERAGE	166	33.0	198.7	49.3	39.5	70.8	56.7	117.9	71.2

III-7 Energy Consumption and Building Air Conditioning Equipment

Building energy consumption is presented in terms of air conditioning equipment in Tables III-18, III-19, and III-20. Electric air conditioning was present in 164 buildings (Table III-18); gas air conditioning was present in 4 buildings (Table 19); steam absorption was present in 17 buildings (Table 20); and two buildings had steam turbine air conditioning. Buildings with electric air conditioning used more electricity but less fuel than buildings with steam absorption.

TABLE III - 18A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH ELECTRIC AIR CONDITIONING
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	NO.OF BLDGS	ELECTRICITY		OTHER FUELS		TOTAL	
		MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	3.	62.1	14.9	101.4	13.8	163.5	16.1
MIDDLE ATLANTIC	11.	87.1	37.9	64.9	23.0	147.7	44.6
EAST NORTH CENTRAL	22.	61.8	38.3	56.7	29.9	108.7	32.6
WEST NORTH CENTRAL	28.	48.0	19.4	68.3	41.6	116.3	48.5
SOUTH ATLANTIC	37.	85.1	48.2	75.2	103.3	160.3	128.4
EAST SOUTH CENTRAL	8.	70.3	32.4	47.6	24.2	117.9	55.3
WEST SOUTH CENTRAL	12.	53.6	6.1	32.9	36.0	86.5	32.1
MOUNTAIN	27.	45.9	39.9	27.5	36.4	71.8	57.8
PACIFIC	16.	46.3	18.3	57.4	66.2	103.2	60.7
NATIONAL AVERAGE	164.	69.3	42.5	63.6	75.2	131.2	95.5

TABLE III - 18B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH ELECTRIC AIR CONDITIONING
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	NO.OF BLDGS	ELECTRICITY		OTHER FUELS		TOTAL	
		MEAN	STD.DEV.	MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	3.	54.7	28.1	123.2	29.7	177.9	45.9
MIDDLE ATLANTIC	11.	55.1	33.3	64.9	29.3	114.1	41.6
EAST NORTH CENTRAL	22.	48.2	29.3	75.1	44.6	119.9	48.5
WEST NORTH CENTRAL	28.	42.5	22.2	74.5	50.8	117.0	56.4
SOUTH ATLANTIC	37.	67.9	47.7	60.6	72.2	128.5	101.5
EAST SOUTH CENTRAL	8.	47.7	30.3	40.9	18.9	88.6	45.8
WEST SOUTH CENTRAL	12.	43.7	9.1	57.1	51.9	100.7	50.1
MOUNTAIN	27.	50.9	63.9	60.8	46.4	109.5	76.7
PACIFIC	16.	44.5	22.0	48.8	54.3	90.2	50.6
NATIONAL AVERAGE	164.	52.0	40.0	64.1	53.8	114.5	70.0

TABLE III - 19A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH GAS AIR CONDITIONING
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		NO.OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST NORTH CENTRAL	27.9	Undefined	1.	182.0	Undefined	209.9	Undefined
SOUTH ATLANTIC	33.2	Undefined	1.	111.6	Undefined	144.7	Undefined
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
MOUNTAIN	81.9	30.1	2.	115.9	27.2	197.8	57.3
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	55.4	34.2	4.	144.8	38.3	200.2	43.2

TABLE III - 19B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH GAS AIR CONDITIONING
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		NO.OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST NORTH CENTRAL	27.9	0.0	1.	182.0	0.0	209.9	0.0
SOUTH ATLANTIC	33.2	0.0	1.	111.6	0.0	144.7	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
MOUNTAIN	66.7	47.6	2.	102.1	43.1	168.8	90.7
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	48.6	34.6	4.	124.5	45.9	173.1	59.0

TABLE III-20A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM ABSORPTION AIR CONDITIONING
(BTU/SQ.FT. 000)

WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		NO.OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	58.2	2.7	2.	90.8	22.0	149.0	24.7
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	48.5	0.9	2.	108.7	17.1	157.3	18.0
WEST NORTH CENTRAL	61.1	34.5	6.	86.0	21.9	147.1	29.8
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	49.8	12.4	2.	123.1	2.3	173.0	10.2
MOUNTAIN	38.0	Undefined	1.	115.2	0.0	153.2	0.0
PACIFIC	34.5	3.1	4.	74.3	39.5	108.8	40.7
NATIONAL AVERAGE	49.1	21.2	17.	87.7	31.3	136.9	37.5

TABLE III-20B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM ABSORPTION AIR CONDITIONING
(BTU/SQ.FT. 000)

UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		NO.OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	55.5	5.3	2.	68.5	44.4	123.9	49.7
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	47.8	1.6	2.	94.7	31.3	142.5	32.9
WEST NORTH CENTRAL	53.6	37.0	6.	98.9	39.6	152.6	42.4
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST SOUTH CENTRAL	51.4	17.7	2.	122.8	3.1	174.2	14.5
MOUNTAIN	38.0	0.0	1.	115.2	0.0	153.2	0.0
PACIFIC	34.6	3.5	4.	68.5	46.6	103.0	48.0
NATIONAL AVERAGE	47.5	22.9	17.	91.5	38.2	138.9	42.7

TABLE III - 21A
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM TURBINE AIR CONDITIONING
(BTU/SQ.FT. 000)
WEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		NO.OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST NORTH CENTRAL	142.9	Undefined	1.	107.7	0.0	250.6	0.0
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	51.0	0.0	1.	70.2	0.0	121.2	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
MOUNTAIN	0.0	0.0	0.	0.0	0.0	0.0	0.0
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	105.1	45.2	2.	92.3	18.4	197.4	63.7

TABLE III - 21B
ENERGY CONSUMPTION IN THE 1977 BOMA OFFICE BUILDING SAMPLE
BUILDINGS WITH STEAM TURBINE AIR CONDITIONING
(BTU/SQ.FT. 000)
UNWEIGHTED MEANS AND STANDARD DEVIATIONS
GOVERNMENT OFFICE BUILDINGS

	ELECTRICITY		NO.OF BLDGS	OTHER FUELS		TOTAL	
	MEAN	STD.DEV.		MEAN	STD.DEV.	MEAN	STD.DEV.
NEW ENGLAND	0.0	0.0	0.	0.0	0.0	0.0	0.0
MIDDLE ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST NORTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
WEST NORTH CENTRAL	142.9	0.0	1.	107.7	0.0	250.6	0.0
SOUTH ATLANTIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
EAST SOUTH CENTRAL	51.0	0.0	1.	70.2	0.0	121.2	0.0
WEST SOUTH CENTRAL	0.0	0.0	0.	0.0	0.0	0.0	0.0
MOUNTAIN	0.0	0.0	0.	0.0	0.0	0.0	0.0
PACIFIC	0.0	0.0	0.	0.0	0.0	0.0	0.0
NATIONAL AVERAGE	96.9	65.0	2.	89.0	26.5	185.9	91.5

III-8 Conclusions on Energy Use in Government Office Buildings

The 1977 data base for government office buildings was not representative of government buildings in general either in terms of location or age of buildings. In addition, in some census divisions, the number of observations for some fuel types was very limited, thereby reducing the statistical accuracy of some conclusions. Recognizing that there are some statistical problems it is, nevertheless, possible to make a number of concluding observations on the 1977 data base.

- o In terms of square feet of space in the 1977 data base for commercial and government office buildings, government buildings had relatively less electrically heated space than did the commercial office buildings and had relatively more steam heated space.
- o Government buildings tended to cluster in age between 10 and 49 years, with relatively less new or very old space than the commercial sector.
- o In general, government buildings use less energy than do commercial buildings, with the exception of steam heated buildings. As was the case for commercial office buildings, energy use by government office buildings tended to vary by region of the country and by fuel type.
- o Most government buildings were located in downtown areas; government buildings located in suburban areas tended to use more energy than did downtown buildings.
- o 79% of the government buildings were under 10 stories. There does not appear to be any significant trend in energy use as related to height. In comparison, electric use in commercial office buildings did vary by height.
- o As was the case with the commercial sector energy use, energy use in government buildings was found to vary as a function of building age.
- o Energy consumption also varied with the presence or absence of computer and data processing facilities.
- o Data on air conditioning equipment other than electric air conditioning were very limited; however, it was found that the type of air conditioning has had an effect on energy use.

IV. CONCLUDING COMMENTS

This report has presented data on office building energy use in 1977 for a sample of commercial and government office buildings based on data collected by the Building Owners and Managers Association for its Experience Exchange Report. The data were subjected to as intensive a review and correction procedure as time and resources would permit, and an effort was made to eliminate buildings with questionable data from the data base. Energy consumption data as measured by Btu/Sq. Ft. for electric and fuel use were developed in terms of such building characteristics as fuel type, height, age, equipment, and location.

The commercial office buildings in the 1977 data base are representative to a substantial degree of the overall population of buildings in terms of location and age. In terms of quality of space, it is probable that significant amounts of non-prime space are not included in the data base. It is unknown, however, how much non-prime space exists in the commercial office building sector, and it is, therefore, impossible to evaluate to what degree the buildings are unrepresentative of commercial office buildings in general.

A forthcoming report of the Energy Use in Office Buildings project will present an analysis of a data base which BOMA has gathered for a sample of buildings in 20 cities. In that sample, BOMA attempted to gather data for a random, more statistically representative sample of office buildings; it may, therefore, be possible to characterize the building population in 20 cities between prime and non-prime space and to obtain estimates of energy use in the 2 types of space. This information would then permit an evaluation of the data available from the Experience Exchange Report.

The data presented in this report should be a useful input to models for the forecasting of energy consumption. However, it should be recognized that the data do not provide a cause and effect explanation of what factors drive energy consumption, nor do the data present energy consumption by end use. The 20 city data base will be subjected to a regression analysis under a subsequent task of this project in an effort to obtain insight on what factors cause energy use to vary. No data are gathered for energy use by end use, and it will not be possible, therefore, to develop information on energy use by end use in the regression analysis.

Building energy use simulation programs -- such as the DOE-II, AXCESS, TRACE, Ross Meriwether, etc. -- are typically used to simulate building energy use by end use -- heating, cooling, lighting, hot water, fans, pumps, etc. The programs model energy use as a function of the building shell, the building equipment, and building age. It is currently necessary to rely on these types of programs for end use data, for submetering by function is still not practiced to any significant degree in the commercial office building sector.

The data for government office buildings were of lower quality than those for commercial office buildings; 1977 was the first year in which the government buildings participated in the reporting process. Fewer government building observations were available, and the buildings were not representative of the stock of government buildings in terms of age and location. Therefore, the conclusions regarding the government buildings must be viewed as speculative at this time.

The major objective of the Energy Use in Office Buildings subtask presented in this report was to develop the tabular data. As the data were developed, two additional interesting conclusions emerged: there was a decline in office building energy use between 1975 and 1977, and there is a difference in energy use patterns between commercial and government office buildings.

APPENDIX I

QUESTIONNAIRE USED IN COLLECTING
1977 DATA FOR 1978 EXPERIENCE EXCHANGE REPORT

1978 EXPERIENCE EXCHANGE REPORT

BUILDING
OWNERS
AND
MANAGERS
ASSOCIATION
INTERNATIONAL

1221
Massachusetts Ave. NW
Washington, D.C.
20005

There's a new look to the *Experience Exchange Report (EER)* form this year. But those who have participated in recent years will quickly see that the information requested hasn't changed, except in a few minor instances. The change is in the explanations, given side-by-side with each question for the first time.

Why the big change? Two very important reasons.

First — to make it easier for first-time participants to fill out. Better explanations make it much easier to furnish the requested information. This means it will also be easier and faster for the previous participant to fill out.

Second — to avoid the common misinterpretation of certain questions made in previous years. In processing last year's forms, it was seen that some questions consistently were either left blank or filled in with the wrong type of information. These questions have been rephrased and carefully explained, so it is very important for every previous participant to read the new explanations carefully.

You'll receive a special computer report worth \$125 to BOMA members and \$225 to non-members for your participation. This report analyzes your building's operations in the same way as the *Experience Exchange Report* itself. It breaks your data into cents-per-square-foot figures and provides the same useful statistics such as Management Ratio, Operating Ratio and square feet per person shown in the *EER* tables. It's an extremely valuable document for relating your building to the *Experience Exchange Report* data. Such a report requested through the new *Operating Performance Comparisons* service would cost from \$125 to \$225.

A free copy of the BOMA Standard Method of Accounting or the BOMA Standard Method of Floor Measurement is available if you need it to help fill out your report. To obtain either, just write to BOMA International Information Central, 1221 Massachusetts Avenue NW, Washington, DC 20005, mentioning this report form. Because of the cost of printing, handling and mailing, we would ask that you request copies only if you have specific need for it. For members and purchasers of the *Experience Exchange Report*, both of these can be found in its back section.

Individual assistance in preparing your report is available from several sources. The executive of your local BOMA Association can put you in contact with members familiar with the report, or if you are in a city where there is no local association, write to Dustin Cole, Communications Manager, at the above address, or call 202-638-2929.

Your local BOMA Association will be kept informed of which buildings in your city have filed reports, so that they can encourage greater participation for your city. This is the only information which will be released; *all specific data you furnish remains completely confidential, and is permanently safeguarded.*

FINAL DEADLINE IS APRIL 1 for completed forms, because of the considerable time necessary for processing, checking and analysis. Help us get this, the most important research project conducted by BOMA International, into the hands of the industry as quickly as possible. Persons submitting the first 100 reports will be named in a special "Honor Roll" in the monthly newsletter; *Building Owner and Manager*.

Our sincerest thanks in advance for your participation and support.

Myron Swartz
Chairman
Accounting Committee

Jack L. Dierdorff
President
BOMA International

APPENDIX 1
1978 EXPERIENCE EXCHANGE REPORT FOR DOWNTOWN AND SUBURBAN OFFICE BUILDINGS

Report for (circle one): Calendar year 1977 Fiscal year from _____ to _____

02 Building Name _____
 Building Address _____
 City _____ State _____ Zip _____
01 Please send Individual Building Analysis to: _____
 Address _____
 City _____ State _____ Zip _____
 Report prepared by _____ Phone _____ Date _____

SCHEDULE I - BUILDING AND MANAGEMENT DATA

03 1. STATISTICAL AREAS ☐ Office Area _____ **8-15** Parking: No. Spaces _____
 Measurement method used: Retail Area _____ **16-23** Indoor _____ Outdoor _____
 BOMA NY GSA Storage Area _____ **24-31** Contractor-operated _____ Run by building _____
 Other: _____ Special Area* _____ **32-39** *Describe: _____
 Total Rentable _____
 2. Average 1977 Occupancy: Retail _____ % Office _____ % **40-43**
 3. Building Cleaning: done by (You may check one, more than one, or give percentages)
 Building staff _____ **44** Outside contractor _____ **45** Tenant _____ **46**
 4. AREA SERVICED/ MAINTAINED AT EXPENSE OF BUILDING— whether done by building staff or outside contractor
 Service Office ☐ Other ☐ Total ☐
 Cleaning **47-62** _____
 Electrical _____
 Heating _____
 Air Cond. _____ **63-70**
 Plumbing _____
 Alterations _____
 Repairs _____
 Decorating _____
 5. Assessed Value for Tax purposes
 Land \$ _____
 Bldg. \$ _____
 Total \$ _____
 6. Age in years **71-73** 7. Height in stories **74-76** Number of stories below grade _____
 8. Is Building Occupied by owner or lessee of entire building? NO YES (give percent) _____ %
 9. Office Tenancy: Medical _____ % Utility _____ % Bank or S/L _____ % Government _____ % General Office _____ %
 10. Is Building Agency Operated? Yes **77** No 11. No. of buildings included in this report? **78, POP** **79**
04 12. Building Population (No. of tenants' employees): Office Area **8-13** All other areas **14-19**
 13. Number of Tenants: Office Area **20-23** All other areas **24-27**
 14. Number of employees on Building payroll (not employees of outside contractors): **28-31**
 15. Annual Payroll for all non-management personnel: \$ **32-39**
 16. Building-owned Type Tons Type Energy Used
 Air Conditioning Central **40-45** _____
 Package _____
 Other* _____ *Describe _____
 Annual Depreciation \$ **46-53**
 Number of years remaining on rated life of: Compressors **54-58** Fans **59-62** Ducts **63-66**
 17. Building location: Central Business District Outlying (fringe of downtown) Suburban **67**
 18. Building type: General office, competitive **68** Medical **69** Single Purpose **70** Corporate HQ **70**
 19. Building Electrical Policy: Please give percentages Government-owned **71**
 Office Tenants: Included in rent _____ % Sold, metered _____ % Sold, estimated _____ % **72** Metered direct by utility _____ %
 Other Tenants: Included in rent _____ % Sold, metered _____ % Sold, estimated _____ % **73** Metered direct by utility _____ %

CODING: _____ - _____ - _____ **74-79** No. _____

APPENDIX 1
SCHEDULE II - BUILDING INCOME *Income and Costs in this report are in:* U.S. Dollars Canadian Dollars

Office Area	Retail Area	Storage Area	Special Area	Energy Sales	Miscellaneous	TOTAL OPERATING INCOME
\$	\$	\$	\$	\$	\$	\$
05-08-15	16-23	24-31	32-39	40-47	48-55	56-63

23

SCHEDULE A - OPERATING EXPENSE

	Wages	Supplies/Materials	Contract Services	Miscellaneous	
CLEANING COSTS - A1	06 \$	\$	\$	\$	\$
ELECTRICAL SYSTEM COSTS - A2	07 \$	\$	\$	\$	\$
HEATING COSTS - A3a	08 \$	\$	\$	\$	\$
A/C - VENTILATING COSTS - A3b	09 \$	\$	\$	\$	\$
'COMBINED' HVAC COSTS - A3c	10 \$	\$	\$	\$	\$
ELEVATOR COSTS - A5	11 \$	\$	\$	\$	\$
ADMINISTRATIVE COSTS - A6b	12 \$	\$	\$	\$	\$
	Salaries, Mgt. Fees	Supplies/Materials		Miscellaneous	

	Wages	Supplies/Materials	Contract Services	Miscellaneous	
GENERAL BUILDING COSTS - A6a	13 \$	\$	\$	\$	\$
	Plumbing	Water	Security	Landscaping	
	14 \$	\$	\$	\$	\$

\$ Total of A6a
General Building Costs

	Electric	Gas	Oil	Steam	
ENERGY COSTS - A7	15 \$	\$	\$	\$	\$
	16 KWH	Cu.ft.	U.S. Gallons	Pounds at Fahrenheit temp.	
	17 \$	\$			\$
	18		Tons (2,000 lbs.)		

\$ Total of A7 Energy

U.S. Gallons at Fahrenheit temp. _____

SCHEDULE B - CONSTRUCTION EXPENSE - Expenses for service provided to Tenant Area only.

	Wages	Supplies/Materials	Contract Services	Miscellaneous	
ALTERATIONS	19 \$	\$	\$	\$	\$
DECORATING	20 \$	\$	\$	\$	\$

SCHEDULE C - FIXED CHARGES

	Insurance	Real Estate Tax - Land	Real Estate Tax - Building	Personal Property and special Taxes	
	21 \$	\$	\$	\$	\$
	Leasing Expense	Amortized Tenant Alterations	Depreciation		
	22 \$	\$	\$	\$	\$

Type of Depreciation used:

 Straight-line Accelerated
 Other: _____

TOTAL EXPENSES: \$ _____

NET GAIN OR (LOSS): \$ _____

APPENDIX I
INSTRUCTIONS FOR SECTION TWO

SCHEDULE A - OPERATING EXPENSE

Lines A2 through A5:

These lines do not contain any energy costs; this is costs for maintenance of the named systems only. All energy costs are to be shown in line A7.

Wages and Salaries:

For accurate cost accounting it is essential to divide the salaries of persons whose duties encompass more than one area between the appropriate categories according to percentage of time spent at each. If a specific breakdown is not available, a careful estimate is far more accurate than placing all of these wages into a single category.

Be certain to include social security taxes, compensation insurance, and all fringe benefits in Wages and Salaries.

A1 - Cleaning Costs - Report wages and fringes of employees, including supervisory, who clean offices, lobbies, elevator cabs, corridors, toilets, windows, etc.; report cost of all cleaning supplies, contracts for window and other cleaning, upkeep and ordinary replacement of cleaning equipment.

A2 - Electrical Costs - Cost of maintaining building electrical system only. Includes repairs and ordinary replacements, cost of lamps, fuses and other supplies, wages of electricians and other employees who operate and maintain the electrical system.

A3a - Heating Costs - If building has a combined heating/air conditioning system for which separate costs are not normally obtained, *do not report on this line.* Go to A3c, Combined HVAC. If building has a separate heating system, report cost of maintaining entire system from coal hole or steam meter to office radiators, including labor costs, supplies and parts. Include portion of wages paid engineer, assistant engineer, fireman and any others necessary to operate system.

A3b - Air Conditioning - Ventilating Costs - If building has a combined system which does not facilitate the breakout of heating and A/C-ventilating costs, *do not use this line.* Go to A3c, Combined HVAC. Otherwise, report here all appropriate costs to maintain and operate this system. *Remember to include* all apportioned wages, materials, etc. on a similar basis to that outlined in A3a, Heating Costs.

A3c - Combined HVAC Costs - For reporting all costs related to maintenance, operation and supply of an integrated heating/air conditioning/ventilation system.

A5 - Elevator Costs - Report wages paid elevator starters and operators, cost of labor for inspecting and servicing elevator system and making ordinary repairs; also all other maintenance costs of elevator equipment, signal system, etc., including supplies, materials and ordinary replacements. Also expense for uniforms (cost and upkeep). Maintenance contract should be included after making proper proration for extraordinary repairs.

A6b - Administrative Costs - Report all expenses of office building management and clerical salaries, management fees, fees for legal, auditing, appraisal and engineering services, office supplies and equipment, telephone expense, dues and subscriptions. Include any advertising costs not relating to

space leasing; classified advertising for employees, solicitation for maintenance, supply contracts, etc. *Do not include:* advertising for leasing purposes, leasing commissions or discounts, or any space marketing expense; financial charges such as corporate taxes, or organization expense, executive/corporate salaries and expenses.

A6a - General Building Costs - *Please note carefully* that there are two lines for data; second line requests specific data for subcategories of Plumbing, Water, Security, and Landscaping; here, add all components of each - wages, supplies/materials, contract services and miscellaneous - into a total, and enter appropriately. First line requests the normal breakout of those components for all other General Building Costs not charged to previous sub-categories. Include: keys, lettering on doors, outdoor or public area cleaning, general repairs, directory service, civilian defense preparation costs, etc.

A7 - Energy Costs - Cost and quantity of each type of energy used for building operations and provided or sold to tenants. If temperature on both Steam and Chilled Water *must be furnished* in order to make any calculation of BTU/sq. ft. possible. *Important:* If any portion of your space buys direct from utility, costs and quantities must be obtained and added to totals to produce meaningful energy use figures for your building.

SCHEDULE B - CONSTRUCTION EXPENSE

Alterations, Tenant Area - Cost of minor alterations made in tenant areas, which are assumed by building.

Decorating, Tenant Area - Costs of the normal periodic major cleaning and decorating of offices, refinishing of floors, etc. when paid for by building. Costs of decorating necessitated by alterations should be reported under Alterations, Tenant Area if paid for by building.

SCHEDULE C - FIXED CHARGES

Insurance - Cost of all types of 'building' insurance such as fire, extended coverage, liability and water damage.

Personal Property and Special Taxes - Costs only for personal property taxes and special licenses.

Leasing Expense - Report cost of broker commissions, consultant fees, advertising done for space rental, etc., which relate to leasing of space in building.

Amortized Tenant Alterations - Report annual charge (proration) of major tenant alteration costs, including decorations, paid for by building and amortized over the terms of the leases.

Depreciation - Report here charges for depreciation on the building proper, as well as on all machinery, mechanical equipment, furniture and fixtures. Also, please indicate type of depreciation used.

BOMA is working to forestall the possible requirement for office buildings to report energy-use directly to the federal government. For this, better comparison information for the base year 1972 has been requested. Please help by providing your information in the space on the back of the EER form.

APPENDIX I
INSTRUCTIONS FOR PAGE AT LEFT: PLEASE LEAVE FOLDED.

Before beginning to enter data, please read through the entire form and the explanations which apply to each question. Remember that correlation of data between schedules is essential if accurate relationships are to be shown on both your *Individual Building Analysis* and the *Experience Exchange Report* tables.

GENERAL INSTRUCTIONS

This report form has been color-keyed to assist you in its preparation. Blue indicates account and sub-account titles and black shows general questions and blanks for dollar entries.

Please use dollar amounts only. Do not enter cents on the form. If there is no expense under a heading, please indicate with -0- rather than leaving it blank.

All shaded areas are for computer codings only, and require no entries by you.

To receive your *Individual Building Analysis*, please make sure to fill in that section. It is also very important that the person who actually fills out the report give his or her name and telephone number on the appropriate line, so that he may be reached if there is a question concerning an entry.

SCHEDULE I - BUILDING AND MANAGEMENT DATA

1. Statistical areas: To calculate all other figures correctly, a permanent statistical area must be calculated for each of the rentable building areas. This is done on a 'Single Tenancy Floor' basis. This means that regardless of how a floor is subdivided for multiple tenants, calculations are always based on the 'potentially rentable' area. These statistical areas will not change for the life of the building unless actual structural (not remodeling) changes are made in the building. Be sure to indicate the method of floor measurement used to calculate areas.

Statistical Office Area - Report the total rentable office area in the building, calculated on a Single Tenancy Floor basis.

Statistical Retail Area - Report the total area leased or available for lease as Retail Area. This is normally the ground floor area but may be other locations as well, such as underground, or at upper-level breezeways.

Statistical Special Area - Area leased, used or available for leasing for special purposes such as corporate cafeterias, private clubs, restaurants, etc., which are not on the ground floor of the building.

2. Average 1977 Occupancy - Please average your monthly occupancy rates. This is a very important figure used to factor your costs and income.

4. Area Serviced at Expense of Building - This is extremely important to all allocations of expense between building rentable and office rentable areas. This indicates the allocation of 'Maintenance' costs and not Energy. Please indicate the square footage of the actual statistical area served for each service listed.

6. Age in years: From date building was first available for occupancy.

9. Office Tenancy: Do not include any ground floor 'retail' area doctor's offices or bank-S/L branches.

11. Number of Buildings: If your accounting system is for several buildings on a consolidated basis and you are unable to break them out separately, indicate the actual number of buildings being reported on. Similarly, all statistical areas should show consolidated figures. If more than one building is in report, show averaged age and height in questions 6 and 7.

12. Building Population: Workers in building, not including building employees. If owner-occupied, exclude all personnel equivalent to 'building operating staff'.

14. Building Employees: Wage-rate personnel. Do not include any salaried unless they are actual operations (as opposed to management) personnel.

15. Annual Payroll, non-management: Payroll for the personnel shown on question 14.

16. Building-owned air conditioning: Do not include any units owned and maintained by tenants. Type Energy Used: electric, gas, steam, etc. Package: Under 'Tons' please show total tonnage of all, rather than per unit.

17. Building location: Definition of Central Business District may be obtained from your local BOMA Executive or your Chamber of Commerce.

19. Building Electrical Policy: Please give percentages based on square feet of each in relation to total rentable.

SECTION TWO - INCOME AND EXPENSE DATA

SCHEDULE II - BUILDING INCOME

Office, Retail, Storage, and Special Areas

For general definitions of these areas, see the explanatory notes for Schedule I, question 1, Statistical Areas.

Office Area - Important: space occupied by owner/lessee of building must be included. If space is not charged at fair market value, use cents/sq. ft. averages of rents, as escalated, and charges paid during the year by building tenants.

Energy Sales - Report the gross income from sales to tenants or any other purchaser of electricity or any form of energy (such as steam, chilled water) reported under the 'Energy Costs A7 line below.

Miscellaneous - Report interest earned, cash discounts, recovery of bad debts, sale of waste paper and all other income not reported elsewhere. Include here the gross of all income for all services paid for by tenants which is not included in rent, if these were performed by regular or contract personnel and if the costs for these are included in some part of Schedule A - Operating Expense. If the costs are not included in any Operating Expense category, report only the net income. Such 'extra' services to tenants include above normal "building standard" cleaning, waxing of floors, special security services, special electrical or plumbing facilities, repair of tenants' furnishings, etc.

Income from Escalator or Rent Adjustment Clauses: Report such income in individual rental income categories to which it applies, such as Office Area, Retail Area, etc.

CONTINUED INSIDE

APPENDIX I

YOUR 1972 ENERGY INFORMATION IS URGENTLY REQUESTED

If your trade association can provide energy information in sufficient detail to answer the requests of the federal government, we may be able to forestall any requirement for individual buildings to report directly to the government. Your information for the 'base', or comparison, year of 1972 can be of major help in providing the requested information on an aggregate basis, protecting the confidentiality of all reports. Help your industry and yourself; please take the time to obtain your 1972 data and provide it here.

FOLD HERE

ENERGY COSTS -- A7	Electric	Gas	Oil	Steam	
	15 \$ _____	\$ _____	\$ _____	\$ _____	
	16 _____	_____	_____	_____	
	KWH	Cu.ft.	U.S. Gallons	Pounds at	
	Chilled Water	Coal		Fahrenheit temp. _____	\$ _____
17 \$ _____	\$ _____			Total of A7 Energy	
18 _____	_____	Tons (2,000 lbs.)			48-52
	U.S. Gallons at Fahrenheit temp. _____				

FOLD ON THIS LINE TO MAIL IN WINDOW ENVELOPE

TO SAVE YOU TIME, this form is pre-addressed and designed for return in a window envelope.

DETACH INSTRUCTION SHEET and fold as shown to mail.

AGAIN, OUR SINCERE THANKS for your participation.

1978 Experience Exchange Report
BOMA International
1221 Massachusetts Avenue, NW
Washington, DC 20005

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CHARACTERISTICS OF THE DATA BASE

1. There are 36 cards per building.
2. Each card has a building number, cols 1-4, and a card number cols 5 and 6.
3. The next 19 columns, cols 7-25, contain a vector called NEWREC. NEWREC contains the following variables:
 - a. U.S. census division number, col 7. For a listing of the numbering system for the census divisions, see Attachment 1.
 - b. BOMA region, Col 8, and BOMA city, Cols 9 and 10. For a listing of BOMA regions and cities, see Attachment 2.

- c. Population code of each city, col 11. The codes are as follows:

City Size (number of people)	Code Number
<75,000	1
75,000-125,000	2
125,000-300,000	3
300,000-500,000	4
500,000-750,000	5
750,000+	6

- d. Medical/nonmedical classification, col 12.

The entry "O" denotes a nonmedical building. Any other entry denotes a medical building.

- e. Building age, cols 13-15.
 f. Building height in stories, cols 16-18.
 g. Building size code, col 19.

Building Size (square feet)	Size Code
< 50,000	1
50,000-100,000	2
100,000-300,000	3
300,000-600,000	4
600,000+	5

- h. Building downtown/suburban location, col 20.
 i. Building air conditioning, col 21.
 "O" denotes that the building is air conditioned.

- j. Government/Private Ownership, col 22.

"O" denotes that the building is privately owned; "G" denotes government ownership.

- k. Single Purpose Building Code, Col 23.

"O" denotes that the building is not single purpose.

- l. Agency Management Code, Col 24.

"O" denotes that the building is not managed by an agency.

- m. Number of buildings in report, col 25.

4. The remainder of Card 1 contains the first 3 numbers of a 1×213 vector, REC(I). The 3 numbers are found in cols 26-35, 36-45, 46-55. All elements of the vector REC(I) are defined in Attachment 3.

5. Cards 2 through 31 contain the remainder of REC(I). Each of the cards 2 through 31 has the following format:

Building Number	Card Number	REC	REC	REC	REC	REC	REC	REC									
1	4	6	8	9	18	19	28	29	38	39	48	49	58	59	68	69	78

6. Card 32 contains the following data:

- Building number, Cols 1-4
- Card number, Cols 5-6
- Predominant energy purchased to heat the building: Col 7. Col 7 is coded as follows:

Electricity = 1
Gas = 2
Oil = 3
Steam = 4.

d. Alternative Fuel Capabilities (if any), col. 8.

None	= 0
Electricity	= 1
Gas	= 2
Oil	= 3
Steam	= 4.

e. Grade of oil used, Col 9.

#2 distillate	= 1.
#6 residual	= 2.

- f. Square feet of computer space in the building, Cols 10-15. Such space is counted only where special alterations, such as a raised flooring or additional heating, ventilating, and air conditioning, is required.
- g. Tons of electric air conditioning in the building, Cols 16-20. If window units or a window and central combination are used, the total combined tonnage of all electrical air conditioning equipment is presented.
- h. Tons of steam turbine air conditioning in the building, Cols 21-25.
- i. Tons of steam absorption air conditioning, Cols 26-30.
- j. Whether data are estimated or actual for fuel quantities, cols 31-36. "1" denotes estimated, and "2" denotes actual.

Electricity	col 31
Gas	col 32
Oil	col 33
Steam	col 34
Chilled Water	col 35
Coal	col 36

- k. Whether building is all electric; "1" denotes "maybe" (BOMA uncertain); "2" denotes "yes". Any other entry denotes "no".

7. Card 33 contains real quantity energy data in the following format:

Building Number	Card Number	Electricity kwh (x1000)	Gas cu ft (x1000)	Oil gal (x1000)	Steam Pounds (x1000)
1 4	5 6	7 14	15 22	23 30	31 38

8. Card 34 contains more real quantity data, in the following format:

Building Number	Card Number	Chilled H ₂ O gallons (x1000)	Coal tons
1 4	5 6	7 14	15 22

9. Card 35 contains BTUs (Total) for electricity, gas, oil, steam, coal, all non-electricity, total energy use. The format is as follows:

Building Number	Card Number	Electricity	Gas	Oil	Steam	Coal	All Non Electrical	Total
1 4	5 6	7 16	17 26	27 36	37 46	47 56	57 66	67 76

The following conversion factors were used to convert physical quantities into BTU's:

Electricity :	3412 BTU/kwh
Gas :	1020 BTU/Cu ft.
Oil, #2 :	138,690 BTU/gallon
Oil, #6 :	149,690 BTU/gallon

In cases in which oil type was not specified, it was assumed that #2 oil was used by the building.

Steam :	1000 BTU/cu. ft.
Coal :	No building uses coal

10. Card 36, in the same format as card 35, presents BTU's per square foot of total building area (in square feet) for corresponding quantities.

11. There are no census numbers associated with government buildings, since government buildings are coded by BOMA region and not by city. In the data base furnished by BOMA, all buildings were numbered sequentially. Attachment 4a cross references the sequential numbering system with BOMA's internal numbering system. Attachment 4b lists the city location for each government building.

ATTACHMENT I

CENSUS DIVISIONS AND THEIR NUMBERS

<u>Census Division</u>	<u>Number</u>	<u>Census Division</u>	<u>Number</u>
New England Division	1	West North Central Division	6
Maine		Minnesota	
New Hampshire		Iowa	
Vermont		Missouri	
Massachusetts		North Dakota	
Rhode Island		South Dakota	
Connecticut		Nebraska	
		Kansas	
Middle Atlantic Division:	2	West South Central Division:	7
New York		Arkansas	
New Jersey		Louisiana	
Pennsylvania		Oklahoma	
		Texas	
South Atlantic Division	3	Mountain Division:	8
Delaware		Montana	
Maryland		Idaho	
District of Columbia		Wyoming	
Virginia		Colorado	
West Virginia		New Mexico	
North Carolina		Arizona	
South Carolina		Utah	
Georgia		Nevada	
Florida			
East North Central Division:	4	Pacific Division:	9
Ohio		Washington	
Indiana		Oregon	
Illinois		California	
Michigan		Alaska	
Wisconsin		Hawaii	
East South Central Division:	5		
Kentucky			
Tennessee			
Alabama			
Mississippi			