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M.A. Piette, L.W. Wall, and B.L. Gardiner

April 1985

For Reference

Not to be taken from this room

APPLIED SCIENCE DIVISION

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MEASURED ENERGY PERFORMANCE OF ENERGY-EFFICIENT NEW COMMERCIAL BUILDINGS: RESULTS FROM THE BECA-CN DATA COMPILATION

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April 1985

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ABSTRACT

Measured energy consumption data have been compiled and analyzed for 133 new commercial buildings. Many of these buildings are energy award winners at the forefront of energy-efficient design. About two-thirds of the buildings achieved site energy consumption levels below 70 kBtu/ft^2-yr, or 220 kBtu/ft^2-yr in resource energy units. Almost half of the buildings are all electric. Offices and schools are the dominant building types in the data base. Over 70 percent of the buildings have floor areas larger than 50,000 ft^2. A majority of the buildings presently in the data base are government owned and occupied. Besides energy use, other building characteristics and specific energy-saving features are discussed. Cost data are not available for many of the buildings; preliminary results of the limited data do not show a correlation between energy use and construction cost.

KEYWORDS: Energy Conservation, Commercial Buildings, Office Buildings, Monitoring, Energy Efficiency.

INTRODUCTION

This study represents an extensive and ongoing data collection effort for new commercial buildings designed to be energy efficient, based on actual *measured* performance data. Despite a number of recent reports summarizing the design characteristics of new commercial buildings or reporting on general trends in the stock (Booz-Allen, 1982; DOE, 1982; GE, 1980; EIA, 1981; and BOMA, 1983) there has been a need for a continuing, systematic compilation and analysis of measured data for new, efficient commercial buildings. The BECA-CN* data base attempts to fill that need.

We began this study in 1982 by collecting energy-use data on award winners from competitions sponsored by Owens-Corning, ASHRAE (see insert for a report on the ASHRAE Award Winning Buildings), American Institute of Architects, and the Government of Canada and from buildings described at conferences or in special programs. New government buildings (Federal GSA buildings and California State Office Buildings) were included because of their energy performance guidelines. Although we principally compile data for new energy-efficient commercial buildings, we also compile limited data on conventional buildings since energy data for conventional buildings are needed to establish a performance base line for comparison.

Ideally, we hope to create a data base and devise analytical techniques that allow meaningful comparisons of performance despite differences in climate, occupant densities, operating hours, interior comfort conditions, and special loads such as computers. Another objective is to try to correlate efficient energy usage with features of the building envelope, HVAC or lighting systems, and special equipment or operating practices. This includes analyzing discrepancies between predicted and actual energy performance. A third objective is to analyze the economics of efficient new buildings--specifically, the cost effectiveness of added energy features. Finally, we hope to encourage the exchange of documented performance data and to help establish guidelines for the collection and analysis of such data.

In this article we first discuss our current data collection and analysis procedures. We also discuss the limitations involved with our techniques and with the data currently available. Next, we present the most pertinent results of our present analysis. Finally, we summarize our conclusions and describe future work.

* Buildings Energy-Use Compilation and Analysis (BECA) is an ongoing project at Lawrence Berkeley Laboratory. It includes compilations on the energy performance and cost effectiveness of low-energy new homes (BECA-A), existing "retrofitted" homes (BECA-B), energy-efficient new commercial buildings (BECA-CN), existing "retrofitted" commercial buildings (BECA-CR), appliances and equipment (BECA-D), and validations of building performance models (BECA-V).

DATA COLLECTION AND ANALYSIS

In most cases the first step in gathering data is identifying leads to buildings in reports or journal articles. We then contact the owner, designer, or those responsible for the building's operation (or all three) and collect data using a standard request form to supplement the information contained in the reports and articles. The data are then coded in a consistent format and recorded in the data base.

Types of Data

Data sought for each building include:

- **energy** - usage by fuel type, including peak electric demand, costs, and predicted usage,
- **building description** - location, completion date, gross and conditioned floor area, building type, number of floors,
- **energy-saving features** - lighting and daylighting, HVAC system and controls, building envelope, other features,
- **operating conditions** - hours, occupant density, process loads (e.g., computers or copy machines), temperature and ventilation settings, lighting levels,
- **economics** - total construction cost, added cost of energy features, added operating and maintenance costs.

As a minimum for each building we need to know: size, type, location, year built, annual energy consumption, and some information on features and operating characteristics. Appendix B contains data tables with individual building records for the 133 buildings with actual measured energy values. These tables contain more detailed data on building characteristics, energy use, electric peak demand, energy costs, and special energy features.

Energy Analysis

Our analyses have two main purposes: (1) to find correlations between energy intensities and other building parameters and (2) to compare the BECA-CN energy intensities to other commercial building data sets for bench marks. We calculate energy intensities (kBtu/ft^2-yr, using gross floor area) in both site and resource* units for the most recent year of energy data available for each building.

Limitations of the data restrict evaluations of the energy performance of these buildings. For example, more multi-year data are needed; some of the BECA-CN data represent the first year of occupancy, which may not be indicative of long-term performance. Monthly and seasonal

* Site energy units are calculated using 3413 Btu/kWh. We use 11,500 Btu/kWh for resource units to account for typical power plant efficiency of 33 percent and transmission losses of about 10 percent.

profiles, available for most of the buildings, are essential in sorting out weather-dependent loads and in verifying annual values but have not yet been analyzed in detail. By far the majority of BECA-CN data points currently include only whole-building metered consumption, by fuel type. To get a better understanding of building performance and to make comparisons more meaningful we need more *end-use* (e.g. individual lighting or heating system energy consumption) data. Submetered end-use data will assist us in analyzing specific features. Variations in process loads, outdoor lighting, and operating hours, for example, presently complicate comparisons among building energy intensities.

Economic Assessment

We are able to make only general comparisons of building economics. Both energy and cost data are needed to evaluate the cost effectiveness of a new building, but accurate and complete cost data are very difficult to obtain. Ideally, our analysis would compare the incremental costs of building construction and operation due to the energy-saving design features with the incremental savings in annual energy costs. Lacking these data, we examined the relationship between annual energy consumption and *total* building construction cost for a portion of the data set. Construction costs are not strictly comparable among buildings due to differences in accounting practices. Moreover, these costs vary by location. We offer this comparison as a rough indicator of trade-offs between energy-related first cost and operating costs.

RESULTS OF DATA ANALYSIS

The data base currently consists of 119 U.S. and 14 foreign (mostly Canadian) buildings. The sample includes both very low energy buildings and buildings operating above U.S. stock averages.

Building Characteristics

We summarize some characteristics of the data below.

- **Tenancy**: almost 60% of the buildings are public buildings because government sources have been more willing than private building owners to share energy consumption data. In the future we hope for more cooperative efforts to obtain data on efficient new privately owned and privately occupied buildings.
- **Building type**: office buildings (66%) and educational buildings (14%) are the principal types.
- **Location**: the 119 U.S. buildings are distributed throughout the country across all climate zones with a concentration (about 50% of the total) in the Pacific Northwest and California because of regional studies.

- **Features**: energy management and control systems (EMS's), economizers, and heat-recovery systems are common features and are fast becoming standard equipment for many large commercial buildings. Daylighting is also becoming popular; about one-third of the buildings incorporate some daylighting.
- **Size**: most of the buildings are large. Only 13 of the 133 BECA-CN buildings are under 10,000 ft^2, compared with about three-fourths of the U.S. stock, representing only about 20 percent of the U.S. commercial floor space (EIA, 1981).

Distribution of Energy Consumption

Figure 1 shows the wide range in the actual site energy intensities for the 88 office buildings. The distribution of energy intensities for the 35 all-electric buildings (bottom shade pattern) is very similar to that of the 53 buildings that use some fuel. We do not distinguish between the all-electric and mixed-fueled buildings in the other graphics and tables. However, we do all analyses in both site and resource units; conclusions are similar except as noted below. The majority of the buildings (over 60%) use between 40 and 70 kBtu/ft^2-yr; the median large office intensity is 59 kBtu/ft–yr, and the median small office intensity is 47 kBtu/ft^2-yr. In the next section we further evaluate the energy performance of these buildings by comparing the data to the available bench marks for each building type.

Energy Use by Building Type

The site and resource energy intensities according to building type are summarized in Table 1. Figure 2 shows the same data with less disaggregation among building types. This plot also contains standard deviations for BECA-CN data. The performance data for each building type are compared with 1979 Nonresidential Buildings Energy Consumption Survey (NBECS) data, representative of overall U.S. commercial stock (EIA, 1983), and with energy budgets based on the latest proposed ASHRAE (90-E) standards for new commercial buildings (Battelle PNL, 1983).

The bench mark ranges correspond to differences among U.S. climate zones. In the case of the ASHRAE values, the ranges also include differences across two HVAC systems used to model prototype buildings. Since BECA-CN buildings are much newer than existing stock, we would prefer to compare BECA-CN to energy consumption data for conventional *new* commercial construction rather than *existing* stock. Such data are presently unavailable; therefore we use NBECS data for existing stock.

The average energy intensities for both large and small offices are slightly above the range of ASHRAE standards and well below the intensities of the existing U.S. office stock, as reported in NBECS. The educational buildings contained in our data base consume energy within the ASHRAE 90-E range and well below the NBECS site average but slightly above the NBECS

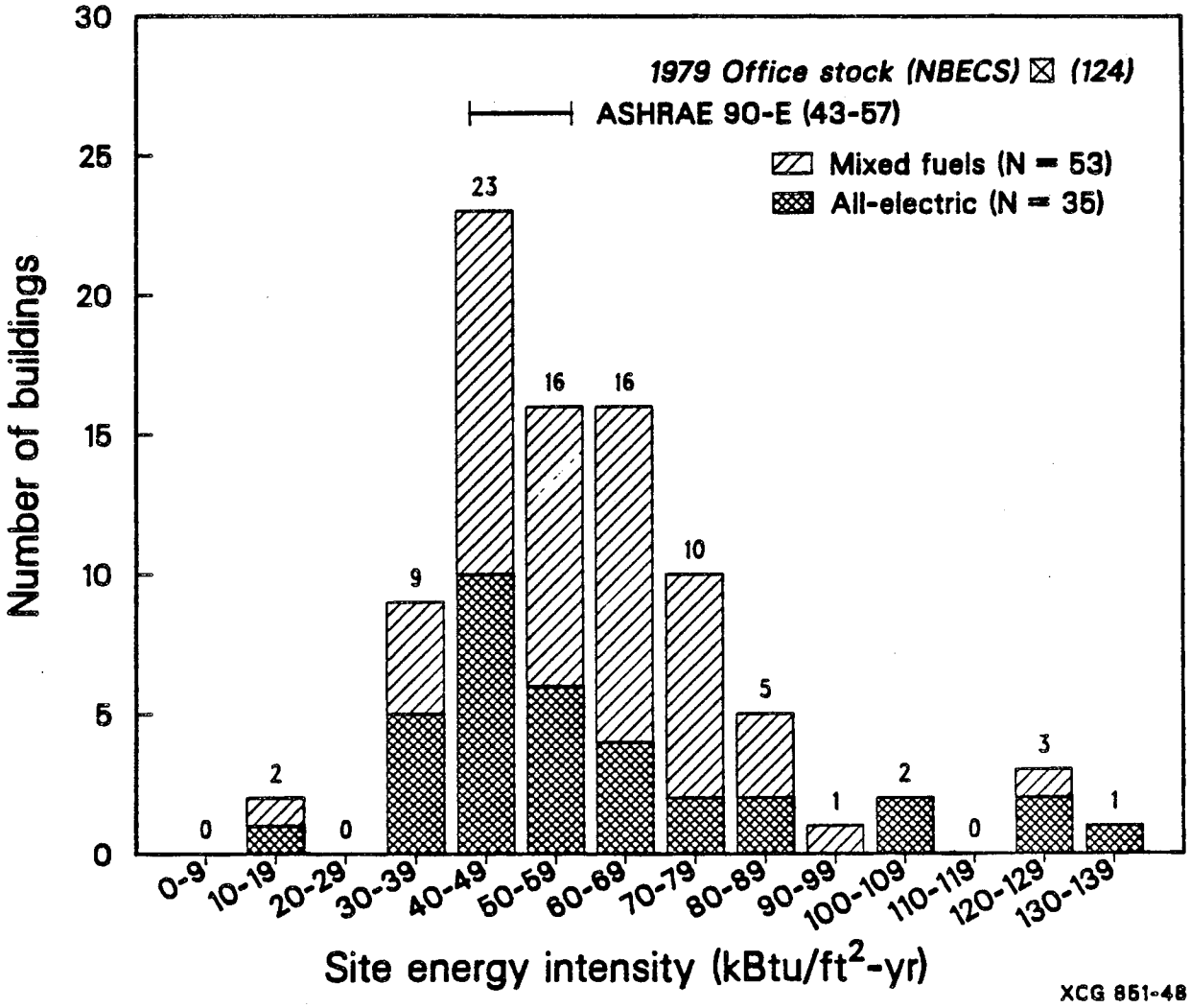

Figure 1. Actual site energy intensity for new office buildings in BECA-CN. The distribution for all-electric and mixed-fuel buildings are similar. Over 60% use between 40 to 70 kBtu/ft^2-yr. The average U.S. office stock (EIA, 1981) and the proposed ASHRAE 90-E values for large offices are included for reference.

Table 1
Summary of Energy Performance

	Site Intensity ($kBtu/ft^2$-yr)							Resource Intensity ($kBtu/ft^2$-yr)					
	BECA-CN				ASHRAE[2] Stnd.	NBECS[3]		BECA-CN				ASHRAE[2] Stnd.	NBECS[3]
Building Type	N	Mean[1]	Median	Range	90-E	Mean	Range	N	Mean[1]	Median	Range	90-E	Mean
Large Office	69	61	59	15-129	43-57			66	176	164	47-435	124-159	
Small Office	19	55	47	11-135	39-51	124	83-147	17	167	145	38-453	133-166	264
College	3	81	74	62-108		87	71-95	3	216	212	186-250		
Secondary	6	73	60	38-129	50-110	87	71-95	5	184	165	129-298	92-191	153
Elementary	9	47	42	32-68		87	71-95	9	143	143	72-209		
Retail	8	77	69	39-134	57-75	87	82-92	8	237	233	130-451	192-252	177
Warehouse	4	42	40	26-62	43-89	108	53-158	3	118	93	53-209	94-130	199
Other	15	61	60	17-99		184	106-131	15	176	176	58-332		335
Total	133	60	56					126	177	165			

1. All BECA-CN means are unweighted, i.e. each building's energy intensity is weighted equally regardless of floor space.
2. ASHRAE values are based on simulations for prototype buildings and are only rough approximations of how buildings would perform under the standard. The ranges include 7 climate zones, and two alternate HVAC systems (Battelle PNL, 1983). The range also incorporates Standard 90-E both with and without daylighting. The values listed for a small office are based on a 49,500 ft^2, 3-story building, which is near the BECA-CN size limit for small offices of 50,000 ft^2. The retail ranges are based on a mall department store, similar in type to most of the BECA-CN retail data. For educational buildings, the range is derived from a junior high prototype, although BECA-CN includes elementary schools, secondary schools, and colleges.
3. NBECS (EIA, 1981) does not distinguish between large and small offices, however, the average U.S. office from this sample has a floor area of 13,700 ft^2. NBECS does not distinguish between colleges, secondary schools and elementary schools. All-electric buildings are averaged with those using mixed fuels. The ranges include sub-averages across 4 U.S. census regions.

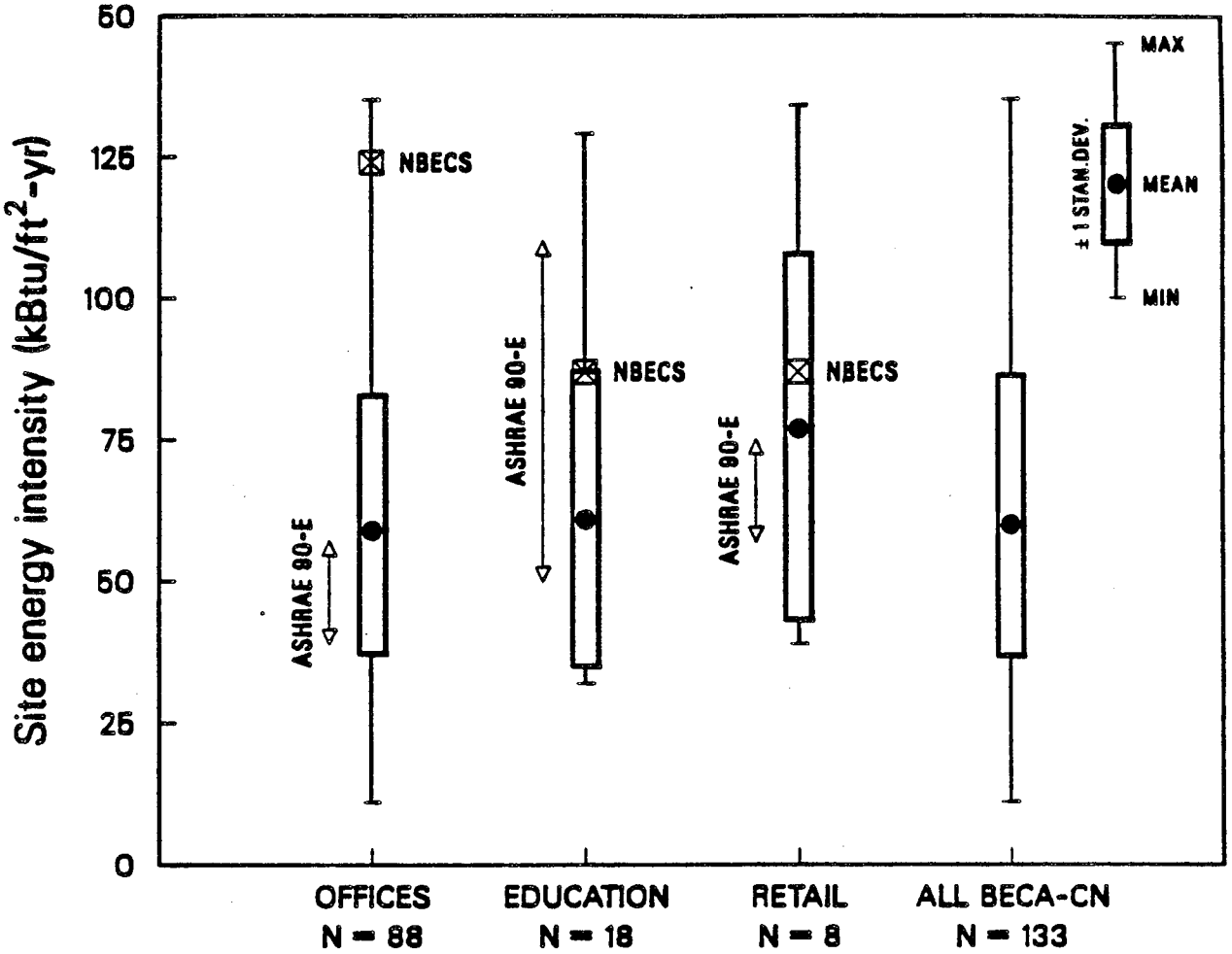

Figure 2. Summary of energy performance by building type for BECA-CN compared to 1979 average U.S. stock (EIA, 1981) and proposed ASHRAE Standard 90-E. Data are from Table 1. The minimum, maximum, mean, and standard deviation are presented for each of the four BECA-CN categories of buildings. No NBECS average or Standard 90-E data are presented for the fourth category because of the wide variety of building types in the total data base. For all three building types the BECA-CN mean is clearly below the U.S. average stock, but in only one case is it within the range of the standard.

resource intensity average. The latter result indicates the relatively higher electricity component of the total building consumption by the BECA-CN educational structures as compared to the overall U.S. educational stock.

There appears to be less emphasis placed on energy-efficient design in the retail sector, compared to offices and schools. For the retail sector the average intensity is approximately the same as the upper value in the ASHRAE 90-E range and below the NBECS site average, but above the NBECS resource average. The "retail" classification covers a wide variety of businesses that require vastly different energy inputs, making the NBECS and ASHRAE bench marks less comparable than for the other commercial building types. Although the NBECS retail data includes energy-intensive supermarkets, BECA-CN does not. The ASHRAE 90-E value is based on a shopping mall department store.

In this section we have attempted to address the questions, "what is an energy-efficient commercial building?" and "efficient compared to what?" These comparisons highlight some of the difficulties in analyzing whole-building data for commercial buildings and in finding valuable bench marks. An example of the problems involved in comparing actual building energy use with energy standards is that the ASHRAE values do not include energy used for exterior lighting, whereas the BECA-CN data do in most cases. Also, the ASHRAE simulations assume only minimal process loads (0.5 to 1.0 W/ft^2); we don't know the process load range among the BECA-CN buildings. As mentioned earlier, we hope to make comparisons more valid in the future as end-use data become available, enabling us to correct for the energy consumption of these extraneous systems.

Economics

Neither energy intensity nor annual energy costs are correlated with construction costs. Figure 3 shows the relationship between resource energy intensity and construction cost for the 63 buildings with available cost data. We present this plot in resource energy units since they reflect energy costs better than site units. All costs are inflated to 1984 dollars and normalized by building floor area. Even though most (60%) of these buildings are offices, the data are well scattered. The average BECA-CN construction cost is \$76/ft^2; the average resource energy intensity for this subset is 181 kBtu/ft^2-yr. These averages compare favorably with the NBECS average of 264 kBtu/ft^2-yr (resource intensity) for 1979 office stock and with average U.S. office building costs*, which range from \$55/ft^2 to \$85/ft^2 (Dodge, 1976 and 1982). The buildings in this subsample that are the least energy intensive are as likely to be at the low end of the range of

* This range is derived from 1976 and 1982 national average construction costs per ft^2 for corporate and general offices. Dodge divides averages into low, middle, and high cost buildings to represent differences in construction quality and complexity.

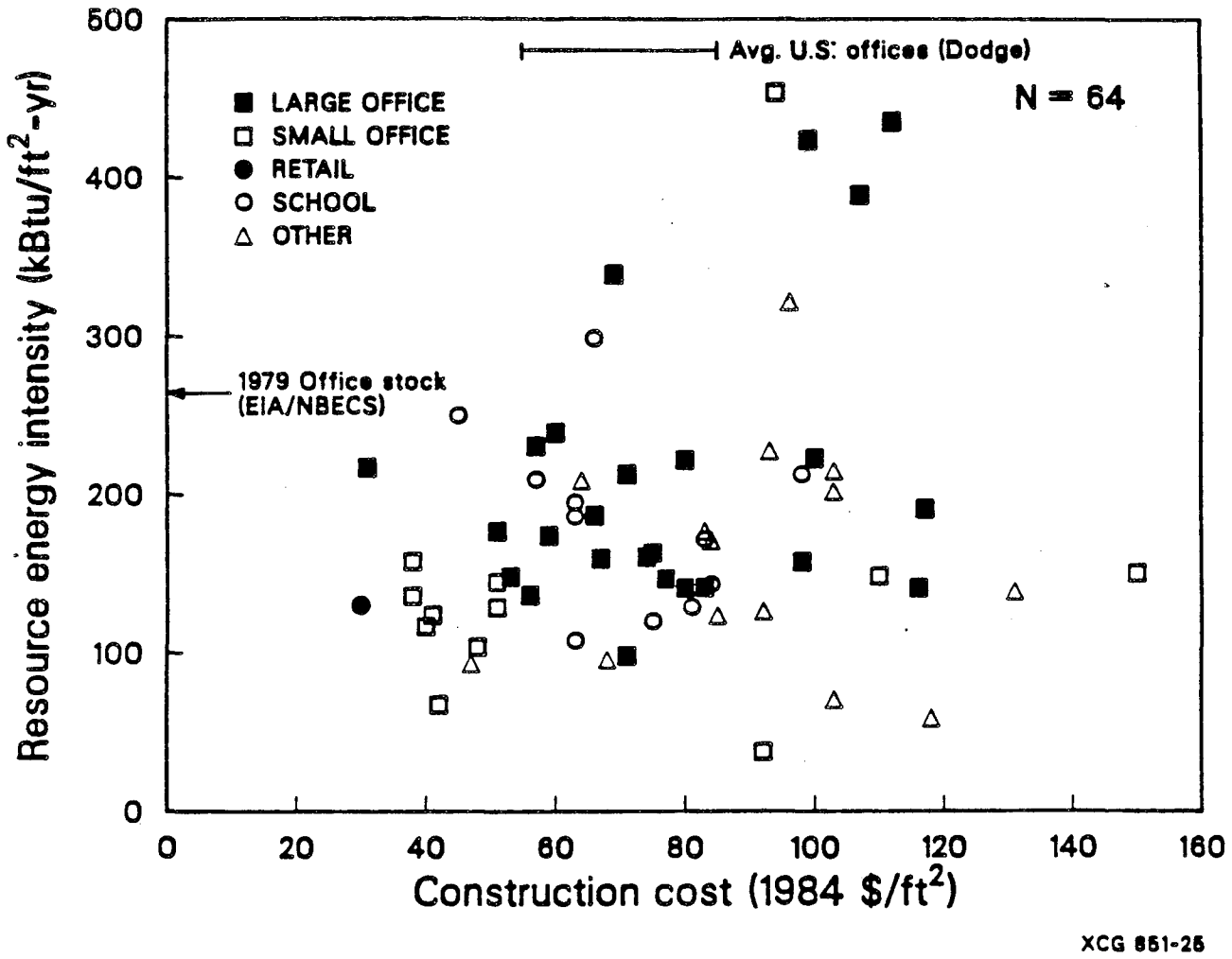

Figure 3. Resource energy intensity versus construction cost, for new commercial buildings in BECA-CN. Based on this subsample there is no clear correlation between construction costs per square foot and energy intensities; it is possible to produce a low-energy building over a considerable range of construction costs. National average construction costs for offices ($55/ft^2 to $85/ft^2) are included for reference.

construction costs as at the high end. The data suggest it is possible to build relatively low-cost buildings that also perform well.

Actual vs. Predicted Energy Use

Figure 4 shows actual measured site energy intensity versus the designed site intensity for a subset of 33 buildings. The average site energy intensity for this sample is 57 kBtu/ft^2-yr, and the average predicted value is 46 kBtu/ft^2-yr. Much of the difference between the two preceding averages can be attributed to the 8 cases for which designed performance levels of 30-40 kBtu/ft^2-yr (site) were not achieved and actual total site intensities ranged from 60 to 127 kBtu/ft^2-yr. We will continue to collect energy data and operating characteristics from all 33 of these buildings to see if they more closely approach their designed consumption.

Discrepancies between "predicted" and actual consumption are to be expected. Many of these "predictions" are based on simulations made to test the relative performance of various strategies, not to predict the actual performance. For several of the buildings, the design estimates did not include major process loads. In addition, buildings are often not operated according to design conditions. Some of the buildings contain design features that are currently not being used.

We offer two examples. In one office building we visited, the light-dimming controls were installed but not yet operational even though the building had been fully occupied for over a year and daylighting was ample. This building uses 77 kBtu/ft^2-yr, about twice the design prediction of 35 kBtu/ft^2-yr. In another large office the actual energy use of 101 kBtu/ft^2-yr was almost three times the design value of 38 kBtu/ft^2-yr during the first year of full occupancy. The building is operated longer hours than anticipated, which would be expected to increase the energy consumption. This increased operating schedule has also limited the effectiveness of the design features. A night flushing system to cool down the structural thermal mass has not been used because it causes turbulence and noise unacceptable to nighttime occupants. In addition, the design prediction of energy use did not include process loads. A computer center in the building contributes to the high energy consumption; current monitoring will enable us to assess the magnitude of this load.

Energy Intensity vs. Building Size

Figure 5 shows that, on average, the larger BECA-CN buildings use about the same amount of energy per square foot as the entire sample. There appears to be a larger range of energy intensities for small buildings than for larger ones. This may be partially attributable to the greater weather dependency of small buildings; internal gains tend to dominate the conditioning requirements of large buildings. Again, the present compilation of buildings operate at intensities well below 1979 office stock and 1979 school stock as reported by NBECS.

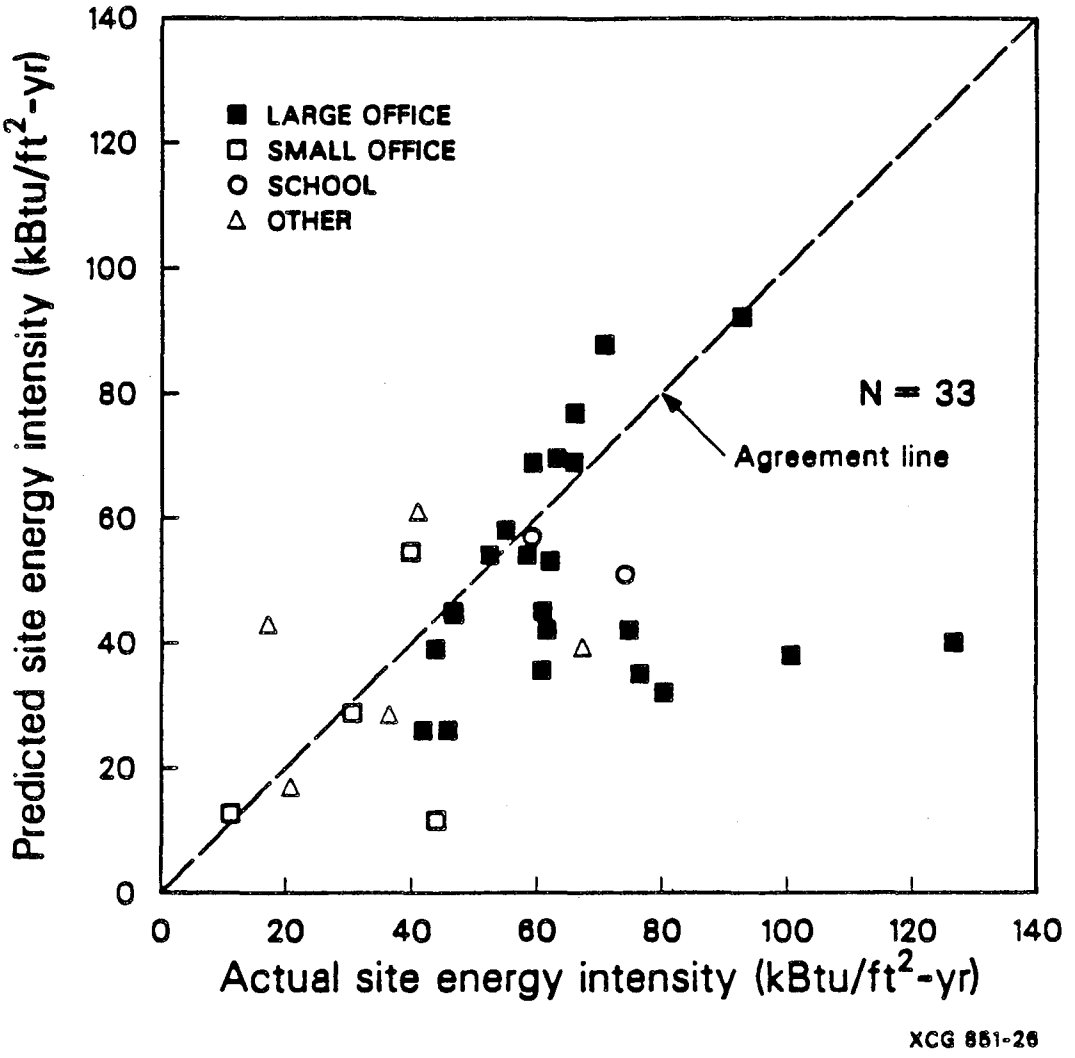

Figure 4. Predicted energy intensity versus actual energy intensity, for new commercial buildings in BECA-CN. The average actual site intensity is 57 kBtu/ft^2-yr, and the average predicted intensity is 46 kBtu/ft^2-yr. Energy use is above predictions for two-thirds of the buildings. The most important reason for the discrepancies is that design conditions often varied greatly from actual operating conditions.

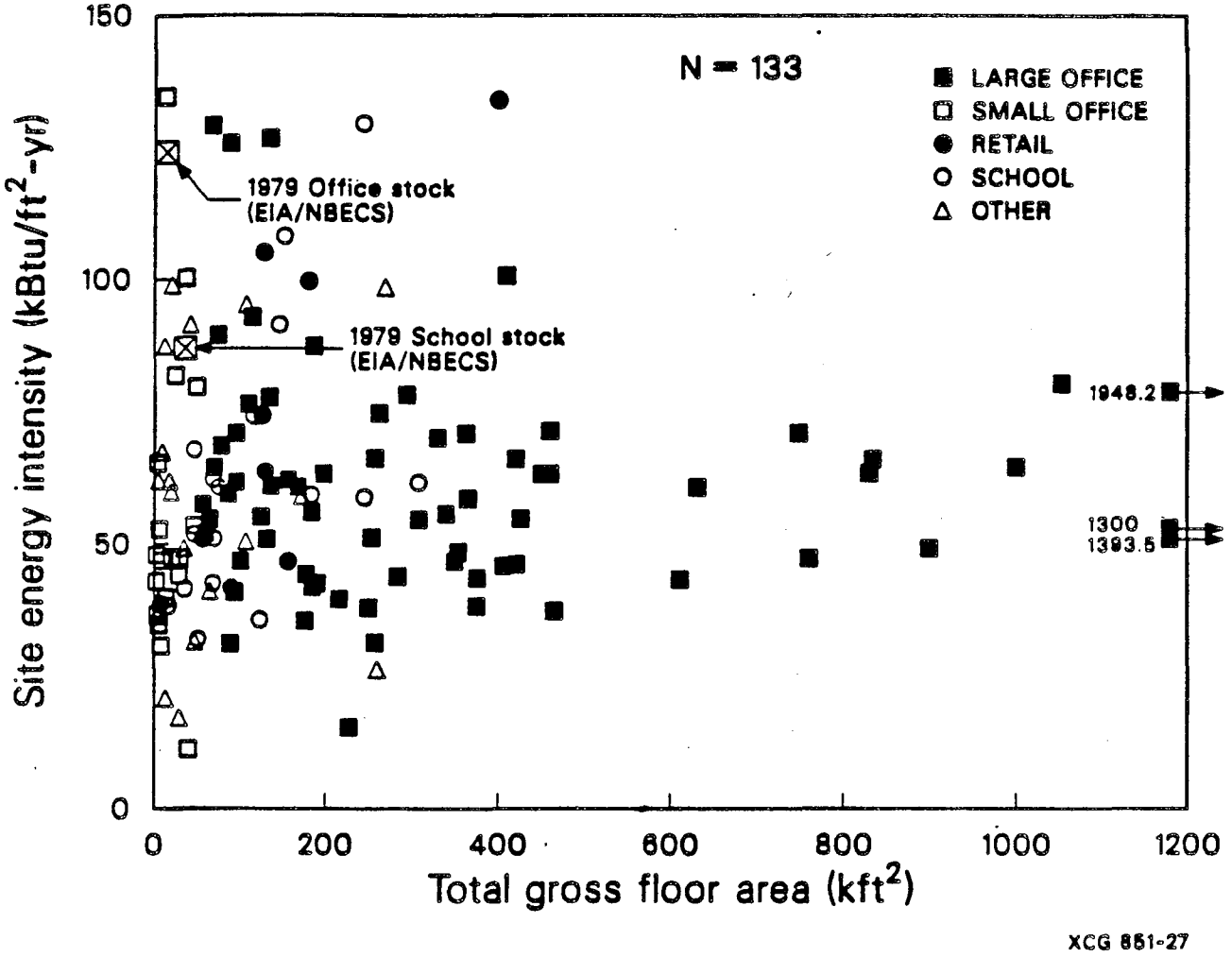

Figure 5. Site energy intensity versus gross floor area for new commercial buildings in BECA-CN. The larger buildings use, on average, about as much energy per square foot as the average for the overall sample, but there appears to be more variation in energy intensities among smaller buildings. Average 1979 U.S. office and school stock are included for reference.

CONCLUSIONS

The data presented in this paper provide an initial view of trends in new, energy-efficient commercial buildings. Most new buildings in our sample are operating at energy intensities far below average for the U.S. commercial building stock and near the range predicted for the proposed ASHRAE 90-E guidelines. The low energy use of these building may be attributed to a variety of building features, as documented in the data tables (discussed earlier). Innovative design features involving the HVAC system and controls are common in this sample. For the newest buildings there is also emphasis on efficiency-related features of the glazing, daylighting, and lighting systems.

Limitations in data continue to restrict our understanding of energy use in new commercial buildings. The wide range of energy intensities is difficult to explain with annual whole-building energy data. Occupancy, operating, and weather conditions may affect the energy consumption more than the presence of energy-efficient features. These factors should be taken into account in evaluation of the energy performance of commercial buildings.

To address these issues future work will include compiling data on additional buildings, collecting additional detail on building operating and occupancy conditions, and improving our base line data for comparison. Along this line, we will be collecting detailed end-use data, which are becoming available for many new commercial buildings. A large-scale end-use monitoring project in the Pacific Northwest will be a major source for these data. We are also studying the use of EMS's as a source of submonitored data. In addition, we are working on evaluating "low-power" buildings and documenting the performance of various load-management techniques.

Since the data compilation project is a continuing effort, we solicit from the reader any comments, suggestions, or leads to additional data sources.

ACKNOWLEDGMENTS

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The authors would like to thank the many people who supplied the actual building data for this study, as well as those who provided us with valuable leads to new data. Special thanks to Robert Shibley for his assistance in helping us gather data on the Owens-Corning Energy Award Winners and to the many ASHRAE members and staff who supplied us with information on the ASHRAE Energy Awards Program. We also thank Scott Crowder, Denise Flora, and John Hartmann for their assistance with data collection in California and the Pacific Northwest, and

Jeffrey Harris for his helpful advice.

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APPENDIX A

This section and the accompanying figure is to be appear in the ASHRAE Journal article as a highlighted sub-article.

ASHRAE ENERGY AWARD WINNERS

Fourteen commercial buildings that have been national winners in the ASHRAE Energy Awards Program (1981-84) are included in the present data base. Their characteristics, energy performance, and special features are fairly consistent with that for the overall collection of buildings. Twelve of the fourteen buildings are either office buildings or schools. The date of construction for the set ranges from 1978 to 1982. Slightly over one-half are all electric, and exactly one-half are public buildings. The floor areas are large, with all but three buildings over 50,000 ft^2. Ten of the buildings are in the U.S., scattered throughout the country. The other four are located outside of the U.S.. The site energy intensities of the ASHRAE winners are displayed in the histogram (Figure A) and can be compared with the distribution for all the buildings in the data base. The energy performances are very similar, with the average site value of 61 $kBtu/ft^2$-yr for the ASHRAE winners differing only slightly from the average values of 60 $kBtu/ft^2$-yr for the entire 133-building collection. Both values are much lower than the average energy consumption intensities of existing commercial stock. A majority of the ASHRAE award-winning buildings have EMS's, economizers, heat-recovery systems, and thermal storage as part of their special energy features.

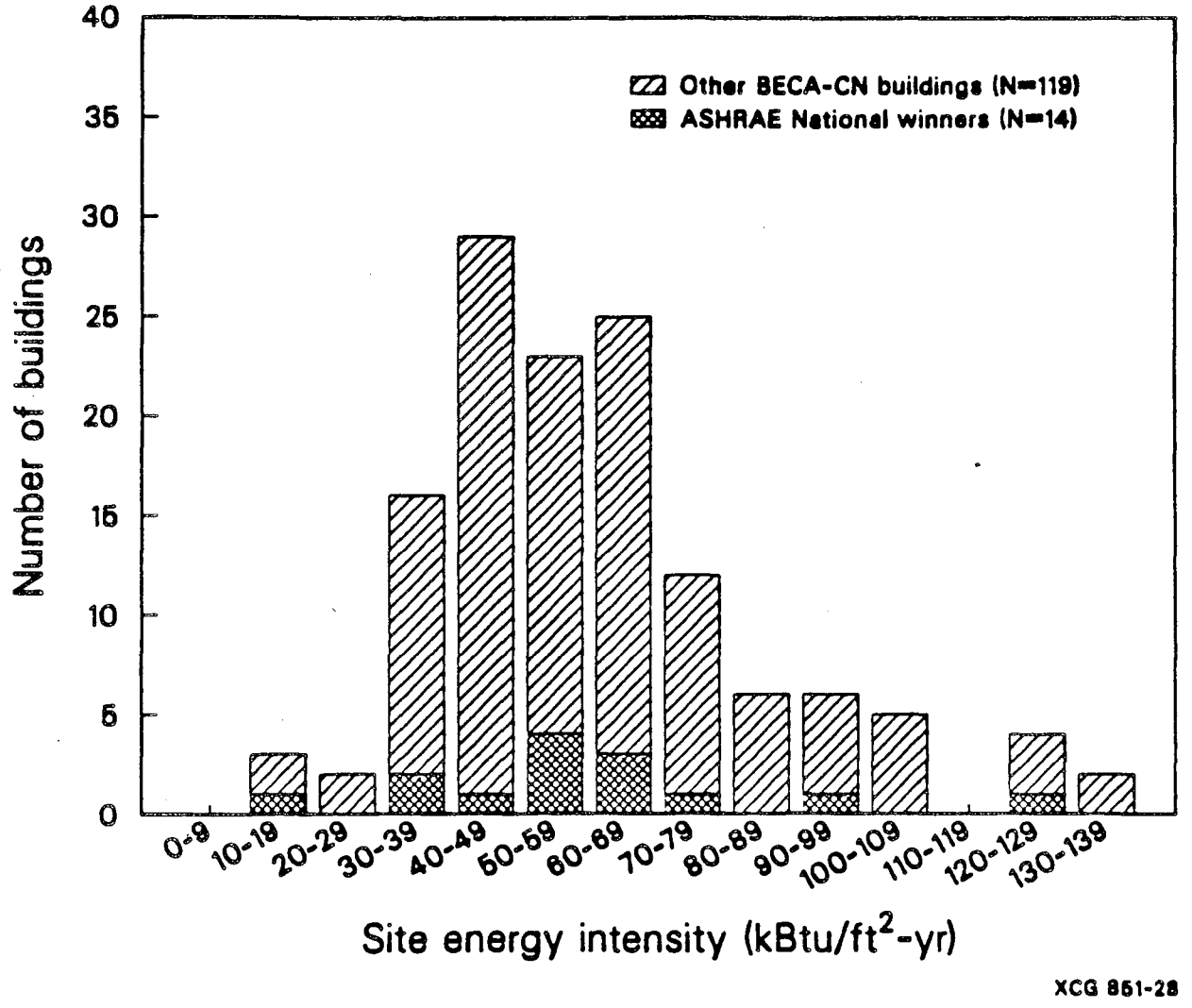

Figure A. Actual site energy intensity of the ASHRAE winners compared to the entire BECA-CN collection. The distribution of energy performance for these two samples are very similar. Nine of the fourteen ASHRAE winners are offices; three are schools.

APPENDIX B

BECA-CN Data Table Definitions

July 1985

These data tables contain characteristics, features and energy usage for 133 buildings in the BECA-CN (Buildings Energy-Use Compilation and Analysis - part CN: New Energy-Efficient Commercial buildings) data base. The data are in order by building type and descending floor area.

The BECA-CN data base contains additional information for each buildings not printed below. Some of this information will be printed in future reports. Contact the Buildings Energy Data Group at Lawrence Berkeley Laboratory for more information.

Data Table 1 Definitions: FEATURES OF BUILDINGS IN BECA-CN

A. BUILDING IDENTIFICATION NUMBER: assigned arbitrarily.

B. LOCATION: city (B1) and state (B2) where building is located. For buildings located outside of the United States, country is printed instead of state (B2). These are AU-Australia, CN-Canada, JP-Japan, and PH-Philippines.

C. BUILDING TYPE: based on predominant use of occupied space.

LOFF	Large office building, over 50,000 ft^2
SOFF	Small office building, less than 50,000 ft^2
BANK	Branch bank and loan offices
COLL	College or university
SECN	Secondary school, high school
ELEM	Elementary school, primary
DEPT	Department store
SHOP	Shopping center
RETL	Retail
CLIN	Clinic
ARPT	Airport terminal
LIBR	Library
WARE	Warehouse
OTHR	Other type of building (ex: community center, laboratory, post office)

D. YEAR BUILT: year construction completed.

E. GROSS FLOOR AREA: total gross floor area in 1000 ft^2. This includes conditioned and non-conditioned spaces, but generally does not include parking. If parking is included it is noted in the comments section (Y). For three of the buildings we only have conditioned floor area. A "C" follows the floor area value in these cases.

F. NUMBER OF FLOORS: maximum number of stories, excluding indoor parking.

G1. ENVELOPE R-VALUES WALL: average wall R-value (English Units).

G2. ENVELOPE R-VALUES ROOF: average roof R-value (English Units).

G3. ENVELOPE R-VALUES GLASS: average glass R-value (English Units).

H. NUMBER OF PANES: predominant number of window panes.

I1. GLASS AS % OF WALLS ALL: overall % of wall area covered by windows.

I2. GLASS AS % OF WALLS SOUTH: southern wall % of area covered by windows.

J1. OCCUPANTS NUMBER/KFT^2: average number of occupants per 1000 ft^2. This data is also often estimated.

J2. OCCUPANTS HOURS: building occupancy code.

M	Minimal (less than 40 hrs/week)
R	Regular (40-50 hrs/week)
E	Extended (51-75 hrs/week)
F	Full (76-168 hrs/week)

Data Table 2 Definitions: CHARACTERISTICS OF BUILDINGS IN BECA-CN

The first two columns in Table 2 are the same as the first two in Table 1. The definitions below begin with the third column.

K. INSTALLED LIGHTING LOAD (W/FT^2): installed lighting load. Data may not be consistent among buildings. Often this data is estimated. We ask for overall average for the building, but data may be for the office area only, for example. Task lighting is often not included.

L1. LIGHTING TYPE 1: space for the three main types are recorded in the data base. The most predominant two are printed here. The first type is the major type. The codes are:

FLU	Fluorescent
HGV	Mercury vapor
HAL	Metal halide
INC	Incandescent
HPS	High pressure sodium
HID	High intensity discharge (when we don't know if it is HGV, HAL, or HPS)
PFL	Parabolic Fluorescent Luminaires.

L2. LIGHTING TYPE 2: see above (L1).

M. AVERAGED USED LIGHTING LOAD (W/FT^2): average used load. This data is also often estimated. May or may not include task lighting.

N1. DAYLIGHT TYPE:

RF	Reflectors for bouncing light into the building
LW	Light wells
SKY	Skylights for lighting (not included if just decorative)
RM	Roof monitors
AT	Atrium for lighting (often for heat gain too)
SH	Light shelves
CL	Clerestory.
OT	Other

N2. LIGHT CONTROLS:

SW	Switches for banking rooms or floors
CP	Computerized (on the Energy Management System)
PC	Photocell for dimming with daylight sources
PM	Photocell & Microprocessor
TM	Timer
PS	Personnel Sensors
RS	Radio active switches for easy control
DM	Dimmers that allow selective reductions

OT Other type

O1. SPECIAL EQUIPMENT: (some of these codes may be found in either column O1 or O2, there is some overlap.)

ST Thermal Storage (hot or cold water tanks, ice, eutectic salts, etc.)
TM Thermal Mass (usually means trombe walls, passive solar)
SO Active Solar
EB Earth Berms
EZ Economizer
ED Direct Evaporative Cooling
HR Heat Recovery
HL Heat Recovery Luminaires
OW Operable Windows
CT Cooling Tower
SH External Shading (fixed or movable)
FS Fixed External Shading
MS Movable External Shading
MI Movable Insulation
HL Heat Recovery Luminaires
OT Other

O2. SPECIAL CONTROLS OR CONTROL STRATEGIES: (some of these codes may be found in either column O1 or O2, there is some overlap.)

EMS Energy Management Control System
NS Night Setback
LM Load Management
NC Natural cooling/night ventilation
TM Timers/clock thermostats
OA Outside Air (use for cooling, i.e. economizer usage)

P1. PRIMARY HEATING FUEL:

S Steam
E Electricity
G Natural Gas
O Oil
H Solar
X Other (one case includes purchased geothermal hot water)
N None

P2. PRIMARY HEATING EQUIPMENT DESCRIPTION:

RS Resistance (electric)
HP Heat Pump
HR Heat Recovery
SO Active Solar
BO Boiler
IR Infrared (used in warehouses)
FR Furnace

RP Roof Top Package
OS Off Site Source

Q1. PRIMARY COOLING FUEL:

S Steam
E Electricity
H Solar (for solar absorption chillers)
W Chilled Water
N None

Q2. PRIMARY COOLING EQUIPMENT DESCRIPTION:

HP Heat Pump
CH Chiller (general: don't know type)
CC Centrifugal Chiller
RC Reciprocating Chiller
AC Absorption Chiller
SA Solar Absorption
EC Evaporative Cooling
ST Thermal Storage (Ice or Water)
RP Rooftop Package
DX Direct Expansion Cooler
OS Off site source (chilled water)
OT Other
N None

Data Table 3 Definitions: ENERGY CONSUMPTION OF BUILDINGS IN BECA-CN

The first two columns in Table 3 are the first and the fourth column in Table 1. The definitions below begin with the third column.

R. YEAR OF DATA: most recent year of energy data available for the building. The year built is printed next to data year to show the age of the building for the year of data. For many of the buildings, this is the first year of operation.

S1. MEASURED ANNUAL ENERGY INTENSITY ELECTRICITY (KWH/FT^2-YEAR): electrical energy consumption in.

S2. MEASURED ANNUAL ENERGY INTENSITY FUEL, OTHER (KBTU/FT^2-YEAR): fuel (gas, oil, etc.) and other (steam, chilled water, etc.) consumption totals at the site.

S3. ANNUAL RESOURCE ENERGY (KBTU/FT^2-YEAR): Total resource energy intensity. Electricity is multiplied by 11,500 to convert kWh to Btu.

S4. ANNUAL SITE ENERGY (KBTU/FT^2-YEAR): Total site energy intensity. Electricity is multiplied by 3413 to convert kWh to Btu.

T. PREDICTED ANNUAL SITE TOTAL (KBTU/FT^2-YEAR): predicted annual site energy intensity. Sometime these predictions do not include all of the building loads. When available, we record the prediction method.

U1. MEASURED PEAK ELECTRICITY LOAD (W/FT^2) WINTER: peak electrical load for the winter (heating) months of November through April.

U2. MEASURED PEAK ELECTRICITY LOAD (KW/FT^2) SUMMER: peak electrical load for the summer (cooling) months of May through October.

V. ANNUAL ENERGY COST (1984 $\$/FT)^2$: total energy cost per ft^2 for the recorded year of operation. All costs have been adjusted to first quarter 1984 dollars using GNP deflators from the first quarter dollars of the year for the energy data.

W. CONSTRUCTION COST (1984 $\$/FT^2$): total building construction cost per ft^2 excluding land. Costs have been adjusted to first quarter 1984 dollars using GNP deflators.

X. CFA RATIO: conditioned floor area ratio. Obtained by dividing the conditioned floor area by the gross floor area.

Y. BUILDING CONFIDENCE LEVELS: Our assessment of the data quality.

- A Well documented case study information, high confidence in most values
- B Reported or certified by reputable person who had direct access
- C Marginally Acceptable, second hand data

Z. COMMENTS: miscellaneous information.

DATA TABLE 1: CHARACTERISTICS OF BUILDINGS IN BECA-CN
N = 133, JULY 1985

(A) BLDG ID	(B1) CITY/STATE	(B2)	(C) BLDG TYPE	(D) YEAR BUILT	(E) FLOOR AREA (K SQFT)	(F) # FLOORS	(G1) <-------ENVELOPE------> <-------R-VALUES------> WALL	(G2) ROOF	(G3) GLASS	(H) # PANES	(I1) <GLASS AS %> <-OF WALLS-> ALL	(I2) SO.	(J1) <-OCCUPANTS-> (#/K SQFT)	(J2) HRS
4	WASHINGTON	DC	LOFF		1948.2	6				1		64 %	2.1	
51	STE-FOY	CN	LOFF		1393.5	8	10.9	16.7	2.0		46 %		2.2	R
37	TORONTO	CN	LOFF	1975	1300.0	23	10.0	14.3				52 %	3.8	R
71	HOUSTON	TX	LOFF	1981	1053.3	5	6.7	5.0	0.9		54 %	60 %	0.1	R
136	EL SEGUNDO	CA	LOFF	1982	1000.0	21				1	60 %		5.3	F
24	SAN DIEGO	CA	LOFF	1976	899.2									
47	NORTH YORK	CN	LOFF	1978	834.0	13				2				R
1	SEATTLE	WA	LOFF	1973	830.0	38					50 %		3.0	R
66	ATLANTA	GA	LOFF	1980	760.4	24	25.0	20.0		2		50 %		
147	SAN FRANCISCO	CA	LOFF	1981	748.7	38				1	50 %	50 %		R
42	ANCHORAGE	AK	LOFF	1979	631.3		16.7	16.7		2		27 %		R
17	INDIANAPOLIS	IN	LOFF		611.2	6				1	70 %	70 %	2.6	
13	JACKSON	MS	LOFF		465.3	15								R
182	REGINA	CN	LOFF	1981	460.0	15	11.0	20.0		2		40 %		R
65	BIRMINGHAM	AL	LOFF	1981	460.0	3	20.0	12.5		2				
20	LINCOLN	NE	LOFF	1975	450.2	7	3.0	7.1				80 %	2.0	
145	WESTLAKE VILLAGE	CA	LOFF	1982	426.0	3	5.9	5.3	2.0	2	60 %		2.3	R
14	COLUMBIA	SC	LOFF		421.4									
2	PORTLAND	OR	LOFF	1975	420.5	20					42 %		3.3	
74	SACRAMENTO	CA	LOFF	1982	410.0	2	14.3	14.3		2			4.9	
165	PORTLAND	OR	LOFF	1982	406.0	15				1			3.2	R
10	SYRACUSE	NY	LOFF	1976	376.0	14	10.0	16.7		2	13 %		2.4	
19	AKRON	OH	LOFF		375.6	5				2	25 %	25 %		
169	PORTLAND	OR	LOFF	1980	365.0C					2				R
52	LONDON	CN	LOFF	1980	362.6	9	10.5			2	28 %		2.8	R
56	TACOMA	WA	LOFF	1971	354.1C	5	11.1	11.1						R
25	WOODBURY	MN	LOFF	1978	350.0			20.0						
30	TROY	MI	LOFF	1979	339.5	3								R
55		PA	LOFF	1971	330.0						25 %		5.5	
50	LONDON	CN	LOFF	1976	308.5	11	11.6			2	25 %			R
48	RED DEER	CN	LOFF	1979	294.0	6	14.3	10.9		2	28 %			R
70	IDAHO FALLS	ID	LOFF	1979	284.0	3	12.5	16.7		2	40 %	40 %	5.3	R
62		MI	LOFF	1979	263.0	14	12.5		1.8		20 %		2.5	
23	VAN NUYS	CA	LOFF	1975	258.2									
9	ALBANY	NY	LOFF	1974	257.4	10	6.7	5.7	2.0		15 %		4.7	
15	FT.LAUDRDALE	FL	LOFF	1979	253.6	4				2			1.6	
11	NORFOLK	VA	LOFF		250.3									
32	BRISBANE	AU	LOFF	1980	227.6	26				2				
183	PERTH	AU	LOFF	1980	216.8	3				1				R
3	FAIRBANKS	AK	LOFF	1977	197.3	4								
149	SAN FRANCISCO	CA	LOFF	1980	191.0	19				1	50 %	50 %		
8	NEW HAVEN	CT	LOFF		186.8									
60	TOPEKA	KS	LOFF	1977	185.2	4	20.0	11.9			17 %		3.2	
16	ORLANDO	FL	LOFF	1975	183.6	6							2.7	
143	BURLINGAME	CA	LOFF	1980	177.6	9				1			3.9	R

DATA TABLE 1 - CONTINUED: CHARACTERISTICS OF BUILDINGS IN BECA-CN

(A) BLDG ID	(B1) CITY/STATE	(B2)	(C) BLDG TYPE	(D) YEAR BUILT	(E) FLOOR AREA (K SQFT)	(F) # FLOORS	(G1) <-------ENVELOPE------> <-------R-VALUES------> WALL	(G2) ROOF	(G3) GLASS	(H) # PANES	(I1) <GLASS AS %> <-OF WALLS-> ALL	(I2) SO.	(J1) <-OCCUPANTS-> (#/K SQFT)	(J2) HRS
5	MANCHESTER	NH	LOFF	1976	176.4	7	16.7	16.7		2	6 %			E
141	WALNUT CREEK	CA	LOFF	1982	168.0	3				1		50 %		E
117	LONG BEACH	CA	LOFF	1982	156.0	4	14.3	25.0		1	38 %			R
126	ANAHEIM	CA	LOFF	1980	136.1	7	12.5	20.0		1			2.2	R
67	SACRAMENTO	CA	LOFF	1979	135.0	2								E
140	SANTA CLARA	CA	LOFF	1981	134.0	3							2.4	
6	FITCHBURG	MA	LOFF		131.2									
115	SAN JOSE	CA	LOFF	1982	125.0	3	20.0	16.7		1	38 %			
49	SWIFT CURRNT	CN	LOFF	1977	114.9	5				2	30 %		2.6	F
135	SANTA ROSA	CA	LOFF	1983	110.0	3							2.7	F
41	BROOKFIELD	WI	LOFF	1979	101.2		22.2	11.2		2				
116	SANTA ROSA	CA	LOFF	1983	96.0	4	16.7	25.0		1	37 %			
171	SEATTLE	WA	LOFF	1981	95.5	2	16.7	16.7		2		50 %	4.5	E
22	HURON	SD	LOFF	1977	94.4	5	6.5	8.3		2		13 %		
38	WAUWATOSA	WI	LOFF	1979	89.6		20.0	11.1						
158	CORVALLIS	OR	LOFF	1983	89.0	2	11.0	18.9		2			4.8	R
72	MINNEAPOLIS	MN	LOFF	1977	86.6								3.3	E
184	LAVAL	CN	LOFF	1981	78.2	5				2	27 %			R
148	PLEASANTON	CA	LOFF	1983	75.0	3								
157	SEATTLE	WA	LOFF	1982	70.0	5				2			3.7	E
162	PORTLAND	OR	LOFF	1978	68.0	4	7.7	10.9	1.9	2	22 %	13 %	3.7	
12	HATTIESBURG	MS	LOFF	1974	65.2	4					20 %			R
21	FAYETTEVILLE	AR	LOFF		60.4									
163	BOZEMAN	MT	LOFF	1979	56.7	3	8.3	25.0	2.0	2	47 %	52 %	3.5	F
57	SAGINAW	MI	SOFF	1976	49.5	1							3.4	E
81	BROOKFIELD	WI	SOFF	1979	47.1		22.2	20.8			40 %			
76	TOKYO	JP	SOFF	1982	40.6	4	8.1	9.8		2		50 %	3.9	R
18	CARBONDALE	IL	SOFF		37.5	2								E
7	PITTSFIELD	MA	SOFF		30.5									
174	NEWPORT	OR	SOFF	1982	29.6	2						90 %	3.4	R
82	RICHLAND	WA	BANK	1980	24.7									E
78	COEUR D'ALENE	ID	SOFF	1981	21.5	2	20.0	30.3		2			3.3	R
43	W. VALLEY C.	UT	SOFF	1981	14.9			35.7						
35	AUSTIN	TX	SOFF	1978	14.6		16.7	20.0				43 %		R
68	SPOKANE	WA	BANK	1979	13.5		8.3	14.3					3.7	R
161	SUNNYSIDE	WA	SOFF	1981	9.7	1	14.3	25.0	1.8	2			6.2	R
36	DENVER	CO	SOFF	1977	9.0	2	25.0	55.6		2		28 %		E
133	PALM DESERT	CA	BANK	1982	6.5									
175	SWEET HOME	OR	SOFF	1979	6.3	3				2	6 %	6 %		R
128	PALO ALTO	CA	SOFF	1980	4.6	1								
166	YAKIMA	WA	SOFF	1982	4.5	1	22.7	33.3		2		13 %	6.7	E
150	BOISE	ID	SOFF	1978	3.2	2	18.9	20.0		2		10 %	4.4	R
177	SPRINGFIELD	OR	SOFF	1977	3.1	2	20.0	40.0		2				R
173	PORTLAND	OR	SHOP	1981	400.0	2								E
155	BELLEVUE	WA	DEPT	1982	180.0	3								

DATA TABLE 1 - CONTINUED: CHARACTERISTICS OF BUILDINGS IN BECA-CN

(A) BLDG ID	(B1) CITY/STATE	(B2)	(C) BLDG TYPE	(D) YEAR BUILT	(E) FLOOR AREA (K SQFT)	(F) # FLOORS	(G1) <-------ENVELOPE-------> <-------R-VALUES------> WALL	(G2) ROOF	(G3) GLASS	(H) # PANES	(I1) <GLASS AS %> <-OF WALLS-> ALL	(I2) SO.	(J1) <-OCCUPANTS-> (#/K SQFT)	(J2) HRS
151	PORTLAND	OR	DEPT	1981	155.9									E
153	PORTLAND	OR	DEPT	1981	128.9	2								
154	TACOMA	WA	DEPT	1983	127.8	2								
152	LYNNWOOD	WA	DEPT	1979	125.1	2								
176	EUGENE	OR	DEPT	1983	55.9	1				2		2 %		E
34	FORT WAYNE	IN	RETL	1979	7.6	1	20.0	35.7				21 %		E
58	WESTMINSTER	CO	COLL	1977	307.7		15.4			2				F
27	TOMS RIVER	NJ	SECN	1979	245.0									R
63	MINNEAPOLIS	MN	COLL	1977	244.2		14.3	14.3		2			2.0	F
26	BASSETT	VA	SECN	1978	183.0	1	7.1	7.7	0.9	1	12 %			
144	STANFORD	CA	COLL	1977	152.0	7		10.0		1	50 %	50 %	1.6	
160	SPOKANE	WA	SECN	1982	146.0	2					6 %		9.0	R
168	PENDLETON	OR	ELEM	1982	123.7	2							17.5	R
164	TACOMA	WA	COLL	1980	115.9	7							7.1	E
159	PUYALLUP	WA	ELEM		90.2C					3				R
53	OTTAWA	CN	COLL	1973	75.6	4	10.0	7.1		2	17 %			F
69	MIAMI	FL	ELEM	1979	70.0	2	11.1	29.4					14.3	E
59	RESTON	VA	ELEM	1977	69.0	1							14.3	
75	BURKE	VA	ELEM	1982	69.0	1							14.3	
156	BOISE	ID	ELEM	1979	51.4	1	16.7	25.0			6 %	6 %		
40	NIAGARA	WI	ELEM	1979	46.9		8.3	12.5		2				
61	SANTA ANA	CA	ELEM	1974	46.6								17.2	R
39	SHEBOYGAN	WI	ELEM	1979	35.8		9.4	13.2		2				
29	REEDSBURG	WI	SECN	1978	16.8	1								E
33	BALTIMORE	MD	OTHR		270.0									
80	ST. PAUL	MN	WARE		260.0		12.5	16.7		2	20 %			
28	KANSAS CITY	KS	OTHR	1979	172.0	2								E
172	SEATTLE	WA	OTHR	1983	108.4	2	16.7	16.7		2	65 %	50 %	1.8	R
54	BARRIE	CN	OTHR	1976	107.5	5	12.5	16.7		2	7 %			E
127	THOUS. OAKS	CA	OTHR	1982	66.0	1				2				F
170	BILLINGS	MT	WARE	1978	48.0	1								E
64	MTN VIEW	CA	OTHR	1979	43.0	2	20.0	30.3		2				F
73	ASPEN	CO	WARE	1980	35.3		20.0	40.0	1.5		20 %		1.4	E
83	MILLBROOK	NY	OTHR	1978	29.7	2	15.4			2	13 %			R
178	SPOKANE	WA	OTHR	1980	21.2		12.5	30.3					43.9	E
31	ASPEN	CO	OTHR	1980	20.5	1								
167	LEWISTON	MT	WARE	1981	18.0								1.7	R
44	MOUNT AIRY	NC	LIBR	1982	13.5		20.0	20.0		2	11 %	66 %	3.7	E
132	SANTA ROSA	CA	OTHR	1980	12.7	1	20.0	20.0		2				
45	GUNNISON	CO	ARPT	1981	9.7		20.8	33.3		2				
46	TROY	NY	OTHR	1981	5.2		23.3	30.3						F
125	DAVIS	CA	OTHR	1982	5.2	1	11.1	20.0					4.0	E
137	LOS ANGELES	CA	CLIN	1983	4.8	1	11.0	30.3	1.0	1			3.1	E

DATA TABLE 2: FEATURES OF BUILDING IN BECA-CN
N = 133, JULY 1985

(A)	(C)	(K)	(L1)	(L2)	(M)	(N1)	(N2)	(O1)	(O2)	(P1)	(P2)	(Q1)	(Q2)
		<----------LIGHTING---------->						<----SPECIAL-FEATURES---->		<----HEATING--->		<---COOLING-->	
BLDG ID	BLDG TYPE	INSTALLED LIGHT (W/SQFT)	TYPE 1	TYPE 2	AVG USED LIGHT (W/SQFT)	DAYLIGHT TYPE	LIGHT CONTROLS	SPECIAL EQUIPMENT	CONTROLS & STRATEGY	FUEL TYPE	EQUIP	FUEL TYPE	EQUIP
4	LOFF	2.5	FLU					EZ	EMS TM	S		E	CC
51	LOFF	1.6	FLU	INC			CP	HR CT	HR	E	HP	E	
37	LOFF	2.2	FLU	HCV			CP	ST HR	EMS LM		HP		
71	LOFF	1.3	FLU	INC		AT RF	CP	EZ CT SH	SH EZ	E	RS	E	CH
136	LOFF	1.6	FLU	HCV	0.8		CP	ST OT	EMS	G	BO	E	
24	LOFF							SH	EMS				
47	LOFF	2.0				AT		ST HR CT	ST HR	G	BO	E	CC
1	LOFF				3.5		CP		EMS	S		E	CC
66	LOFF	1.0	HPS				PM	SO EZ ST	EMS			E	CC
147	LOFF		FLU	INC		AT	SW CP	EZ	EMS OA	S		E	
42	LOFF	1.4	FLU	INC			CP	CT		G	BO		CC
17	LOFF		FLU				SW	EMS NS	EMS NS	S		E	CC
13	LOFF		FLU						EMS				
182	LOFF	2.0						EZ	EMS LM		BO	E	CC
65	LOFF	2.0	PFL					SO ST	HR	E	BO	E	CC
20	LOFF	2.0	FLU	INC			SW		OA TM	G	BO	E	CC
145	LOFF		FLU		2.1	SKY AT		FS HR	EMS	E	HR	E	CH
14	LOFF												
2	LOFF		FLU						EMS	S		E	CC
74	LOFF	2.5	FLU	PFL	1.5	CL AT	SW	ST HR EZ	EMS OA	N	HR	E	CH
165	LOFF		FLU	HCV			CP	TM EZ HR	EMS	E		E	
10	LOFF		FLU				SW		NS OA EZ	E		E	
19	LOFF	0.8	FLU	HCV			SW		TM OA	G		E	
56	LOFF	2.8					OT	ST HR FS	EMS	E	HP	E	CC
169	LOFF							HR EZ	EMS	E	RS	E	HP
52	LOFF		FLU			AT	CP	HR EZ	EMS	E	HP	E	CC
56	LOFF	2.8					OT	ST HR FS	EMS	E	HP	E	CC
25	LOFF							ST EZ	EMS		HR		
30	LOFF	2.2							EMS NS		BO		CH
55	LOFF								OA EMS		HR		CC
50	LOFF	2.2							NS TM	S	OS	E	CC
48	LOFF	2.1						EZ	TM		OS		CC
70	LOFF	1.4	HPS	FLU	1.2	RF	SW	NS OA	HR ST	E	HP	E	HP
62	LOFF	1.8	PFL					HR CT	HR				
23	LOFF												
9	LOFF		FLU				SW	HR EZ		E		E	
15	LOFF		FLU	INC									
11	LOFF												
32	LOFF								OA NC				
183	LOFF							EZ HL FS SO ST	EMS	O	BO	E	CC
3	LOFF												
149	LOFF		FLU	INC				OW	OA		HP	E	
8	LOFF												
60	LOFF	2.0	FLU			AT		EZ	EMS		HR	E	CC
16	LOFF		FLU						EMS				
143	LOFF		FLU				CP DM	EZ	EMS	G	BO	E	CH

DATA TABLE 2 - CONTINUED: FEATURES OF BUILDING IN BECA-CN

(A)	(C)	(K)	(L1)	(L2)	(M)	(N1)	(N2)	(O1)	(O2)	(P1)	(P2)	(Q1)	(Q2)
		<----LIGHTING---->						<----SPECIAL-FEATURES---->		<----HEATING--->		<---COOLING-->	
BLDG ID	BLDG TYPE	INSTALLED LIGHT (W/SQFT)	TYPE 1	TYPE 2	AVG USED LIGHT (W/SQFT)	DAYLIGHT TYPE	LIGHT CONTROLS	SPECIAL EQUIPMENT	CONTROLS & STRATEGY	FUEL TYPE	EQUIP	FUEL TYPE	EQUIP
5	LOFF	2.3						SO ST	NS HR				
141	LOFF	3.0	FLU			SKY	CP	EZ	EMS				
117	LOFF	4.0	HAL			AT	CP	SH EZ HR		G			
126	LOFF		FLU			SKY	PS	TM FS HL	EMS	G		E	RC
67	LOFF	2.1						ST ED HR EB SH	HR	E	BO	E	EC
140	LOFF		FLU			SKY AT	PC	MS FS TM			BO		CH
6	LOFF												
115	LOFF	1.9				AT SKY LW	PC	ST TM EZ SH	EMS NC	G			
49	LOFF	1.8	FLU					EZ	NS TM LM	G	BO	E	CC
135	LOFF		PFL			AT SKY	PM	ST HR EZ FS ED				E	ST
41	LOFF	2.0							TM	E	OS		
116	LOFF	1.8				AT		ST EZ SH TM	NC				
171	LOFF	3.0	FLU	HPS			SW	EZ HL ST	NS	E	HP	E	HP
22	LOFF	2.0	FLU				TM	EZ	NS TM	G	BO	E	RC
38	LOFF	2.0							TM				
158	LOFF					LW	SW	FS HR EZ	EMS		HR	E	CH
72	LOFF	1.2	FLU	HAL		CL		SO HR	EZ EMS	S			AC
184	LOFF		FLU		1.5		SW	HR	NS LM	E	HR	E	CH
148	LOFF	2.3	PFL			SKY AT		SH					
157	LOFF	1.8	INC	FLU			RS	EZ	NS	E		E	CH
162	LOFF		FLU	INC	3.0			SO		E	HP	E	HP
12	LOFF		FLU							G	BO	E	CC
21	LOFF												
163	LOFF		FLU		3.0	NONE		SO ST HR OT	NS EZ	G	BO	E	CC
57	SOFF							SO ST		O	BO		AC
81	SOFF	2.0						EZ	NS TM	E	OS	E	RP
76	SOFF	0.7	FLU				PM	SO ST EB HR	EMS NC	E	HP	E	AC
18	SOFF		FLU			SKY	SW	SO	EMS		SO	E	AC
7	SOFF												
174	SOFF	1.7	FLU			SKY SH AT	SW PC	ST TM OT	NS	E		E	
82	BANK							SO ST					AC
78	SOFF		FLU			AT		EZ EB	TM NS				DX
43	SOFF					SH CL	PC	NC EMS	NC EMS	G		E	EC
35	SOFF	1.5	FLU					SO ST					
68	BANK		PFL					SO ST		E	BO		
161	SOFF		FLU				SW	EB FS TM OT	EMS	E	HP	E	HP
36	SOFF	1.3	INC	FLU		SC CL	SW	SO ST	NC	E	HP		
133	BANK					SKY CL		EB		H	SO	H	SA
175	SOFF							SO OT		E	FR	E	
128	SOFF		FLU			SKY		ST OW	NC	H	SO	E	CH
166	SOFF	2.4	FLU						NS	G	RP	E	RP
150	SOFF		FLU	INC		SKY	SW	OT		X	HP	E	HP
177	SOFF									E	HP	E	HP
173	SHOP		FLU			SKY				E	RP	E	RP
155	DEPT		FLU	INC					EMS				

DATA TABLE 2 - CONTINUED: FEATURES OF BUILDING IN BECA-CN

(A)	(C)	(K)	(L1)	(L2)	(M)	(N1)	(N2)	(O1)	(O2)	(P1)	(P2)	(Q1)	(Q2)
		<----LIGHTING---->						<----SPECIAL-FEATURES---->		<----HEATING--->		<---COOLING-->	
BLDG ID	BLDG TYPE	INSTALLED LIGHT (W/SQFT)	TYPE 1	TYPE 2	AVG USED LIGHT (W/SQFT)	DAYLIGHT TYPE	LIGHT CONTROLS	SPECIAL EQUIPMENT	CONTROLS & STRATEGY	FUEL TYPE	EQUIP	FUEL TYPE	EQUIP
151	DEPT								EMS	E	BO	E	CH
153	DEPT		FLU	INC									
154	DEPT		FLU	INC					EMS				
152	DEPT		FLU	INC									
176	DEPT		FLU				CP						
34	RETL	2.5	FLU	INC			SW	ST EB ED		E	HP	E	
58	COLL							SO ST HR			HP		HP
27	SECN		HPS					HR ST					
63	COLL	2.5	FLU			SKY		HR		S		S	AC
26	SECN							EZ	TM	O	BO	E	CC
144	COLL		FLU			SKY LW CL		MS OW	NC	S	OS	W	OS
160	SECN		FLU	HAL		LW		EB HR EZ	EMS				
168	ELEM	2.1				RM SKY		SO EB ST OW	NS	H			
164	COLL		FLU	HAL		OT		OW ST		E	HP	E	HP
159	ELEM							OT	EMS		HP		
53	COLL	2.5	FLU	HCV						S	OS		
69	ELEM	2.0	HPS	HAL		SKY		HR ST SO				E	AC
59	ELEM					SKY		HR SO ST EZ	TM	E	BO	E	
75	ELEM							SO ST HR EZ	TM	E	BO	E	
156	ELEM						SW	EB SO ST HL EZ		E		E	
40	ELEM	2.2							TM				RP
61	ELEM							EZ TM EB					
39	ELEM	2.0						EZ	TM		BO		
29	SECN	1.9					SW	SO ST	HR EMS	E	HP		
33	OTHR							HR ST	EMS	N	HR		CC
80	WARE							SO ST	HR EMS				AC
28	OTHR							EZ		E	HP	E	RC
172	OTHR	3.0	FLU	HPS			DM	EZ HL	NS TM	E	RP	E	RP
54	OTHR							ST HR	EMS	E	HP	E	CC
127	OTHR					CL		ST OW SH	NC LM				
170	WARE							SO			IR		
64	OTHR	2.6			1.5	CL SKY	PC	EB SH ST EZ		G	BO	E	RC
73	WARE	1.5	FLU	INC		SKY	SW	ST	NC	G	BO		
83	OTHR	1.8	HPS			SKY AT		EB MI ST HR SO	EMS	H	SO		
178	OTHR		FLU	HID		SKY		EB TM SO OT		G		E	
31	OTHR							EZ			SO	E	EC
167	WARE		FLU	HAL		SKY		EB OT FS SO		E	HP	E	HP
44	LIBR	1.3	FLU	INC		CL SH		ST EZ	NC LM TM	E	HP	E	HP
132	OTHR	2.3	PFL	FLU		SKY		ST EZ SH ED	OA TM LM				OT
45	ARPT	1.5				SH CL	TM	ST SO	NC LM NS	E	BO	N	N
46	OTHR		FLU			SKY RF		MI SO ST	LM NC	E	RS	E	
125	OTHR		FLU			SKY		HR EZ	OA NS	G	FR	E	
137	CLIN					CL SKY		OW SH	TM NC	G	HP	E	HP

DATA TABLE 3: ENERGY DATA FOR BUILDINGS IN BECA-CN
N = 133, JULY 1984

(A) BLDG ID	(D) YEAR BLT	(R) YR OF DATA	(S1) ELEC (KWH/ SQFT)	(S2) FUEL&OT (KBTU/ SQFT)	(S3) SOURCE (KBTU/ SQFT)	(S4) SITE (KBTU/ SQFT)	(T) PRED (KBTU/ SQFT)	(U1) WINT.	(U2) SUM.	(V) ANNUAL (EN $/ SQFT)	(W) CONSTR (48/ SQFT)	(X) CFA RATIO	(Y) CONF LVL	(Z) COMMENTS
			<----MEASURE ANNUAL ENERGY---->					<MEASURED PEAK> <ELEC (W/SQFT)		<-ECONOMICS->				
4			12.6	35.7	200.9	78.8		2.9	3.9	1.24		.61	A	NO SPECIAL EFFIC FEATURES
51		3	15.3	0.0	175.7	52.1		3.5	3.5			.60	C	GROSS FLR AREA INCLDS GARAGE
37	1975		14.9	1.6	174.0	52.5	54.0				59		C	
71	1981	2	23.5	0.0	270.5	80.3	32.0			1.38		.85	B	PRED. INTENSITY EXCLUDS CMPTR, ETC.
136	1982	1	18.4	1.6	213.6	64.5			4.7	1.42		.96	A	TWO BUILDINGS
24	1976	6	13.7	2.6	160.7	49.2				1.61			A	GSA; NOT VERY "ENERGY-EFFICIENT" DESIGN
47	1978		13.7	19.4	176.7	66.0	68.8	3.2	3.6		51	.78	C	FLR INCLDS GARGE,BLDG# INCLDS LANDSCAPE
1	1973	10	17.0	5.2	204.2	63.4		4.8	5.5	0.41		.93	B	NO SPECIAL FEATURES, WELL RUN
66	1980	2	13.8	0.0	159.3	47.3			3.8		67		A	BRONZED VISION GLASS
147	1981					71.0						1.00	C	ENERGY DATA NOT YET ON FILE; PART RETAIL
42	1979	1	12.0	20.0	157.4	60.7	35.6			0.42	98		A	EFFICIENT HVAC EQUIP
17			7.3	18.3	111.4	43.3				0.40		1.00	A	ENERGY USE UP: CMPTR & FLEXTIME
13			10.9	0.0	125.6	37.3		2.8	2.5	0.61		.62	A	
182	1981		14.3	22.7	186.7	71.3					66		C	CONVENTNL SYSTEM OVER HI TECH
65	1981	1	18.5	0.0	212.9	63.2				0.93	71		A	HEAT EXTRACTED FROM POND
20	1975	8	9.0	32.4	136.2	63.2	69.5	2.9	3.9	0.63	56	.76	A	TINTED INSUL GLASS, 75% OCCUPIED
145	1982	2	16.0	0.0	184.2	54.7			5.0	1.31		.73	A	SOME SUBMETERING; BUILDING SOLD
14			11.7	6.3	140.4	46.1		3.7	4.4	0.79		.59	A	
2	1975	9	15.1	13.4	196.4	66.0		3.9	3.6	1.23		.93	B	GROSS NOT INCLUDE PARKING
74	1982	1	29.5	0.0	339.0	100.6	38.0	5.2	5.3		69	.89	A	PRED. ENRG EXCLDS PROCS.
165	1982	2	13.4	0.0	154.4	45.8	26.0	4.1	4.2	0.61	0	.89	B	CP-30W/SQ FT, 1 PANE 1ST FLRS
10	1976	7	12.7	0.0	146.5	43.5				0.95	77	.78	B	GROSS FLR AREA INCLDS GARAGE
19			5.7	18.9	83.9	38.2		2.1	2.3	0.54		.90	A	FLR AREA INCLDS GARG, 88% OCCUPIED
169	1980	4	17.1	0.0	197.2	58.5	54.0	4.7	5.3	0.89				EFFIC HVAC, WELL OPERATED
52	1980	2	17.6	10.7	213.1	70.8	87.7					.61	C	ENRG AND FLR AREA ECLDS GARGE
56	1971	11	14.2	0.0	163.0	48.4		6.2	5.1	0.28	75		A	HEAT RECOV OFF CHILLERS, STORED
25	1978	2				46.6	45.0				65		B	HEAT RECOV FROM CMPTR
30	1979	3	15.6	2.5	181.5	55.6				0.89			A	PIPING FOR DECEN. HVAC
55	1971	1				70.0					67		B	HEAT RECOV FROM LIGHTS
50	1976	6	9.7	21.6	132.8	54.6		4.0	3.5			.70	C	GARGE INCLD, PRCS:SNOW MLT
48	1979	1	8.5	49.2	147.0	78.2						.75	C	EFFICIENT HVAC EQUIP
70	1979	3	12.8	0.0	147.8	43.8	39.0	5.4		0.31	53	.99	A	WATER THERMAL STORAGE
62	1979	3	21.9	0.0	251.7	74.7	42.0					.77	A	CURTAIN WALL, 2-COLOR EXTER, DAYLITE
23	1975	7	6.8	8.2	86.1	31.3				0.51		.89	A	GSA; NOT VERY "ENERGY-EFFICIENT" DESIGN
9	1974	9	19.4	0.1	222.8	66.1	76.7	10.3	7.7	1.33	100		A	NO SPECIAL EFFIC FEATURES
15	1979		15.0	0.0	172.4	51.1		3.2	3.3	0.93			A	GROSS FLR AREA INCLDS GARAGE
11			11.1	0.0	127.6	37.9		3.2	2.7	0.32			A	
32	1980	1	4.0	1.8	47.4	15.3				0.24			B	GROSS FLR AREA INCLDS GARAGE
183	1980		8.1	11.9	105.3	39.6							C	CMPTR DEDUCTED, $32000=SOLAR
3	1977	6	8.9	32.9	135.1	63.2				1.09			A	GROSS FLR AREA INCLDS GARAGE
149	1980	3	12.1	1.1	140.6	42.5			4.0	0.92	80	.93	A	
8			11.3	48.7	179.1	87.4				1.47			A	
60	1977	5	12.3	0.0	141.1	41.9	26.0			0.57	83		A	
16	1975		16.4	0.0	188.9	56.0		5.9	5.9	1.02		.71	A	VERY LITTLE INFO ON BLDG
143	1980	4	11.2	5.9	134.8	44.2			4.0	0.88		.92	A	EMS USED TO BILL TENANTS AFTER-HOUR-USE

DATA TABLE 3 - CONTINUED: ENERGY DATA FOR BUILDINGS IN BECA-CN

(A) BLDG ID	(D) YEAR BLT	(R) YR OF DATA	(S1) <----MEASURE ANNUAL ENERGY----> ELEC (KWH/ SQFT)	(S2) FUEL&OT (KBTU/ SQFT)	(S3) SOURCE (KBTU/ SQFT)	(S4) SITE (KBTU/ SQFT)	(T) PRED (KBTU/ SQFT)	(U1) <MEASURED PEAK> <ELEC (W/SQFT) WINT.	(U2) LOAD> SUM.	(V) <-ECONOMICS-> ANNUAL (EN $/ SQFT)	(W) CONSTR ($40/ SQFT)	(X) CFA RATIO	(Y) CONF LVL	(Z) COMMENTS
5	1976	6	7.8	8.9	98.6	35.5		2.3	2.5	0.66			A	GROSS FLR AREA INCLDS GARAGE
141	1982	2	12.8	17.1	164.5	60.8				1.05			B	
117	1982	2	16.0	7.5	191.5	62.1	53.0		5.6	1.46			A	
126	1980	4	16.0	6.3	190.5	60.9	45.0				117		B	EMS, LIGHTING RETROFITS 1983
67	1979	5	32.4	16.1	388.5	126.6	40.0		7.0	0.98	107	.88	B	HEAT RECOV FROM CMPTR RM A/C
140	1981	2	17.8	16.9	221.7	77.7			4.2	0.81	80		B	WEDGE-SHAPED BUILDING
6			4.5	35.7	86.9	50.9		2.1	2.2	0.68			A	
115	1982	2	11.2	17.0	145.2	55.1	58.0		4.2	0.86			A	
49	1977	4	14.7	42.7	211.6	92.8	92.1						C	EFFICIENT HVAC EQUIP
135	1983	1	15.7	22.8	203.6	76.4	35.0		4.6	1.27			A	SITE VISIT; DAYLITE CNTRLS NOT WORKING
41	1979	1	13.7	0.0	157.3	46.7		4.2	3.6	0.80			A	EFFICIENT HVAC EQUIP
116	1983	1	10.0	27.5	142.4	61.6	42.0		4.4	0.88			A	
171	1981	1	20.8	0.0	239.0	70.9		4.3	3.6	0.35	60	.83	B	SOME 24 HR./DAY USE & AUDITORIUM
22	1977		7.1	16.7	98.0	40.8		2.3	3.1	0.56	71	.65	A	FLR AREA INCLDS GARG, 86% OCCUPIED
38	1979	1	9.1	0.0	104.9	31.1		2.3	2.6	0.51		.51	A	EFFICIENT HVAC EQUIP
158	1983	1	36.8	0.0	423.4	125.7		7.7	6.3	1.45	99		A	CMPTR HEAT RECOV=MOST HEAT
72	1977	5	11.0	22.0	160.4	59.4	68.8			0.04	74		A	BOTH ACTIVE AND PASSIVE SOLAR
184	1981		20.1	0.0	230.7	68.5					57		C	HEATED FROM CHILLED HEAT RECOV
148	1983	1	13.0	45.1	194.4	89.4			4.9	1.22		.96	A	AWAIT MORE DESCRIPTIVE DATA
157	1982	2	18.9	0.0	217.0	64.4		5.0	4.6	0.38	31	.90	B	MINIMAL DAYLIT & GREENHOUSE
162	1978	5	37.8	0.0	434.6	129.0		6.4	7.1		112	.88	B	SOLAR NOW OFF, DELAMPED
12	1974	9	10.6	18.3	140.6	54.6		4.6	6.0	0.87	116	.59	A	NO SPECIAL EFFIC FEATURES
21			9.1	20.8	125.4	51.9		3.1	3.8	0.49			A	
163	1979	3	8.3	28.9	124.8	57.4		2.7	4.1	0.38		.87	A	ACTIVE SOLAR HEAT-LONG HRS.
57	1976	7	8.7	50.0	149.9	79.6		2.3	2.3	0.86	150		A	BOTH ACTIVE AND PASSIVE SOLAR
81	1979	1	15.7	0.0	180.0	53.4		5.5	4.8	0.97		.81	B	
76	1982	1	3.3	0.0	37.7	11.2	12.7			0.48	92	.66	B	PHOTOVOLTS & 2 SKINND,60% OCCUPIED
18			29.4	0.0	337.6	100.2		11.5	11.8	1.85		.96	A	
7			4.7	31.2	85.5	47.3		1.6	2.3	0.62			A	
174	1982	2	12.9	0.0	148.3	44.0	11.6	6.5	3.6		110	.97	A	PREDICTED NOT INCL. PROC.
82	1980	2	24.0	0.0	275.6	81.8		9.6	7.2	0.70			B	ACTIVE SOLAR W/HIGH MAINT COSTS
78	1981	1	10.9	10.1	135.8	47.4					38	.72	C	ATRIUM FOR DIRECT GAIN TOO
43	1981	1				39.9	54.6			0.59	62	1.00	B	
35	1978		10.4	4.2	124.0	39.8				0.59	41		B	BOTH ACTIVE AND PASSIVE SOLAR
68	1979	4	39.4	0.0	453.2	134.5		11.9	10.2	1.22	94	.67	B	ACTIVE SOLAR, HIGH MAINT COSTS
161	1981	3	13.7	0.0	157.7	46.8	44.6				38	.97	B	BEAD WALL & TROMBE WALL
36	1977		9.0	0.0	103.6	30.7	28.8				48		C	ABSORBING GLASS ALSO, SUNSCOOPS
133	1982					52.7							C	METERED ENERGY DATA NOT ON FILE
175	1979	4	10.2	0.0	116.8	34.7		5.2	3.5	0.57	40	.79	B	ACTIVE SOLAR NOT AS GOOD AS EST.
128	1980	4	19.1	0.0	219.9	65.2				0.87		1.00	A	ACTIVE SOLAR
166	1982	2	3.8	23.8	67.3	36.7		2.4	4.0	0.38	42	1.00	B	EFFIC HVAC, WELL INSULATED
150	1978	6	10.0	13.8	128.8	47.9		7.8	7.2	0.58	51	.94	B	SWITCH TO GEOTH. '83
177	1977	5	12.6	0.0	144.7	42.9				0.42	51		A	
173	1981	2	39.2	0.0	450.9	133.8				1.81	363	1.00	C	NOT INCLUDE 5 DEPART. STORES
155	1982	2	29.2	0.0	335.8	99.7		6.7	6.4				B	

DATA TABLE 3 - CONTINUED: ENERGY DATA FOR BUILDINGS IN BECA-CN

(A)	(D)	(R)	(S1)	(S2)	(S3)	(S4)	(T)	(U1)	(U2)	(V)	(W)	(X)	(Y)	(Z)
			<----MEASURE ANNUAL ENERGY---->					<MEASURED PEAK>		<-ECONOMICS->				
ID	YEAR BLT	YR OF DATA	ELEC (KWH/ SQFT)	FUEL&OT (KBTU/ SQFT)	SOURCE (KBTU/ SQFT)	SITE (KBTU/ SQFT)	PRED (KBTU/ SQFT)	<ELEC (W/SQFT) WINT.	LOAD> SUM.	ANNUAL (EN $/ SQFT)	CONSTR (4/ SQFT)	CFA RATIO	CONF LVL	COMMENTS
151	1981	3	13.7	0.0	157.5	46.7							B	
153	1981	3	18.6	0.0	214.4	63.6		6.7	5.7				B	
154	1983	1	30.8	0.0	354.0	105.1		5.2	6.6				B	REMODELED AND EXPANDED 1983
152	1979	5	21.8	0.0	250.6	74.4		5.8	6.1				B	
176	1983	1	14.9	0.0	173.7	50.9		4.3	4.0			.88	C	ONLY 9 MNTHS ENERGY, PRORATED
34	1979	4	11.3	0.0	130.1	38.6		5.0	4.2	0.54	30		A	
58	1977	6	15.4	9.0	186.0	61.5		4.1	4.2	0.84	63		A	PARTIAL UNDERGROUND, ACTIVE SOLAR
27	1979	2	17.2	0.0	197.8	58.7				1.00			B	REGENERATIVE HEAT RECOVERY WHEELS
63	1977	5	15.6	76.0	298.3	129.3				1.04	66	.68	A	
26	1978	2	8.6	29.9	128.7	59.2	57.0						B	AIR COOLED CENTRIFUGAL CHILLER
144	1977	7	10.5	72.4	212.4	108.1					98	.69	B	SQUARE FOOTAGE NEEDS RECONCILIATION
160	1982	2	9.1	60.4	164.9	91.4		3.1	3.4	0.66			B	40% BELOW GRADE
168	1982	2	10.4	0.0	119.8	35.6		5.4	5.4	0.53	75		A	ROCK BED STORAGE
164	1980	4	21.7	0.0	249.8	74.1	51.0	2.9	3.1	0.24	45		C	RENOVATN, LARGE GLAZE AREA
159			6.6	19.1	94.9	41.6		3.2	2.8				A	AIRFLOW/EXTRACT AIR WINDOWS=OT
53	1973					60.6				0.35	64		C	
69	1979	4	14.9	0.0	171.5	50.9		5.3	5.2	1.03	83	.92	A	HEAT WHEEL STORAGE
59	1977	2	12.4	0.0	143.0	42.4				0.53	84	.96	A	HEAT RECOV FROM CMPTR
75	1982	1	18.2	0.0	209.3	62.1				0.98	57	.96	A	HEAT RECOV FROM CMPTR
156	1979	5	9.4	0.0	107.6	31.9		5.6	3.9	0.35	63		B	GOOD OCC RESPONSE
40	1979	1	15.2	0.0	174.3	51.7				0.72			A	EFFICIENT HVAC EQUIP
61	1974	9	15.7	14.0	194.9	67.7					63		B	
39	1979	1	3.8	28.3	72.3	41.4				0.36			A	EFFICIENT HVAC EQUIP
29	1978	4	11.2	0.0	128.7	38.2				0.57	81		A	ICE MAKER HEAT PMPS, ICE/WTR STOR
33			28.9	0.0	332.1	98.5				1.28			C	HALF OF ENRG LOADS: PROCS LOADS
80						26.3					75		C	BOTH ACTIVE AND PASSIVE SOLAR
28	1979		17.3	0.0	199.3	59.1							B	SATISFIES ASHRAE STD 90-75
172	1983	1	27.9	0.0	320.8	95.2					96	.81	B	OFFICE, LAB, & MISC.
54	1976	2	14.8	0.0	170.3	50.5				0.56	84		C	WATER THERMAL STORAGE
127	1982	1	12.0	0.0	138.1	41.0	61.0				131		B	
170	1978	6	2.7	22.3	53.2	31.5		1.1	1.2	0.22			A	WARE/OFFICE, SOLAR NOT OPERATNL
64	1979	4	15.2	39.5	214.4	91.4				1.35	103	1.00	A	SOLAR COOLING PLANNED BUT NOT INSTALLED
73	1980	2	5.4	30.8	92.7	49.2				0.45	47		A	A/C IN COMPUTER ROOM ONLY
83	1978	5	5.1	0.0	58.1	17.2	43.0	2.8	2.6	0.81	118		A	DATA INCLDS ACT SOLAR, NOW DOWN
178	1980	4	9.6	66.2	176.3	98.9		2.2	2.6	0.77	83	1.00	B	ENERGY COSTS << COMPARISONS CENTERS
31	1980	2	17.5	0.0	201.4	59.8				1.01	103		A	BOTH ACTIVE AND PASSIVE SOLAR
167	1981	2	18.1	0.0	208.5	61.9					64		C	OFFICE/WARE W/IR HEAT TOO
44	1982		6.1	0.0	69.9	20.8	17.0				103	.98	B	
132	1980	4	12.1	46.1	184.9	87.3				1.21		1.00	B	
45	1981		19.7	0.0	226.9	67.3	39.3				93	.88	B	
46	1981		10.7	0.0	123.0	36.5	28.5				85	.83	B	POLICE USE 168HRS/WK,MOST 63HRS
125	1982	3	7.9	35.0	125.7	61.9				0.82	92	1.00	B	REFLECTIVE COATING ON ROOF
137	1983	1	7.3	11.5	95.3	36.3			6.7	0.59	68		A	PSYCHIATRISTS CLINIC/OFFICE

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