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FIXED FACILITIES ENERGY CONSUMPTION INVESTIGATION DATA USERS MA--ETC(U)
FEB 78 L WINDINGLAND, B SLIWINSKI, A MECH

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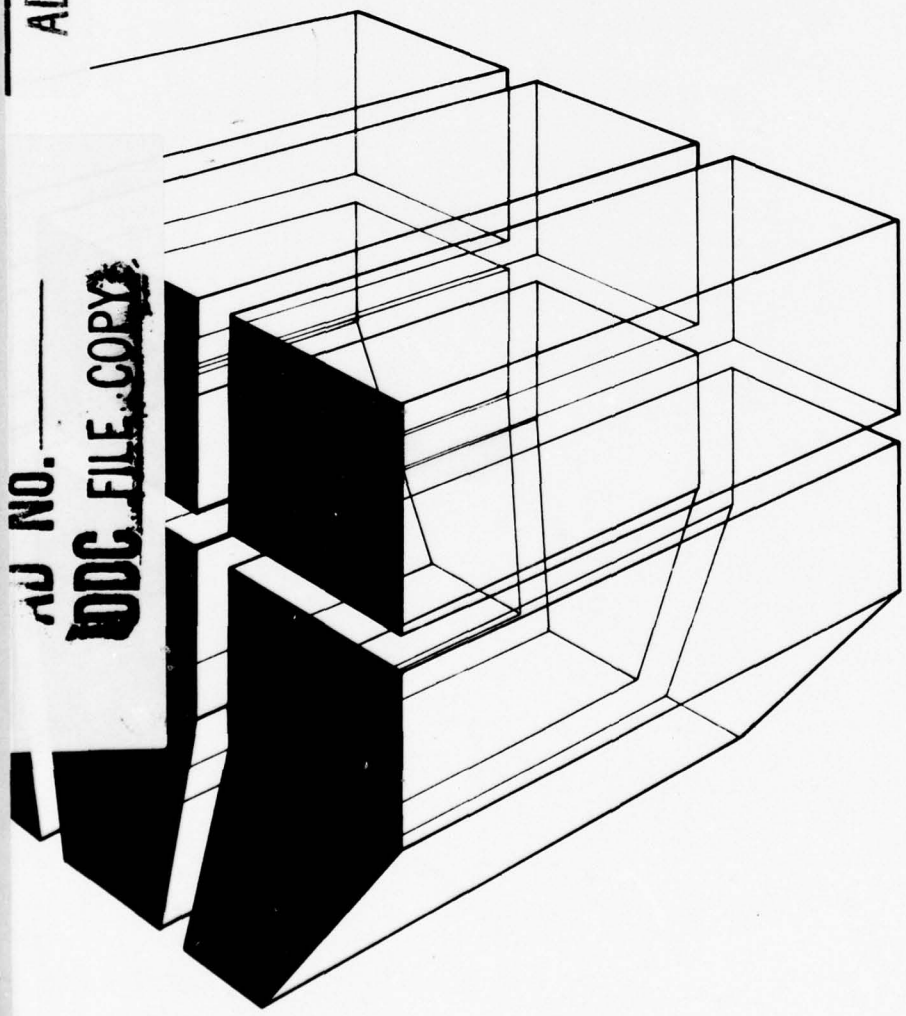
construction engineering research laboratory

INTERIM REPORT E-127
February 1978
Fixed Facility Energy Consumption Investigation

FIXED FACILITIES ENERGY CONSUMPTION INVESTIGATION DATA USERS MANUAL



by
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This report describes a study being conducted to identify energy consumption patterns at fixed Army facilities. The procedure used to select sites, buildings, and instruments for monitoring is described, as is the data storage system and the method for data access. The report describes and provides photographs of over 110 buildings presently being monitored at three Army posts and describes the energy parameters being monitored in each building. The structure of the energy data storage system is described, and instructions on how to obtain the energy use data that have been gathered are provided, along with examples of available data output formats.

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FOREWORD

This work was performed for the Directorate of Facilities Engineering, Office of the Chief of Engineers (OCE), under Project 4A762731AT41, "Design, Construction, and Operation and Maintenance Technology for Military Facilities"; Technical Area 06, "Energy Systems"; Work Unit 007, "Fixed Facility Energy Consumption Investigation." Mr. J. Walton, DAEN-FEU-A, served as the OCE Technical Monitor.

This work is a joint effort of the U.S. Army Facilities Engineering Support Agency (FESA) and the Energy Branch (EPE), Energy and Power Division (EP), U.S. Army Construction Engineering Research Laboratory (CERL). The following individuals made major contributions to this project: MAJ Love, Mr. G. Aveta, and Mr. R. Moss of FESA, and Mr. D. Hittle, Mr. J. Hall, Mr. J. Fornango, Mr. P. Anderson, Dr. P. Kong, Mr. R. Gorham, Mr. K. Morgan, and Mr. R. Lidral of CERL.

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COL J. E. Hays is Commander and Director of CERL, and Dr. L. R. Shaffer is Technical Director. Dr. D. J. Leverenz is Chief of EPE and Mr. R. G. Donaghy is Chief of EP.

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1 INTRODUCTION

Background

The "energy crisis," which was formally recognized as a result of the 1973-74 oil embargo against the United States, has had a significant impact on the nation and the military. In addition to the increased costs for utilities, the military problem has included the "zero growth" requirement for facilities energy use. The achievement of this goal has been complicated by the fact that at the time of the crisis, the Army did not have a complete understanding of how, where, or when energy was being used in its fixed facilities. Metering of individual buildings to monitor energy consumption occurred only where an installation was to be financially reimbursed for the energy, as in the cases of facilities that housed contractors working on the installation, certain tenant activities, and family housing. (Some of these facilities were not actually metered, but the energy consumption was estimated.)

The increased cost of fuel and electricity affected installations' operations budgets and attracted the attention of installation commanders, major commands, and the Office of the Chief of Engineers (OCE). In an effort to reduce the energy cost, architect and engineering firms were employed to try to find ways of reducing energy consumption, primarily through modifications to structures. The results of these studies indicated a percentage reduction that could be achieved, but the actual amount of energy that could be saved was unknown because the previous consumption or baseline energy usage for individual buildings was unknown.

OCE therefore initiated a study of the energy problem on Army fixed facilities. As various areas for investigation were identified, it became apparent that a knowledge of the energy consumption patterns of facilities on Army installations was required.

Objective

The objectives of this study are (1) to collect data relating to the flow, demand patterns, and uses of the various forms of energy consumed on Army installations, (2) to compile a data file for use in later analysis, and (3) to analyze the collected data to determine how the energy was consumed, identify conservation measures, and improve energy utilization.

The purpose of this report is to describe the types and locations of buildings being monitored, the energy parameters being monitored, the instrumentation system, the method by which the data is being stored, and the method by which the collected data can be obtained.

Approach and Scope

The study is being conducted in the following steps:

1. Determine potential Army users of energy usage information and their data requirements

2. Select specific Army posts and major consumer groups for monitoring based on size, geographical location, weather, use, and major command

3. Select specific buildings for application of instrumentation in each major consumer group

4. Select and procure required instrumentation and monitoring systems to record energy use on an hourly basis

5. Install instrumentation and interfacing and recording equipment at energy sensor locations

6. Develop and maintain a data management system for storage, retrieval, and analysis of energy consumption data

7. Provide potential users with reports and information for using the energy consumption data in their studies.

This report covers steps 1 through 6 of the approach and provides information for determining what data are available and how to obtain or access the data. It does not include collected data, data analysis, or discussions of how the data can be extrapolated to other geographical locations. These topics will be discussed in a separate document.

Organization of Report

Chapter 2 provides a brief discussion of the users and their requirements, and describes the selection of the specific Army posts, major consumer groups,

and buildings for monitoring, as well as the selection of energy parameters and instrumentation. Chapter 3 describes the energy data file system and the methods of accessing and obtaining the data and data samples.

The appendices provide more detailed information. Appendix A provides instructions and examples of how the user can access the data directly. Appendix B lists the types of buildings being monitored, their locations, and what parameters are being measured in each building ordered by consumer group; Appendix C provides the same information ordered by post. Appendix D provides a general verbal description and photograph of each building being monitored. Appendix E describes the instrumentation that was used for each energy parameter.

2 PREPARATION FOR DATA COLLECTION

Definition of User Requirements

The first step of the project was to define the users and uses of building energy data. The military users were defined as Corps Division and District Engineers; OCE, major command, and facilities engineers; and research laboratories. These users have a wide range of needs—from yearly consumption total to analysis of hour-by-hour energy usage data. It was determined that installation of continuous metering devices that would record the hourly use of energy entering the building would be required to satisfy all the identified needs. Since all Army buildings could not be monitored, a method for selecting a representative sample of buildings and energy users was defined. The next three sections describe this method.

Post Selection

Three Army posts were selected for the investigation: Fort Belvoir, VA, Fort Carson, CO, and Fort Hood, TX. These posts represent two major Army commands (TRADOC and FORSCOM) to provide data on facility energy use on posts with different missions. The two posts in the same command (Fort Carson and Fort Hood) have a significant size variation, thus permitting determination of the effects of size on energy use profiles.

The posts are in different geographical areas, so gathered data can be studied for variations with climate and differences in energy use for various building construction methods, such as provision of insulation levels.

Consumer Group Selection

The Army real property indexing system separates facilities into over 40 building categories. These building categories were consolidated into the following eight major energy consumer groups representing different post functions: troop housing (TH), family housing (FH), administration/training buildings (AT), storage buildings (ST), production/maintenance buildings (PM), medical/dental buildings (MD), community support facilities (CF), and portions of each post's utility distribution system (UD). This consolidation includes nearly every functional type of building on the three posts.

Building Selection

Specific buildings in each of the eight consumer groups were selected for energy usage monitoring. The buildings were selected based primarily on construction type and construction era (e.g., for barracks, World War II type, 1960's I-type, and modern Army standard design types were selected). In some instances, identical buildings were chosen for comparison of life style effects and control systems variation. Also, similar buildings at two different locations were chosen for consideration of weather effects on energy consumption. Table 1 shows the number and type of buildings at each site selected for monitoring. Appendices B and C provide complete listings of the building and energy parameters being monitored by consumer group and post, respectively. Appendix D provides a description and photograph of each building being monitored.

Energy Parameter Selection

The energy parameters to be monitored in each building were then determined. For most buildings, the energy parameters selected included all the energy being used to operate the building, such as total natural gas consumption and total electrical consumption. Some buildings, however, were selected for detailed energy analysis to determine how energy is used with a building. Monitoring for these buildings included building temperatures, humidity, electricity for mechanical systems, lighting energy use, and energy input and output of mechanical systems. Table 2 shows the buildings selected for detailed monitoring and the energy parameters being

Table 1

Summary of Buildings Being Monitored

	Fort Carson	Fort Belvoir	Fort Hood	Total
Troop Housing Barracks	9	6	11	26
Dining Facilities	2	1	3	6
Family Housing	4	9	10	23
Administration/Training	5	3	8	16
Medical/Dental	1	1	4	6
Storage	2	2	1	5
Production/Maintenance	5	2	5	12
Community Support Facilities	4	5	11	20
Utility Points Distribution	13	11	23	47
Weather Parameters	1	1	1	3
	46	41	77	164

monitored. In addition, a complete weather station at each post was installed for on-site monitoring of ambient temperature, dewpoint temperature, solar radiation, wind speed, wind direction, and barometric pressure.

Instrument Selection

The instrumentation system was selected to be relatively simple for facilities engineering personnel to install, operate, and maintain without creating a serious manpower burden. Components having the highest possible accuracy and dependability consistent with price were selected. Ninety percent of all selected instruments are utility-grade electrical and gas meters with a long history of accuracy. Appendix E describes each instrumentation package and lists the manufacturer, model number, and accuracy of each component. The instruments are being recalibrated on a 6-month schedule.

Processing of Recorded Data

Data recording is accomplished by magnetic pulse-recording devices which record pulse rates from individual sensors on a 36-day magnetic tape cartridge. The devices also place time pulses on the tape to provide for accurate hourly energy usage determination. Each pulse recorder can accommodate three energy parameters. The tapes are changed monthly by facilities engineering personnel and shipped to the U.S. Army Construction Engineering Research Laboratory (CERL) for interpretation and subsequent reading into the data file storage system. At CERL the data tapes are read into a computer, monthly profiles are plotted, and daily totals are printed for each data monitoring point.

The data tapes arriving at CERL are checked monthly for inconsistencies and obvious calibration discrepancies. Weather data are checked against weather information from the nearest national

Table 2

Detailed Monitoring Points

Description	Post Bldg Number	FFECI Data Point Number	Energy Parameters Being Monitored*
Barracks (Fort Carson)	1951	132	E, CWFT, HWFT, BT, BH
Barracks (Fort Hood)	87015	335	E, CWFT, HWFT, BT, BH
Administration (Fort Hood)	87016	334	E, G, CWFT, BT, BH
Central Plant (Fort Hood)	87018	332	Building electricity, Electricity for each chiller, Chiller and Condenser flows and temperatures, Gas to each boiler
Administration (Fort Belvoir)	358	297	E, CWFT, HWFT, BT, BH

*Energy Parameter Key
- E = Electrical
- G = Gas
- O = Oil
- CWFT = Chilled water flow and temperature
- HWFT = Hot water flow and temperature
- BT = Building temperature
- BH = Building humidity

weather station each month. The data are then read into a private disc storage unit located at the Naval Ship Research and Development Center (NSRDC) computer facility.

3 ENERGY DATA FILE SYSTEM

Data System Structure

The Fixed Facilities Energy Consumption Investigation (FFECI) Data Storage System is a collection of FORTRAN programs, Control Data Corporation (CDC) control card procedures, and permanent files, that performs input, storage, and output of FFECI data. The system resides as permanent files on a private disc pack at the NSRDC computer facility. The system can be used in batch mode on either the CDC 6600 or 6700 computers and can be used interactively on the 6600 system. The system is structured into three types of files: (1) data files, (2) data description files, and (3) system software files. The following sections describe these files.

Data Files

The data files contain the collected data stored in their raw form as hourly pulse counts. The data are stored as pulse counts to reduce storage requirements and simplify error correction. The files also contain information for identifying the data and for converting the pulse counts to engineering units. One file is maintained for each building; the files are identified by the three digits of the base data point (BDPT). Figure 1 illustrates the identification system.

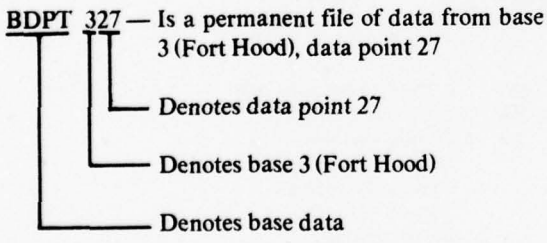


Figure 1. Data file identification system.

Data Description Files

The data description files are permanent files containing information describing each data site. They are used by the FFECI system software when adding data and correcting existing data. The files are also available to the user to aid in analyzing FFECI data. The file and file name is **basedescription** which describes data other than weather data; specifically, data point number, channel name, consumer group, base building number, building description, sensor type, engineering unit conversion factors, and name of engineering unit.

System Software Files

The system software files contain the working part of the FFECI Data Storage System. The programs in the system software files perform all data input, output, and correction functions. The files contain source and object codes for all programs and subroutines, and cataloged control language procedures for system operation. The cataloged control language procedures are used for data base maintenance and for direct data access.

Data Access

Data Formats and Methods of Access

Data are usually available for access within 1 month after collection. Users can obtain data from the system in two ways: directly (users with computer facilities) and indirectly through written requests to CERL or the U.S. Army Facilities Engineering Support Agency (FESA).

Data are supplied in any of the following standard formats:

1. Hourly profiles plotted by day or daily profiles plotted by month for a single monitoring point

2. Daily and monthly totals for a single monitoring point.

Figures 2 and 3 are examples of monthly profiles for a single monitoring point. They show electrical and gas usage for data point 320 (a family housing unit at Fort Hood). Monthly profiles of this type are produced when data tapes are originally read, prior to input to the NSRDC computer system; they are therefore available only by written request to CERL.

Figure 4 shows the daily and monthly totals of electrical and gas usage for data point 320. This type of output is also produced when the data are originally processed, but is available for direct access through program ENERGY. (See Appendix A.)

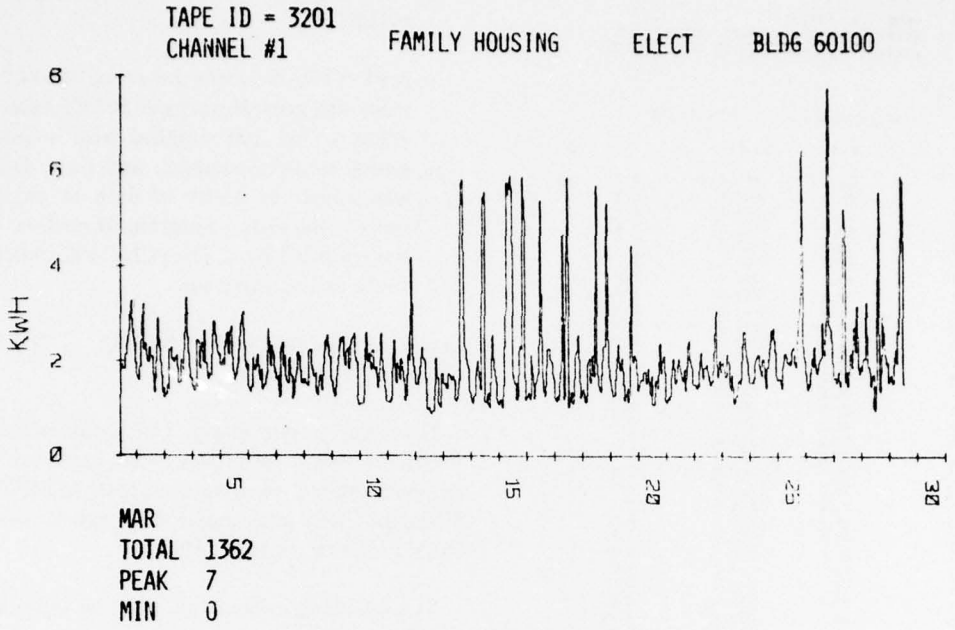


Figure 2. Monthly profile of family housing electrical usage for data point 320.

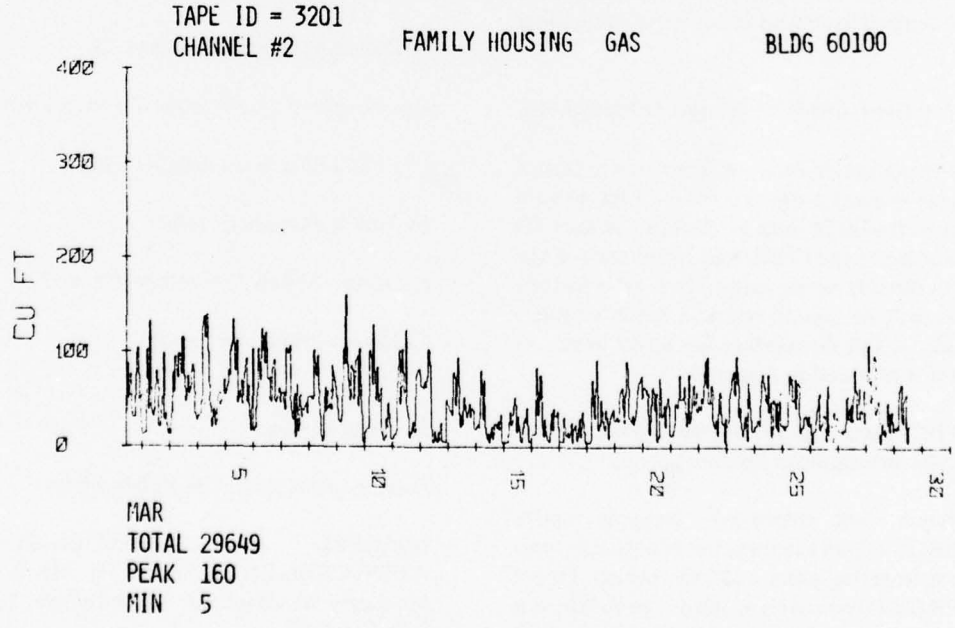


Figure 3. Monthly profile of family housing gas usage for data point 320.

TAPE I.D. 3201
START TIME=1004 START DATE=010377
FINISH TIME=1532 FINISH DATE=290377

FAMILY HOUSING BLDG 60100

	KWH	CU FT	
1 MAR	30.4	761.0	0.0
2 MAR	50.5	1085.0	0.0
3 MAR	47.0	1621.0	0.0
4 MAR	48.5	1411.0	0.0
5 MAR	53.5	1727.0	0.0
6 MAR	43.6	1720.0	0.0
7 MAR	42.1	1240.0	0.0
8 MAR	42.8	1231.0	0.0
9 MAR	49.2	1631.0	0.0
10 MAR	41.9	1002.0	0.0
11 MAR	42.8	1010.0	0.0
12 MAR	36.1	970.0	0.0
13 MAR	52.8	1076.0	0.0
14 MAR	48.2	617.0	0.0
15 MAR	69.2	484.0	0.0
16 MAR	45.2	653.0	0.0
17 MAR	51.5	399.0	0.0
18 MAR	50.6	680.0	0.0
19 MAR	43.3	1068.0	0.0
20 MAR	39.2	1190.0	0.0
21 MAR	41.2	1031.0	0.0
22 MAR	43.7	1111.0	0.0
23 MAR	42.0	1033.0	0.0
24 MAR	47.4	975.0	0.0
25 MAR	54.7	941.0	0.0
26 MAR	60.0	644.0	0.0
27 MAR	53.6	889.0	0.0
28 MAR	50.9	1060.0	0.0
29 MAR	40.4	505.0	0.0
TOTALS	1363.9	29675.0	0.0

Figure 4. Daily and monthly totals for family housing electrical and gas usage for data point 320.

Other formats can be obtained by special request.

Data from Fort Carson begin in June 1976, while those from Forts Belvoir and Hood begin in October 1976.

Direct Access (for Users With Computer Facilities)

Users with computer batch or interactive terminal facilities may request a user ID from CERL to gain direct access to FFECI data at NSRDC. A user ID must be acquired from CERL well in advance of any attempts to directly access data. Users who directly access data will be able to work in batch or interactive mode. A full description for direct access of FFECI data is provided in Appendix A.

The FFECI Data Storage System software presently provides two methods for data access:

1. A batch and interactive program called ENERGY allows examination of data for a specific monitoring point and time period. Use of ENERGY interactively is subject to constraints on interactive usage. ENERGY has graphic capabilities. Appendix A gives instructions for and examples of the use of the program ENERGY.

2. A FORTRAN subroutine called DAYCNT provides the general-purpose FFECI data access. When called and supplied with a base, data point, recorder channel, and date, DAYCNT will return 24 hours of data in engineering units to the calling program. If no data exist for the specified item, DAYCNT will indicate this to the calling program.

Indirect Access (for Access Without Computer Facilities)

Users can obtain energy consumption data from CERL or FESA through written requests. Facility engineers should send data requests to FESA, while Divisions, Districts, major commands, and OCE should send requests to CERL.

The following information must be supplied when requesting data:

1. FFECI data point number (Appendices B or C)

2. Building number (Appendices B or C)

3. Dates (Inclusive dates of data desired)

4. Type of format

5. Data type (Appendices B or C)

An example of a data request is shown below:

1. FFECI data point number - 205

2. Building number - 1689

3. Dates - 20 Feb 77 through 20 Mar 77

4. Hourly profiles by month, daily and monthly totals

5. Electric, Gas

Data requests should be addressed to:

USACERL
ATTN: CERL-EH/
Mr. Larry Windingland
P.O. Box 4005
Champaign, IL 61820

FESA-ED-EI
ATTN: Mr. R. Moss
Fort Belvoir, VA 22060

4 SUMMARY

This report has described the types and locations of buildings being monitored, the energy parameters being monitored, and the instrumentation system used in a study being conducted to determine the energy use in Army fixed facilities. The report also described the structure of the system for storing collected data and the means for obtaining these data.

APPENDIX A:

DIRECT ACCESS OF FFECI DATA

This appendix provides instructions to those users of FFECI data that desire to access and manipulate the data through **their own** computer facility, batch, or interactive modes. Examples of data requests and expected outputs are provided to assist the user in obtaining the desired information. The last section of this appendix provides guidance to users to minimize the cost of obtaining the FFECI data.

Authorization

All direct access of FFECI data must be authorized by US Army CERL. Requests for permission to access FFECI data retrieval and manipulation programs should be made to:

US Army CERL
ATTN: CERL-EH/L. Windingland
P.O. Box 4005
Champaign, IL 61820

Phone number: commercial 217-352-6511,
FTS number 958-7011

Request should be received at CERL one week prior to intended usage so user-requested files can be transferred to public disk storage. Data transfer, storage, and access costs are the responsibility of the user.

The FFECI data base is on the CDC 6600/6700 computer at the Naval Ship Research and Development Center (NSRDC) in Bethesda, Maryland. Data access is achieved by using CERL program ENERGY in either a batch or interactive mode.

Batch mode requires preparation of a punched card input deck which is transmitted to NSRDC through the user's computer center. The user should consult his computer center to check NSRDC availability. The user without this capability has the option to acquire NSRDC availability, use interactive access, or request FESA or CERL to perform the data access as explained in Chapter 3 of this report.

Interactive mode requires a computer terminal with a telephone link and an NSRDC interactive user name and password. The user with an NSRDC account has the option of acquiring one from NSRDC or through CERL. Since NSRDC restricts all interactive access of data files on private storage, the request for usage must be received at least one week prior to desired use. Details of interactive input is outlined in the section of this appendix titled "Interactive Input."

Although program ENERGY has been tested, any significant non-user, non-data program errors should be reported to CERL (ATTN: CERL-EH/L. Windingland).

Batch Input

Batch use of program ENERGY requires the input of a punched card deck through a computer center card reader to NSRDC. The punched card deck is made up of a set of control cards, an End Of Record (EOR) card (7/8/9 multi-punch), data cards, and an End Of Information (EOI) card (6/7/8/9 multi-punch). The term multi-punch will be used to denote the punching of more than one number in column one; the numbers to be punched will precede the word "multi-punch" and will be separated by slashes (/). Prepunched End of Information cards are normally available at the user's computer center.

The input deck has the following general form:

Control Cards

7/8/9 Multi-Punch (End of Record)

Data Cards

6/7/8/9 Multi-Punch (End of Information)

Control Cards

Four control cards are required to use the program ENERGY in batch mode. They are:

Job Card

Charge Card

ATTACH,PROFIL,FFECIPROFIL,ID = PUWS.

BEGIN,FFECI,PROG = ENERGY.

Each control card must start in Column 1 and end with a period. The job card and charge card are unique to each user project.

The job card contains a job name, the amount of core storage required (CM), time information (T) in seconds, and job priority (P). The use of program ENERGY also requires the addition of RP = 1 to the job card to enable the user to access data files not in public disk storage. A job card should be punched as indicated below.

PWS83,CM100000,T100,P2,RP = 1.

After the period (usually beginning in Column 50), the user should add his/her name, telephone number, and extension. This information will aid in the identification and separation of the user's output from that of other users.

The charge card contains user identification and NSRDC job order number; i.e., cost code. A charge card should be punched as indicated below.

CHARGE,PUWS,1189056883,RS,I.

The preceding examples have job, charge, and user parameters unique to US Army CERL. The user should consult his/her computer center and/or pages 2-2 and 2-3 of the NSRDC Computer Center Reference Manual for further details about job and charge cards. Appropriate job, charge, and user parameters will be available only through the user's computer center.

The remaining control cards should be punched as indicated below to attach and execute program ENERGY.

ATTACH,PROFIL,FFECPROFIL,ID = PUWS.

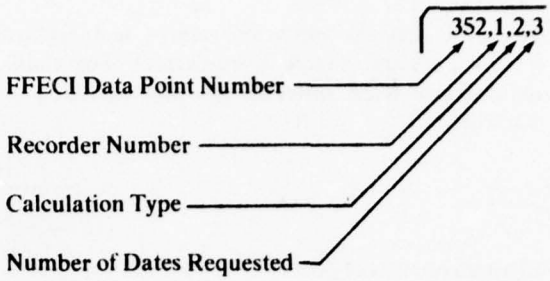
BEGIN,FFECI,PROG = ENERGY.

Data Cards

The data card deck for FFECI data access consists of three types of cards:

1. Building Card
2. Channel Identifier Card
3. Date Card.

The Building card contains the FFECI data point number, calculation type, and the number of dates requested.



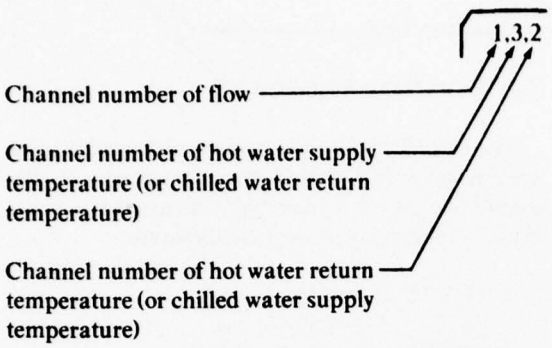
The FFECI data point number and recorder number can be found in Table B1 of Appendix B. The calculation type is a single digit integer from one to eight. The calculation types available are:

1. Monthly data report
2. Monthly data report and plot
3. Daily data report
4. Daily data report and plot
5. Monthly Btu report
6. Monthly Btu report and plot
7. Daily Btu report
8. Daily Btu report and plot.

The first four calculation types access data which are directly read from instruments and stored on individual channels of a pulse recorder, i.e., gas and electricity. The Btu reports are made up of computed energy consumption values in buildings not served by a primary energy source (such as gas or oil) but are provided with hot or chilled water from a central plant. These calculations require input from three separate channels: (1) flow, (2) supply temperature, and (3) return temperature. Energy in Btus is calculated by multiplying the flow rate by the temperature differential between the supply and return lines. The number of dates is an integer from one to twelve.

The Channel Identifier card follows the Building card when one of the Btu calculation types, i.e., types 5 to 8, has been designated on the Building card. The Channel Identifier card consists of three one-digit integers separated by commas. The integers will denote the channels of the flow, the hot water supply temperature (or chilled water return tem-

perature), and the hot water return temperature (or chilled water supply temperature). The channel order of these variables can also be found in Table B1.



It must be noted that the Channel Identifier card is omitted whenever calculation types 1, 2, 3, or 4 have been designated on the Building card. The Channel Identifier card is applicable **only to Btu** calculations.

The Date cards are now added to the input deck. The number of Date cards used must be equal to the number of dates requested on the Building card. Date cards are of two types: day/month/year and month/year. The user will select the type which corresponds to the calculation type designated on the Building card; i.e., monthly or daily.

Day	7,4,77 day,month,year
Month	4,77 month, year

Date formats are integers separated by commas—day, month, year—for a daily request and—month, year—for a monthly request. The days and months may be either one or two digits. Years may be two or four digits. The Building card, the Channel Identifier card (when appropriate), and the Date cards make up one input set. Additional input sets may be added after the last Date card of the set.

Examples

Construct an input deck requesting the following information:

1. Monthly data and plot for FFECI data point 352, Recorder 1. The months November 1976, and April and May 1977 are desired.

2. Daily Btu data for FFECI data point 129, Recorder 3. The data is desired for April 7, 1977, and May 20, 1977. From Table B1 we know that channel 1 is hot water flow, channel 2 is the hot water supply temperature, and channel 3 is the hot water return temperature.

Control Cards

Job

Charge

ATTACH,PROFIL,FFECIPROFIL,ID=PUWS.

BEGIN,FFECI,PROG=ENERGY.

7/8/9 Multi Punch (EOR)

Input Set 1

352,1,2,3

11,76

4,77

5,77

Input Set 2

134,2,7,2

1,3,2

7,4,77

15,6,77

6/7/8/9 Multi Punch (EOI)

Due to the difference in plotters and their appropriate software, program ENERGY is written to send its plots to a common output center at CERL. CERL uses a Houston Instrument plotter. Those users who wish to have plots made at their computer site should contact CERL (ATTN: CERL-EH/L. Windingland) to discuss the feasibility of such an action.

The resulting outputs from batch use of program ENERGY are identical to those resulting from inter-

active use. Outputs are presented in the section entitled "Batch Output" of this appendix.

Interactive Input

Request for usage of program ENERGY interactively must be received at least one week prior to desired use. Interactive use requires the transfer of all needed data files to public disk storage. Interactive use of program ENERGY is similar to batch use except that input is typed into an on-line computer terminal. At the end of each line (i.e., card image) a carriage return is required to transmit the command or input. Carriage return will be represented by (CR) in the remainder of this appendix. Interactive control commands do not require periods at the end of each line.

For interactive use a computer terminal is connected to NSRDC via telephone. It is suggested that a high-speed terminal (30 CPS) is used, though both 10 and 30 CPS lines are available. The terminals should be in half-duplex mode. Contact is made with NSRDC by calling Area Code 202 229-6000. A high pitched sound will cue the user to connect the terminal. The user must press (CR). NSRDC will respond with its name and the time. The user now logs in and inputs commands as described below.

The control commands for interactive usage are similar to the batch control card.

Login (CR)	In place of job card
Password (CR)	In place of charge card

ATTACH,PROFIL,FFECIPROFIL,ID = PUWS (CR)

BEGIN,INTER (CR)

The login command includes the user name but does not include core storage amount, time information, and priority. These are system defaults in the interactive mode. The user password is most often the cost code used on the batch charge card. Sample log-in and password commands are:

LOGIN,PUWSCERL83,SUP (CR)

1189056883 (CR)

Please note that NSRDC will prompt the user after the login command is sent. Ten spaces will be blacked out and the password will be requested. The user then enters the 10-digit password and pushes the carriage return. If the user name and password are correct, NSRDC will request control commands by printing COMMAND. The remaining control cards are entered after this has been printed by NSRDC.

After the control commands have been completed, program ENERGY will prompt the user's input. The user is advised to read the input description in the previous section. Interactive is identical except that the prompting statements notify the user of what is to be entered. The order and format of data are the same as in the batch input. The interactive routine also allows the user repeat capabilities on FFECI data points and calculation types. A question will be asked by the computer and can be answered by the user with a YES or a NO.

The following sample provides the prompting statements and input for interactive request of the same data request in examples 1 and 2 of the section of this appendix entitled "Batch Output." In this sample, each user input is underlined and followed by a carriage return. All data is entered after the two hyphens (--) and is followed by a carriage return. All multiple data entries must be separated by commas. (See Figure A1.) The locations of requested outputs have been noted but the outputs themselves are deleted. They will be presented in the section of this appendix entitled "Data Output."

To stop execution the user must request data point 0 (zero). After execution is complete, the user must enter LOGOUT before disconnecting the phone. If the user has hung up the phone or has disconnected accidentally, he/she should call NSRDC again, log into the machine, and enter LOGOUT. After the LOGOUT command has been entered, the computer will respond with a cost summary. Note: If the user does not LOGOUT, he/she will be charged for the connect time used until his/her entry channel has been cleared (usually around 30 minutes).

Data Output

Output from program ENERGY is identical for batch and interactive modes. See Figures A2 through A7 for examples of each report type and plot type. It should again be noted that all plots are automatically sent to CERL.

```
(CR)
NSRDC 6600 INTERCOM V4.5
DATE   11/22/77
TIME   09.26.48.
LOGIN,USER SAMPLE,SUP (CR)
########## ENTER PASSWORD-(CR)
COMMAND- ATTACH,PROFIL,FFECIPROFIL,ID=PUWS (CR)
 PF CYCLE NO. = 001
COMMAND- BEGIN,INTER (CR)
ENTER 3-DIGIT DATA POINT NUMBER; ZERO MEANS STOP--352 (CR)
ENTER 1-DIGIT RECORDER NUMBER--1 (CR)

        THIS PROGRAM HAS THE FOLLOWING CALCULATION
      OPTIONS:

            1. MONTHLY DATA REPORT
            2. MONTHLY DATA REPORT AND PLOT
            3. DAILY DATA REPORT
            4. DAILY DATA REPORT AND PLOT
            5. MONTHLY BTU REPORT
            6. MONTHLY BTU REPORT AND PLOT
            7. DAILY BTU REPORT
            8. DAILY BTU REPORT AND PLOT


ENTER NUMBER OF OPTION DESIRED--2 (CR)
ENTER THE NUMBER OF MONTHS DESIRED--3 (CR)
ENTER MONTH AND YEAR (MM,YY)--11,76 (CR)
ENTER MONTH AND YEAR (MM,YY)--4,77 (CR)
ENTER MONTH AND YEAR (MM,YY)--5,77 (CR)
DATA FOR THE FOLLOWING MONTHS WAS REQUESTED;

        NOV 1976
        APR 1977
        MAY 1977: DATA NOT AVAILABLE

WOULD YOU LIKE THE SAME DATA POINT?
ENTER 'YES' OR 'NO'--NO (CR)
ENTER 3-DIGIT DATA POINT NUMBER; ZERO MEANS STOP--129 (CR)
ENTER 1-DIGIT RECORDER NUMBER--3 (CR)
WOULD YOU LIKE SAME TYPE OF CALCULATION PERFORMED?
ENTER 'YES' OR 'NO'--NO (CR)

        THIS PROGRAM HAS THE FOLLOWING CALCULATION
      OPTIONS:

            1. MONTHLY DATA REPORT
            2. MONTHLY DATA REPORT AND PLOT
            3. DAILY DATA REPORT
            4. DAILY DATA REPORT AND PLOT
            5. MONTHLY BTU REPORT
            6. MONTHLY BTU REPORT AND PLOT
```

Figure A1. Sample interactive ENERGY input (user input is underlined).

```
                7. DAILY BTU REPORT
                8. DAILY BTU REPORT AND PLOT


ENTER NUMBER OF OPTION DESIRED--7 (CR)
ENTER FLOW CHANNEL (1, 2, OR 3)--1 (CR)
ENTER HOT WATER SUPPLY OR COLD
WATER RETURN CHANNEL (1, 2, OR 3)--2 (CR)
ENTER HOT WATER RETURN OR COLD
WATER SUPPLY CHANNEL (1, 2, OR 3)--3 (CR)
ENTER THE NUMBER OF DAYS DESIRED--2 (CR)
ENTER DAY, MONTH, AND YEAR (DD,MM,YY)--7,4,77 (CR)
ENTER DAY, MONTH, AND YEAR (DD,MM,YY)--20,5,77 (CR)
DATA FOR THE FOLLOWING DAYS WAS REQUESTED;

          7 APR 1977
         20 MAY 1977


WOULD YOU LIKE THE SAME DATA POINT?
ENTER 'YES' OR 'NO'--NO (CR)
ENTER 3-DIGIT DATA POINT NUMBER; ZERO MEANS STOP--0 (CR)
 $CARU$ PLOT UNITS IS  582.
 $ H I PLOT END
  ERROR IN ROUTE FUNCTION LFN= TAPE86
  COPYING Q FILE
      STOP
      31.901 CP SECONDS EXECUTION TIME
COMMAND- LOGOUT (CR)
CPA          32.616 SEC
SS           33.691 SEC
EST. SYSTEM COST   $     6.28
EST. CONNECT COST $     0.50
CONNECT TIME     0 HRS.     12 MIN.
 11/22/77  LOGGED OUT AT 09.39.08.
```

Figure A1. (continued)

ENERGY DATA FOR DATA POINT 1331 - FORT CARSON
BUILDING 1953

FEBRUARY 1977

DAY	ELECT KWH		
1	434.6	0.0	0.0
2	451.7	0.0	0.0
3	452.5	0.0	0.0
4	458.9	0.0	0.0
5	484.3	0.0	0.0
6	501.0	0.0	0.0
7	443.4	0.0	0.0
8	436.9	0.0	0.0
9	423.2	0.0	0.0
10	434.0	0.0	0.0
11	423.8	0.0	0.0
12	364.5	0.0	0.0
13	342.9	0.0	0.0
14	344.4	0.0	0.0
15	422.3	0.0	0.0
16	381.4	0.0	0.0
17	394.0	0.0	0.0
18	450.1	0.0	0.0
19	453.2	0.0	0.0
20	447.0	0.0	0.0
21	440.9	0.0	0.0
22	401.0	0.0	0.0
23	392.3	0.0	0.0
24	393.1	0.0	0.0
25	425.1	0.0	0.0
26	413.7	0.0	0.0
27	458.4	0.0	0.0
28	412.8	0.0	0.0
MONTHLY TOTAL	11881.6	0.0	0.0
DAILY AVERAGE	424.3	0.0	0.0
DAILY MAXIMUM	501.0	0.0	0.0

Figure A2. Sample monthly data report.

ENERGY DATA FOR DATA POINT 3201 - FORT HOOD
BUILDING 60100

7 APR 1977

	ELECT	GAS	
HOUR	KWH	CU FT	
1	1.8	13.0	0.0
2	1.5	5.0	0.0
3	1.4	6.0	0.0
4	1.5	5.0	0.0
5	1.5	5.0	0.0
6	1.5	5.0	0.0
7	1.4	5.0	0.0
8	1.3	5.0	0.0
9	1.6	65.0	0.0
10	2.4	95.0	0.0
11	5.1	29.0	0.0
12	5.7	27.0	0.0
13	4.6	24.0	0.0
14	2.6	28.0	0.0
15	1.7	42.0	0.0
16	2.0	12.0	0.0
17	2.0	24.0	0.0
18	2.0	52.0	0.0
19	2.2	35.0	0.0
20	2.0	21.0	0.0
21	2.5	12.0	0.0
22	3.6	19.0	0.0
23	2.8	25.0	0.0
24	3.0	19.0	0.0
DAILY TOTAL	57.6	578.0	0.0
HOURLY AVERAGE	2.4	24.1	0.0
HOURLY MAXIMUM	5.7	95.0	0.0

Figure A3. Sample daily data report.

ENERGY DATA FOR DATA POINT 1293 - FORT CARSON
BUILDING 1363

JANUARY 1977

DAY	MILLION BTUS	INVALID DATA (HRS)
1	16.321	0
2	15.830	0
3	13.695	0
4	14.258	0
5	16.072	0
6	15.835	0
7	14.206	0
8	17.834	0
9	19.482	0
10	17.851	0
11	15.996	0
12	15.587	0
13	13.659	0
14	14.395	0
15	14.850	0
16	15.708	0
17	12.614	0
18	12.688	0
19	11.954	0
20	12.293	0
21	12.287	0
22	11.890	0
23	13.019	0
24	14.348	0
25	13.641	0
26	12.386	0
27	12.093	0
28	14.303	0
29	14.439	0
30	14.283	0
31	12.619	0
MONTHLY TOTAL	446.434	0
DAILY AVERAGE	14.401	
DAILY MAXIMUM	19.482	

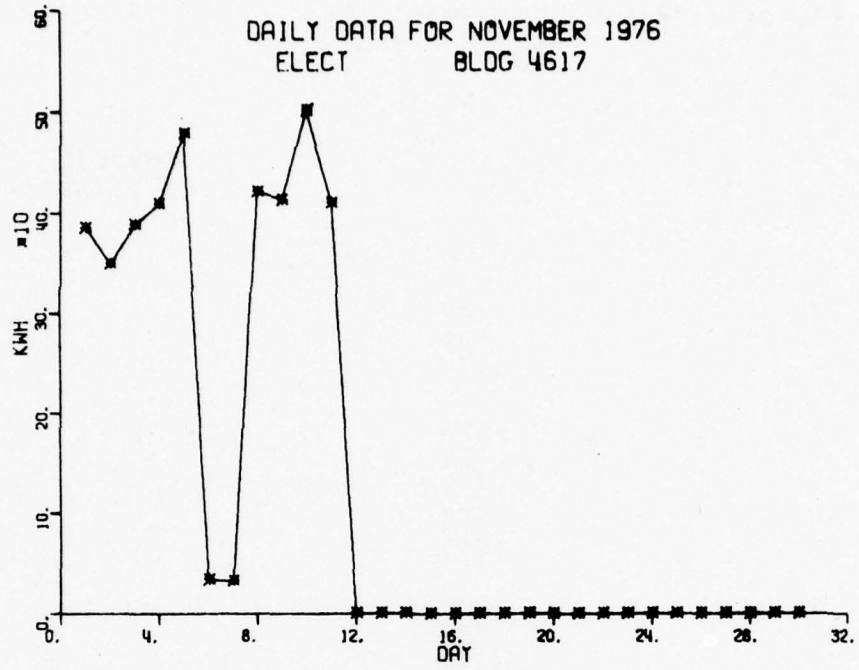
Figure A4. Sample monthly Btu report.

ENERGY DATA FOR DATA POINT 1293 - FORT CARSON
BUILDING 1363

7 APR 1977

HOUR	MILLION BTUS	INVALID DATA (HRS)
1	.424	
2	.450	
3	.460	
4	.459	
5	.474	
6	.475	
7	.460	
8	.394	
9	.358	
10	.311	
11	.298	
12	.289	
13	.287	
14	.290	
15	.273	
16	.288	
17	.291	
18	.288	
19	.297	
20	.314	
21	.333	
22	.311	
23	.364	
24	.383	
DAILY TOTAL	8.572	0
HOURLY AVERAGE	.357	
HOURLY MAXIMUM	.475	

Figure A5. Sample daily Btu report.



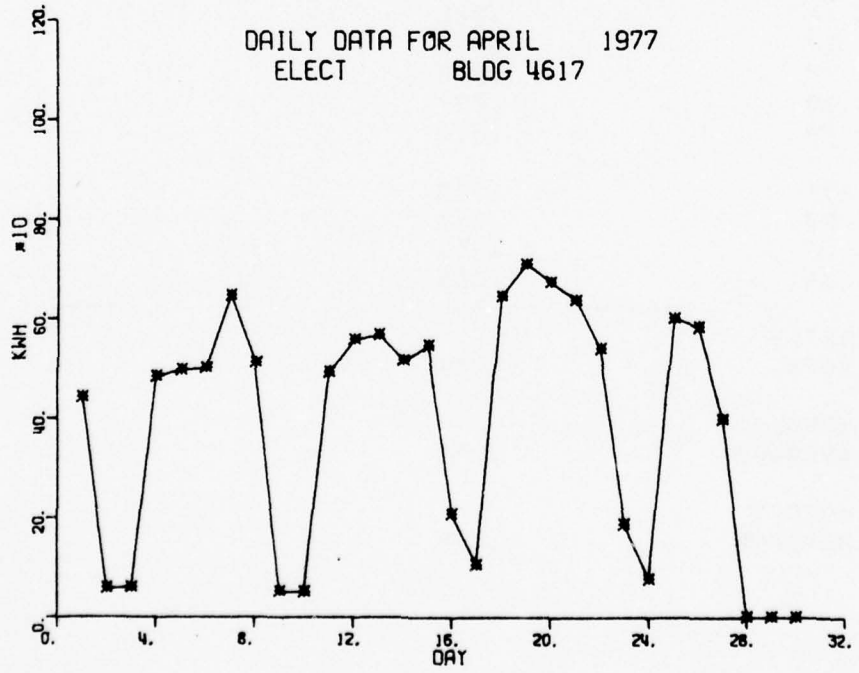
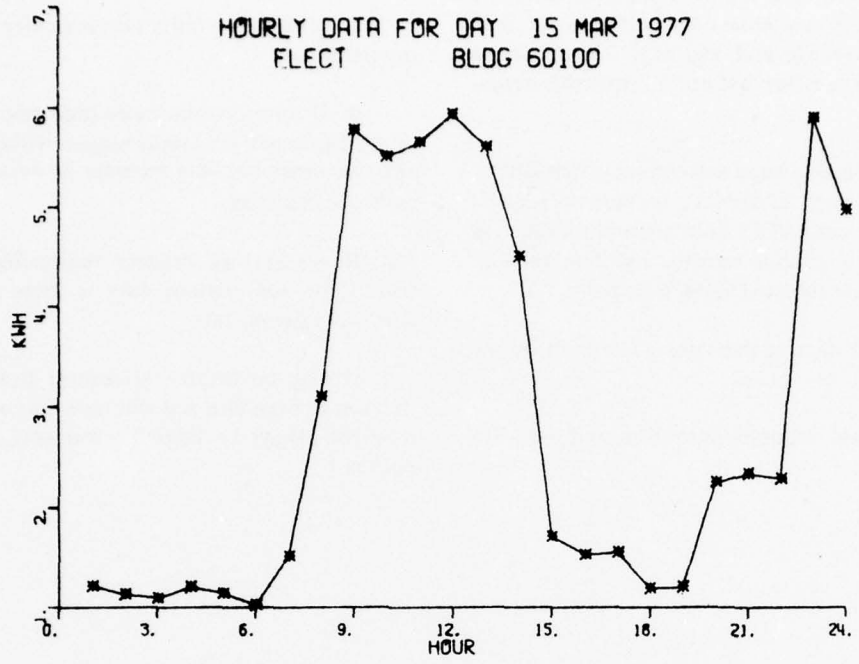


Figure A6. Sample monthly plots.



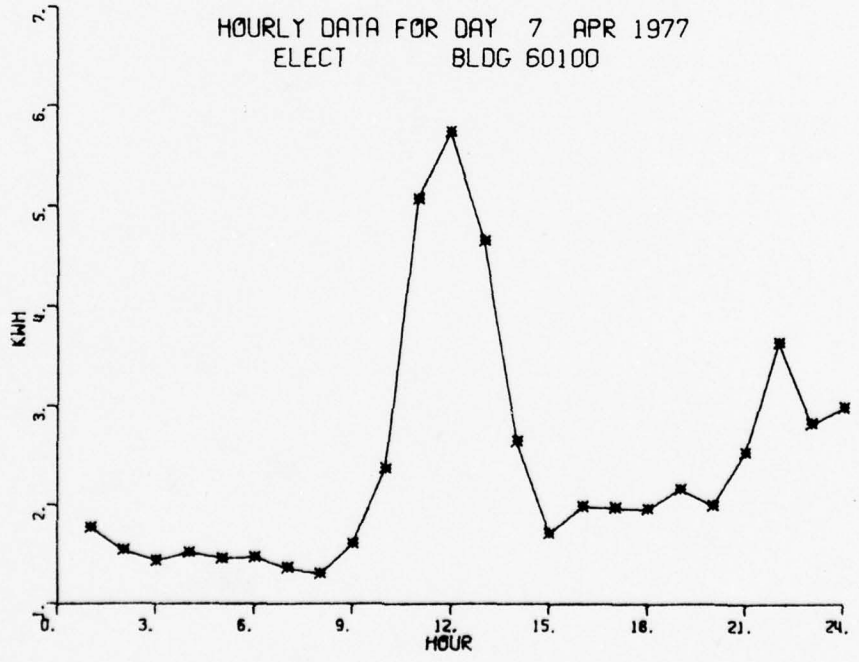


Figure A7. Sample daily plots.

Efficiency

The data access and reports attainable from the FFECI data base can be less costly if data access is approached carefully and logically. The following are some guidelines for fast and inexpensive execution.

1. When accessing large amounts of either Btu or non-Btu data from ENERGY, be sure to request data from only one FFECI data point at a time. It is less expensive to change recorder number, calculation time, or data than to change data point.

2. Group all data of the same data point by the following rules:

a. Separate requests into Btu and non-Btu categories

b. Within these categories, order the data by recorder number from low to high

c. Within a recorder number order the data requests by date

d. If dates within a recorder number overlap or are duplicated (i.e., daily request within a monthly request) order the data requests by calculation type rather than by date.

3. Be careful to request reasonable dates. A search for non-existent data is more costly than access of existing data.

4. It may be helpful to request Btu data after dates have been checked with non-Btu output. (This may not always be helpful when only Btu data is needed.)

APPENDIX B:

DATA POINTS BEING MONITORED (BY MAJOR CONSUMER GROUP)

Table B1 lists all present FFECI monitoring points organized by major consumer group. The table provides a brief description of each building, the real property building number at the post, the FFECI data point number, which includes the location, and the energy parameter(s) being monitored. Users should refer to the location and energy parameter keys for information regarding building location and energy parameter type. Appendix D presents a detailed description of the buildings.

Location Key

The first digit of the data point number indicates the building location:

1 = Fort Carson
2 = Fort Belvoir
3 = Fort Hood

Energy Parameter Key

E = Electrical
G = Gas
O = Oil
W = Weather station
BT = Building temperature
BH = Building humidity
CWF = Chilled water flow
CWRT = Chilled water return temperature
CWST = Chilled water supply temperature
HWF = Hot water flow
HWRT = Hot water return temperature
HWST = Hot water supply temperature
DHWF = Domestic hot water flow
MWF = Medium hot water flow
MWRT = Medium hot water return temperature
MWST = Medium hot water supply temperature
WF = Dual temperature water flow
WFR = Dual temperature water return temperature
WFS = Dual temperature water supply temperature

Weather Parameter Key

DBT = Dry bulb temperature
WBT = Wet bulb temperature
SOLR = Horizontal solar radiation
WSPD = Wind speed
WDIR = Wind direction
BPRE = Barometric pressure

Table B1

Data Points by Building Type

Description	Building Number	FFECI Data Point	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Troop Housing						
Barracks "T"	811	126	1	E	G	
			2	CWF	CWST	CWRT
Barracks "I"	1044	128	1	E		
			2	CWF	CWST	CWRT
			3	HWF	HWST	HWRT
Barracks "H"	1219	127	1	E	G	
Barracks "I"	1363	129	1	E		
			2	CWF	CWRT	CWST
			3	HWF	HWST	HWRT
Barracks—New	1951	132	1	DWHF		
			2	CWF	CWST	CWRT
			3	MWF	MWST	MWRT
			4	BT1	BT2	E
			5	E	E	E
Barracks—New	1953	133	1	E		
			2	CWF	CWST	CWRT
			3	HWRT	HWST	HWF
Barracks—WW II	3471	136	1	E	G	
Barracks—WW II	3472	137	1	E	G	
Barracks	203	238	1	E	O	
Barracks	1464	228	1	E		
Barracks	2111	226	1	E		
			2	HWST	HWRT	HWF
Barracks	2203	223	1	E	O	
Barracks	12005	340	1	E	G	
Barracks	16008	339	1	E	G	
Barracks	27002	342	1	E		
Barracks	27006	343	1	E		
Barracks	34006	346	1	E		
Barracks	34010	347	1	E		
Barracks	41008	338	1	E	G	
Barracks	87015	335	1	E		
Bachelor Officers' Quarters	7304	119	1	E	G	
Bachelor Officers' Quarters	470	221	1	E		
			2	O	O	
Bachelor Officers' Quarters	508	222	1	E		
			2	G	O	
Bachelor Officers' Quarters	36006	331	1	E	G	
Dining Facility	1040	130	1	E	G	
			2	HWF	HWST	HWRT
Dining Facility	1661	131	1	E	G	
			2	HWF	HWST	HWRT
Dining Facility	231	224	1	E	O	G
Dining Facility	87017	333	1	E	G	
			2	CWF	CWST	CWRT
Dining Facility and Central Plant	27004	341	1	E	G	G
Dining Facility and Central Plant	34008	345	1	E	G	G

Table B1 (continued)

Description	Building Number	FFECI Data Point	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Family Housing						
Family Housing	17	110	1	E	G	
Family Housing	4644	122	1	E	G	
Family Housing	7022	115	1	E	G	
Family Housing	7269A	116	1	E	G	
Family Housing	51	218	1	E	O	
Family Housing	452	216	1	E	O	
Family Housing	553	213	1	E	G	
Family Housing	579	214	1	E	G	
Family Housing	922	207	1	E		
Family Housing	1501	211	1	E	G	
Family Housing	1551	210	1	E	G	
Family Housing	1663	204	1	E	G	
Family Housing	1689	205	1	E	G	
Family Housing	180	327	1	E	G	
Family Housing	178	326	1	G		
Family Housing	5658	371	1	E	G	
Family Housing	5669	322	1	E	G	
Family Housing	6443-1	324	1	E	G	
Family Housing	6449-1	372	1	E	G	
Family Housing (General Officers)	6794	329	1	E	G	
Family Housing	6809	325	1	E	G	
Family Housing	60062	319	1	E	G	
Family Housing	60100	320	1	E	G	
Administration/Training						
Administration	741	153	1	E	G	
Administration	1048	135	1	E		
			2	HWF	HWST	HWRT
Administration—WW II	1544	154	1	E	G	
Administration—New	2060	134	1	E		
			2	CWF	CWST	CWRT
			3	HWF	HWST	HWRT
Administration	358	297	3	CWF	CWST	CWRT
			4	HWF	HWST	HWRT
			5	E	E	E
			6	O	BT	BR
Administration/ Laboratory	399	230	1	E	G	
Administration	16010	365	1	E	G	
Administration	27001	344	1	E		
Administration	37010	370	1	E	G	
Administration	34011	348	1	E		
Post Headquarters	1430	148	1	E	G	
Post Headquarters	216	231	1	E		
			2	O		
Post Headquarters	1	361	1	E	G	
Headquarters	16011	374	1	E	G	
Headquarters	37011	368	1	E	G	

Table B1 (continued)

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Community Support Facilities						
Enlisted Open Dining Facility	1230	145	1	E	G	
Enlisted Open Dining Facility	1200	241	1	E	G	E
Enlisted Open Dining Facility (NCO Mini Dome)	42000	353	1	E	G	
Enlisted Personnel Service Club	121	356	1	E	G	
Officers' Open Dining Facility	7300	118	1	E	G	
Officers' Open Dining Facility	20	219	1	E		
			2	O	O	
Commissary	1525	143	1	E	G	
Commissary Annex	3572	149	1	E	G	
Commissary	238	220	1	O		
			2	O		
Commissary	50001	354	1	E		
			2	G		
Swimming Pool	182	227	1	E		
			2	O	O	
Theater	2120	239	1	E	O	
Community Center	108	362	1	E	G	
Four Seasons Cafe	136	330	1	E	G	
Main PX	135	376	1	E	G	
Branch PX	87008	336	1	E		
			2	WF	WST	WRT
Gymnasium	12018	363	1	E	G	
Gymnasium	37010	364	1	E	G	
Field House	23001	375	1	E	G	
Production/Maintenance						
Laundry	402	146	1	E		
Laundry Steam Plant	403	146	1		G	
Laundry	611	240	1	E		
Maintenance Shop	2492	139	1	E	G	
Maintenance Shop	2992	138	1	E	G	
Maintenance Shop	8000	140	1	E	G	
Maintenance Shop	4617	352	1	E	G	
Maintenance Shop	9529	349	1	E	G	
Maintenance Shop	30015	373	1	E		
			2	G		
Maintenance Shop	32016	350	1	E	G	
Maintenance Shop	40001	351	1	G		
			2	E	E	E
Motor Pool	1949	234	1	E		
			2	E		

Table B1 (continued)

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Medical/Dental						
Dispensary	1007	147	1	E	G	
Dispensary	24001	358	1	E	G	
Dispensary	31002	359	1	E	G	
Hospital	3071	232	1	E	E	
Hospital	36000	357	1	E		
Dental Clinic	1099	233	1	E		
			2	HWRT	HWF	HWST
Dental Clinic	330	360	1	E	G	
Storage						
Storage	237	152	1	E	G	
Storage and Shop	1304	151	1	E	G	
Warehouse	335	236	1	E		
Warehouse	1108	235	1	E		
			2	O		
Warehouse	49015	366	1	E	G	
Utilities Distribution						
Feeder—1		102	1		E	
Feeder—2		102	1	E		
Feeder—3		104	1		E	
Feeder—4		104	1	E		
Feeder—5		107	1		E	
Feeder—6		106	1	E		
Feeder—7		107	1	E		
Feeder—8		106	1		E	
Feeder—1		301	2		E	
Feeder—2		301	4		E	
Feeder—3		301	5	E		
Feeder—4		301	6		E	
Feeder—5		301	6			E
Feeder—6		301	2	E		
Feeder—7		301	1			E
Feeder—8		301	6	E		
Feeder—9		301	3	E		
Feeder—10		301	4			E
Feeder—11		301	4	E		
Feeder—12		301	5		E	
Feeder—13		301	2			E
Feeder—14		301	1		E	
Feeder—15		301	5			E
Feeder—16		301	1	E		
Airfield		141	1	E		
Family Hsg—7220	100 Units	112	1	E		
Family Hsg—4629	64 Units	120	1	E		
Family Hsg—7270	4 Units	114	1	E		
Family Hsg Units	27 Units	104	1	E		
Fam Hsg Feeder		203	1	E		
Fam Hsg Feeder		206	1	E		
Fam Hsg Feeder		209	1	E		
Fam Hsg Feeder		212	1	E		
Fam Hsg Feeder		215	1	E		
Barracks Feeder	2117	225	1	E		
Substation-CKT7	3067	217	1	E		
2500 KVA Transformer	3072	201	1	E		

Table B1 (continued)

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Utilities Distribution (continued)						
FDR 1600 Area	3072	201	1		E	
Transformer Vault		242	1	E		
Administration Feeder		229	1	E		
Post Pump Station	6898	367	1	E		
Central Energy	10006					
Plant and	and	337	1	E	E	E
Barracks	10007		2	E	G	G
Central Plant	87018	332	1	E	E	E
			2	E	G	G
			3	CWF	CWST	CWRT
			4	CWF	CWST	CWRT
			5	CWF	CWST	CWRT
			6	WF	WRT	
Reg ST-West		317	1	E		
Trans-R6AAF		318	1	E		
Pershing Park Feeder		321	1	E		
Chaffe Village Feeder		323	1	E		
McNair Village Feeder		328	1	E		
Weather						
Fort Carson		196	1	DBT	DPT	SOLR
			2	WSPD	WDIR	BPRE
Fort Belvoir		296	1	DBT	DPT	SOLR
			2	WSPD	WDIR	BPRE
Fort Hood		396	1	DBT	DPT	SOLR
			2	WSPD	WDIR	BPRE

APPENDIX C:

DATA POINTS BEING MONITORED (BY INDIVIDUAL POST AND BY MAJOR CONSUMER GROUP)

Tables C1 through C3 list all present FFECI monitoring points organized by major consumer group. The tables provide a brief description of each building, the real property building number at the post, the FFECI data point number, which includes the location, and the energy parameter(s) being monitored. Users should refer to the location and energy parameter keys for information regarding building location and energy parameter type. Appendix D presents a detailed description of the buildings.

Location Key

The first digit of the data point number indicates the building location:

1 = Fort Carson
2 = Fort Belvoir
3 = Fort Hood

Energy Parameter Key

E = Electrical
G = Gas
O = Oil
W = Weather station
BT = Building temperature
BH = Building humidity
CWF = Chilled water flow
CWRT = Chilled water return temperature
CWST = Chilled water supply temperature
HWF = Hot water flow
HWRT = Hot water return temperature
HWST = Hot water supply temperature
DHWF = Domestic hot water flow
MWF = Medium hot water flow
MWRT = Medium hot water return temperature
MWST = Medium hot water supply temperature
WF = Dual temperature water flow
WFR = Dual temperature water return temperature
WFS = Dual temperature water supply temperature

Weather Parameter Key

DBT = Dry bulb temperature
WBT = Wet bulb temperature
SOLR = Horizontal solar radiation
WSPD = Wind speed
WDIR = Wind direction
BPRE = Barometric pressure

Table C1

Data Points at Fort Carson by Building Type

Description	Building Number	FFEC1 Data Point	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Troop Housing						
Barracks "T"	811	126	1	E	G	
			2	CWF	CWST	CWRT
Barracks "I"	1044	128	1	E		
			2	CWF	CWST	CWRT
			3	HWF	HWST	HWRT
Barracks "H"	1219	127	1	E	G	
Barracks "I"	1363	129	1	E		
			2	CWF	CWRT	CWST
			3	HWF	HWST	HWRT
Barracks—New	1951	132	1	DWHF		
			2	CWF	CWST	CWRT
			3	MWF	MWST	MWRT
			4	BT1	BT2	E
			5	E	E	E
Barracks—New	1953	133	1	E		
			2	CWF	CWST	CWRT
			3	HWRT	HWST	HWF
Barracks—WW II	3471	136	1	E	G	
Barracks—WW II	3472	137	1	E	G	
Bachelor Officers' Quarters	7304	119	1	E	G	
Dining Facility	1040	130	1	E	G	
			2	HWF	HWST	HWRT
Dining Facility	1661	131	1	E	G	
			2	HWF	HWST	HWRT
Family Housing						
Family Housing	17	110	1	E	G	
Family Housing	4644	122	1	E	G	
Family Housing	7022	115	1	E	G	
Family Housing	7269A	116	1	E	G	
Administration/Training						
Administration	741	153	1	E	G	
Administration	1048	135	1	E		
			2	HWF	HWST	HWRT
Post Headquarters	1430	148	1	E	G	
Administration—WW II	1544	154	1	E	G	
Administration—New	2060	134	1	E		
			2	CWF	CWST	CWRT
			3	HWF	HWST	HWRT
Community Support Facilities						
Enlisted Open Dining Facility	1230	145	1	E	G	
Commissary	1525	143	1	E	G	
Commissary Annex	3572	149	1	E	G	
Officers' Open Dining Facility	7300	118	1	E	G	

Table C1 (continued)

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Production/Maintenance						
Laundry	402	146	1	E		
Laundry Steam Plant	403	146	1		G	
Maintenance Shop	2492	139	1	E	G	
Maintenance Shop	2992	138	1	E	G	
Maintenance Shop	8000	140	1	E	G	
Medical/Dental						
Dispensary	1007	147	1	E	G	
Storage						
Storage	237	152	1	E	G	
Storage and Shop	1304	151	1	E	G	
Utilities Distribution						
Family Hsg—7220	100 Units	112	1	E		
Family Hsg—4629	64 Units	120	1	E		
Family Hsg—7270	4 Units	114	1	E		
Family Hsg Units	27 Units	104	1	E		
Feeder—1		102	1		E	
Feeder—2		102	1	E		
Feeder—3		104	1		E	
Feeder—4		104	1	E		
Feeder—5		107	1		E	
Feeder—6		106	1	E		
Feeder—7		107	1	E		
Feeder—8		106	1		E	
Weather		196	1	DBT	DPT	SOLR
			2	WSPD	WDIR	BPRE

Table C2

Data Points at Fort Belvoir by Building Type

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Troop Housing						
Barracks	203	238	1	E	O	
Bachelor Officers' Quarters	470	221	1	E		
			2	O	O	
Bachelor Officers' Quarters	508	222	1	E		
			2	G	O	
Barracks	1464	228	1	E		
Barracks	2111	226	1	E		
			2	HWST	HWRT	HWF
Barracks	2203	223	1	E	O	
Dining Facility	231	224	1	E	O	G
Family Housing						
Family Housing	51	218	1	E	O	
Family Housing	452	216	1	E	O	
Family Housing	553	213	1	E	G	
Family Housing	579	214	1	E	G	
Family Housing	922	207	1	E		
Family Housing	1501	211	1	E	G	
Family Housing	1551	210	1	E	G	
Family Housing	1663	204	1	E	G	
Family Housing	1689	205	1	E	G	
Administration/Training						
Post Headquarters	216	231	1	E		
			2	O		
Administration	358	297	3	CWF	CWST	CWRT
			4	HWF	HWST	HWRT
			5	E	E	E
			6	O	BT	BH
Administration	399	230	1	E	G	
Community Support Facilities						
Officers' Open Dining Facility	20	219	1	E		
			2	O	O	
Swimming Pool	182	227	1	E		
			2	O	O	
Commissary	238	220	1	O		
			2	O		
Enlisted Open Dining Facility	1200	241	1	E	G	E
Theater	2120	239	1	E	O	
Production/Maintenance						
Laundry	611	240	1	E		
Motor Pool	1949	234	1	E		
			2	E		

Table C2 (continued)

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Medical/Dental						
Dental Clinic	1099	233	1	E		
			2	HWRT	HWF	HWST
Hospital	3071	232	1	E	E	
Storage						
Warehouse	335	236	1	E		
Warehouse	1108	235	1	E		
			2	O		
Utility Distribution						
Barracks Feeder	2117	225	1	E		
Substation-CKT7	3067	217	1	E		
2500 KVA Transformer	3072	201	1	E		
FDR 1600 Area	3072	201	1		E	
Fam Hsg Feeder		203	1	E		
Fam Hsg Feeder		206	1	E		
Fam Hsg Feeder		209	1	E		
Fam Hsg Feeder		212	1	E		
Fam Hsg Feeder		215	1	E		
Transformer Vault		242	1	E		
Administration Feeder		229	1	E		
Weather		296	1	DBT	DPT	SOLR
			2	WSPD	WDIR	BPRE

Table C3

Data Points at Fort Hood by Building Type

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Troop Housing						
Barracks	12005	340	1	E	G	
Barracks	16008	339	1	E	G	
Barracks	27002	342	1	E		
Barracks	27006	343	1	E		
Barracks	34006	346	1	E		
Barracks	34010	347	1	E		
Bachelor Officers' Quarters	36006	331	1	E	G	
Barracks	41008	338	1	E	G	
Barracks	87015	335	3	WF	WST	WRT
			4	E	BT	BH
Dining Facility and Central Plant	27004	341	1	E	G	G
Dining Facility and Central Plant	34008	345	1	E	G	G
Dining Facility	87017	333	1	E	G	
Family Housing						
Family Housing	178	326	1	G		
Family Housing	180	327	1	E	G	
Family Housing	5658	371	1	E	G	
Family Housing	5669	322	1	E	G	
Family Housing	6443-1	324	1	E	G	
Family Housing	6449-1	372	1	E	G	
Family Housing (General Officers)	6794	329	1	E	G	
Family Housing	6809	325	1	E	G	
Family Housing	60062	319	1	E	G	
Family Housing	60100	320	1	E	G	
Administration/Training						
Post Headquarters	1	361	1	E	G	
Administration	16010	365	1	E	G	
Headquarters	16011	374	1	E	G	
Administration	27001	344	1	E		
Administration	34011	348	1	E		
Administration	37010	370	1	E	G	
Headquarters	37011	368	1	E	G	
Community Support Facilities						
Community Center	108	362	1	E	G	
Enlisted Personnel Service Club	121	356	1	E	G	
Four Seasons Cafe	136	330	1	E	G	
Main PX	135	376	1	E	G	
Officers' Club Open Dining Facility	5764	355	1	E	E	G
Gymnasium	12018	363	1	E	G	
Field House	23001	375	1	E	G	
Gymnasium	37010	364	1	E	G	
Enlisted Open Mess (NCO Mini Dome)	42000	353	1	E	G	
Commissary	50001	354	1	E		
			2	E		
Branch PX	87008	336	1	E		
			2	WF	WFS	WFR

Table C3 (continued)

Description	Building Number	FFECI Data Point Number	Recorder Number	Parameter Monitored by Channel Number 1	2	3
Production/Maintenance						
Maintenance Shop	4617	352	1	E	G	
Maintenance Shop	9529	349	1	E		
			2	G		
Maintenance Shop	30015	373	1	E		
			2	G		
Maintenance Shop	32016	350	1	E	G	
Maintenance Shop	40001	357	1	G		
			2	E	E	E
Medical/Dental						
Dental Clinic	330	360	1	E	G	
Dispensary	24001	358	1	E	G	
Dispensary	31002	359	1	E	G	
Hospital	36000	357	1	G		
Storage						
Warehouse	49015	366	1	E	G	
Utility Distribution						
Post Pump Station	6898	367	1	E		
Central Energy Plant	10006					
and Barracks	10007	337	1	E	E	E
			2	E	G	G
Feeder 16		301	1	E		
Feeder 14		301	1		E	
Feeder 7		301	1			E
Feeder 6		301	2	E		
Feeder 1		301	2		E	
Feeder 13		301	2			E
Feeder 9		301	3	E		
Feeder 11		301	4	E		
Feeder 2		301	4		E	
Feeder 10		301	4			E
Feeder 3		301	5	E		
Feeder 12		301	5		E	
Feeder 15		301	5			E
Feeder 8		301	6	E		
Feeder 4		301	6		E	
Feeder 5		301	6			E
Reg ST-West		317	1	E		
Trans-R6AAF		318	1	E		
Pershing Park Feeder		321	1	E		
Chaffe Village Feeder		323	1	E		
McNair Village Feeder		328	1	E		
Central Plant	87018	332	1	E	E	E
			2	E	G	G
			3	CWF	CWST	CWRT
			4	CWF	CWST	CWRT
			5	CWF	CWST	CWRT
			6	CWF	CWRT	
Weather						
		396	1	DBT	DPT	SOLR
			2	WSPD	WDIR	BPRE

APPENDIX D:

BUILDING DESCRIPTIONS AND PHOTOGRAPHS

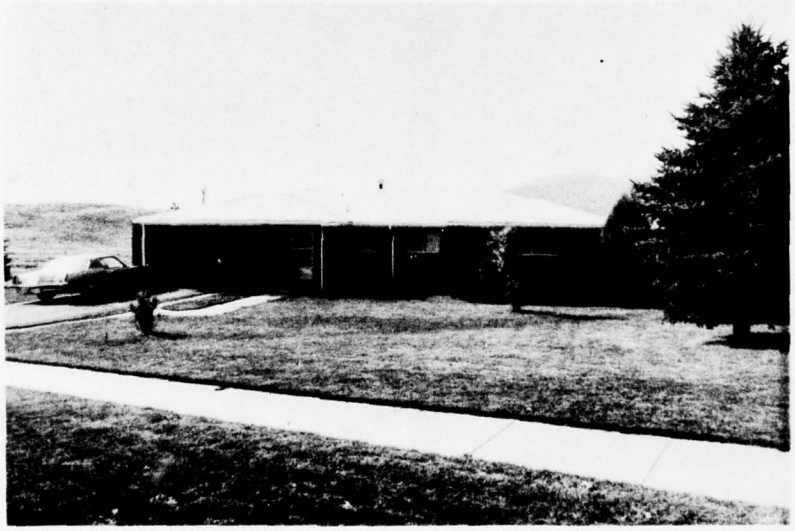
This appendix provides a narrative description and photograph of each building being monitored. The energy parameters being monitored in each building are also provided in the narrative. The facilities are presented in order by FFECI data point number.

Fort Carson, CO
Building 17
Data Point 110
Single-Family Housing

Building 17 is one of a complex of single-family houses (buildings 1 through 27) built in 1957 for senior field-grade officers. This one-story house has a total floor area of 1906 sq ft (177 m^2), an overall length of 55.4 ft (16.9 m), and a width of 43.3 ft (13.2 m). The total exterior wall area is 1753 sq ft (163 m^2), of which 14 percent (247 sq ft [23 m^2]) is glass. The combined U-value of the exterior wall is 0.33 Btus/°F-hr-sq ft (1.87 W/°K-m^2), and that of the roof/ceiling is 0.08 Btus/°F-hr-sq ft (0.45 W/°K-m^2).

The house is heated by a ducted warm air system employing a gas-fired furnace of 97,000-Btuh (102 000 kJ/hr) bonnet output capacity.

The energy parameters being monitored in this building are electricity and natural gas.



Fort Carson, CO
Building 7022
Data Point 115
Single-Family Housing

Building 7022 is one of the single-family houses built in 1957 for field-grade officers. This one-story house has a total floor area of 1640 sq ft (152 m^2), an overall length of 54.5 ft (16.6 m), and a width of 41.5 ft (12.6 m). The total exterior wall area is 1600 sq ft (149 m^2), of which 15 percent (240 sq ft [22 m^2]) is glass. The combined U-value of the exterior wall is 0.30 Btu/°F-hr-sq ft (1.70 W/°K-m^2), and that of the roof/ceiling is 0.10 Btu/°F-hr-sq ft (0.57 W/°K-m^2).

The house is heated by a ducted warm air system employing a gas-fired furnace of 98,000-Btuh (103 300 kJ/hr) bonnet capacity.

The energy parameters being monitored in this building are electric and natural gas.

Fort Carson, CO
Building 7269-A
Data Point 116
Family Housing—Duplex

This unit is half of a duplex house built in 1958 to provide family housing for company-grade officers. The two-story unit has a total floor area of 1835 sq ft (170 m²), including a full basement. This rectangular structure has a frontal width of 23.2 ft (7.1 m) and a depth of 26.5 ft (8.1 m). The total exterior wall area is 1435 sq ft (133 m²), of which 10 percent (142 sq ft [13 m²]) is glass. The combined U-value of the exterior wall is 0.30 Btu/°F-hr-sq ft (1.70 W/°K-m²), and that of the roof/ceiling is 0.10 Btu/°F-hr-sq ft (0.57 W/°K-m²).

The unit is heated by a ducted warm air system employing a gas-fired furnace of 64,500-Btuh (68 000 kJ/h,) bonnet output capacity.

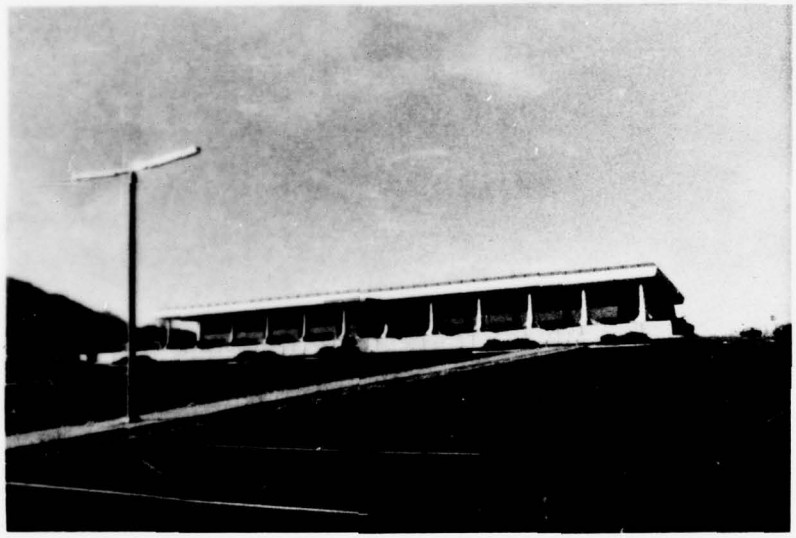
The energy parameters being monitored in this building are total electric and natural gas.

Fort Carson, CO
Building 7300
Data Point 118
Officers' Open Dining Facility

Building 7300 is an officers' open dining facility building constructed in 1959. This one-story brick structure has a total floor area of 19,089 sq ft (1773 m²). The building dimensions are 160.7 × 113 ft (49.0 × 34 m), plus an offset of 18.7 × 50 ft (5.7 × 15 m). The total exterior wall area is 6980 sq ft (648 m²), of which 28 percent (1984 sq ft [184 m²]) is glass. The combined U-value of the exterior wall is 0.47 B[illegible] sq ft (2.67 W/°K-m²), and that of the ro[illegible] 0.23 Btus/°F-hr-sq ft (1.31 W/°K-m²).

The building is heated and cooled by five roof-mounted, packaged gas-fired heating and vapor compression refrigeration units. The total capacity of the five units is 490,000 Btuh (517 000 kJ/hr) and 862,500 Btuh (910 000 kJ/hr) heating. Three additional roof-mounted, packaged gas-fired heating and evaporative cooling units with a total capacity of 960,000 Btuh (1 013 000 kJ/hr) and 13,500 cfm (6.3 m³/min) are used to supply makeup air for the kitchen.

The energy parameters being monitored in this building are electricity and natural gas.

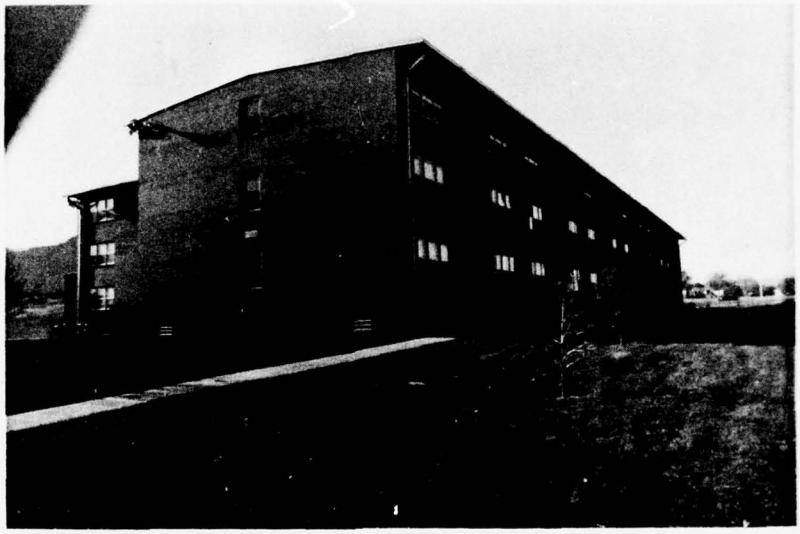


Fort Carson, CO
Building 7304
Data Point 119
Bachelor Officers' Quarters (BOQ)

Building 7304 is a BOQ without dining facilities built in 1970. The three-story structure is composed of a primary building 238 × 42 ft (73 × 13 m) and a wing of 55.7 × 42 ft (17.0 × 13 m). The building has a total floor area of 37,100 sq ft (3447 m^2), which includes a basement mechanical room of 994 sq ft (303 m^2). The total exterior wall area is 21,905 sq ft (2035 m^2), of which 16 percent (3464 sq ft [352 m^2]) is glass. The combined U-value of the exterior wall is 0.31 Btus/°F-hr-sq ft (1.75 W/°K-m^2), and that of the roof/ceiling is 0.05 Btus/°F-hr-sq ft (0.28 W/°K-m^2).

The building is heated by a multi-loop, low-temperature, hot-water system employing baseboard radiators located along the inside perimeter. Hot water for heating is supplied by a boiler of 1.28 × 10^6 Btuh (1.35 × 10^6 kJ/hr) output capacity. Ventilation is accomplished through individual ventilation fans serving each room.

The energy parameters being monitored in this building are total electricity and natural gas.



Fort Carson, CO
Building 4644
Data Point 122
Family Housing—Multi

Building 4644 is a one-story fourplex house built in 1972. Each housing unit has a typical width and depth of 40.8 and 30 ft (2.4 and 9.1 m), respectively. The units are arranged end to end, resulting in an overall width of 163.2 ft (49.7 m). The total floor area is 4900 sq ft (455 m^2), and the total exterior wall area is 3180 sq ft (295 m^2), of which 17.5 percent (556 sq ft [52 m^2]) is glass. The combined U-value of the exterior wall is 0.25 Btus/°F-hr-sq ft (1.42 W/°K-m^2); that of the roof/ceiling is 0.90 Btus/°F-hr-sq ft (5.11 W/°K-m^2).

Each housing unit is heated by a ducted warm-air system, each of which employs four gas-fired furnaces of 100,000-Btuh (105 500 kJ/hr) bonnet output capacity.

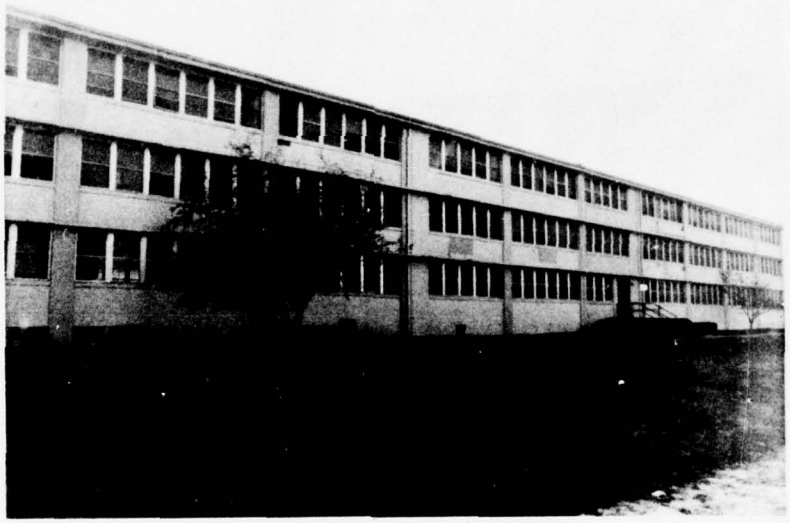
The energy parameters being monitored in this building are total electricity and natural gas.

Fort Carson, CO
Building 811
Data Point 126
Bachelor Enlisted Quarters With
Dining Facilities (Barracks)

This building is an enlisted barracks with dining facilities constructed in 1956. It has a total floor area of 40,427 sq ft (3756 m^2). The building is a three-story rectangular structure with a length of 267 ft (81 m) and a width of 39 ft (12 m), plus a one-story L-shaped dining facility with an overall length of 121.7 ft (37.1 m) and width of 57.7 ft (17.6 m). It was designed for a total capacity of 178 personnel. The building has 7790 sq ft (724 m^2) of single glazed windows. The combined U-value for the exterior wall is 0.54 Btu/°F-hr-sq ft (3.07 W/°K-m^2), and that of the roof is 0.14 Btu/°F-hr-sq ft (0.79 W/°K-m^2).

The structure employs a fin-tube perimeter radiation system for heating, with hot water supplied from two 23.4 × 10^6 Btuh (24.7 × 10^6 kJ/hr) gas-fired boilers. Cooling is supplied from chilled water piped from a central plant.

The energy parameters being monitored in this building include total electricity, natural gas, chilled water flow, and supply/return chilled water temperature.

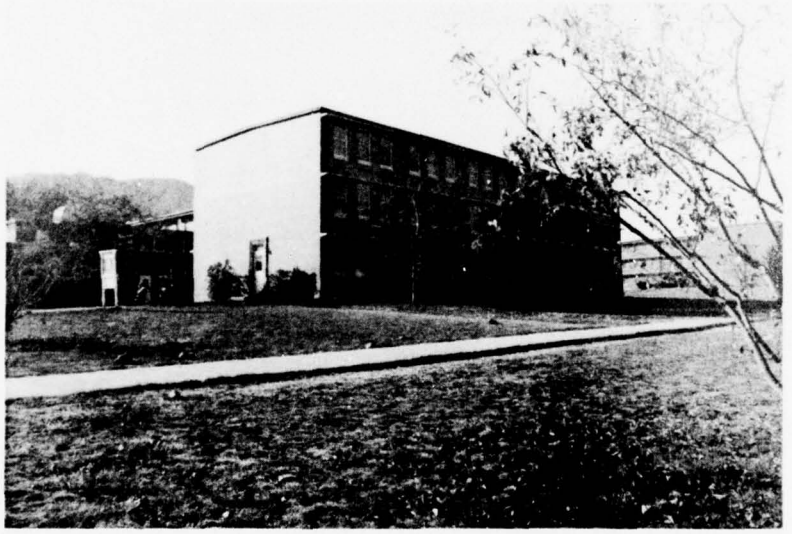


Fort Carson, CO
Building 1219
Data Point 127
Bachelor Enlisted Quarters
With Dining Facilities (Barracks)

Building 1219 is an enlisted personnel barracks with dining facilities constructed in 1958. The building is composed of a three-story I-shaped barracks wing with overall dimensions of 235.3 × 117.3 ft (71.2 × 35.8 m), and a two-story rectangular kitchen and dining wing of 77.2 × 57.7 ft (23.5 × 17.6 m). The total floor area is 51,760 sq ft (4809 m^2), including a basement boiler room of 1640 sq ft (161.6m^2).

The building is heated by fin-tube radiators and two air-handling units. The air-handling units supply 11,200 and 5500 cfm (317 and 156 m^3/min) of heated ventilating air to the kitchen and mess hall areas, respectively. Two converters produce low-temperature (180° to 200°F [82° to 93°C]) hot water from medium-temperature (225° to 350°F [107° to 177°C]) hot water generated by two 40.68 × 10^6 Btuh (42.92 × 10^6 kJ/hr) gas-fired boilers.

The energy parameters being monitored in this building are electricity and natural gas.



Fort Carson, CO
Building 1044
Data Point 128
Bachelor Enlisted Quarters (Barracks)

Building 1044 is an enlisted personnel barracks building built in 1971. The three-story building has a total floor area of 42,683 sq ft (3965 m^2), which includes a partial basement of 2030 sq ft (189 m^2). The total exterior wall area is 10,230 sq ft (950 m^2), of which 40 percent (4080 sq ft [3.79 m^2]) is composed of windows and other glass areas. The combined U-value of the exterior wall is 0.50 Btu/°F-hr-sq ft (2.8 W/°K-m^2), and that of the roof is 0.13 Btu/°F-hr-sq ft (0.74 W/°K-m^2).

Heating of the three floors is accomplished by fin-tube radiators located along the perimeter. Hot water for heating is obtained from a shell-and-tube water-to-water converter with a capacity of 1.9×10^6 Btuh (2.0×10^6 kJ/hr). The converter produces low-temperature (180° to 200°F [82° to 93°C]) hot water from medium-temperature (225° to 350°F [107° to 177°C]) hot water supplied from a central plant. Two fans, each with 63,000 cfm (1783 m^3/min) capacity, provide ventilation for the three floors.

The basement is served by a medium-temperature hot water heating and ventilating unit with a capacity of 262,000 Btuh (276 410 kJ/hr) and 4130 cfm (117 m^3/min). It also includes an exhaust fan of 4000 cfm (113 m^3/min). Cooling is supplied by a central plant.

The energy parameters being monitored in this building include electricity and chilled and hot water flow and supply/return temperature.

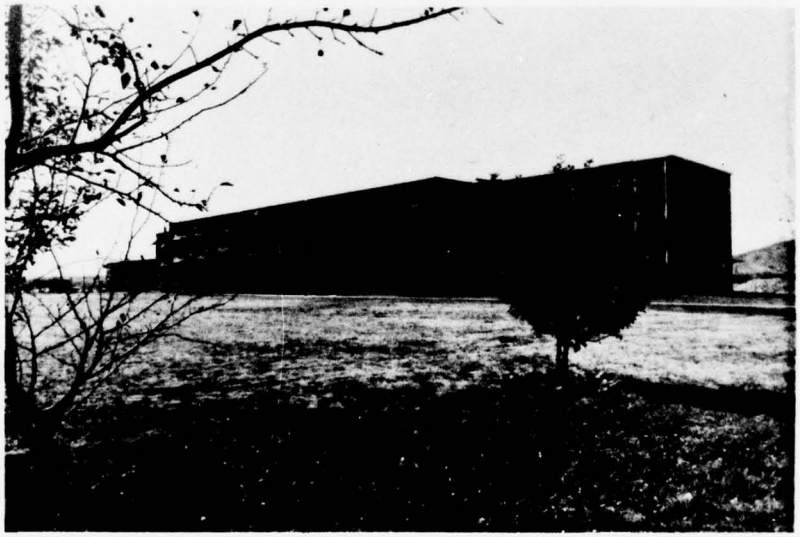
Fort Carson, CO
Building 1363
Data Point 129
Bachelor Enlisted Quarters (Barracks)

Building 1363 is an enlisted personnel barracks building built in 1966 and recently modified. The three-story building has a total floor area of 42,683 sq ft (3965 m^2), which includes a partial basement of 2030 sq ft (189 m^2). The total exterior wall area is 10,230 sq ft (950 m^2), of which 40 percent (4080 sq ft [379 m^2]) is composed of windows and other glass areas. The combined U-value of the exterior wall is 0.50 Btus/°F-hr-sq ft (2.84 W/°K-m^2), and that of the roof is 0.13 Btus/°F-hr-sq ft (0.74 W/°K-m^2).

Heating of the three floors is accomplished by fin-tube radiators located along the perimeter. Hot water for heating is obtained from a shell-and-tube water-to-water converter with a capacity of 1.9×10^6 Btuh (2.0×10^6 kJ/hr). The converter produces low-temperature (180° to 200°F [82° to 93°C]) hot water from medium-temperature (225° to 350°F [107° to 177°C]) hot water supplied from a central plant. Two fans, each with 63,000 cfm (1783 m^3/min) capacity, provide ventilation for the three floors. Chilled water is supplied to the fans from a central plant.

The basement is served by a medium-temperature hot water heating and ventilating unit with a capacity of 262,000 Btuh (276 410 kJ/hr) and 4130 cfm (117 m^3/min). It also includes an exhaust fan of 4000 cfm (113 m^3/min).

The energy parameters being monitored in this building include electricity, chilled water flow, medium-temperature hot water flow, and the chilled and hot water supply and return temperatures.

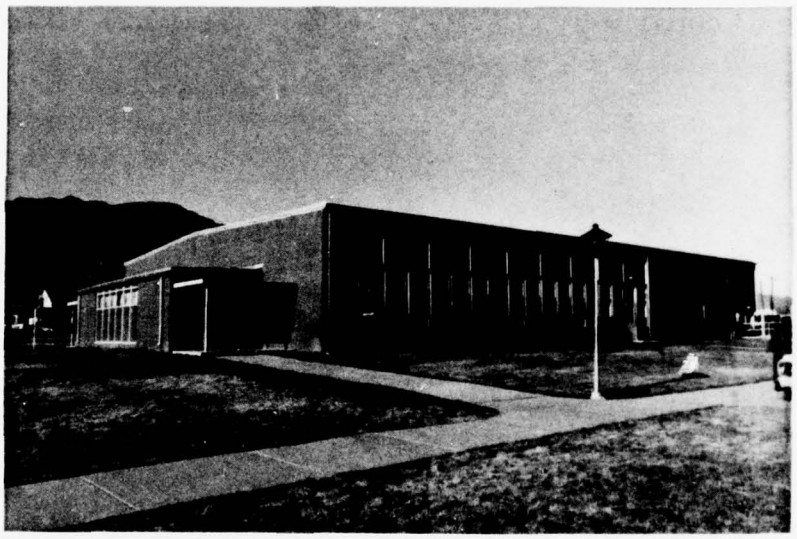


Fort Carson, CO
Building 1040
Data Point 130
Enlisted Dining Facility

Building 1040 is a consolidated dining facility for five companies constructed in 1971. The one-story brick and masonry structure has an overall length and width of 136.2 and 86.3 ft (41.5 and 26.3 m), respectively. The total floor area is 13,270 sq ft (1233 m^2), which includes mezzanine area.

Heating is accomplished by fin-tube radiators located along the perimeter and three air-handling units with a total capacity of 1.03×10^6 Btuh (1.09×10^6 kJ/hr), and 19,000 cfm (538 m^3/min). Ventilation is provided by two fans with 32,000 cfm (1906 m^3/min) total capacity. A converter produces low-temperature (180° to 200°F [82° to 93°C]) hot water for the heating units from medium-temperature (225° to 350°F [107° to 177°C]) hot water generated by a 1.55×10^6 Btuh (1.64×10^6 kJ/hr) low-pressure, gas-fired boiler.

The energy parameters being monitored in this building are electricity, natural gas, and low-temperature, hot-water flow and supply/return temperatures.

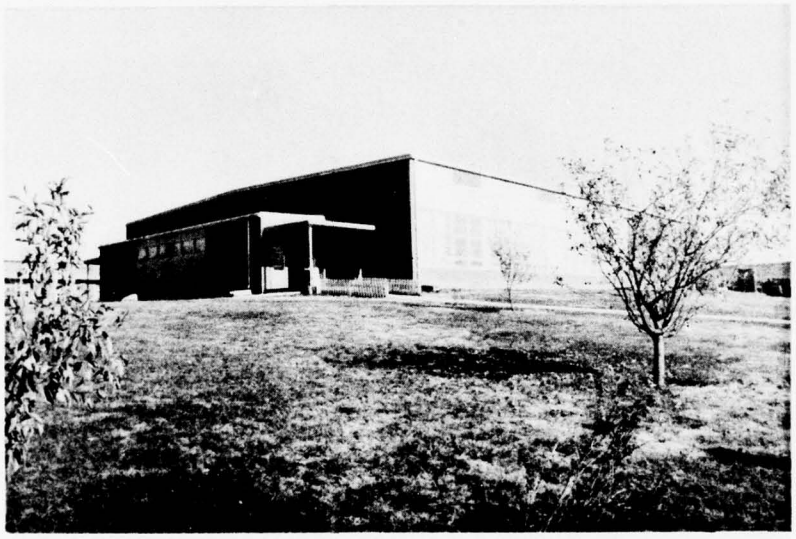


Fort Carson, CO
Building 1661
Data Point 131
Enlisted Dining Facility

Building 1661 is a consolidated dining facility for five companies constructed in 1967. The one-story brick and masonry structure has an overall length and width of 136.2 and 86.3 ft (41.5 and 26.3 m). The total floor area is 13,270 sq ft (1233 m^2), which includes mezzanine area.

Heating is accomplished by fin-tube radiators located along the building perimeter and three air-handling units with total capacity of 1.03×10^6 Btuh (1.09×10^6 kJ/hr), and 19,000 cfm (538 m^3/min). A converter produces low-temperature (180° to 200°F [82° to 93°C]) hot water for the heating units from medium-temperature 225° to 350°F [107° to 177°C]) hot water generated by a 1.55×10^6 Btuh (1.64×10^6 kJ/hr) low-pressure gas-fired boiler.

The energy parameters being monitored in this building are electricity, natural gas, and low-temperature hot water flow and supply/return temperature.

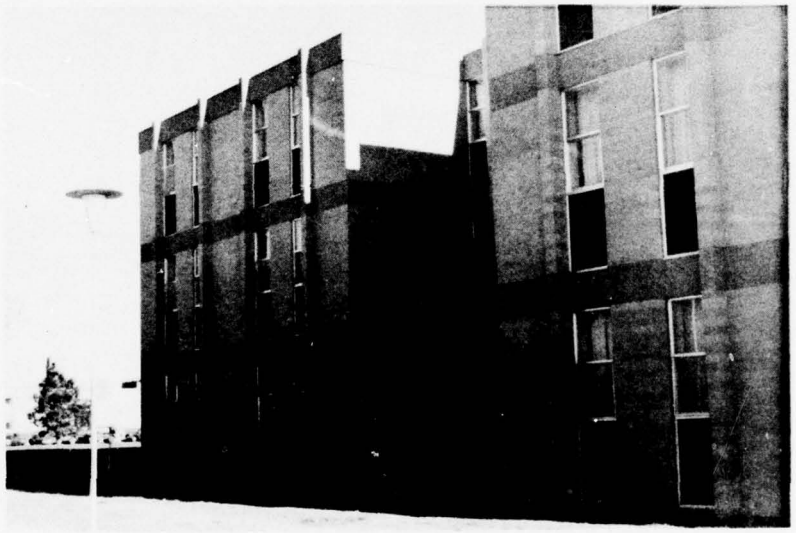


Fort Carson, CO
Building 1951
Data Point 132
Bachelor Enlisted Quarters (Barracks)

Building 1951 is a modular-type enlisted personnel barracks building constructed in 1974. The three-story building is composed of two modules connected by a breezeway. Each module is made up of two 46-ft (14 m) deep × 38.7-ft (11.8 m) wide structures connected by a 16 × 16 ft (5 × 5 m) lounge. The total floor area of the building is 21,280 sq ft (1977 m^2). The total exterior wall area is 19,925 sq ft (1851 m^2), of which 12 percent (2398 sq ft [223 m^2]) is glass. The combined U-value of the exterior wall is 0.38 Btu/°F-hr-sq ft (2.16 W/°K-m^2), and that of the roof is 0.11 Btu/°F-hr-sq ft (0.62 W/°K-m^2).

Heating and cooling are accomplished by individual fan-coil units located in each room, corridor, and lounge. Hot and chilled water are supplied from a central plant. A converter is used to produce low-temperature (180° to 200°F [82° to 93°C]) hot water for the fan-coil units.

The energy parameters being monitored in this building include electricity, high-temperature hot water flow, medium-temperature hot water flow, chilled water flow, and the supply/return temperatures for each. Building temperature and humidity for each floor and the domestic hot water flow are also being monitored.

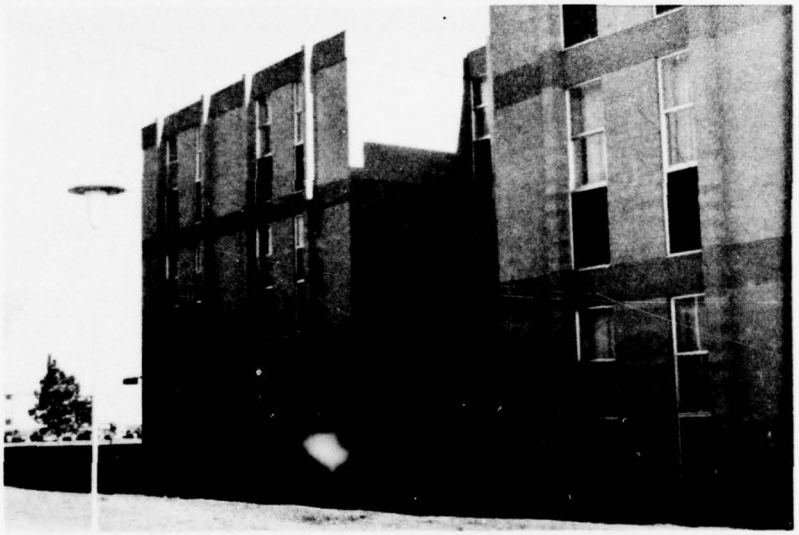


Fort Carson, CO
Building 1953
Data Point 133
Bachelor Enlisted Quarters (Barracks)

Building 1953 is a modular-type enlisted personnel barracks constructed in 1974. The three-story building is composed of two modules connected by a breezeway. Each module is made up of two 46-ft (14 m) deep × 38.7-ft (11.8 m) wide structures connected by a 16 × 16 ft (5 × 5 m) lounge. The total floor area of the building is 21,280 sq ft (1977 m^2). The total exterior wall area is 19,925 sq ft (1851 m^2), of which 12 percent (2398 sq ft [223 m^2]) is glass. The combined U-value of the exterior wall is 0.38 Btus/°F-hr-sq ft (2.16 W/°K-m^2), and that of the roof is 0.11 Btu/°F-hr-sq ft (0.62 W/°K-m^2).

Heating and cooling are accomplished by individual fan-coil units located in each room, corridor, and lounge. Hot and chilled water are supplied from a central plant. A converter is used to produce low-temperature (180° to 200°F [82° to 93°C]) hot water for the fan-coil units.

The energy parameters being monitored in this building include electricity, medium-temperature hot water flow, chilled water flow, and chilled and hot water supply/return temperatures.



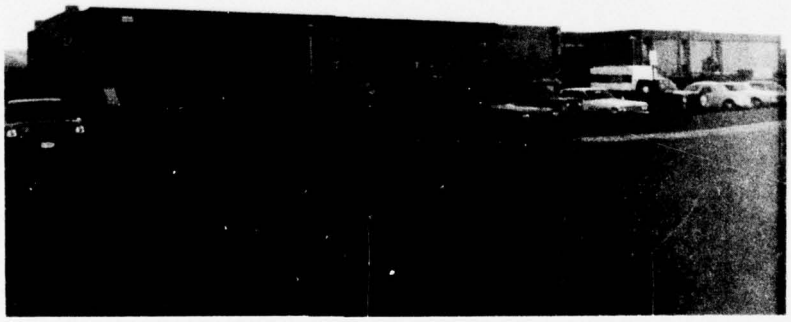
Fort Carson, CO
Building 2060
Data Point 134
Administration Building

Building 2060 is a two-battalion headquarters and classroom building built in 1974. The one-story structure has a ground floor area of 18,770 sq ft (1744 m^2) and a basement area of 3330 sq ft (309 m^2). The length and width are 259 and 77 ft (79 and 23 m), respectively. The total exterior wall area is 8235 sq ft (765 m^2), of which 9 percent (733 sq ft [65 m^2]) is composed of single-glazed windows. The combined U-value of the exterior wall is 0.38 Btu/°F-hr-sq ft (2.16 W/°K-m^2), and that of the roof/ceiling is 0.04 Btu/°F-hr-sq ft (0.23 W/°K-m^2).

Heating and cooling of office and classroom spaces on the first floor are accomplished by a multizone dual-duct system. Space temperature in each zone is maintained by mixing dampers modulated by zone thermostats. Hot water for heating is obtained from a shell-and-tube water-to-water converter with a capacity of 910,000 Btuh (960 050 kJ/hr). The converter produces low-temperature (180° to 200°F [82° to 93°C]) hot water from medium-temperature (225° to 350°F [107° to 177°C]) hot water supplied from a central plant. Chilled water for cooling is also supplied from a central plant.

Heating of storage and mechanical rooms on the first floor is accomplished by unit heaters. A second air-handling unit provides heating and ventilation for the basement.

The energy parameters being monitored in this building include electricity, medium-temperature hot water flow, chilled water flow, and hot water and chilled water supply/return temperatures.



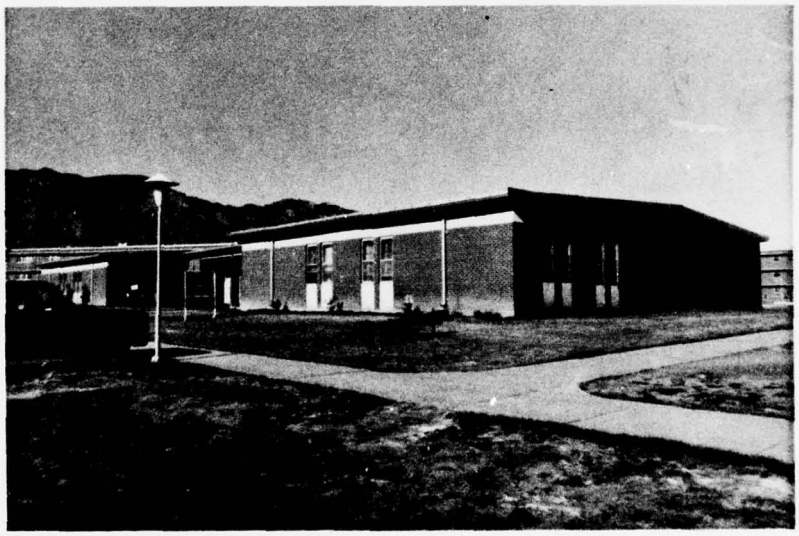
Fort Carson, CO
Building 1048
Data Point 135
Administration Building

Building 1048 is a two-battalion headquarters and classroom building built in 1971. The one-story structure has a total floor area of 11,990 sq ft (1114 m^2), with length of 178 ft (54 m) and width of 77 ft (23 m). The total exterior wall area is 7300 sq ft (678 m^2), of which 8.8 percent (642 sq ft [60 m^2]) is composed of single-glazed windows and other glass areas. The combined U-value of the exterior wall is 0.27 Btus/°F-hr-sq ft (1.53 W/°K-m^2), and that of the roof/ceiling is 0.08 Btus/°F-hr-sq ft (0.45 W/°K-m^2).

The heating system consists of a water-to-water converter, fin-tube radiators, convectors, and fan-coil units. The converter produces low-temperature (190°F [88°C]) hot water for the terminal units from medium-temperature (225° to 350°F [107° to 177°C]) hot water supplied from a central plant.

Cooling is accomplished by three air handling units supplied with chilled water from a 58.6-ton (53.2 t) refrigeration unit with an air-cooled condenser.

The energy parameters being monitored in this building include the electricity, medium-temperature hot-water flow, and supply/return water temperatures.

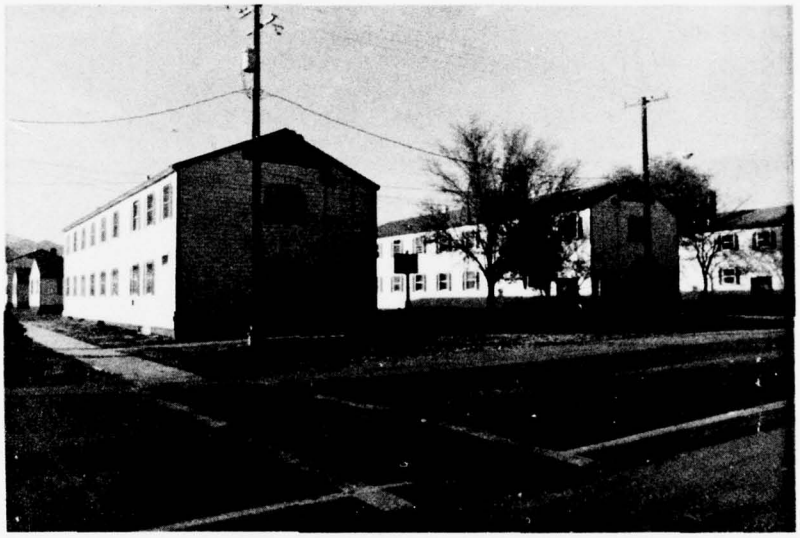


Fort Carson, CO
Buildings 3471 and 3472
Data Points 136 and 137
Bachelor Enlisted Quarters (Barracks—WW II)

Buildings 3471 and 3472 are enlisted personnel barracks constructed in 1942. Each two-story building has a total floor area of 5310 sq ft (498 m^2), an overall length of 90 ft (27 m), and width of 29.5 ft (9.0 m). The total wall area is 4183 sq ft (389 m^2), of which 11 percent (463 sq ft [43 m^2]) is glass. The combined U-value of the exterior wall is 0.34 Btus/°F-hr-sq ft (1.93 W/°K-m^2), and that of the roof/ceiling is 0.21 Btus/°F-hr-sq ft (1.19 W/°K-m^2).

Each building is heated by a 259,000-Btuh (273 245 kJ/hr) gas-fired boiler ducted warm air system employing a gas-fired furnace. The buildings have no air conditioning.

The energy parameters being monitored in these buildings are electricity and natural gas.

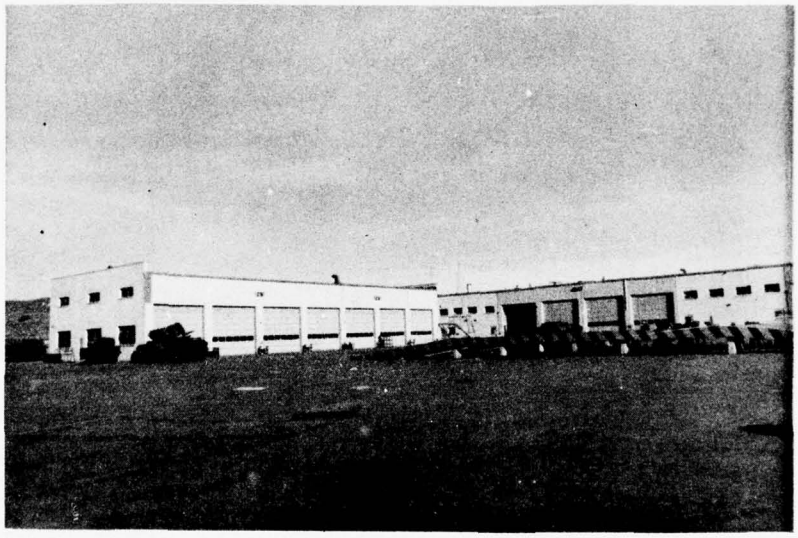


Fort Carson, CO
Building 2992
Data Point 138
Maintenance Shop

Building 2992 is a battalion motor repair shop built in 1966. The L-shaped one-story building has a total ground floor area of 21,060 sq ft (1956 m^2), plus mezzanine floor area of 5780 sq ft (537 m^2). The building dimensions are 151 × 60 ft (46 × 18 m) and 300 × 40 ft (91 × 12 m).

Heating is accomplished by fin-tube radiators located along the perimeter of the building and by unit heaters located in the shop area. Four gas-fired ventilation units with a total capacity of 750,000 Btuh (791 250 kJ/hr) and 10,800 cfm (306 m^3/min) provide ventilation to the shop area. Two gas-fired hot water boilers with capacities of 3.37 and 4.5 × 10^6 Btuh (9.96 and 4.75 × 10^6 kJ/hr), respectively, supply hot water to the heating units.

The energy parameters being monitored in this building are electrical and natural gas consumption.

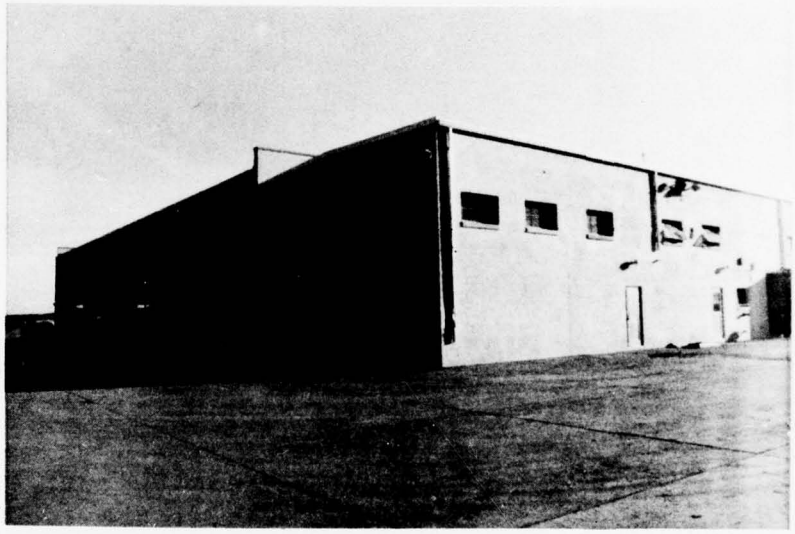


Fort Carson, CO
Building 2492
Data Point 139
Maintenance Shop

Building 2492 is a battalion motor repair shop built in 1966. The L-shaped one-story building has a total ground floor area of 21,060 sq ft (1956 m^2), plus mezzanine floor area of 5780 sq ft (537 m^2). The building dimensions are 151 × 60 ft (46 × 18 m) and 300 × 40 ft (91 × 12 m).

Heating is accomplished by fin-tube radiators located along the perimeter of the building and unit heaters located in the shop area. Four gas-fired ventilation units with a total capacity of 750,000 Btuh (791 250 kJ/hr) and 10,800 cfm (306 m^3/min) provide ventilation to the shop area. Two gas-fired hot water boilers with capacities of 3.37 and 4.5 × 10^6 Btuh (9.96 and 4.75 × 10^6 kJ/hr), respectively, supply hot water to the heating units.

The energy parameters being monitored in this building are electricity and natural gas consumption.



Fort Carson, CO
Building 8000
Data Point 140
Maintenance Shop

Building 8000 is a consolidated field maintenance shop built in 1971. The building has a total floor area of 252,808 sq ft (23 486 m^2), which includes a second floor area of 38,407 sq ft (7213 m^2). The overall dimensions of the building are 685 × 38.5 ft (209 × 12 m).

Heating is accomplished by fin-tube radiators, unit heaters, and gas-fired ventilation units. Three hot water boilers of 3.6, 3.6, and 1.5 × 10^6 Btuh (3.8, 3.8, and 1/6 × 10^6 kJ/hr) capacities supply hot water to the heating units.

The energy parameters being monitored in this building are electrical and natural gas consumption.

Fort Carson, CO
Building 1525
Data Point 143
Commissary

Building 1525 is a commissary constructed in 1974. This one-story masonry structure has a length and width of 416 and 192 ft (127 and 59 m), respectively. The total floor area is 81,455 sq ft (7567 m^2), including mezzanine areas. The total exterior wall area is 25,184 sq ft (2340 m^2), of which 3 percent (672 sq ft [62 m^2]) is glass. The combined U-value of the exterior wall is 0.17 Btu/°F-hr-sq ft (0.96 W/°K-m^2), and that of the roof/ceiling is 0.13 Btu/°F-hr-sq ft (0.74 W/°K-m^2).

The building is heated and cooled by five air-handling units. The total capacity of the units is 1.03 $\times$ 10^6 Btuh (1.09 $\times$ 10^6 kJ/hr) heating and 1.15 $\times$ 10^6 Btuh (1.21 $\times$ 10^6 kJ/hr) cooling. Additional fin-tube radiators, unit heaters, and convectors are used for heating. One gas-fired boiler with an output capacity of 1.80 $\times$ 10^6 Btuh (1.90 $\times$ 10^6 kJ/hr) supplies low-temperature (200°F [93°C]) hot water to the heating units.

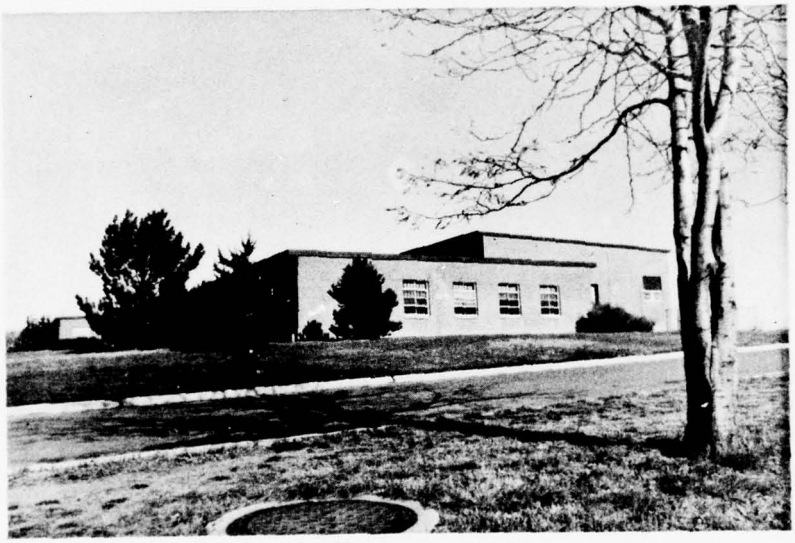
The energy parameters being monitored in this building are electricity and natural gas.

Fort Carson, CO
Building 1230
Data Point 145
Enlisted Open Dining Facility

Building 1230 is an enlisted personnel club constructed in 1959. This one-story masonry structure has a total floor area of 26,732 sq ft (2483 m^2) and overall dimensions of 256.3 × 147.3 ft (78.1 × 44.9 m). The total exterior wall area is 15,142 sq ft (1407 m^2), of which 16 percent (2386 sq ft [222 m^2]) is glass. The combined U-value of the exterior wall is 0.29 Btu/°F-hr-sq ft (1.65 W/°K-m^2), and that of the roof is 0.10 Btu/°F-hr-sq ft (0.57 W/°K-m^2).

The building is heated and ventilated by five air-handling units with total capacity of 3.2 × 10^6 kJ/hr) and 45,340 cfm (1283 m^3/min). Additional unit heaters with a total capacity of 175,440 Btuh (185 089 kJ/hr) serve the vestibules and kitchens. Two gas-fired low-pressure (15 psig [103 kPa]) boilers, each with a capacity of 50.2 × 10^6 Btuh (53.0 × 10^6 kJ/hr), supply steam to the air-handling units and unit heaters.

The energy parameters being monitored in this building are electricity and natural gas.

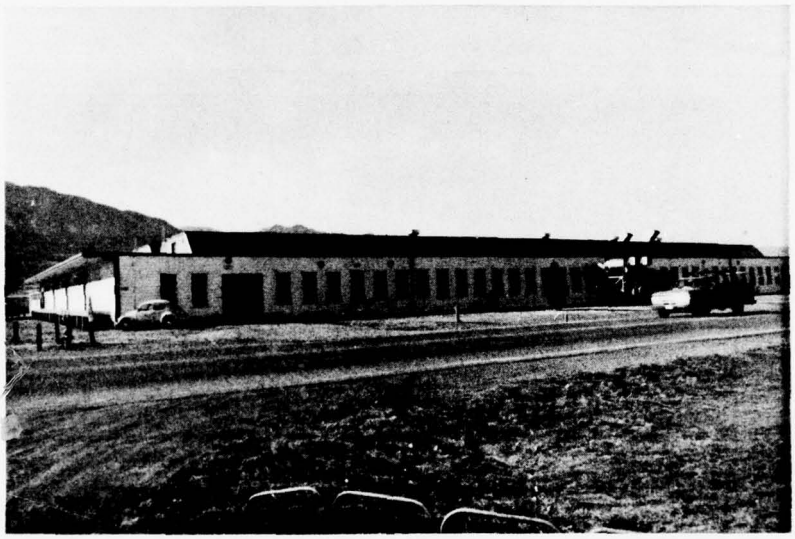


Fort Carson, CO
Building 402
Data Point 146
Laundry

Building 402 is a laundry building constructed in 1942. The one-story wood-frame structure has a total floor area of 52,957 sq ft (4920 m^2). The overall dimensions of the building are 270.5 × 234.5 ft (82 × 72 m).

Heating is accomplished by unit heaters and radiators with a total capacity of 3.47 × 10^6 Btuh (3.66 × 10^6 kJ/hr). Steam for heating is supplied by the boilers in the laundry steam plant (Building 403). Hot water converters produce hot water for laundry use.

The energy parameter being monitored in this building is electricity.

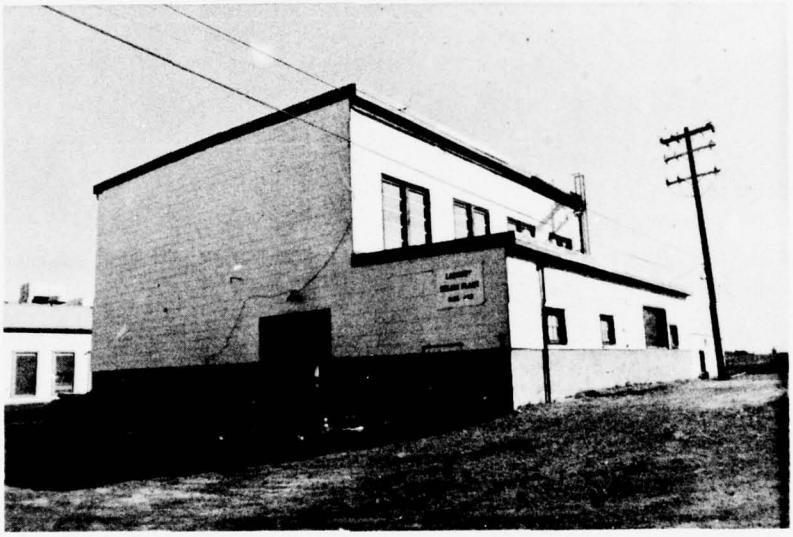


Fort Carson, CO
Building 403
Data Point 146
Laundry Steam Plant

Building 403 is a steam plant constructed in 1942. It has a total floor area of 3173 sq ft (295 m^2). The building houses two high-pressure (125 psig [861 kPa]) steam boilers, each having 18 $\times$ 10^6 Btuh (19 $\times$ 10^6 kJ/hr) capacity. The boilers furnish steam for laundry and space heating use in building 402 and for space heating in buildings 304, 305, 309, 310, 311, and 401.

The building is heated by radiators.

The energy parameter being monitored in this building is natural gas.



Fort Carson, CO
Building 1007
Data Point 147
Medical/Dental Facility (Dispensary)

Building 1007 is a regimental dispensary constructed in 1957. This one-story structure has a total floor area of 3821 sq ft (355 m^2), with an overall length of 121 ft (37 m), and width of 40.3 ft (12.3 m). The total wall area is 3371 sq ft (313 m^2), of which 12 percent (405 sq ft [38 m^2]) is glass. The combined U-value of the exterior wall is 0.24 Btus/°F-hr-sq ft (1.36 W/°K-m^2), and that of the roof/ceiling is 0.12 Btus/°F-hr-sq ft (0.68 W/°K-m^2).

The building employs a three-zone central system for heating and cooling. An air-handling unit with a capacity of 3300 cfm (93 m^3/min) distributes tempered air to the three zones. A low-pressure, gas-fired steam boiler with an output capacity of 364,000 Btuh (384 000 kJ/hr) supplies steam at 5 psig (34 kPa) to the steam coil. A refrigeration unit of 10.7 tons (9.7 t) capacity supplies refrigerant to the direct-expansion cooling coil.

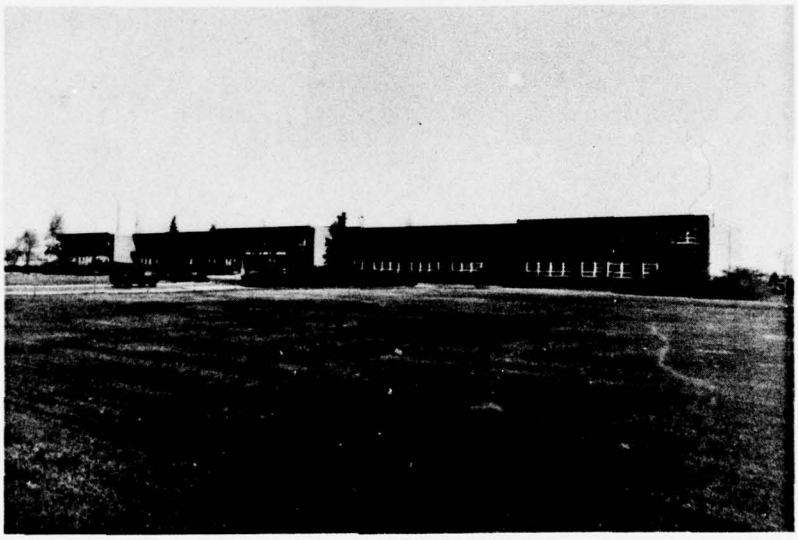
The energy parameters being monitored in this building are electricity and natural gas.

Fort Carson, CO
Building 1430
Data Point 148
Administration Building (Post Headquarters)

Building 1430 is used as post headquarters. The two-story structure built in 1957 has a total floor area of 41,180 sq ft (3826 m^2), which includes a basement floor area of 2590 sq ft (241 m^2). The length and width are 371 and 60 ft (113 and 18 m), respectively. The total exterior wall area is 18,530 sq ft (1721 m^2), of which 34 percent (6300 sq ft [585 m^2]) is glass. The combined U-value of the exterior wall is 0.47 Btu/°F-hr-sq ft (2.67 W/°K-m^2), and that of the roof/ceiling is 0.12 Btu/°F-hr-sq ft (0.68 W/°K-m^2).

Heating is accomplished in three ways. The first and second floors are heated with fin-tube radiators located along the perimeter of the building, with the exception of three rooms which have unit ventilators. The occupied part of the basement is heated by an air-handling unit. All terminal units are served by a two-pipe, low-pressure (15 psig [103 kPa]) steam system, with steam generated by two natural gas 1.13×10^6 Btuh (1.19×10^6 kJ/hr) boilers located in the basement.

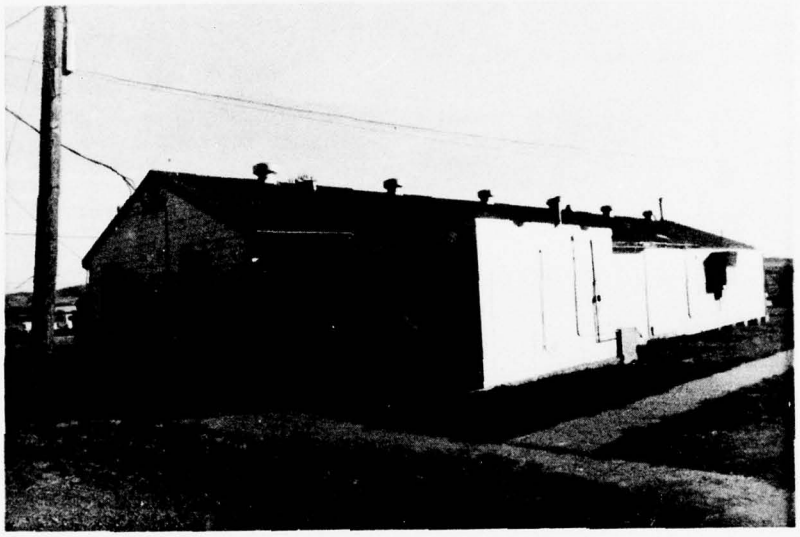
The energy parameters being monitored in this building are electricity and natural gas.



Fort Carson, CO
Building 3572
Data Point 149
Commissary Annex

Building 3572 is a commissary annex building constructed in 1942. The one-story rectangular wood-frame structure is 99.5 ft (30 m) long and 25 ft (8 m) wide. The total floor area is 2488 sq ft (231 m^2). The building is heated by gas-fired unit heaters.

The energy parameters being monitored in this building are electricity and natural gas.

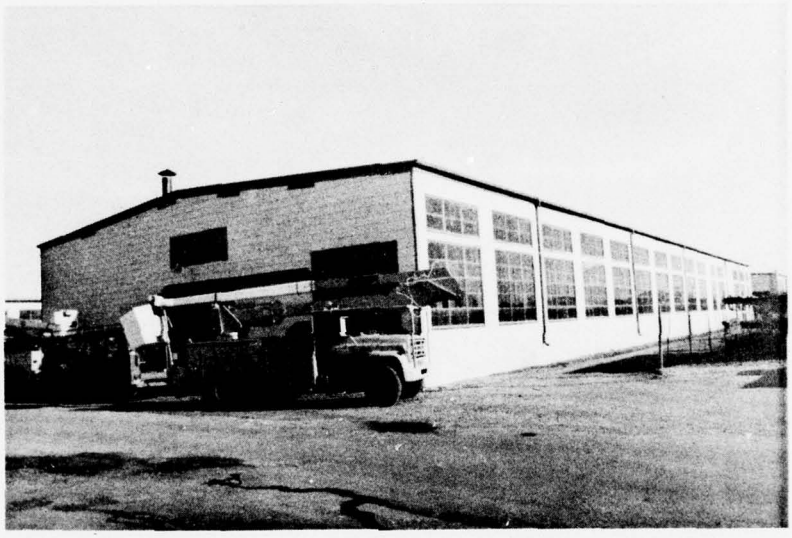


Fort Carson, CO
Building 1304
Data Point 151
Storage and Shop

Building 1304 is a storage building constructed in 1942. The one-story rectangular wood-frame structure is 240 ft (73 m) long and 76 ft (23 m) wide. The total floor area is 18,270 sq ft (1697 m^2).

Heating is accomplished by unit heaters with a total capacity of 3.3×10^6 Btuh (3.5×10^6 kJ/hr) and 55,000 cfm (1557 m^3/min).

The energy parameters being monitored in this building are electricity and natural gas.

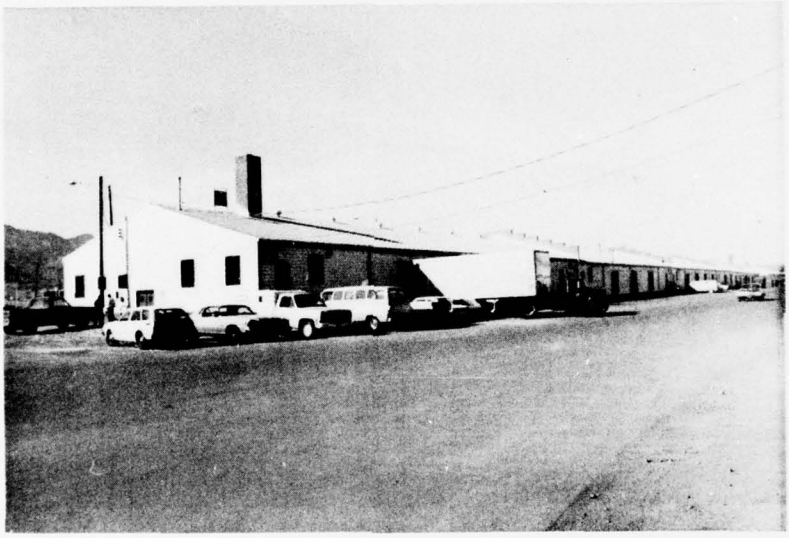


Fort Carson, CO
Building 237
Data Point 152
Storage Building

Building 237 is a one-story storage building constructed in 1942. The rectangular building has a total floor area of 9000 sq ft (836 m^2), a length of 150 ft (46 m), and a width of 60 ft (18 m). The total wall area is 3600 sq ft (334 m^2), of which 2 percent (66 sq ft [6 m^2]) is glass. The combined U-value of the exterior wall is 0.27 Btu/°F-hr-sq ft (1.53 W/°K-m^2), and that of the roof/ceiling is 0.25 Btu/°F-hr-sq ft (1.42 W/°K-m^2).

The building is heated with a ducted warm air system employing a gas-fired furnace.

The energy parameters being monitored in this building are electricity and natural gas.

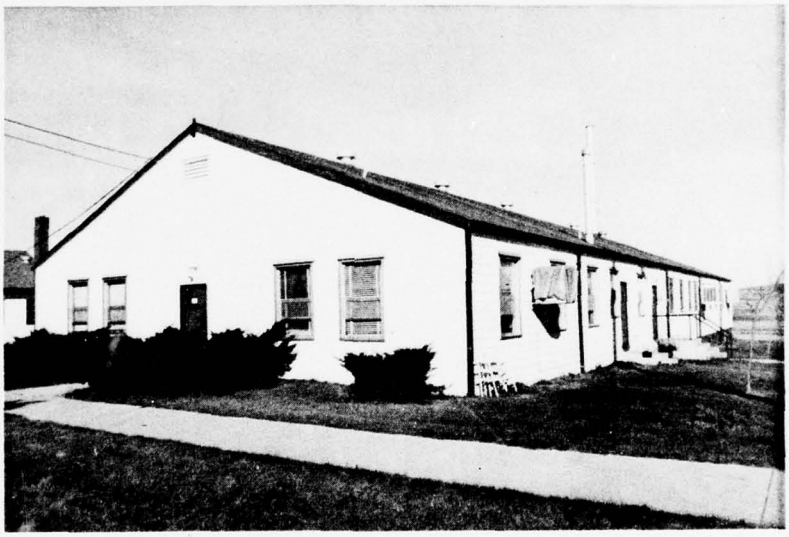


Fort Carson, CO
Building 741
Data Point 153
Administration Building

Building 741 is an administration building constructed in 1942. The one-story wood-frame structure has a total floor area of 7529 sq ft (699 m^2). The building dimensions are 50 × 144 ft (15 × 44 m), plus an offset of 13.5 × 24.3 ft (4.1 × 7.4 m). The total exterior wall area is 4237 sq ft (394 m^2), of which 17 percent (711 sq ft [66 m^2]) is glass. The combined U-value of the exterior wall is 0.33 Btu/°F-hr-sq ft (1.87 W/°K-m^2), and that of the roof/ceiling is 0.27 Btu/°F-hr-sq ft (1.53 W/°K-m^2).

Heating is accomplished by radiators with hot water supplied from a gas-fired boiler.

The energy parameters being monitored in this building are electricity and natural gas.



Fort Carson, CO
Building 1544
Data Point 154
Administration Building (WW II)

Building 1544 is an administration building constructed in 1942. The rectangular two-story wood-frame structure has a total floor area of 8044 sq ft (747 m^2). The length and width are 136.3 and 29.5 ft (41.5 and 9.0 m), respectively. The total exterior wall area is 5880 sq ft (546 m^2), of which 19 percent (1099 sq ft [102 m^2]) is glass. The combined U-value of the exterior wall is 0.32 Btu/°F-hr-sq ft (1.82 W/°K-m^2), and that of the roof/ceiling is 0.25 Btu/°F-hr-sq ft (1.48 W/°K-m^2).

Heating is accomplished by radiators with hot water supplied from a 830,000-Btuh (875 650 kJ/hr) gas-fired boiler.

The energy parameters being monitored in this building are electricity and natural gas.

Fort Belvoir, VA
Building 1663
Data Point 204
Family Housing

Built in 1960, this two-story company-grade family housing duplex encompasses 2934 sq ft (273 m^2). The brick and wood structure has a wood roof with composition shingles. The building is heated with natural gas. Each side of the duplex has a 40-gal (1.5 m^3) water heater.

The energy parameters being monitored in this building are electricity and natural gas.

Fort Belvoir, VA
Building 1689
Data Point 205
Family Housing

Built in 1960, this two-story company-grade family housing duplex encompasses 2934 sq ft (273 m^2). The brick and wood structure has a wood roof with composition shingles. The building is heated with natural gas. Each side of the duplex has a 40-gal (1.5 m^3) water heater.

The energy parameters being monitored in this building are electricity and natural gas.

Fort Belvoir, VA
Building 922
Data Point 207
Family Housing—Multi

Built in 1956, this two-story non-commissioned officer (NCO) family housing eightplex encompasses 9444 sq ft (877 m^2). The brick and wood structure has a wood rafter composition shingle roof. The building is heated with oil and has eight 63-gal (2.4 m^3) water heaters.

The energy parameter being monitored in this building is electricity.

Fort Belvoir, VA
Building 1551
Data Point 210
Family Housing

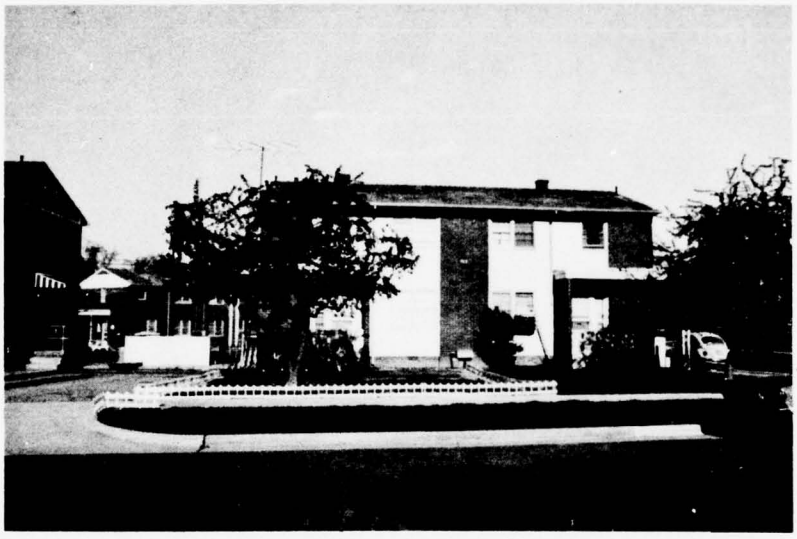
This two-story NCO duplex, built in 1960, encompasses 2642 sq ft (245 m^2). The brick and wood structure employs a wood roof with composition shingles. The building is heated with natural gas. Each unit of the duplex has a 40-gal (1.5 m^3) water heater.

The energy parameters being monitored in this building are electricity and natural gas.

Fort Belvoir, VA
Building 1501
Data Point 211
Family Housing

Built in 1960, this two-story NCO duplex has a total floor area of 2642 sq ft (245 m^2). The brick and wood structure has a wood roof with composition shingles. The building is heated with natural gas. Each unit of the duplex has a 40-gal (1.5 m^3) water heater.

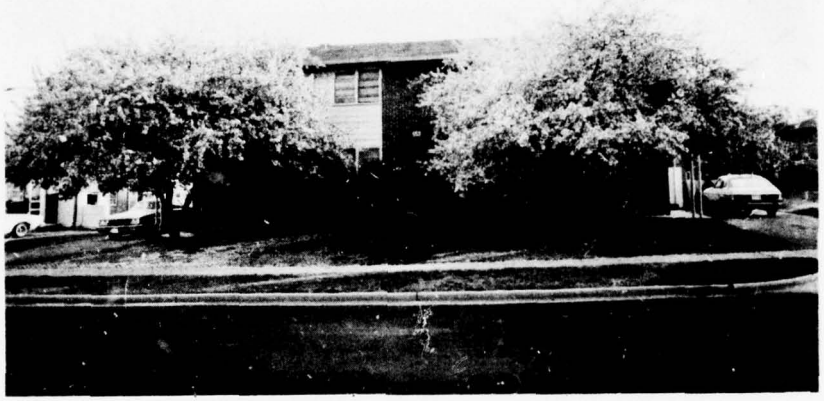
The energy parameters being monitored in this building are electricity and natural gas.



Fort Belvoir, VA
Building 553
Data Point 213
Family Housing—Multi

This two-story company-grade family housing duplex, which was built in 1960, encompasses 2934 sq ft (273 m^2). The brick and wood structure has a wood rafter roof with composition shingles. The building is heated with gas and has a 40-gal (1.5 m^3) hot water heater. Window air conditioners are used to cool the structure.

The energy parameters being monitored in this building are electricity and natural gas.



Fort Belvoir, VA
Building 579
Data Point 214
Family Housing—Multi

This 2934-sq ft (273 m^2), two-story, company-grade family housing duplex was built in 1960. The brick and wood structure has a wood rafter roof with composition shingles. The building is heated with gas and has a 40-gal (1.5 m^3) hot water heater. Window air conditioners are used to cool the structure.

The energy parameters being monitored in this building are electricity and natural gas.

Fort Belvoir, VA
Building 452
Data Point 216
Family Housing—Multi

Built in 1939, this two-story five-family field-grade family housing unit encompasses 12,707 sq ft (1180 m^2). The brick and wood structure has a wooden-rafter-supported composition shingled roof. The building is heated with oil and supplied with 220 gal (8.3 m^3) of hot water.

The energy parameters being monitored in this building are electricity and fuel oil.

Fort Belvoir, VA
Building 51
Data Point 218
Family Housing

Built in 1934, this single-family, two-story field-grade officer family housing unit with attic is constructed of wood and brick. The 3257-sq ft (303 m^2) structure has a wood-rafter-supported slate roof. The building is heated with fuel oil.

The energy parameters being monitored in this building include electricity and fuel oil.

Fort Belvoir, VA
Building 20
Data Point 219
Officers' Open Dining Facility

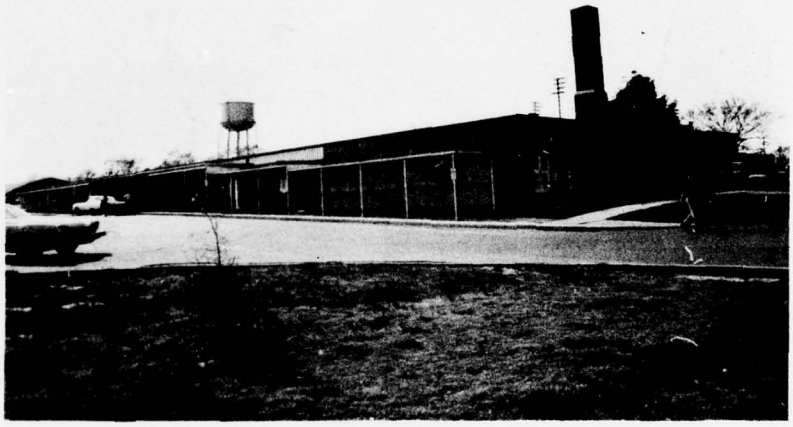
This three-story officers' open dining facility built in 1954 encompasses 66,972 sq ft (6222 m^2). Attached to the three-story main structure is a 4000-sq ft (972 m^2), two-story, eight-person BOQ. Both structures are made of brick and wood and employ a wood rafter system with slate roofing. The building is heated with fuel oil. Twenty-two separate electrical air conditioning units provide cooling.

The energy parameters being monitored in this building are electricity and fuel oil.

Fort Belvoir, VA
Building 238
Data Point 220
Commissary

Built in 1958, the single-story commissary has a total floor area of 25,160 sq ft (2337 m^2). The brick and block building is heated with oil. It has 50 tons (45 *t*) of cooling and a listed capacity of 120 gal (4.9 m^3) of hot water.

The energy parameters being monitored in this building are electricity and fuel oil.



Fort Belvoir, VA
Building 470
Data Point 221
Bachelor Officers' Quarters (BOQ)

Built in 1975, this five-story 227-person BOQ encompasses 108,600 sq ft (10 089 m^2). The brick and steel structure employs a reinforced concrete roof slab with composition shingle roofing. The building is heated with oil. It is supplied with 1135 gph (43.0 m^3/ hr) of hot water and has 185 tons (168 t) of air conditioning.

The energy parameters being monitored in this building are electricity and fuel oil.

Fort Belvoir, VA
Building 508
Data Point 222
Bachelor Officers' Quarters (BOQ)

Built in 1969, this two-story, 42-person BOQ encompasses 18,360 sq ft (1706 m^2). The brick and block structure has a steel-joist-supported gypsum roof deck and built-up roofing. It is heated with oil and supplied with 216 gph (8.2 m^3/hr) of hot water. The listed capacity of its air conditioning unit is 207,000 Btuh (218 385 kJ/hr).

The energy parameters being monitored in this building are electricity, natural gas, and fuel oil.

Fort Belvoir, VA
Building 2203
Data Point 223
Bachelor Enlisted Quarters (Barracks)

Built in 1941, this 26-person enlisted barracks without dining facilities has a total floor area of 4720 sq ft (438 m^2). The wooden structure employs a wood-rafter-supported roof with composition shingles. The building is heated with fuel oil. Listed hot water capacity is 500 gal (18.9 m^3).

The energy parameters being monitored in this building are fuel oil and electricity.

Fort Belvoir, VA
Building 231
Data Point 224
Bachelor Enlisted Dining Facility

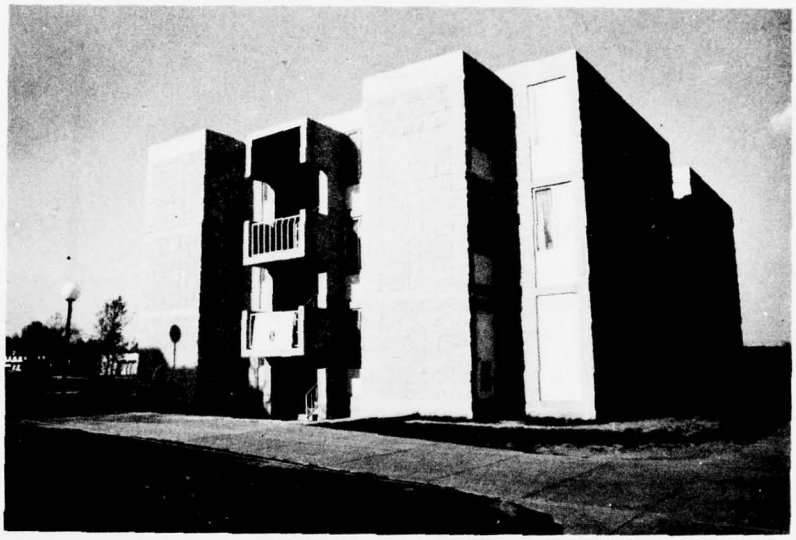
This single-story, 1,200-person enlisted dining facility, which was built in 1968, encompasses 12,982 sq ft (1206 m^2). Constructed of concrete and concrete blocks, the building employs a steel-arch-supported galvanized metal roof deck. The structure is heated with fuel oil and cooled with a 602,000-Btuh (635 110 kJ/hr) air conditioning unit. Domestic hot water capacity is 1200 gph (4.5 m^3/hr), with a 100°F (38°C) rise.

The energy parameters being monitored in this building are electricity, fuel oil, and natural gas.

Fort Belvoir, VA
Building 2111
Data Point 226
Bachelor Enlisted Quarters (Barracks)

This three-story, 132-person enlisted barracks without dining facilities has a total floor area of 19,320 sq ft (1795 m²). The concrete and block building, which was built in 1975, employs a reinforced concrete roof slab with built-up roll roofing. The building is heated with fuel oil. Listed hot water capacity is 285 gal (10.8 m³). Listed refrigeration capacity is 72 tons (65 t).

The energy parameters being monitored in this building are electricity and hot and chilled water flow and supply/return temperatures.



Fort Belvoir, VA
Building 182
Data Point 227
Swimming Pool

The single-story indoor swimming pool was built in 1975. The 11,236-sq ft (1044 m^2) concrete and brick structure employs a reinforced concrete roof slab with built-up roofing and gravel. The building is heated with fuel oil and cooled by mechanical ventilation only. The listed capacity of its hot water system is 55 gpm (2.1 m^3/min).

The energy parameters being monitored in this building are electricity and fuel oil.

Fort Belvoir, VA
Building 1464
Data Point 228
Bachelor Enlisted Quarters (Barracks)

Built in 1958, this three-story 336-person enlisted barracks encompasses 75,034 sq ft (6971 m^2). The concrete block and brick building employs a concrete roof deck with roll composition roofing. The building is heated with fuel oil. Listed capacity of its hot water system is 1900 gal (148 m^3).

The energy parameter being monitored in this building is electricity.

Fort Belvoir, VA
Building 399
Data Point 230
Administration/Laboratory

This three-story office and laboratory building built in 1973 encompasses 38,566 sq ft (3583 m^2). The brick and steel structure employs a steel-joist-supported metal roof deck with built-up roofing. The building is heated with gas and has an 80-gal (30 m^3) water heater and 140 tons (127 t) of air conditioning.

The energy parameters being monitored in this building are electricity and natural gas.

Fort Belvoir, VA
Building 216
Data Point 231
Administration (Post Headquarters)

The three-story concrete and brick post headquarters building was built in 1932. The 23,513-sq ft (2184 m^2) building employs a wood-rafter-supported slate roof. The structure is heated with fuel oil and cooled with window air conditioners.

The energy parameters being monitored in this building are electricity and fuel oil.

Fort Belvoir, VA
Building 1099
Data Point 233
Dental Clinic

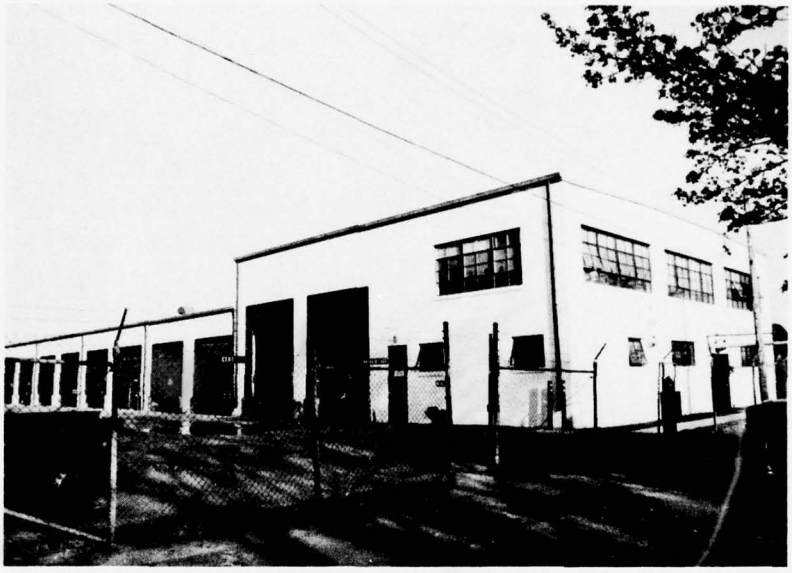
Built in 1970, the single-story dental clinic has a total floor area of 14,188 sq ft (1318 m^2). The block and brick structure employs a wood rafter roof with composition shingles. The structure is heated from a central plant. It is supplied with 252 gph (9.5 m^3/hr) of hot water. Its cooling system is rated at 45 tons (41 t).

The energy parameters being monitored in this building are electricity and hot water flow and supply/return temperatures.

Fort Belvoir, VA
Building 1949
Data Point 234
Motor Pool

Built in 1963, the single-story motor repair shop encompasses 11,235 sq ft (1044 m^2). Built of steel and concrete blocks, the structure employs a steel-joist-supported concrete deck with composition roll roofing. The building is heated with fuel oil. Listed capacity of its water heater is 52 gal (2.0 m^3).

The energy parameters being monitored in this building are electricity and fuel oil.



Fort Belvoir, VA
Building 1108
Data Point 235
Warehouse

Built in 1955, the single-story general-purpose warehouse has a total floor area of 10,000 sq ft (929 m^2). The block and steel structure employs a steel-joist-supported concrete deck with built-up roofing. The building is heated with fuel oil. Hot water is supplied by a 30-gal (1.1 m^3) heater.

The energy parameters being monitored in this building are electricity and fuel oil.

Fort Belvoir, VA
Building 335
Data Point 236
Warehouse

This 11,487-sq ft (1067 m^2) warehouse was constructed in 1942 of brick and glass masonry units. The building employs a steel-joist-supported concrete roof deck with built-up roofing. The structure is heated from a central plant and cooled with forced ventilation.

The energy parameter being monitored in this building is electricity.

Fort Belvoir, VA
Building 203
Data Point 238
Bachelor Enlisted Quarters (Barracks)

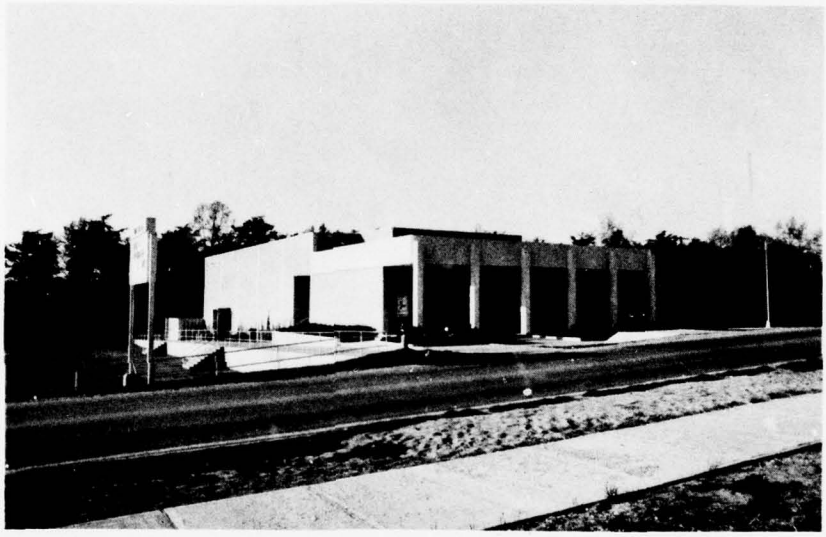
Built in 1928, this three-story, 68-person enlisted barracks without dining facilities encompasses 24,332 sq ft (2260 m^2). The brick and concrete structure employs a wood rafter roof system with composition shingles. The building is heated with fuel oil. It is cooled with a 40-ton (36 t) air conditioner.

The energy parameters being monitored in this building are electricity and fuel oil.

Fort Belvoir, VA
Building 2120
Data Point 239
Post Theater

Built in 1975, this single-story, 500-seat theater with stage encompasses 10,650 sq ft (989 m^2). The concrete block and steel structure employs a steel-joist-supported metal deck with built-up roofing and gravel. The building is heated with natural gas and fuel oil. It has both a 20-gal and a 40-gal (0.8 and 1.5 m^3) water heater.

The energy parameters being monitored in this building are electricity and fuel oil.



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Fort Belvoir, VA
Building 611
Data Point 240
Laundry

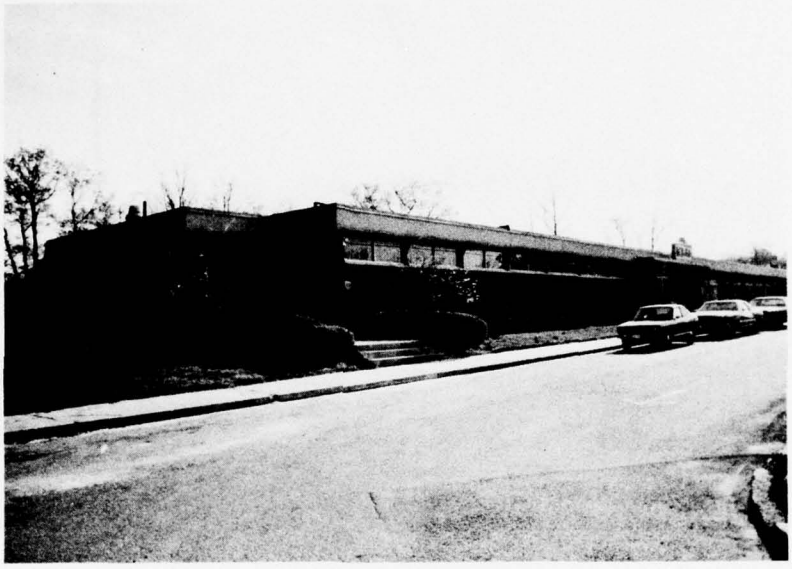
The single-story post laundry facility built in 1941 has a total floor area of 25,922 sq ft (2594 m^2). The wooden building employs a wood truss roof with composition shingles. The building is heated with oil. Refrigeration is used to cool equipment only.

The energy parameter being monitored in this building is electricity.

Fort Belvoir, VA
Building 1200
Data Point 241
Enlisted Open Dining Facility

Built in 1965, the single-story NCO open dining facility encompasses 24,045 sq ft (2234 m^2). The concrete and brick structure employs a steel-joist-supported concrete roof deck with composition roll roofing. The structure is heated with fuel oil and has 100 tons (91 t) of air conditioning. Its hot water capacity is 255 gph (9.7 m^3/hr).

The energy parameters being monitored in this building are electricity and natural gas.



Fort Belvoir, VA
Building 358
Data Point 297
Administration

This three-story office building was built in 1964. The 23,667-sq ft (2199 m^2) concrete and block building employs a steel-joist-supported concrete roof deck with built-up roofing. The building is heated with fuel oil. It is cooled with a mechanically driven chiller.

The energy parameaters being monitored in this building are total electricity, hot water flow, chilled water flow, the hot and chilled water supply and return temperature, oil flow to the hot water heater, chiller electrical power, auxiliary electrical power, building inside temperature, and building inside humidity.

Fort Hood, TX
Building 60062
Data Point 319
Family Housing—Duplex

Built in 1970, this single-story NCO family housing-duplex encompasses 2870 sq ft (267 m^2). The wooden structure employs a wooden rafter system with composition shingles. The building is heated with natural gas. Each half of the duplex is cooled with a 2½-ton (2.3 t) air conditioner and serviced by a 40-gal (1.5 m^3) gas water heater.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 60100
Data Point 320
Family Housing—Duplex

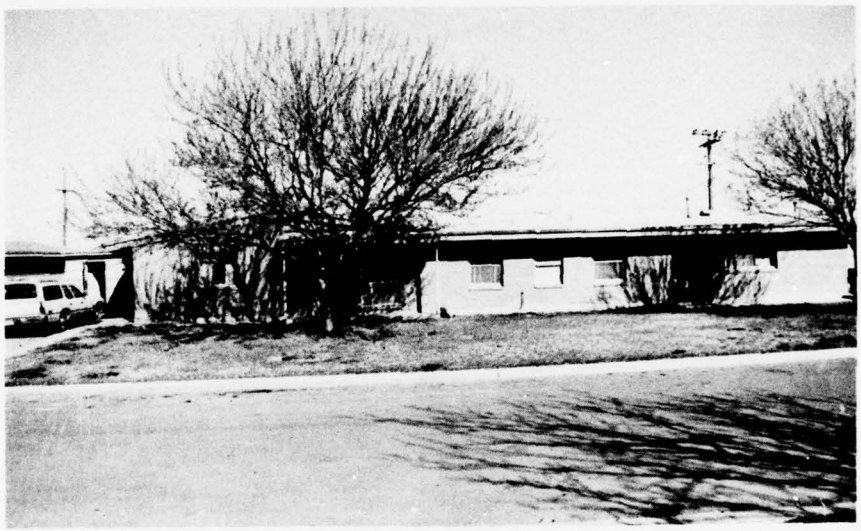
This single-story family housing-duplex built in 1970 has a total floor area of 2870 sq ft (267 m^2). The wooden structure employs a wooden-rafter system with composition shingles. The building is heated with natural gas. Each half of the duplex is cooled with a 2½-ton (2.3 t) air conditioner and is serviced by a 40-gal (1.5 m^3) gas water heater.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 5669
Data Point 322
Family Housing—Duplex

Built in 1962, this single-story, company-grade, family housing-duplex encompasses 2825 sq ft (262 m^2). The wood and brick structure employs a wood-rafter roof system with roll roofing and gravel. The unit is heated with gas and employs a central air conditioner. Listed capacity for the hot water heater is 40 gal (1.5 m^3).

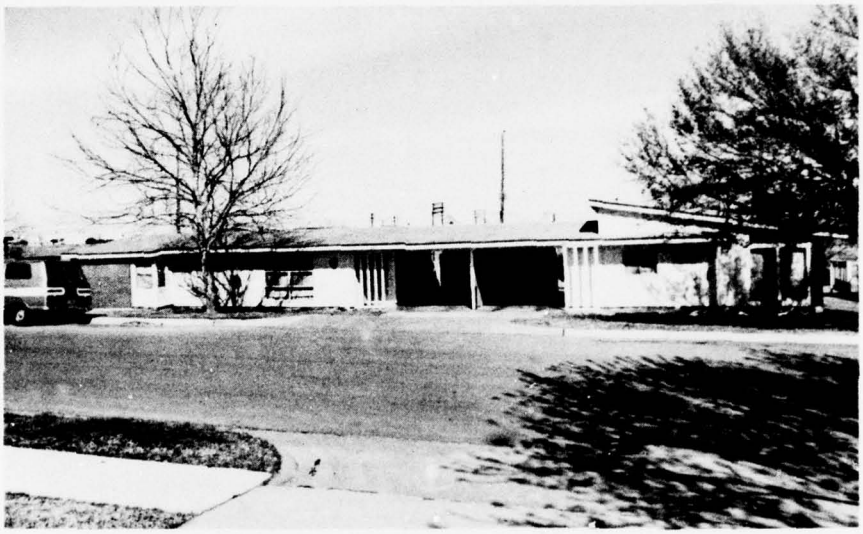
The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 6443-1
Data Point 324
Family Housing—Duplex

Built in 1960, this single-story NCO family housing-duplex encompasses 2720 sq ft (253 m^2). The wood and brick structure employs a wood-rafter system with built-up roll roofing and gravel. Each half of the duplex has an independent heating and cooling system. The hot water capacity is listed as 30 gal (1.1 m^3) at 100°F (38°C) temperature rise.

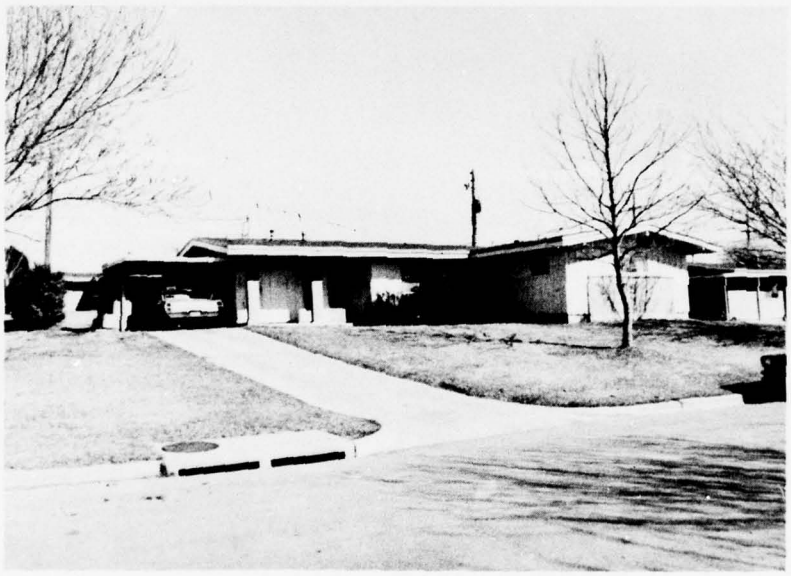
The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 6809
Data Point 325
Family Housing

This single-story field-grade family housing unit encompassing 1626 sq ft (151 m^2) was built in 1961. The wood and brick building employs a wood rafter structural system with built-up roll roofing with gravel. The building is heated with natural gas and cooled with an individual expansion air conditioner. The listed hot water capacity is 40 gal (1.5 m^3) with a 100°F (38°C) temperature rise.

The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 178
Data Point 326
Family Housing—Multi

This two-story NCO family housing eightplex was built in 1951. The 12,573-sq ft (1168 m^2) brick building employs a wooden rafter roof system with composition shingles. The building uses individual gas-fired heaters in each family unit, and each unit is supplied with a 30-gal (1.1 m^3) hot water heater.

The energy parameter being monitored in this building is natural gas usage.

Fort Hood, TX
Building 180
Data Point 327
Family Housing—Multi

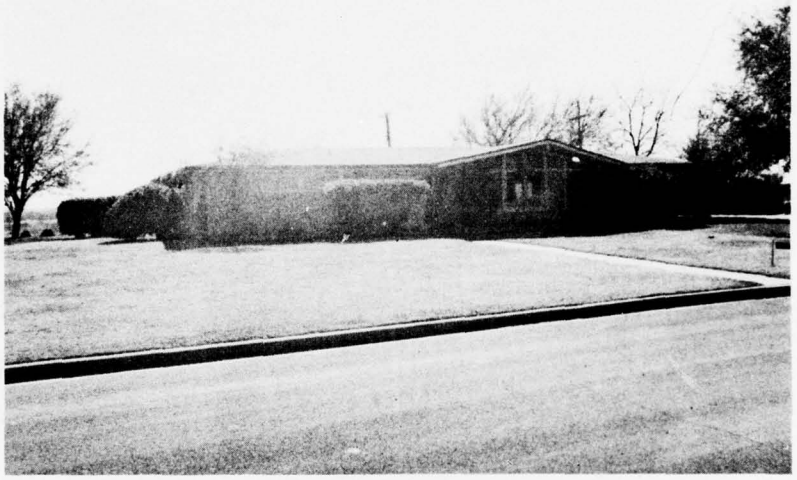
Built in 1951, this two-story NCO family housing eightplex encompasses 12,573 sq ft (1168 m^2). The brick building employs a wooden-rafter roof system with composition shingles. The building uses individual gas-fired heaters in each unit. Each residence is supplied with a 30-gal (1.1 m^3) hot water heater.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 6794
Data Point 329
Family Housing—General Officers

Built in 1956, this single-story general officers' family housing unit encompasses 2334 sq ft (217 m^2). The wood and brick building employs a wooden-rafter-supported roof deck with built-up roll roofing with gravel. The building has a 5-ton (4.5 t) central air system and heat pump.

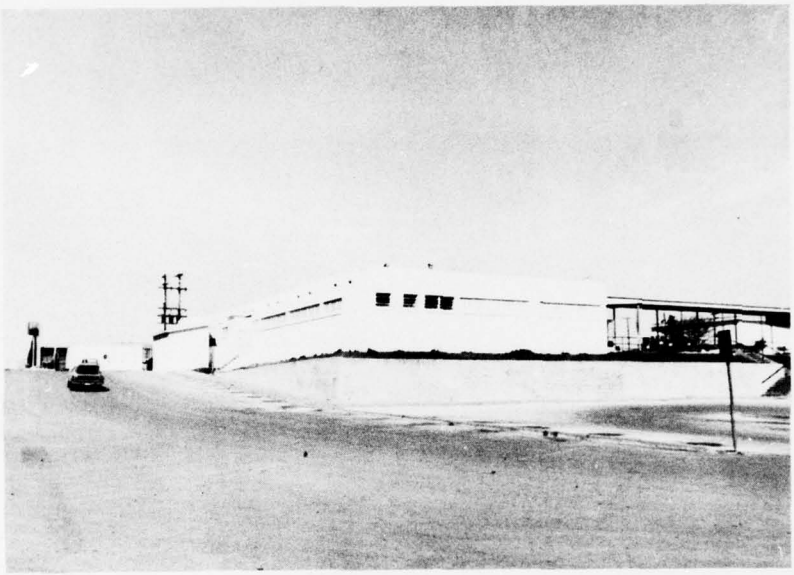
The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 136
Data Point 330
Four Seasons Cafe

The single-story exchange cafe built in 1956 covers 9180 sq ft (853 m^2). The concrete block building employs a concrete joist roof system with built-up roofing. The building is heated by gas. The hot water capacity is listed as 2000 gal (757 m^3) with 100°F (38°C) rise.

The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 36006
Data Point 331
Bachelor Officers' Quarters (BOQ)

Built in 1969, this six-story, 300-person BOQ has a total floor area of 152,737 sq ft (14 189 m²). The building is concrete and brick with a reinforced concrete roof deck topped with built-up roll roofing (without gravel). The building is heated by a natural gas boiler and cooled with chilled water from a reciprocating central unit with distribution through fan-coil units.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 87018
Data Point 332
Central Plant

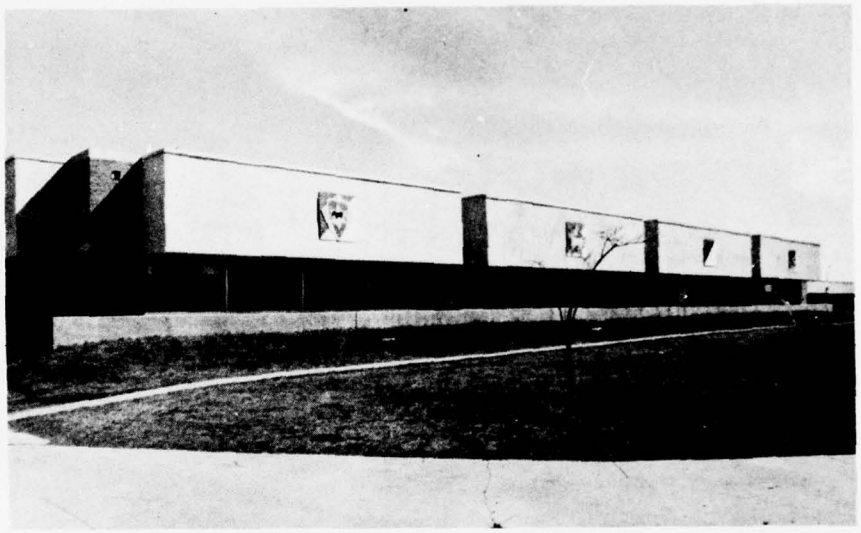
Built in 1975, the single-story combined heating and cooling plant encompasses 3327 sq ft (309 m²). The concrete and block building employs a steel-truss-supported steel deck covered with built-up roll roofing and gravel. The facility houses two 350-hp (261 kW) boilers and 512 tons (464 t) of centrifugal refrigeration equipment.

The energy parameters being monitored for this building are building electricity, electricity to each chiller, gas to each boiler, chilled water flow and supply/return temperatures, and condenser water flow and supply/return temperatures.

Fort Hood, TX
Building 87017
Data Point 333
Dining Facility

Built in 1974, this single-story, 1000-person enlisted dining facility encompasses 15,695 sq ft (1458 m^2) and has dimensions of 108 × 146 ft (33 × 45 m). The concrete block building employs a steel-truss-supported roof deck with built-up roofing. The building is heated with steam supplied by a central energy plant (building 87018). Air conditioning is also supplied from the central plant.

The energy parameters being monitored in this building are electrical usage, natural gas, and chilled water flow and supply/return temperatures.



Fort Hood, TX
Building 87016
Data Point 334
Administration Building

This single-story administration and support building built in 1974 encompasses 25,168 sq ft (2338 m^2) with dimensions of 242 × 104 ft (74 × 32 m). The concrete block and brick structure employs a flat truss steel roof deck covered with built-up roll roofing and gravel. Heating and cooling is supplied from a central energy plant. Domestic hot water capacity includes five 50-gal (1.9 m^3) electric hot water heaters.

The energy parameters being monitored in this building are electrical usage and chilled water flow and supply/return temperatures.

Fort Hood, TX
Building 87015
Data Point 335
Barracks

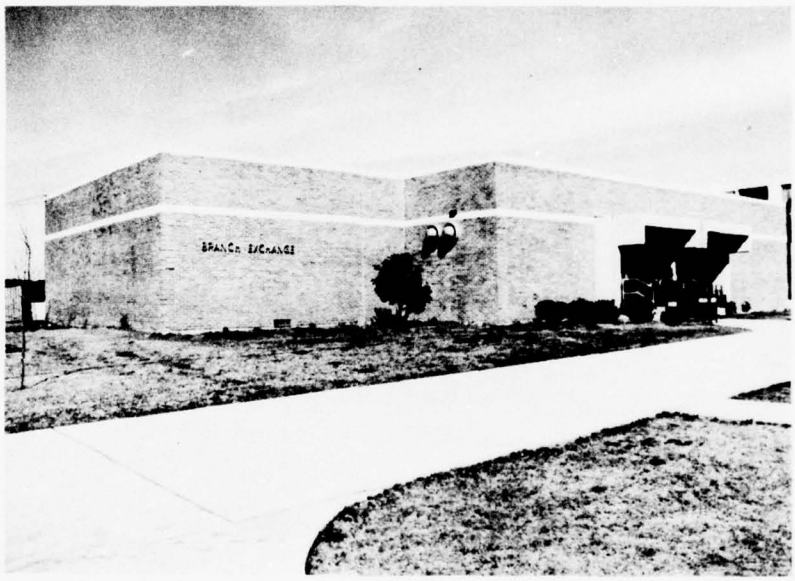
This 42,264-sq ft (3926 m^2), three-story enlisted barracks without dining facilities was built in 1974. The block and brick structure employs a reinforced concrete roof deck with built-up roll roofing and gravel. The building is heated and cooled with steam and cold water supplied by a central plant. The central plant supplies energy for all of the hot water.

The energy parameters being monitored in this building are electrical usage and hot and chilled water flow and supply/return temperatures.

Fort Hood, TX
Building 87008
Data Point 336
Branch PX

Built in 1975, the branch exchange covers 4696 sq ft (436 m^2). The concrete block and brick building employs a steel-truss-supported concrete roof deck with gravel-covered built-up roofing. Air conditioning and heating are provided by a central plant. The domestic hot water heater is listed as being 40 gal (1.5 m^3) with a 100°F (38°C) rise.

The energy parameters being monitored in this building are electrical usage and hot and chilled water flow and supply/return temperatures.



Fort Hood, TX
Buildings 10006 and 10007
Data Point 337
Bachelor Enlisted Quarters
and Central Energy Plant

The two three-story 129-person barracks buildings were built in 1953. Each of the 40,453-sq ft (3721 m^2) concrete and block buildings employs a concrete roof deck with built-up roll roofing and gravel. The structures are heated with two gas-fired 74-hp (55 kW), 100-psi (6.9 kPa) boilers. The buildings have been modernized with the addition of air conditioning and reduction of 60 percent of the window area. Hot water capacity is listed as 865 gal (32.7 m^3) with 100°F (38°C) temperature rise.

The energy parameters being monitored in this building are electrical and natural gas usage, central plant chiller electricity, and boiler natural gas usage.

Fort Hood, TX
Building 41008
Data Point 338
Bachelor Enlisted Quarters (Barracks)

This three-story, 207-person barracks without dining facilities built in 1969 encompasses 41,907 sq ft (3893 m^2). Its basic dimensions are 169 × 57 ft (52 × 17 m). The concrete and brick structure employs a reinforced concrete beamed roof with a reinforced concrete roof deck with built-up roll roofing and gravel. The building is heated with a gas-fired boiler.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 16008
Data Point 339
Barracks

Built in 1966, this three-story, 226-person enlisted barracks covers 41,907 sq ft (3893 m^2). The concrete block and brick building employs a reinforced concrete roof system with built-up roll roofing and gravel. The building has been thermally upgraded and window areas have been reduced by about 40 percent. The structure employs a gas-fired boiler to supply heating.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 12005
Data Point 340
Enlisted Dining Facility

This 11,949-sq ft (1110 m^2) single-story enlisted dining facility built in 1964 has a design capacity of 415 persons. The concrete and brick structure employs a steel-truss-supported metal roof deck with built-up roofing and gravel. The building is heated with a gas-fired boiler and uses chilled water for cooling. The domestic hot water capacity is 1000 gal (37.9 m^3) of storage with 100°F (38°C) rise.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 27004
Data Point 341
Dining Facility and Central Plant

Constructed in 1974, this 1000-person enlisted dining facility and central plant is a brick and block single-story steel truss structure with metal decking and built-up roll roofing. The building encompasses 15,382 sq ft (1429 m^2), which includes a main building of 104 × 153 ft (32 × 47 m) and a boiler room of 52 × 41 ft (16 × 12 m). It is heated by a gas-fired boiler and cooled by chilled water from a centrifugal central unit. Cooled air is circulated with low-velocity air from single- and multiple-zone units. The listed capacity of the chiller is 6.7 × 10^6 Btuh (7.1 × 10^6 kJ/hr). The boiler and chiller in this building also supply energy to buildings 27007, 27006, and 27001.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 27002
Data Point 342
Bachelor Enlisted Quarters (Barracks)

Built in 1974, this 146,098-sq ft (13 573 m^2), 825-person barracks is a three-story brick and block truss structure incorporating a metal roof deck with built-up roll roofing. The building has four wings; two of the wings are 240 × 47 ft (73 × 14 m), and the other two are 212 × 57 ft (65 × 17 m). It is heated by hot water from a central plant serving more than one building. The building is cooled by chilled water from a central plant that has a chiller capacity of 6.7 × 10^6 Btuh (7.1 × 10^6 kJ/hr). Cooled air is circulated with low-velocity air from single- and multiple-zone units. Domestic hot water is also supplied by the central plant (building 27004).

The energy parameter being monitored in this building is electrical usage.

Fort Hood, TX
Building 27006
Data Point 343
Bachelor Enlisted Quarters (Barracks)

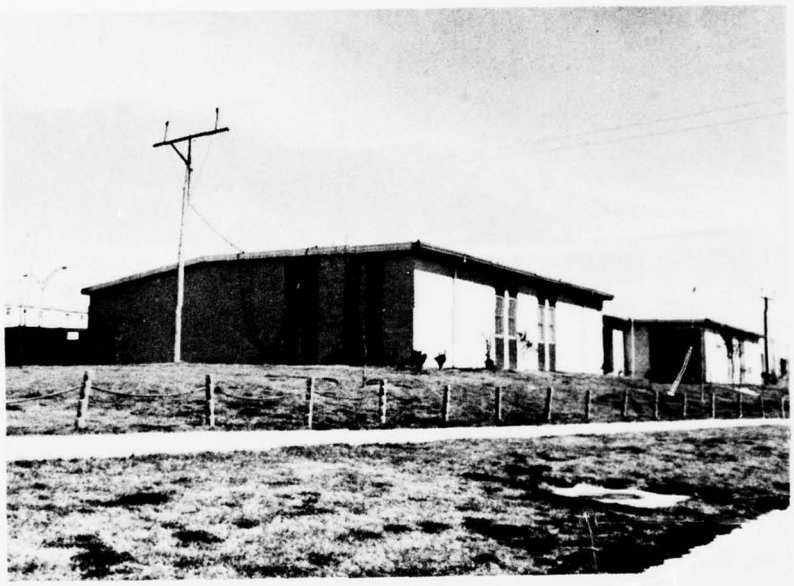
Built in 1974, this 146,098-sq ft (13 573 m^2), 825-person barracks is a three-story brick and block steel truss structure incorporating a metal roof deck with built-up roll roofing. The building has four wings; two of the wings measure 240 × 47 ft (73 × 14 m), and the other two are 212 × 57 ft (65 × 17 m). It is heated by a gas-fired central plant serving more than one building. The building is cooled by chilled water from a central plant that has a chiller capacity of 6.7×10^6 Btuh (7.1×10^6 kJ/hr). Cooled air is circulated with low-velocity air from single- and multiple-zone units. Domestic hot water is also supplied by the central plant (building 27004).

The energy parameter being monitored in this building is electrical usage.

Fort Hood, TX
Building 27001
Data Point 344
Administration and Classroom

Built in 1974, this single-story battalion administration and classroom building encompasses 12,383 sq ft (1150 m^2), which includes a main section that is 178 × 77 ft (54 × 23 m) and two offsets of 20 × 57 ft (6 × 17 m). The block and brick structure employs a steel truss roof with metal decking and built-up roll roofing with gravel. The building is heated and cooled with water supplied by a central plant located in building 27004. The listed cooling capacity for this building is 836,000 Btuh (881 980 kJ/hr). Domestic hot water with a capacity of 40 gph (1.5 m^3/hr) at 100°F (38°C) rise is also supplied from the central plant.

The energy parameter being monitored in this building is electrical usage.



Fort Hood, TX
Building 34008
Data Point 345
Dining Facility and Central Plant

Constructed in 1974, this 1000-person enlisted dining facility and central plant is a single-story brick and block truss structure with metal roof decking and built-up roll roofing. The building encompasses 15,382 sq ft (4688 m^2). It is heated by hot water from a central gas-fired boiler serving more than one building. It is cooled by chilled water from a centrifugal central unit. Cooled air is circulated with low-velocity air from single- or multiple-zone units. Total chiller capacity is rated at 2.2×10^6 Btuh (2.3×10^6 kJ/hr). Water heater capacity is listed as 6285 gal (237 m^3) with 100°F (38°C) rise.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 34006
Data Point 346
Bachelor Enlisted Quarters (Barracks)

Constructed in 1974, this 825-person barracks is a three-story, four-wing brick and steel structure encompassing 146,098 sq ft (13 573 m^2). It has a steel truss roof, steel decking, and built-up roll roofing. It is heated by hot water supplied from a gas-fired central plant and cooled by chilled water produced in the central plant with a centrifugal central unit. Cooled air is circulated with low-velocity air from single- and multiple-zone units. The chiller capacity is listed as 2.2×10^6 Btuh (2.3×10^6 kJ/hr).

The energy parameter being monitored in this building is electrical usage.

Fort Hood, TX
Building 34010
Data Point 347
Barracks

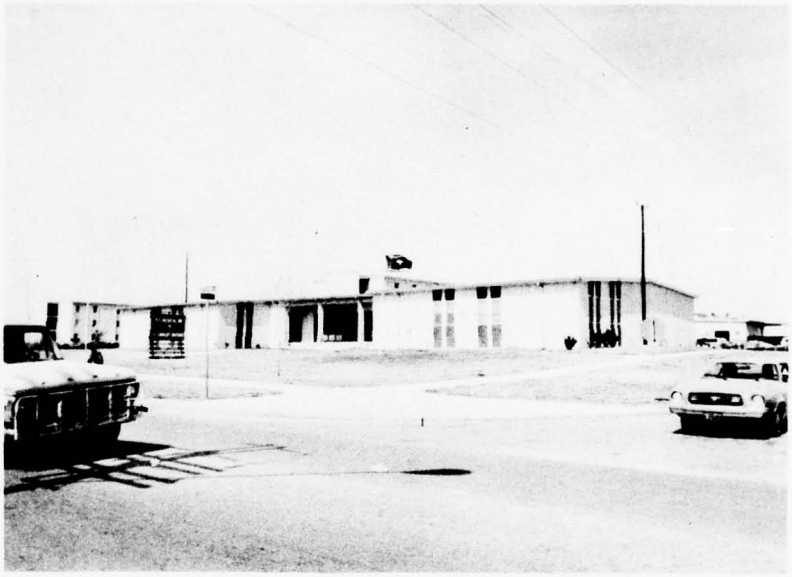
Constructed in 1974, this 825-person barracks is a three-story brick and steel structure encompassing 146,098 sq ft (13 573 m^2). The building has a steel truss roof, steel decking, and built-up roll roofing. It is heated and cooled from a central energy plant (building 34008), which employs a gas-fired boiler and a 2.2×10^6 Btuh (2.3×10^6 kJ/hr) centrifugal chiller. The central plant also supplies hot water to this building.

The energy parameter being monitored in this building is electrical usage.

Fort Hood, TX
Building 34011
Data Point 348
Administration/Classroom

Built in 1974, this single-story battalion administration and classroom building encompasses 12,383 sq ft (1150 m^2). The block and brick structure employs a steel roof with metal decking and built-up roll roofing with gravel. The building is heated with water from a gas-fired boiler located in a central energy plant (building 34008). The central energy plant includes a 2.2×10^6 Btuh (2.3×10^6 kJ/hr) chiller supplying cold water to the building.

The energy parameter being monitored in this building is electrical usage.



Fort Hood, TX
Building 9529
Data Point 349
Maintenance Shop

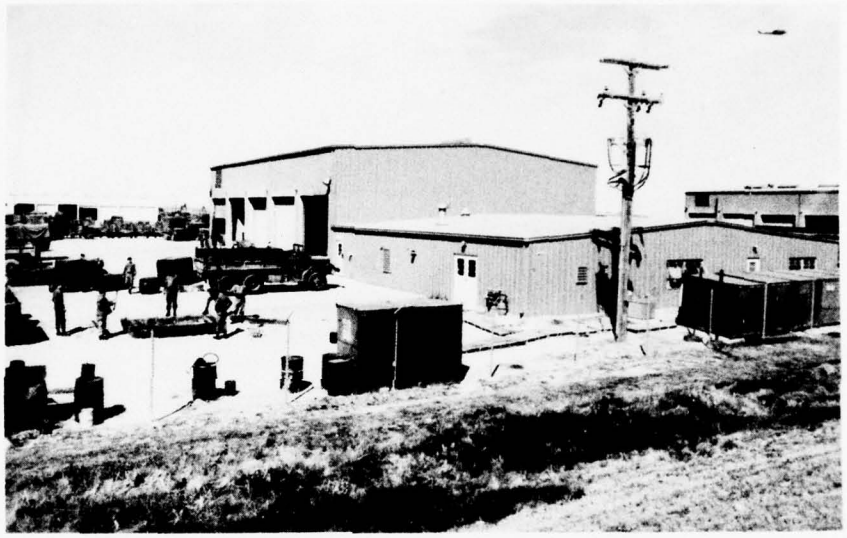
Built in 1956, this one-story motor repair shop has a total floor area of 20,836 sq ft (1936 m^2). The main building is 60 × 144 ft (18 × 44 m) with a wing of 40 × 290 ft (12 × 88 m). The steel and block building employs a steel arch roof with a metal roof deck covered with built-up roll roofing and gravel. The building is heated with natural gas space heaters.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 32016
Data Point 350
Maintenance Shop

Built in 1973, this single-story motor repair shop encompasses 11,550 sq ft (1073 m^2) with dimensions of 70 × 165 ft (21 × 50 m). The steel-walled structure employs a steel-joist-supported galvanized roof. The heating fuel is natural gas. The listed cooling capacity is 8 tons (7 t). A 30-gph (1.1 m^3/hr) gas boiler heater supplies domestic hot water.

The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 40001
Data Point 351
Maintenance Shop

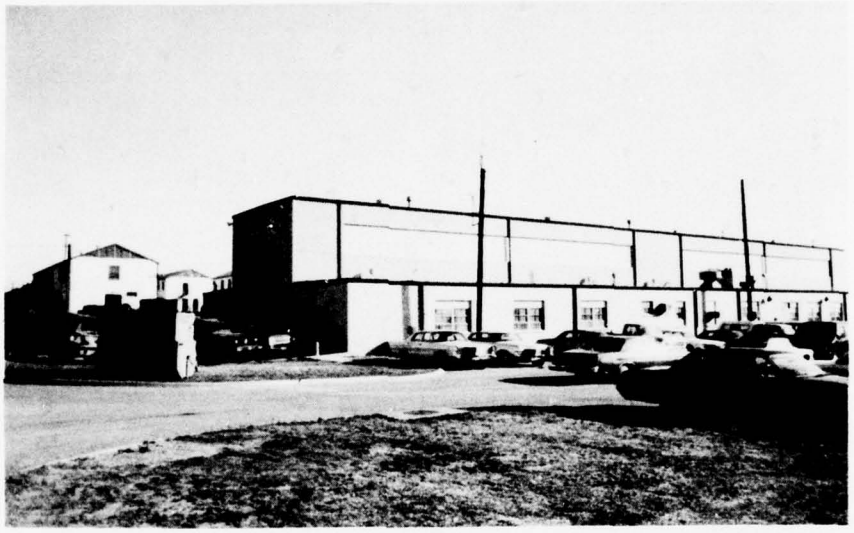
This single-story field maintenance shop, which was built in 1956, encompasses 83,793 sq ft (7784 m^2) with dimensions of 246 × 310 ft (75 × 94 m). The steel and block building employs an open web joist-supported steel deck covered with built-up roll roofing and gravel. The building is heated with natural gas space heaters. In 1959, four 1-hp (0.7 kW) air conditioners were installed. The listed domestic hot water capacity is 84 gph (3.2 m^3/hr) with a 60°F (15°C) rise.

The energy parameters being monitored in this building are electrical and gas usage.

Fort Hood, TX
Building 4617
Data Point 352
Maintenance Shop

Built in 1959, this concrete block and steel maintenance shop covers 14,000 sq ft (1301 m^2). Flat steel trusses support a metal roof deck with built-up roofing and gravel. The building is heated with natural gas. It is not air conditioned. The structure is supplied with a 20 gph (0.8 m^3/hr) hot water heater at a 100°F (38°C) rise capacity.

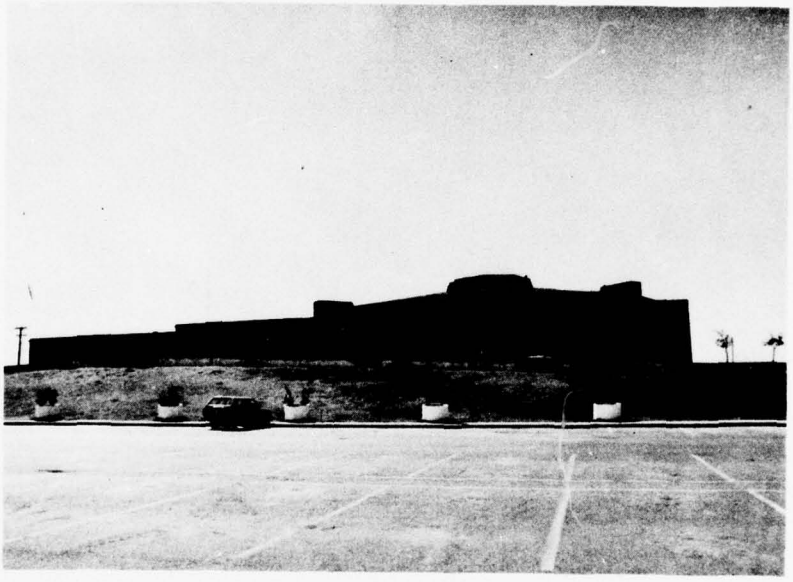
The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 42000
Data Point 353
Enlisted Open Dining Facility (NCO Mini Dome)

This single-story enlisted open dining facility was built in 1971. The 23,345-sq ft (2169 m^2) concrete and brick building employs a steel-truss-supported metal roof deck with built-up roll roofing. The building is heated with a gas-fired boiler. The building has a 200-ton (181 t) cooling capacity distributed through fan-coil units. The domestic hot water capacity is 420 gph (15.9 m^3/hr) at 100°F (38°C) rise.

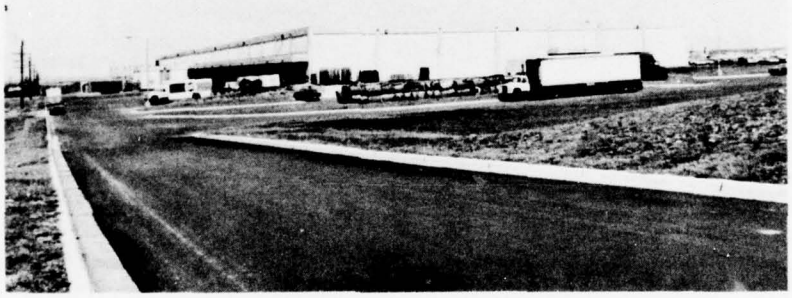
The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 50001
Data Point 354
Commissary

Built in 1975, the single-story commissary encompasses 127,780 sq ft (11 870 m^2), the main structure being 475 × 240 ft (145 × 73 m). The concrete and block building employs flat steel trusses, a metal roof deck, and built-up roll roofing with gravel. The building is heated with a natural gas boiler and has a fuel oil capability. The listed cooling capacity is 2.14 × 10^6 Btuh (2.26 × 10^6 kJ/hr) distributed through fan-coil units. Hot water capacity is listed as 200 gph (7.6 m^3/min) at 100°F (38°C) temperature rise.

The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 5764
Data Point 355
Officers' Open Dining Facility

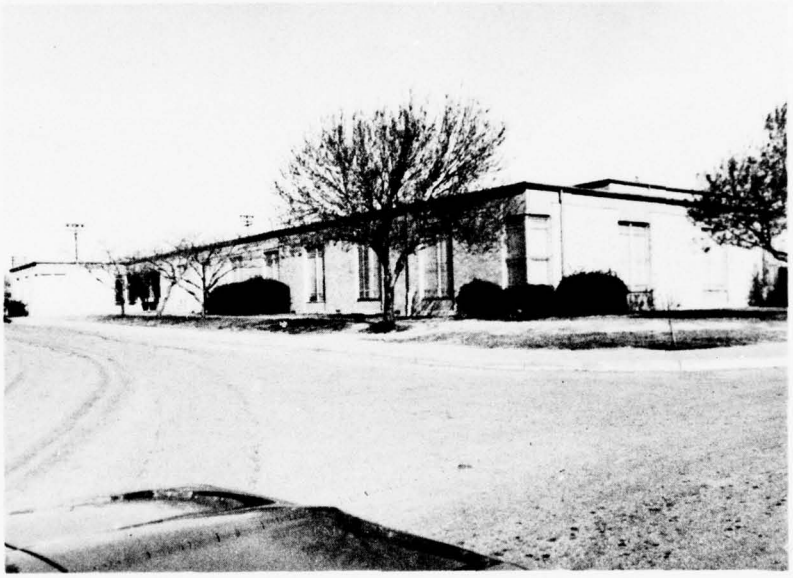
The single-story officers' dining facility built in 1959 has a total floor area of 29,547 sq ft (2745 m^2). The block and brick building employs a steel-joist-supported concrete deck covered with built-up roll roofing. The building is heated with a natural gas-fired boiler and cooled with a chilled water centrifugal system. The listed hot water capacity is 270 gph (10.2 m^3/hr) with an 85°F (29°C) rise.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 121
Data Point 356
Enlisted Personnel Service Club

Built in 1967, this 32,000-sq ft (2973 m^2) single-story enlisted personnel service club is a concrete and brick building employing a flat steel-truss-supported metal roof deck with built-up roofing and gravel. The structure is heated with gas and cooled with a central centrifugal chiller.

The energy parameters being monitored in this building are electrical and natural gas usage.



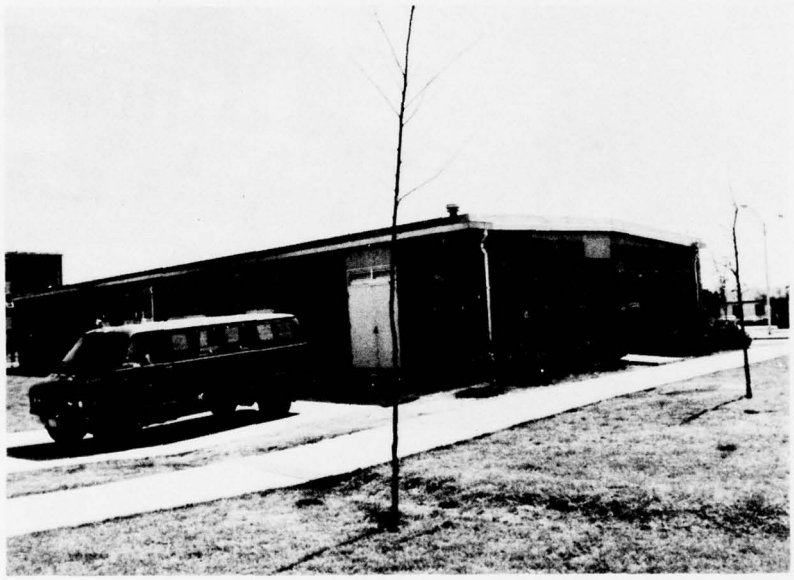
Fort Hood, TX
Building 36000
Data Point 357
Hospital

Gas is monitored but the building is being heated intermittently with fuel oil.

Fort Hood, TX
Building 24001
Data Point 358
Dispensary

Built in 1975, this single-story dispensary without beds encompasses 4106 sq ft (381 m^2). The building dimensions are 97 × 42 ft (30 × 13 m). The block and brick structure incorporates a stell-truss-supported metal deck covered with built-up roofing and gravel. The structure has a gas-fired boiler. Its air conditioning system is rated at 128,000 Btuh (135 040 kJ/hr). The domestic hot water system is gas fired and rated at 50 gph (1.9 m^3/hr) at 100°F (38°C) rise.

The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 31002
Data Point 359
Dispensary

Built in 1972, this single-story dispensary without beds covers 3808 sq ft (354 m^2), which includes a 47 × 36 ft (14 × 11 m) main section and a 42 × 25 ft (13 × 7 m) offset. The brick and block building employs a steel-arch-supported metal roof deck with built-up roll roofing and gravel. The structure is heated with a natural-gas-fired boiler. The listed capacity of the chiller is 128,000 Btuh (135 040 kJ/hr). Domestic hot water is heated with natural gas at a capacity of 50 gph (1.9 m^3/hr) at 100°F (38°C) rise.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 330
Data Point 360
Dental Clinic

Built in 1968, this single-story, 18-chair dental clinic has a total floor area of 9497 sq ft (882 m²) with dimensions of 93 × 102 ft (28 × 31 m). The block and brick building employs a steel truss roof system with built-up roofing and gravel. The building is heated with natural gas and cooled with a 75-hp (56 kW) chilled water compressor.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 1
Data Point 361
Post Headquarters

The 12,390-sq ft (1151 m^2) post headquarters building was built in 1942. Constructed of wood, the structure employs a wood rafter system covered with composition shingles. The building is heated by natural gas.

The energy parameters being monitored in this building are electricity and natural gas.

Fort Hood, TX
Building 108
Data Point 362
Community Center

Built in 1943, the single-story general-purpose building encompasses 27,737 sq ft (2577 m^2). The wooden building employs a wooden arched roof with composition shingles. The building is gas heated. Listed capacities are 55 tons (50 *t*) for air conditioning and 250 gph (9.4 m^3/hr) of hot water.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 12018
Data Point 363
Gymnasium

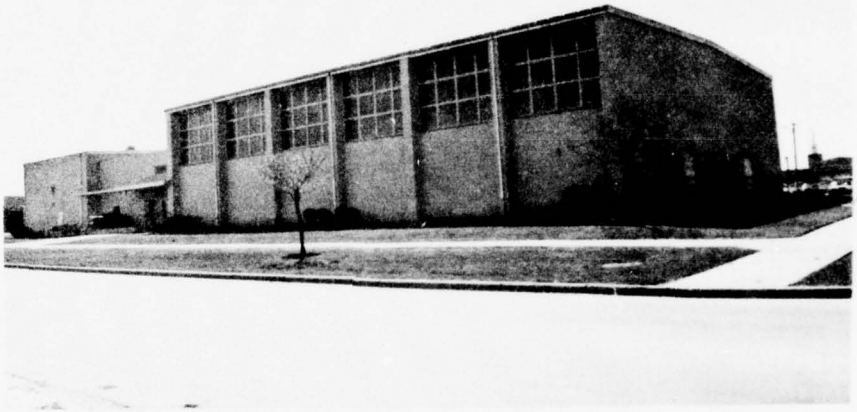
Built in 1966, this 20,572-sq ft (1911 m^2) single-story gymnasium is a concrete block and brick structure employing a steel-joist-supported metal roof deck covered with built-up roll roofing. The building is heated with a gas-fired furnace. It is not air conditioned. The building uses two 300-gph (11.4 m^3/hr) domestic hot water heaters.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 37017
Data Point 364
Gymnasium

This single-story gymnasium built in 1969 encompasses 20,019 sq ft (1860 m²), with dimensions of 208 × 100 ft. The block and brick structure employs a steel-joist-supported metal roof deck with built-up roll roofing. The building is heated with a gas-fired boiler. It has no air conditioning system.

The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 16010
Data Point 365
Administration

Built in 1966, this single-story administration and supply building covers 12,180 sq ft (1132 m^2) with dimensions of 209 × 57 ft (70 × 17 m). The brick and block building employs a steel-truss-supported metal roof deck with built-up roll roofing and gravel. The building uses a gas-fired boiler and a central air conditioner energy system. Hot water capacity is listed as 70 gal (2.6 m^3) with a 100°F (38°C) temperature rise.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 49015
Data Point 366
Warehouse

Built in 1965, this single-story, general-purpose warehouse encompasses 32,624 sq ft (3681 m^2), of which the main building is about 200 × 200 ft (61 × 61 m). The block and brick structure employs a steel-joist-supported metal roof deck with built-up roll roofing with gravel. Natural gas is used to heat the building. The listed hot water capacity is 20 gal (0.8 m^3).

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 6898
Data Point 367
Post Pump Station

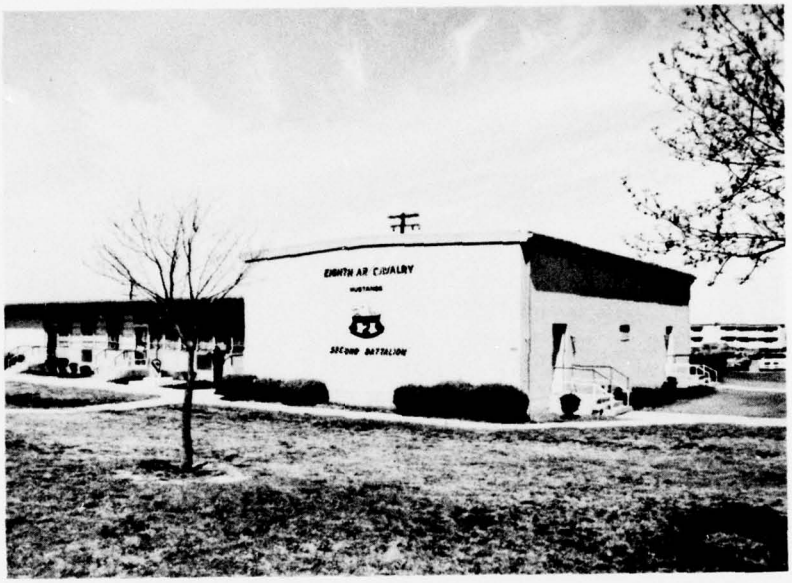
The single-story pump station, which was built in 1963, has a total floor area of 3710 sq ft (345 m^2). The concrete block structure employs a flat steel truss roof, a metal roof deck, and built-up roofing without gravel. The building is heated with direct-fired gas space heaters. The pumping station has the capacity to pump 21 $\times$ 10^6 gpd (0.8 m^3/day).

The energy parameter being monitored in this building is electrical usage.

Fort Hood, TX
Building 37011
Data Point 368
Administration/Classroom (Headquarters)

Built in 1968, this single-story battalion administration and classroom building encompasses 6136 sq ft (570 m^2), of which 3200 sq ft (297 m^2) is used for administration and 2500 sq ft (232 m^2) for classroom. The block and brick structure employs a steel-joist-supported metal deck covered with built-up roll roofing. The building is heated with a gas-fired boiler.

The energy parameters being monitored in this building are electrical and natural gas usage.



Fort Hood, TX
Building 37010
Data Point 370
Administration

Built in 1968, this single-story administration and supply building covers 12,180 sq ft (1132 m^2). The block and brick structure employs a steel-truss-supported metal deck with built-up roll roofing and gravel. The building is heated by a gas-fired boiler.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 5658
Data Point 371
Family Housing

Built in 1962, this single-story, company-grade family housing duplex encompasses 2802 sq ft (260 m^2). The wood and brick structure employs a wood rafter roof system with roll roofing and gravel. The unit is heated with gas and employs a central air conditioner. Listed capacity for the hot water heater is 40 gal (1.5 m^3).

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 6449-1
Data Point 372
Family Housing

Built in 1960, this single-story NCO duplex covers 2720 sq ft (253 m^2). The wood and brick structure employs a wood rafter system with built-up roll roofing and gravel. Each half of the duplex has an independent heating and cooling system. The hot water capacity is listed as 30 gal (1.1 m^3) at 100°F (38°C) temperature rise.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 30015
Data Point 373
Maintenance Shop

This single-story motor repair shop built in 1966 encompasses 20,240 sq ft (1880 m^2). The main building is 290 × 40 ft (88 × 12 m) and has a 144 × 60 ft (44 × 18 m) wing. The steel and block building employs a steel truss roof with metal decking and built-up roofing with gravel. The building is heated with a gas-fired boiler and has electric window air conditioners in the office area. The domestic hot water capacity is 60 gph (2.3 m^3/hr).

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 16011
Data Point 374
Administration/Classroom (Headquarters)

Built in 1966, this single-story battalion administration and classroom building encompasses 6136 sq ft (570 m^2), of which 3320 sq ft (308 m^2) are used for administrative space and 2520 sq ft (234 m^2) are used for classroom space. The block and brick structure employs a steel-joist-supported metal roof deck with built-up roofing. The structure is heated with a gas-fired boiler. Hot water is supplied from a 30-gal (1.1 m^3) hot water heater.

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 23001
Data Point 375
New Field House

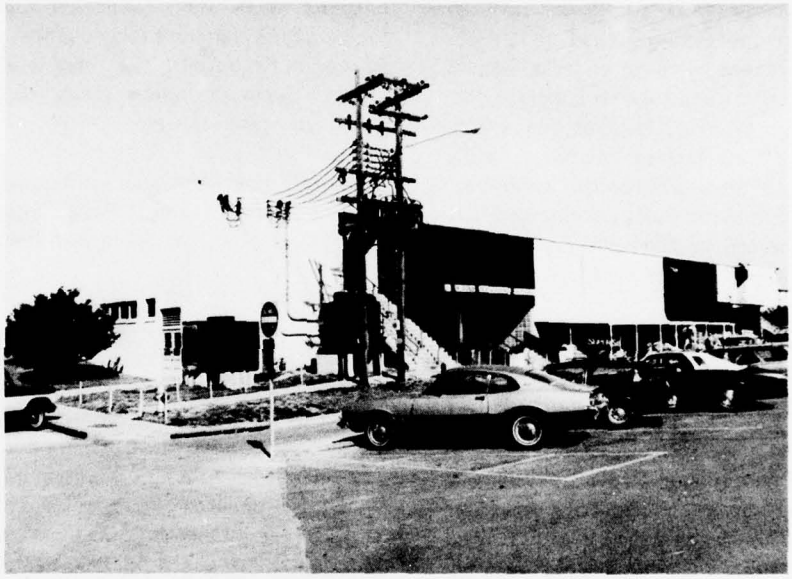
Built in 1975, the one-story physical fitness center has a total floor area of 62,000 sq ft (5760 m^2), including 1200 sq ft (111 m^2) of basement. The block and brick building employs a flat steel-truss-supported metal roof deck with a gravel-covered built-up roof. Heat is supplied by a gas-fired boiler. An 82,100 Btuh (86 616 kJ/hr) chiller provides cooling. The listed hot water capacity is 403 gph (15.3 m^3/hr) at 160° to 180°F (71° to 82°C).

The energy parameters being monitored in this building are electrical and natural gas usage.

Fort Hood, TX
Building 135
Data Point 376
Main PX

Built in 1956, the 40,360-sq ft (374 m^2) two-story main exchange retail store is a concrete block building employing a reinforced concrete joist roof system with built-up roofing. The structure is heated with gas and cooled with a 40-ton (36 t) central air conditioner with an air-cooled condenser. The building is supplied with a 2000-gal (7.6 m^3) capacity domestic hot water heater.

The energy parameters being monitored in this building are electrical and natural gas usage.



APPENDIX E:

INSTRUMENTATION SYSTEM

Introduction

The major data collection system chosen was the pulse-recording system, an on-site data-logging system. A conditioned signal from the sensor is transmitted to the pulse recorder where it is converted into a series of pulses, the density of which is proportional to the signal being recorded. The pulses are recorded on audio cassettes in the recorder located near the sensor. Two- and four-channel recorders are available, and hourly data are recorded. The cassettes must be changed monthly by the facility engineering personnel and mailed to CERL, where the tapes are processed to convert from a pulse signal to a digital signal which is compatible with the data storage system. The date, site, sensor identifier, and time are manually entered onto the computer during the processing of the audio cassettes. Because these cassette tapes are changed only monthly, daily checking of the sensors to insure proper operation cannot be performed.

The following paragraphs describe the individual components of the instrumentation system.

Recorder

To determine consumption characteristics of facilities, recording data on an hourly basis was considered desirable. The Westinghouse recorders used in this project far exceed this minimum requirement. They are powered by an ac 120-V source. By shorting to ground one terminal of the data channel, one side of the ac power wave is filtered and the magnetic tape is biased negative or positive (depending on which of the two terminals is shorted). This change of state or bias from positive to negative is recorded on the magnetic tape as a pulse. All three data channels are accessed through a terminal board to which the meter or sensor is wired. The meter or sensor then alternately shorts the terminals to ground at a rate proportional to the rate of the energy consumption.

Electric Meters

Although different electric services were encountered with the many facilities metered, the project uses a few general types of electric meters in conjunction with current and potential transformers. Three-phase meters used were three-stator and rated at 120 or 240 V. Single-phase meters were rated for 240 V and were single-stator. The pulse-initiating or recorder-shorting device used in the electric meters consisted of a photo SCR (a light sensitive four-layer diode). When the photo SCR is darkened, it behaves as an open circuit. When exposed to light, it conducts current in one direction. Two photo SCRs are connected in parallel, with opposing polarity; when an ac voltage is applied to the pair, the dc output is positive or negative, depending on which photo SCR is exposed to light. SCR output is controlled by reflecting a light off the watthour meter induction disc which is partially darkened at appropriate points. During revolution of the induction disc, the SCR output changes, and a connected single-pole double-throw (SPDT) latching relay changes state with each change in dc output. The relay is wired to the recorder which alternately shorts the data channel with each change in state.

Another type of pulse-initiating device used functions basically the same, except the switching is done mechanically by gears coupled to the induction disc.

Gas Meters

Gas service varied in size with the many facilities metered in the project. However, all gas metering applications were monitored using only two types of gas meters: positive displacement diaphragm meters and turbine flow meters. The meters ranged in size from 415 (standard residential service) to 5000 cu ft/hr (12 to 142 m^3/hr) (average industrial service). For extremely large gas flows (9000 to 30,000 cu ft/hr [255 to 840 m^3/hr], the turbine-style gas meter was utilized.

The pulse-initiating device for all the gas meters was internally contained; all the devices were the same except those in the 415 diaphragm meters. The 415 meter arrangement added another gear to the register gears which rotated a small magnet with the flow of gas. Rotation of this magnet caused an SPDT reed switch to transfer between contacts. These contacts were wired to the recorder and alternately shorted the data channel at a rate proportional to the rate of flow of gas. The other gas meters had a similar arrangement, except that with the flow of gas a spring compressed and released, which forced a magnet to travel up and down across a fixed path. The magnet movement caused an SPDT switch to operate similarly to the switch in the 415 meter.

In some instances, existing meters had to be fitted with a pulse-initiating device to interface with the data recorders.

The design for both types of meters used cams driving a microswitch to provide the required switch closures for the recorders.

Flow Meter and Temperature Sensor

Many contemporary Army facilities have heating or cooling provided by a central plant which provides heated or chilled water to a complex of buildings. In these applications, it was necessary to monitor the water flow rate and temperature change in the water supply and return lines to and from the building. From this information, the total energy consumed in heating or cooling supplied by the central plant to each building could be determined.

Each flow meter is used in conjunction with a flow-rate transmitter. The flow meter consists of a turbine with a permanent magnet rotor immersed in the pipe flow. The rotation of the magnet produces an ac signal in a coil sealed in the tubular support; the frequency of the signal is proportional to the flow-rate. The flow-rate transmitter is a frequency-to-current converter (4 to 20 mA range) which eliminates error due to line loss where the flow-rate transmitter is installed remote to the recorder.

The temperature sensors used were platinum resistance temperature detectors (RTD). The platinum wire changes resistance in direct proportion to a change in temperature. Solid-state electronics with integrated circuits sense the changes in the resistance of the RTD and produce an output signal of 0 to 1 V dc corresponding to a temperature range.

The outputs of the flow meter and the temperature sensor are not compatible with the recorders. Consequently, using an analog-to-frequency (A/F) converter for each flow meter and temperature sensor was required. The A/F converter accepts the 4 to 20 mA output of the flow meter or the 0 to 1 V dc output of the temperature sensor and produces the SPDT switch closure output required for the records. The A/F converter output ranges from 0 to 4000 counts per hour for 0 to 1 V dc input, producing switch closures at a rate proportional to the rate of flow or the temperature of the water.

Oil Monitoring

Fort Belvoir is the only installation in the project that uses oil heating for other than emergency use. The oil burned at Fort Belvoir is either number 2 or 5. Oil consumption monitoring is accomplished by recording the running time of each oil burner motor using a repeat cycle timer with the data recorders. The repeat cycle time consists of a synchronous motor driving a cam which operates an SPDT microswitch. The cycle timer is connected to the motor circuit and is energized when the oil burner turns on. Full consumption reports are forwarded from the post to CERL each month to determine the amount of oil consumed in each burner per unit of time.

The repeat cycle timers are not commonly stocked items. They were built for use in this project from written specifications.

Instrument Accuracy

Table E1 lists the accuracy of the instrumentation described above.

Table E1

Instrument Accuracy

HWFT — Water flow and temperature measurement	
CWFT	
1. Mead PT-220-6 flowmeter	±1% of full scale
2. Mead FX-70 flow-rate transmitter	±.5% of full scale
3. 100 Ω Platinum RTD	±.1 Ω at 0°C
4. Weather Measure Corp. T621-3	±.5%
5. Scientific Columbus 6070 V/F converter	±.05%
6. Westinghouse WR4C pulse recorder	±1 pulse interval ±4 pulses/tape
T_1 — Air temperature measurement	
1. Weather Measure Corp. thermistor probe	±.15°C linearity
2. Weather Measure Corp. T621	±.17°C
3. Scientific Columbus 6070 V/F converter	±.05%
4. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
T_3 — Dewpoint temperature measurement	
1. Weather Measure Dew temperature probe	±.15°C
2. Weather Measure BD105-1 Signal Conditioning	±.17°C
3. Scientific Columbus 6070 V/F converter	±.05%
4. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
E_1 — Single phase power measurement	
1a. Current Transformer 5-A secondary ANSI metering class	.3%
1b. *Potential Transformer* 120-V secondary ANSI metering class	.3%
2. Westinghouse D2S Single phase Watthour meter w/pulse initiator	±.5%
3. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
E_2 — Three phase power measurement	
1a. Current transformer 5-A secondary ANSI metering class	.3%
1b. Potential transformer 120-V secondary metering class	.3%
2. General Electric VW64S 3 Stator Watthour meter w/pulse initiator	±.5%
3. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
O — Oil Flow Measurement	
1. Repeat cycle timer (boiler run time)	±.05%
2. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
G — Natural Gas Measurement	
1a. Rockwell 415 gasmeter w/pulse initiator	±1%
b. Rockwell 1600 gasmeter w/pulse initiator	±1%
c. Rockwell 3000 gasmeter w/pulse initiator	±1%
d. Rockwell 5000 gasmeter w/pulse initiator	±1%
e. Rockwell T18000 gasmeter w/pulse initiator	±1%
2. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape

Table E1 (continued)

S	**— Horizontal Solar Radiation Measurement**	
	1. Weather Measure Corp. R413 Star Pyranometer with signal conditioning	±2% *see manufacturers' specifications
	2. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
W	**— Wind Speed and Direction Measurement**	
	1. Weather Measure Corp. W101-P SKYVANE Wind Sensor with signal conditioning	±1 mph below 25 mph ±5% above 25 mph
	2. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
B	**— Barometric Pressure Measurement**	
	1. Weather Measure Corp. B242 Analog Output Barometer with signal conditioning	±.5 mb (0-40°C)
	2. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
BH	**— Relative Humidity Measurement**	
	1. Weather Measure Corp. HM111P Relative Humidity Indicator	±.5%
	2. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape
BT	**— Building Temperature Measurement**	
	1. Weather Measure Corp. thermistor probe	±.15°C linearity
	2. Weather Measure Corp. T621 Remote temperature indicator	±.17°C
	3. Scientific Columbus 6070 V/F converter	±.05%
	4. Westinghouse WR4C pulse recorder	±1 pulse/interval ±4 pulses/tape

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