GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. ______

Project No. P-81-804 DATE 5-26-82

Project Director: C. L. Johnson School/Lab Physical Plant

Sponsor: Department of Energy, Region IV, 1655 Peachtree Street, N.E., Atlanta, Ga 30309

Type Agreement: Grant No. DE-FG44-81R431094

Award Period: From 5-1-81 To 9-30-82 (Performance) 12-31-82 (Reports)

Sponsor Amount: $15,000 Contracted through:

Cost Sharing: $15,000 (P-94-142) ~~GTRI~~/GIT

Title: Technical Assistance & Energy Conservation Measures; Grant Programs for Schools & Hospitals & Bldgs Owned by Units of Local Government & Public Care Institutions.

ADMINISTRATIVE DATA OCA Contact Don Hasty

1) Sponsor Technical Contact:

2) Sponsor Admin/Contractual Matters:

Ray F. Pettit, Director
Atlanta Support Office
U.S. Department of Energy
1655 Peachtree St. N.E.
Atlanta, Ga 30309

Defense Priority Rating: N/A Security Classification: N/A

RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT.

COMMENTS:

Project has been in effect for some time; initiation paperwork is abbreviated. Reporting and Controls being handled by Physical Plant.

COPIES TO:

~~Administrative Coordinator~~
Research Property Management
Accounting
Procurement/EES Supply Services

Research Security Services
~~Reports Coordinator (OCA)~~
Legal Services (OCA)
Library

EES Public Relations (2)
Computer Input
Project File
Other

FORM OCA 4:781

GEORGIA INSTITUTE OF TECHNOLOGY

OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 4/6/84

Project No. P-81-804

School/XXX Physical Plant

Includes Subproject No.(s)

Project Director(s) C. R. Johnson XXXX / GIT

Sponsor Department of Energy, Region IV

Title Technical Assistance and Energy Conservation Measures: Grant Programs For Schools and Hospitals and Building Owned By Units of Local Government and Public Care Institutions

Effective Completion Date: 9/30/82 (Performance) 12/31/82 (Reports)

Grant/Contract Closeout Actions Remaining:

- [x] None
- [ ] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other

Continues Project No.

Continued by Project No.

COPIES TO:

Project Director (Johnson)
Research Administrative Network
Research Property Management
Accounting
Procurement/EES Supply Services
Research Security Services
Reports Coordinator (OCA)
Legal Services

Library
GTRI
Research Communications (2)
Project File
Other

Form OCA 60:1028

GEORGIA INSTITUTE OF TECHNOLOGY
A Unit of the University System of Georgia
PHYSICAL PLANT DIVISION

915 Atlantic Drive, N.W. – Atlanta, Georgia 30318 **404 – 894–** 4106

DOE Grant #DE-FG44-80R431023 Project Summary

This grant was originally awarded for the conversion of the HVAC system in the Howey Physics Building. When bids for the job came in, the cost was much greater than expected. After discussion with DOE officials, it was decided that we propose substitute ECM's. We proposed and they approved substitute ECM's that involved the design and installation of a computerized Energy Monitoring and Control System, in four of the larger campus buildings, one being the Howey Physics building. These buildings total over a half million square feet, almost 13% of our total campus space.

It is estimated that those four buildings alone use over a half million dollars energy each year. These four buildings receive their heating and and cooling energy, and electricity, from our central campus distribution systems. The buildings are not seperately metered for this usage, except for the electricity. Part of this project was to install steam and chilled water meters. We chose ones that could interface with the computer and have a low turn-down ratio to measure low flow rates.

All four buildings have an inoperative Honeywell Delta 2000 system. We were able to reuse many at the existing wiring and sensors. This, plus the fact that we used in-house labor for both design and installation, helped keep costs below that of a comparable commercial installation.

PERIOD COVERED BY THIS REPORT

From MO	DA	YR	To MO	DA	YR
7	1	82	12	31	82

OMB No. 038-R0456
Expires 10/82
Form No. CS-438
Schedule C

U.S. DEPARTMENT OF ENERGY
Washington, D.C. 20585

No further monies or other benefits may be paid out under this program unless this report is completed and filed as required by P.L. 95-619, Title III. See Item F on Instruction Sheet for Provisions Regarding Confidentiality of Information.

ENERGY CONSERVATION MEASURE (ECM) PROGRESS REPORT

1. Federal Grant Identification No.
   DE-FG44-80R430123

2. Program/Project Title
   Title III, Energy Conservation Program For Schools and Hospitals

3. Name and Address of Grantee
   Georgia Institute of Technology, PPD, 915 Atlantic Drive N.W., Atlanta Georgia 30318

4. Building Name or Number	5. Check the box below which best describes the status of the ECM(s) for each building listed in item 4. completed	on schedule per Grant Application	not on schedule per Grant Application
#2 Skiles	X		
#77 Gilbert Library	X		
#81 Physics			X
#100 Graduate Library	X		

6. Unexpended Federal funds for completed T.A.'s checked in item 5. $ NONE

7. For each building not on schedule, complete Energy Conservation Measure Variance Report, Form No. CS 438-D.

8. Signature of Grantee Project Director and date

ERIOD COVERED BY THIS REPORT

rom						To					
IO		DA		YR		MO		DA		YR	
7			1	8	2	1	2	3	1	8	2

OMB No. 038-R0456
Expires 10/82
Form No. CS-438
Schedule D

U.S. DEPARTMENT OF ENERGY
Washington, D.C. 20585

HIS REPORT IS MANDATORY:
o further monies or other benefits may be paid out under this program unless this report is ompleted and filed as required by P.L. 95-619, Title III. See Item F on Instruction Sheet or Provisions Regarding Confidentiality of Information.

ENERGY CONSERVATION MEASURE VARIANCE REPORT

. Federal Grant Identification No.	DE-FG44-80R430123	
. Program/Project Title	Title III, Energy Conservation Program For Schools and Hospitals	
. Name and Address of Grantee	Georgia Institute of Technology 915 Atlantic Drive, N.W. Atlanta, Georgia 30318	
. Building Name or Number	#81 Howey Physics	
. What is the estimated delay in the completion date provided on the Grant Application?	Four months	
a. What caused the delay?	Large workload on in-house technicians performing installation	
o. What corrective action do you plan to take?	Materials have been purchased, design completed, and installation has begun, only delayed.	
	Federal	non-Federal
a. What is the accrued cost to date?	$20,000	$ 4,985.57
o. What is the estimated cost to complete the project?	-	$18,941.95
c. Add items 7a and 7b	$20,000	$23,927.52
l. Total funds authorized (DOE USE ONLY)		

. Signature of Grantee Project Director and date

1/31/83

OMB No. 038-R0456
Expires 10/82

FOR ENERGY CONSERVATION MEASURE GRANTS

FORM NO. CS-438
SCHEDULE E

U.S. Department of Energy

FINANCIAL STATUS REPORT (Follow instructions on the back)	1. Federal and State agencies to which report is submitted: Ga. Office Of Energy Res.	2. FEDERAL GRANT OR OTHER IDENTIFYING NUMBER: DE-FG44-80R430123	OMB APPROVED No.	PAGE 1 OF 1 PAGES
3. RECIPIENT ORGANIZATION (Name and complete address, including ZIP code): Ga. Institute of Technology, 915 Atlantic Drive, N.W., Atlanta, Georgia 30318	4. EMPLOYER IDENTIFICATION NUMBER: 58-6002023		6. FINAL REPORT: XX YES ☐ NO	7. BASIS: XX CASH ☐ ACCRUAL
	8. PROJECT/GRANT PERIOD (See instructions) FROM (Month, day, year) 2/1/80 TO (Month, day, year) 12/31/82	9. PERIOD COVERED BY THIS REPORT FROM (Month, day, year) 7/1/82 TO (Month, day, year) 12/31/82		

10. PROGRAMS/FUNCTIONS/ACTIVITIES ▶	Contractor Costs (a) OVERHEAD AND LABOR	(b) MATERIALS	In-House Costs (c) LABOR AND FRINGE BENEFITS	(d) MATERIALS	(e) OTHER ALLOWABLE COSTS		(g) TOTAL
a. Net outlays previously reported	$ --	$ --	$ 6,971.01	$ 55,233.61	$ --		$ 62,204.62
b. Total outlays this report period	--	--	13,293.04	42,770.96	--		56,064.00
c. Less Program income credits							
d. Net outlays this report period (Line b minus line c)							
e. Net outlays to date (Line a plus line b)	--	--	20,264.05	98,004.57	--		118,268.62
f. Less Non Federal share of outlays	--	--	20,264.05	37,254.57	--		57,518.62
g. Total Federal share of outlays (Line e minus line f)	--	--	zero	60,750.00			60,750.00
h. Total unliquidated obligations							
i. Less Non Federal share of unliquidated obligations shown on line h							
j. Federal share of unliquidated obligations							
k. Total Federal share of outlays and unliquidated obligations							
l. Total cumulative amount of Federal funds authorized							
m. Unobligated balance of Federal funds	--	--	None	None	--		None

11. INDIRECT EXPENSE	a. TYPE OF RATE (place an "X" in appropriate box)	provisional ( ) final ( )	predetermined ( ) fixed ( )	
	b. RATE	c. BASE	d. TOTAL	e. FEDERAL SHARE

12. REMARKS Attach any explanation deemed necessary or information required by Federal sponsoring agency in compliance with governing legislation

13. CERTIFICATION I certify to the best of my knowledge and belief that this report is correct and complete and that all outlays and unliquidated obligations are for the purposes set forth in the award documents

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL

DATE REPORT SUBMITTED 1/31/83

TYPED OR PRINTED NAME AND TITLE Utilities Jim Frazier, Engineer

TELEPHONE (Area code, number and extension) (404)894-4106

THIS REPORT IS MANDATORY: No further monies or other benefits may be paid out under this program unless this report is completed and filed as required by P.L. 95-619, Title III. See Item F on Instruction Sheet for Provisions Regarding Confidentiality of Information.

This Report is due 90 days following completion of an ECM project. The entire Report will be submitted to the Georgia Office of Energy Resources.

Grantee: Georgia Institute of Technology, PPD
915 Atlantic Drive, N.W.
Atlanta, Georgia 30318

Building Name: Skiles, Physics, Gilbert & Graduate Library

Description of Each Measure	Cost of Measure	$ Energy Savings	Original Payback Period	Estimated Payback Period Based On Actual Cost
Skiles Installation of computerized EMCS	$ 31,980.56	$37,687.73	2.09 YR	0.85 YR
Physics Installation of computerized EMCS	$ 43,927.52	$39,957.11	3.27 YR	1.10 YR
Gilbert Library Installation of computerized EMCS	$ 25,302.89	$26,507.99	3.29 YR	0.95 YR
Graduate Library Installation of computerized EMCS	$ 35,999.60	$37,989.59	3.27 YR	0.95 YR
NOTE: See seperate sheet for description				
TOTALS	$137,210.57	$142,137.40	2.95 YR	0.97 YR
	Total Cost	Total $ Savings	Average Original Payback Period	Average Estimated Payback Based On Actual Cost

GRANT #DE-FG44-80R430123

TO WHOM IT MAY CONCERN:

All energy conservation measures implemented conform

to Ga. Institute of Technology, PPD Energy Conservation
(Grantee's Name)

Grant Application awarded on February 1, 1980.
(see Notice of Grant Award for date)

(Grantee's Director or Superintendent)

2-25-83
Date

Georgia Institute of Technology
Atlanta, Georgia 30332

Associate Vice President (Finance)

February 8, 1983

Mr. Walter C. Butler, Jr.
Acting Director
Atlanta Support Office
Department of Energy
Savannah River Operations Office
1655 Peachtree Street, N.E.
Atlanta, Georgia 30318

Subject: Grant Close-out
(1) DE-FG44-81R431094
(2) DE-FG44-80R430123

Dear Mr. Butler:

Reference is made to item one of your request for items needed to close-out the subject grants.

The Defense Contract Audit Agency (DCAA) is Georgia Tech's cognizant audit agency. It is their practice to perform a direct cost audit and an indirect cost audit annually at Georgia Tech. Their audit reports are available to all federal agencies having contracts and grants at Georgia Tech. If you have not received copies of the audit reports needed, I suggest you contact Mr. Joe Allen - Supervisory Auditor or Mr. John Gray, Auditor at telephone number 881-4428. If you prefer to write, their address is:

Defense Contract Audit Agency
Atlanta Region
Atlanta Branch
1459 Peachtree Street - Suite 200
Atlanta, Georgia 30309

If I can be of further assistance in this matter, please let me know.

Sincerely,

David V. Welch, Manager
Grants and Contracts Accounting

DVW/dld

P-81-804

GEORGIA INSTITUTE OF TECHNOLOGY
A Unit of the University System of Georgia
PHYSICAL PLANT DIVISION

915 Atlantic Drive, N.W. — Atlanta, Georgia 30318 404 — 894—

February 18, 1983

Mr. Paul Burkes
Ga. OER
270 Washington St.
Room 015
Atlanta, Georgia 30334

Dear Mr. Burkes,

Enclosed please find all documentation required for both year-end reporting and final project close-out of both Ga. Tech's DOE Grants. This includes Form 438 Schedule C, D, & E, Form SH-2, Certificate of Compliance, Project Summary Sheets, and information related to the Audit Reports. Barbara Till at DOE's Atlanta Office (881-2523) has spoken with DCAA (see letter attached) and informs me that the information they provide will fulfill the requirements of the Financial Audit and Compliance Report.

Note that all jobs except the EMCS installation in the Howey Physics building are complete. Most materials have been purchased for this job, but since all labor is in-house this job has had several delays.

Since these buildings were not individually metered for utilities in the past, we do not have accurate figures on enery usage and savings. Calculated savings are based on conclusions of a study of a similar EMCS installation in another of our campus buildings (See report attached). The payback times were better than originally expected for two reasons - first, percentage savings were greater than expected, and second, these savings are based on utility costs of a later date than those originally used.

If any more information or documentation is needed for this grant reporting and close-out, please contact me at (404) 894-4106.

Yours truly,

Jim Frazier
Utilities Engineer

JF/tk

EDGE BUILDING ENERGY ANALYSIS

February 1983

Georgia Institute of Technology
Physical Plant Division

Stephen L. Peet
Utilities Engineer

OUTLINE

INTRODUCTION

Edge (Athletic Association) Building Energy Analysis

An energy study was conducted on the new Edge (Athletic Association) Building during the months of December 1982 and January 1983. The study's purpose was to determine the effect of the Georgia Tech Facilities Management System (FMS) on the building's energy consumption. The building was operated in both manual mode, using conventional controls, and automatic (FMS) mode, using direct digital controls; while data was collected for analysis. A preliminary analysis of the data showed a distinct pattern of energy use relating to temperature and the type of day being a weekday or a weekend. Further economic analysis showed over a thirty-one percent reduction in total energy costs when the building is operated in automatic mode versus the manual mode of operation. This report does not cover the benefits of a central reporting fire detection system, or the benefits to the preventative maintenance program that FMS data provides.

COMPARISON OF OPERATIONAL MODES

This building was constructed with conventional electric/ pneumatic "manual" controls and direct digital (FMS) "automatic" controls. The systems were installed using a controls interception method which allows a direct digital process control system to co-exist with a conventional electrical/pnuematic control system. This methodology allows for the installation of advanced direct digital controls, without disrupting the existing control system. Also, the existing controls are used for a 100% backup of the automatic controls. Data can be collected through the Computerized Facilities Management System in either mode of operation. During the test, such data was collected.

There are two types of air handling equipment used in the Edge building: multizone units (MZU), and single zone units (AHU). The control strategy for conventional controls, manual mode, is to modulate the supply air temperature to the space based on a thermostat. The AHU's modulate the cooling and heating coil valves, based on a return air thermostat, to maintain a constant return air temperature. The MZU's position a space damper to supply the correct mixture of hot or cold air based on a room thermostat. The hot and cold supply air or "deck" temperatures are controlled by maintenance personnel daily changing the pneumatic valves that control the heating or cooling coils. Both types of units use a manual control for the outside air damper. The equipment runs twenty-four hours a day in manual mode.

The control strategy for automatic mode uses a direct digital feedback control system to operate the air handling units. The coil valves in both types of units are modulated based on room temperature sensors and the amount of deviation from a predetermined set point temperature. In the MZU's, the space damper is positioned to supply the correct mixture of hot and cold air, but the "deck" temperatures are modulated to supply the zone with the most need, with all hot or cold supply air. The outside air dampers are opened proportionally with the heating or cooling need, or with an enthalpy calculation, the ratio of outside air to return air that will require the minimum amount of energy to heat or cool. The set point temperature is determined by the time of day, using setback or set up set point temperatures during unoccupied periods, and by the outside air temperature. The units are on a time schedule, running only during occupied periods, except to keep a minimum or maximum space temperature during unoccupied periods.

Energy expenditures are reduced and room temperatures will vary less when the air handling units are operated automatically. The automatic operation saves energy by modulating deck temperatures on the MZU's dynamically, using outside air for heating or cooling when appropriate, and by changing the set point temperature during unoccupied periods. Also, energy is saved by not running the units when the area is not occupied. The energy savings includes a reduction of electrical, steam, and chilled water consumption.

PRELIMINARY DATA ANALYSIS

All data was collected and tabulated. All energy types were recalculated in million BTU's. Each energy source and totals were plotted against average daily temperature for trend analysis. Trend analysis was done using linear regression or method-of-least-squares, a best straight line fit. The data was then broken into two catagories, weekdays and weekends. This was further broken down by energy type, electric and steam. Since the data was collected during a non-cooling season and cooling season data is unavailable; the cooling season was calculated by using the same energy slope per degree, and zero energy at fifty degrees fahrenheit. This temperature was used since observation of the building in operation showed some areas using no heat starting around and above fifty degrees.

In all catagories, the deviation from the calculated straight line was less than fifteen percent. The cost of energy for each energy type is directly proportion to the amount used, therefore cost versus temperature was used. Cost of energy information was taken as average of 1982 cost of energy supplied by the Georgia Tech Physical Plant Engineering Department (see references). All temperature and degree day information was taken from NOAA information (see reference). A computer program was written to evaluate the data.

ANALYSIS OF DATA

1. General

Three sets of data and seven methods, including degree days and average daily temperatures, were used to evaluate the annual energy cost. The annual cost of both modes of operation, automatic and manual, were calculated. All data and methods were included in a computer program to do the analysis. Although there are differences in the methods, all the results were similiar.

After the data was catagorized by type of day and energy, linear regression was done to determine the equation for heating dollars per degree (temperature) and degree day. Then, the cooling dollars equation was calculted using the method described in the preliminary data analysis. A heating/cooling crossover temperature was calculated at the temperature where heating and cooling energy expenditures were equal. The daily cost of energy was calculated using the following constraints: is the day a weekday, weekend or holiday (the same as a weekend); is the date during the heating only season, October 15 through April 15; is the temperature above, below, or equal to 65 degrees (degree days) or the heating/cooling crossover temperature (daily average temperature). The annual cost was calculated by summing the daily temperatures, or calculating directly from heating and cooling degree days per year.

2. Atlanta Weather Data

Seven methods of evaluation were used using three sets of Atlanta weather data: a normal temperature year (A.) is a thirty year average of daily average temperatures; sample year (B.) the daily average temperatures for July 1981 through June 1982; daily heating and cooling degree days (C.) for a normal temperature year; daily heating and cooling degree days (D.) for a sample year; annual heating and cooling degree days (E.) for a normal temperature year; annual heating and cooling degree days (F.) for a sample year; annual heating and cooling degree days (G.) from reference 1. A daily average temperature is the average of the high and low temperatures for a given day. The number of heating degree days is the difference between 65 degrees and an average temperature below 65 degrees. The number of cooling degree days is the difference between 65 degrees and an average temperature above 65 degrees.

3. Normal and Average Daily Temperatures

Traditionally, annual degree days are used to estimate annual energy consumption or costs. Three methods of analysis, E, F, and G, calculate the energy cost in this manner. Methods A and B use the daily normal and the daily average temperatures to calculate daily, and then annual energy costs. By using a daily calculation, the energy costs can be estimated more accurately by taking into account the type of day, the season, and "null" or zero degree days.

This method uses the daily temperature as a base for the energy calculation. The daily temperature is compared to the heating/cooling crossover temperature. During the heating only season (central plant chilled water not available) of October 15 through April 15, if the temperature is above the crossover temperature; the electric cost is evaluated at the crossover temperature, and the heating cost is calculated from the heating equation (always positive or zero). During the heating only the season, when the temperature is below the crossover temperature, both heating and electric costs are calculated from their respective equations. During the heating/cooling season the heating or cooling equations are used depending on whether the temperature is below or above the crossover temperature. Electric energy cost remains constant above the crossover temperature.

Appendix two has all the output from the computer program. In the sections "Automatic" and "Manual operation - using average temperatures", all results for A and B are listed, including the energy formulae coefficients. The comparative results are listed on the last page of appendix two.

4. Daily Degree Days

Methods C and D are similiar to A and B except the calculations and equations are based on daily degree days. During the heating season, cooling degree days are considered as zero degree days. The heating equations for steam and electric are evaluated at zero or positive heating degree days. During the heating/cooling season, the heating or cooling equations are used as applicable. The. electric cost for cooling is evaluated as a zero heating degree day. In appendix two, sections "Automatic" and "Manual operation - using degree days", is the results of C and D.

5. Annual Degree Days

The number of annual heating and cooling degree days (E.) is for a daily normal temperature year. The number of annual heating and cooling degree days (F.) is for a sample year daily average tempera-ture. The number of annual heating and cooling degree days (G.) is from reference one. In all three cases, the weekday energy equation is used. The electric cost is determined by multiplying the y-intercept by 365 days (the base) and by multiplying the slope by the number of heating degree days. The heating cost was determined by multiplying the y-intercept by the percent of heating degree days to total degree days (the base) and the slope by the number of heating degree days. The cooling cost was determined by multiplying the y-intercept by the percent of cooling degree days to the total degree days (the base) and the slope by the number of cooling degree days. The results of E, F, and G are in appendix two, sections "Automatic" and "Manual - using degree days".

6. Results

The summary of results are in the last section of appendix two. In all methods of analysis, operation of the building by the Facilities Management System costs less per year than operation of the building by conventional controls. There is a savings by each type of utility ranging from a fourteen percent savings for heating, to over thirty-six percent savings for electricity. The average savings on total utilities cost per year is $24,066 for all methods of analysis. The Facilities Management System is more than a thirty-one percent (31%) savings over the conventional controlling system.

CONCLUSIONS

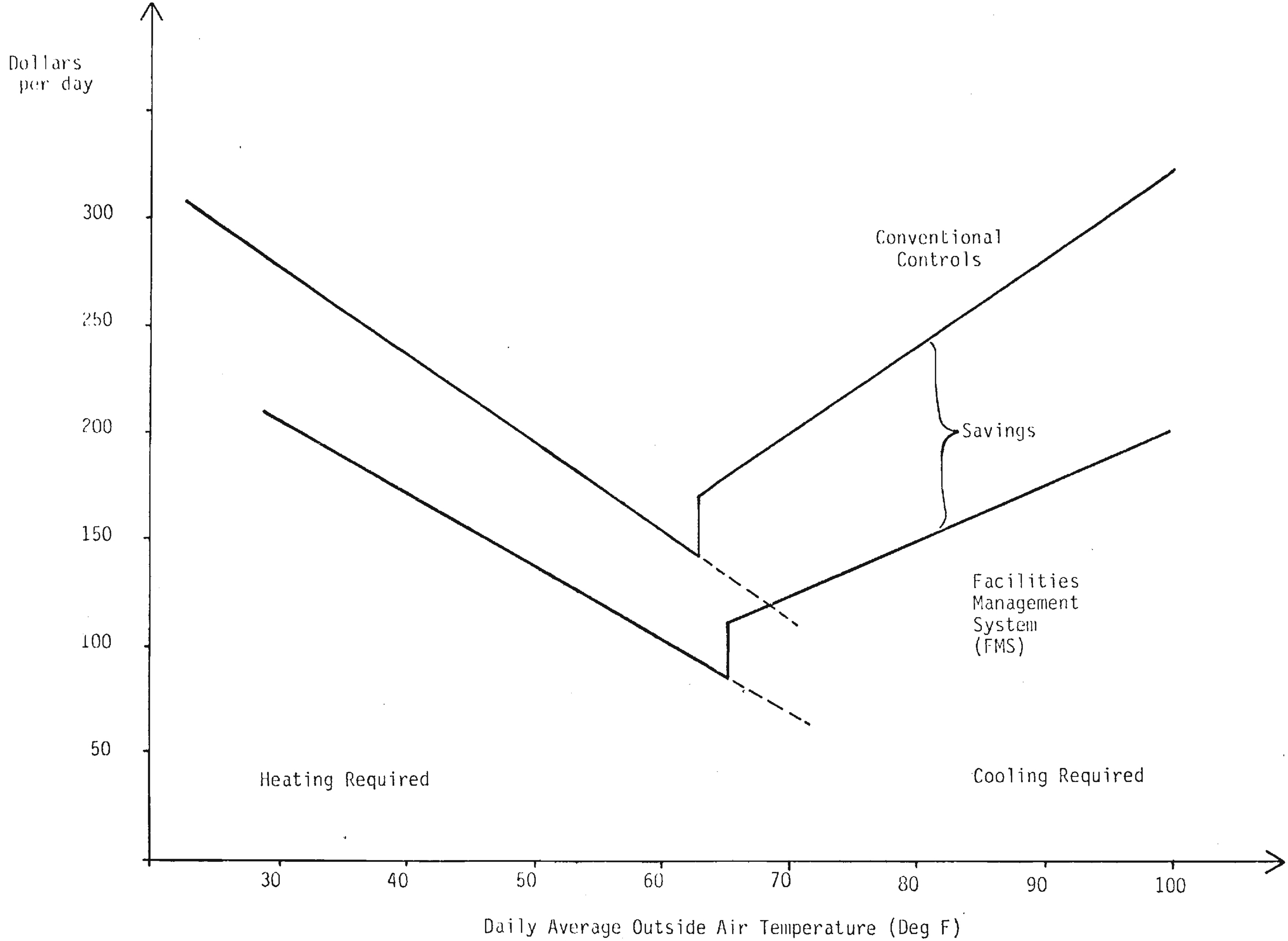
An energy study was conducted on the new Edge (Athletic Association) Building to determine the effect of the Facilities Management System on the building's energy consumption. Using several different methods of analysis, the results were the same. The direct digital control system saves $24,000 per year of the total utility expenditures. This results in the Facilities Management System saving thirty-one percent (31%) over the conventional controlling system. This does not include the financial impact of a central reporting fire detection system or preventative maintenance infomation made available by the facilities management system.

REFERENCES

1. National Oceanic and Atmospheric Administration (NOAA),"COMPARITIVE CLIMATIC DATA for the United States Through 1980",Environmental Data and Information Service, National Climatic Center, Asheville, NC, May 1981.

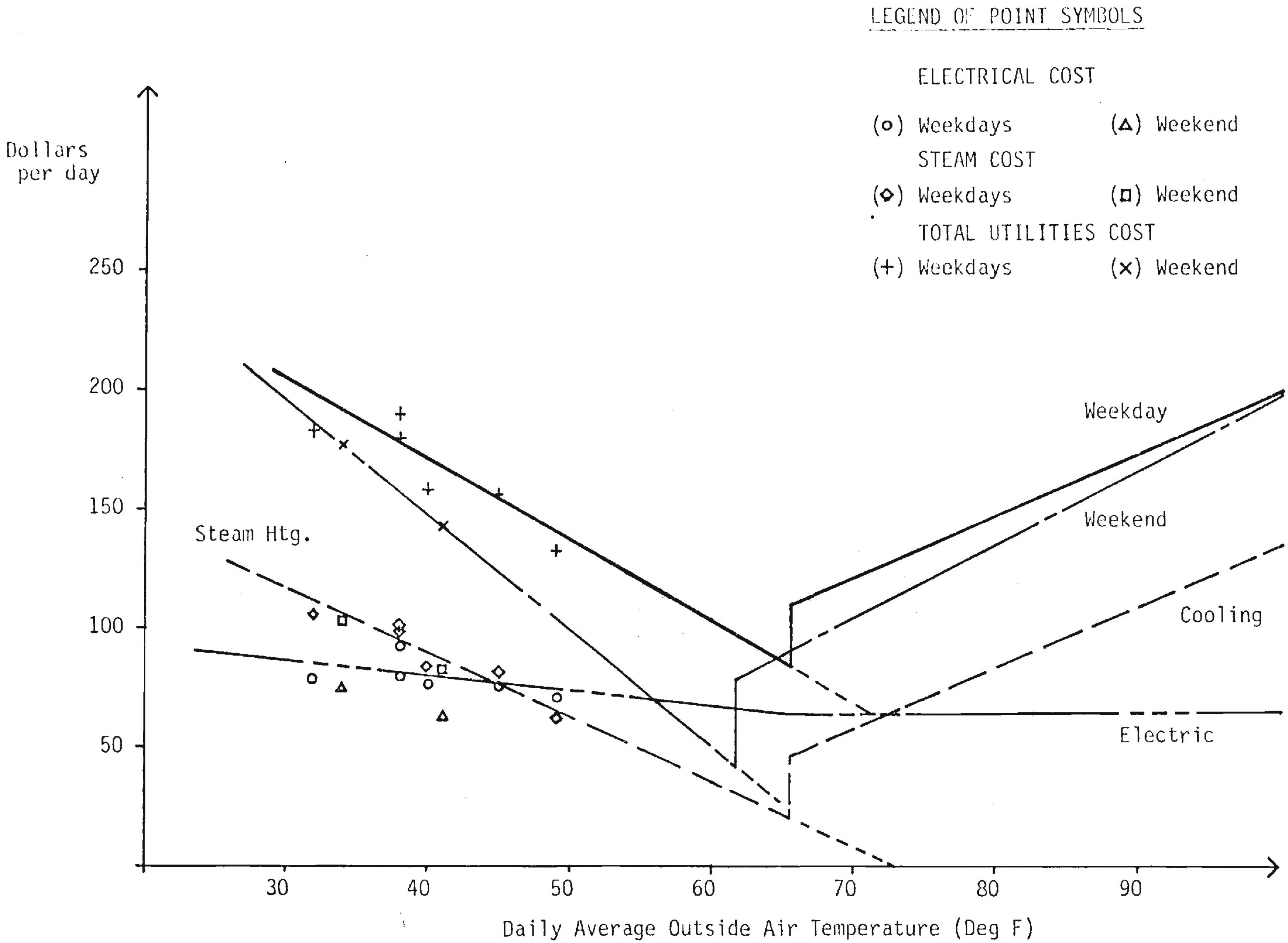
2. NOAA, "LOCAL CLIMATOLOGICAL DATA - Monthly summary, Atlanta, Georgia", Environmental Data and Information Service, National Climatic Center, Ashevill, NC, July 1981 - June 1982.

3. Frazier, Jim, Utilities Engineer, Physical Plant Division, Georgia Institute of Technology.

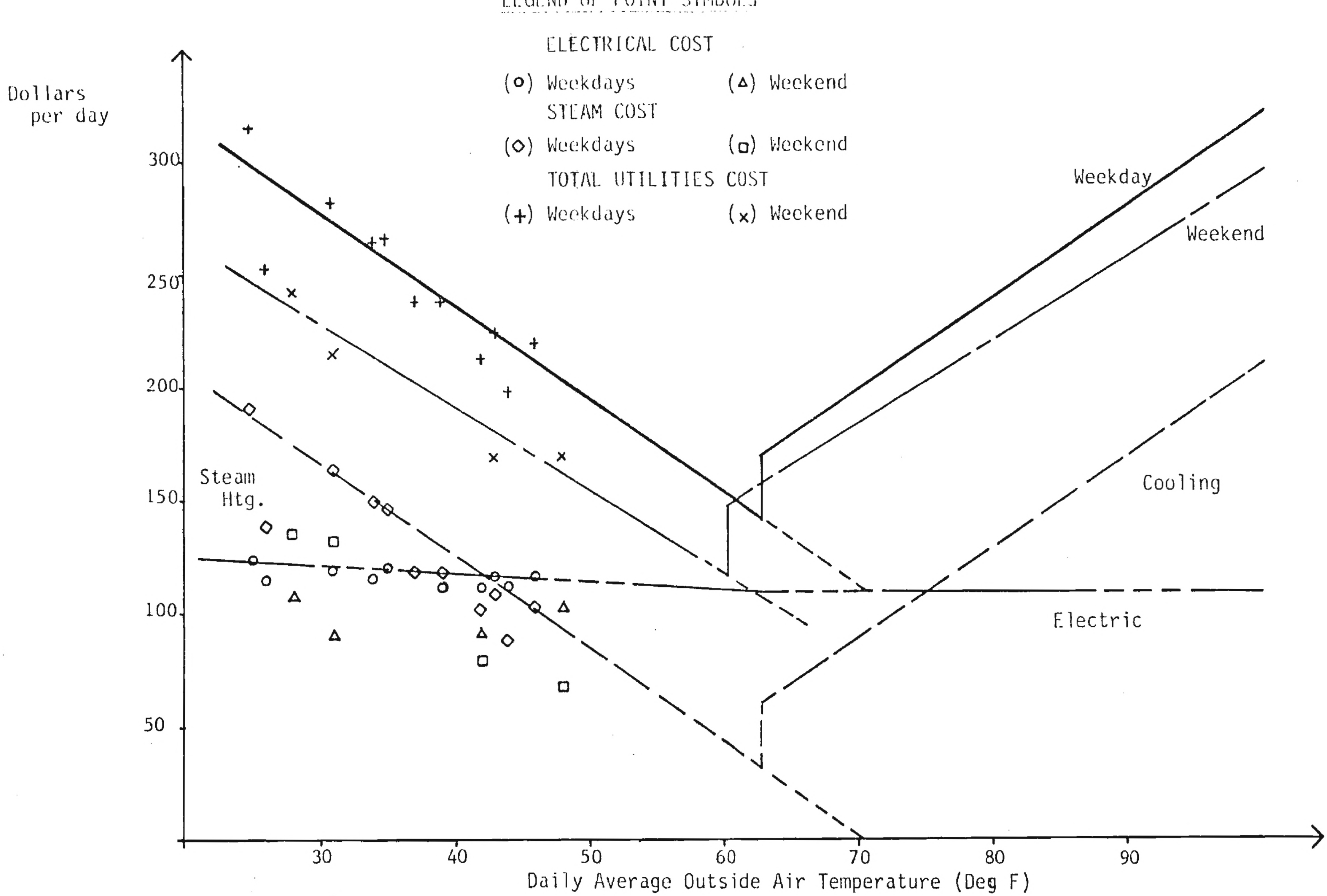


Edge Building Total Utilities Cost Comparison

Appendix 1 - A

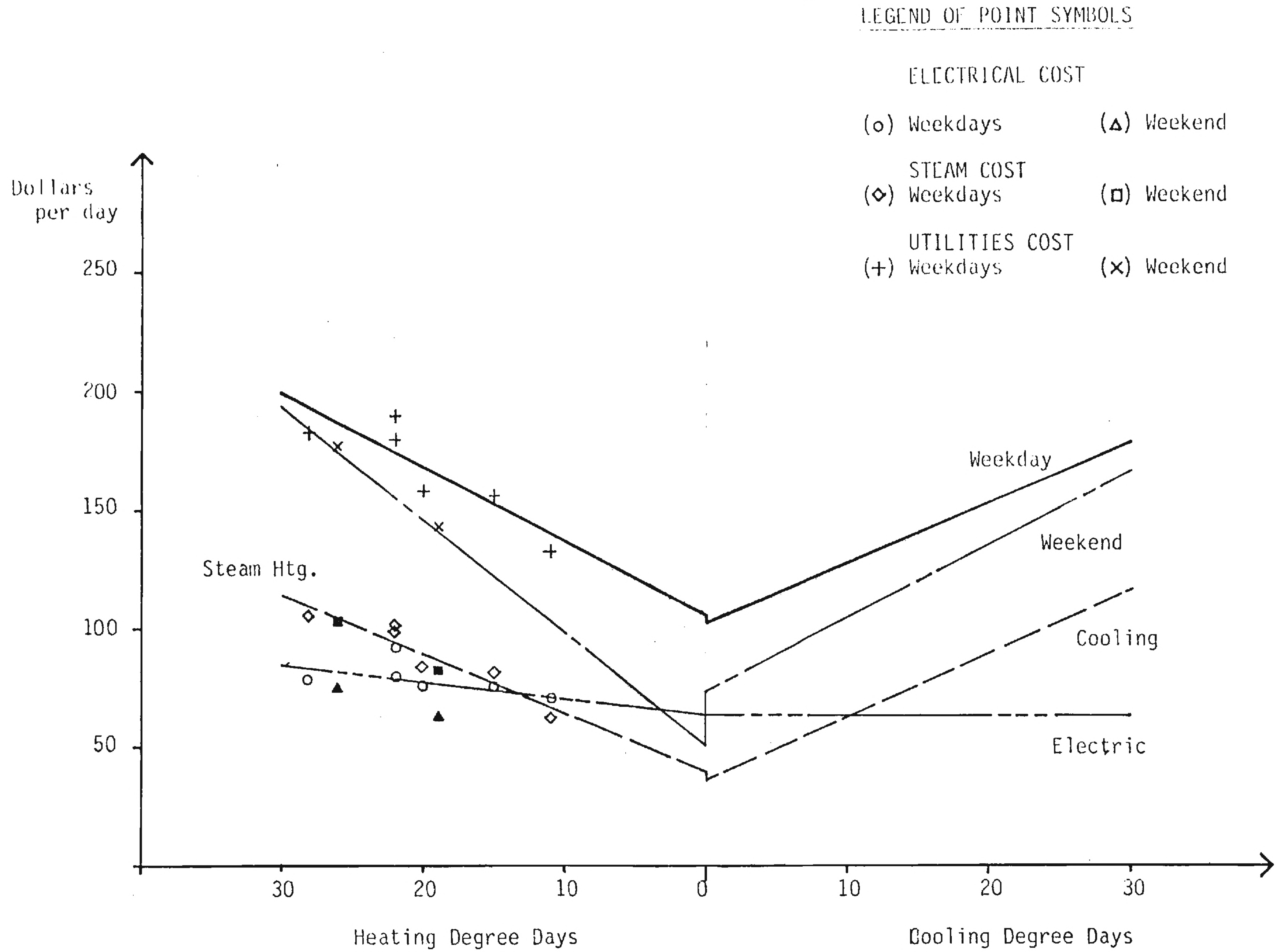


Edge Building Utilities Cost
Facilities Management System (FMS)



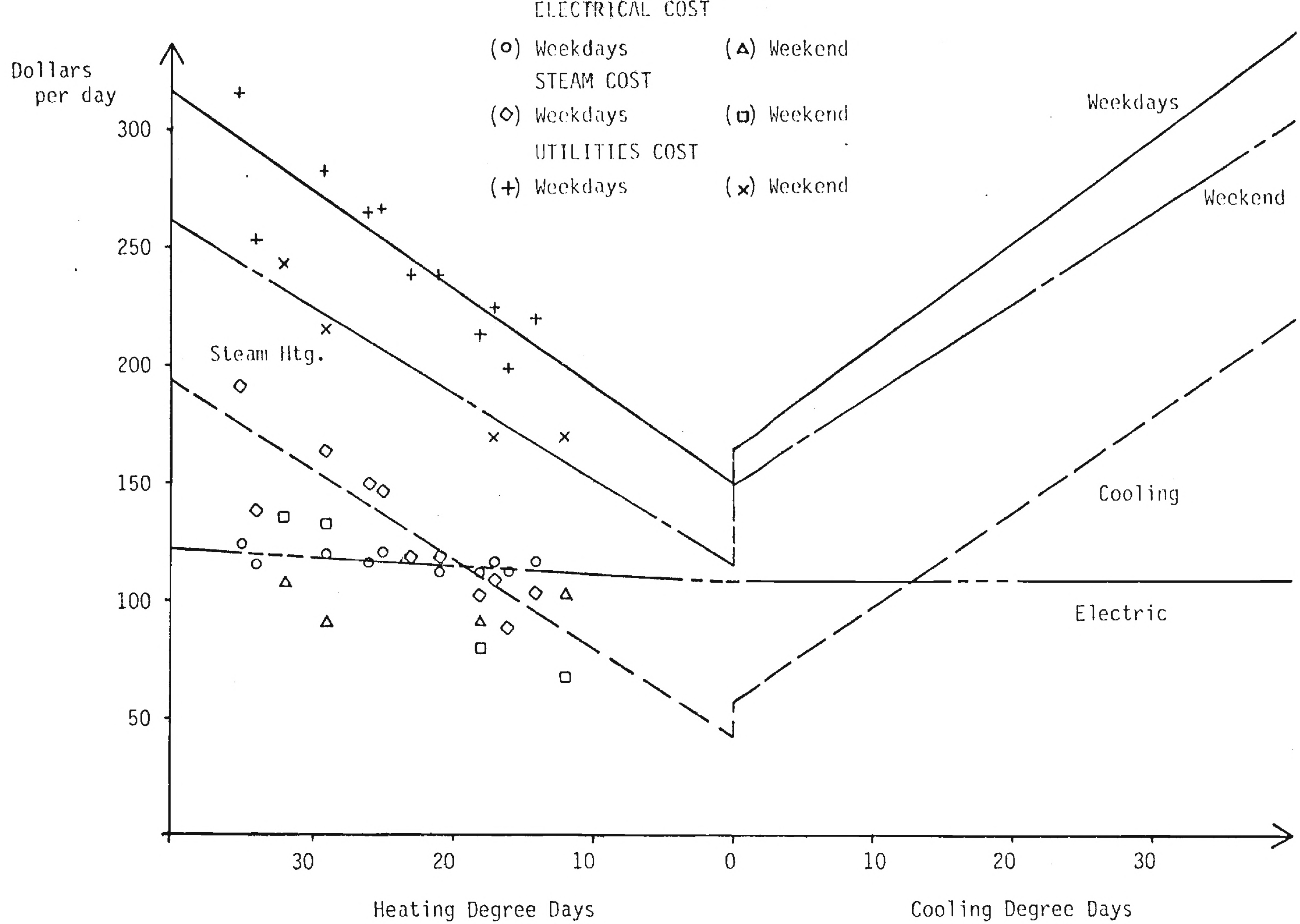
Edge Building Utilities Cost
Conventional Controls

Appendix 1 - C



Edge Building Utilities Cost
Facilities Management System (FMS)

Appendix 1 - D



Edge Building Utilities Cost
Conventional Controls

Appendix 1 - E

DATA BASE - COLLECTED FROM BUILDING OPERATION

date	Bin Deg	Degree Days	Electric KWH	Steam 1000 #	Elec E6 Btu	Steam E6 Btu	Total E6 Btu	Elec Dollars	Steam Dollars	TOTAL Dollars
121782	43	22	2200.0	15830.0	7.51	14.77	22.28	90.61	98.4[illegible]	189.04
121882	37	28	1900.0	16650.0	6.48	15.53	22.02	78.25	103.5[illegible]	181.78
121982	39	26	1800.0	16420.0	6.14	15.31	21.46	74.13	102.1[illegible]	176.23
122082	46	19	1500.0	13060.0	5.12	12.18	17.30	61.78	81.2[illegible]	142.99
122182	45	20	1800.0	13270.0	6.14	12.38	18.52	74.13	82.5[illegible]	156.65
122282	43	22	1900.0	16180.0	6.48	15.09	21.58	78.25	100.6[illegible]	178.86
122382	50	15	1800.0	13030.0	6.14	12.16	18.30	74.13	81.0[illegible]	155.16
122482	54	11	1700.0	10040.0	5.80	9.36	15.16	70.02	62.4[illegible]	132.44
10583	39	26	2800.0	24010.0	9.56	22.41	31.97	115.32	149.2[illegible]	264.61
10683	44	21	2700.0	20460.0	9.22	19.09	28.30	111.20	127.2[illegible]	238.42
10783	48	17	2800.0	17420.0	9.56	16.25	25.81	115.32	108.3[illegible]	223.64
10883	49	16	2700.0	14020.0	9.22	13.07	22.29	111.20	87.1[illegible]	198.38
10983	53	12	2500.0	10650.0	8.53	9.93	18.46	102.96	66.2[illegible]	169.19
11083	47	[illegible]		12630.0	7.51	11.78	19.29	90.61	78.5[illegible]	169.14
[illegible]				16290.0	9.22	15.20	24.41	111.20	101.2[illegible]	212.49
				19000.0	9.90	17.72	27.62	119.44	118.1[illegible]	237.58
				22170.0	9.56	20.69	30.25	115.32	137.8[illegible]	253.17
				23550.0	9.90	21.97	31.87	119.44	146.4[illegible]	265.87
				6600.0	9.56	15.48	25.03	115.32	103.2[illegible]	218.54
				[illegible]1770.0	8.87	20.31	29.18	107.08	135.3[illegible]	242.45
				9940.0	7.51	18.60	26.11	90.61	123.9[illegible]	214.60
				6190.0	9.90	24.44	34.33	119.44	162.8[illegible]	282.29
				[illegible]0750.0	10.24	28.71	38.95	123.56	191.2[illegible]	314.76

APPENDIX TWO - section 1

A normal (from NOAA) temperature year

temp	$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
.9	22837.93	14823.23	11994.81	49655.91

July 1981 - June 1982 **** Sample year ****

temp	$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
.6	23277.63	15331.55	12489.62	51098.71

heating above 81.2 degrees (on weekends)
heating above 73.2 degrees (on weekdays)
nimum energy @ 65.6 degrees (on weekdays)
nimum energy @ 61.6 degrees (on weekends)

uation Coefficients - Electric Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
-0.67	107.75	0.00	64.07

uation Coefficients - Electric Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
-1.77	142.98	0.00	34.24

uation Coefficients - Steam Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
-2.46	199.43	2.58	-122.80

uation Coefficients - Steam Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
-2.98	218.50	3.14	-149.23

A normal (from NOAA) temperature year

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
22508.30	15021.84	10262.04	47792.20

degree days	cooling degree days	null degree days
2976.0	1468.0	8.0

July 1981 - June 1982 **** Sample year ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
22940.12	15603.96	10920.72	49464.88

degree days	cooling degree days	null degree days
3108.0	1853.0	3.0

uation Coefficients - Electric Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
0.67	64.47	0.00	64.47

uation Coefficients - Electric Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
1.77	28.24	0.00	28.24

uation Coefficients - Steam Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
2.46	39.79	2.58	36.84

uation Coefficients - Steam Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
2.98	24.50	3.14	44.77

culating energy cost using the number of degree days times
the weekday energy use lines

degree days	cooling degree days	null degree days
2976.0	1468.0	

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
25514.00	17034.25	8231.30	50779.56

degree days	cooling degree days	null degree days
3108.0	1853.0	

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
25601.89	16731.36	9805.76	52139.01

degree days	cooling degree days	null degree days
3095.0	1589.0	

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
25593.24	17197.17	8663.41	51453.82

A normal (from NOAA) temperature year

temp	$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
.9	38861.98	17314.70	18008.45	74184.94

July 1981 - June 1982 **** Sample year ****

temp	$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
.6	38940.32	18197.71	18199.44	75337.25

heating above 75.8 degrees (on weekends)
heating above 70.4 degrees (on weekdays)
nimum energy @ 62.9 degrees (on weekdays)
nimum energy @ 60.2 degrees (on weekends)

uation Coefficients - Electric Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
-0.37	131.30	0.00	108.24

uation Coefficients - Electric Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
-0.07	100.96	0.00	96.48

uation Coefficients - Steam Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
-3.80	288.29	4.00	-190.17

uation Coefficients - Steam Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
-3.59	252.52	3.77	-179.28

A normal (from NOAA) temperature year

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
38725.71	18107.64	14686.34	71519.75

degree days	cooling degree days	null degree days
2976.0	1468.0	8.0

July 1981 - June 1982 **** Sample year ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
38766.61	18708.61	15687.19	73162.56

degree days	cooling degree days	null degree days
3108.0	1853.0	3.0

uation Coefficients - Electric Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
0.37	107.47	0.00	107.47

uation Coefficients - Electric Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
0.07	96.12	0.00	96.12

uation Coefficients - Steam Use Cost Wkday

HEATING		COOLING	
ope	y-int	slope	y-int
3.80	41.07	4.00	57.05

uation Coefficients - Steam Use Cost Wkend

HEATING		COOLING	
ope	y-int	slope	y-int
3.59	19.45	3.77	53.79

culating energy cost using the number of degree days times
the weekday energy use lines

degree days	cooling degree days	null degree days
2976.0	1468.0	

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
40318.64	21356.49	12747.26	74422.38

degree days	cooling degree days	null degree days
3108.0	1853.0	

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
40367.02	21211.32	15185.51	76763.88

degree days	cooling degree days	null degree days
3095.0	1589.0	

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
40362.25	21675.60	13416.44	75454.31

**** A Normal temperature year - daily average temperatures ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
22837.93	14823.23	11994.81	49655.91 yearly $ for F.M.S.
38861.98	17314.70	18008.45	74184.94 yearly $ for manual
16024.05	2491.47	6013.64	24529.03 $ saved (man. vs. FMS)
41.23	14.39	33.39	33.06 % savings (over manual)

**** Sample Year - daily average temperatures ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
23277.63	15331.55	12489.62	51098.71 yearly $ for F.M.S.
38940.32	18197.71	18199.44	75337.25 yearly $ for manual
15662.69	2866.16	5709.82	24238.54 $ saved (man. vs. FMS)
40.22	15.75	31.37	32.17 % savings (over manual)

**** A Normal Temperature Year - daily degree days ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
22508.30	15021.84	10262.04	47792.20 yearly $ for F.M.S.
38725.71	18107.64	14686.34	71519.75 yearly $ for manual
16217.41	3085.80	4424.30	23727.55 $ saved (man. vs. FMS)
41.88	17.04	30.13	33.18 % savings (over manual)

**** Sample Year - daily degree days ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
22940.12	15603.96	10920.72	49464.88 yearly $ for F.M.S.
38766.61	18708.61	15687.19	73162.56 yearly $ for manual
15826.49	3104.65	4766.47	23697.68 $ saved (man. vs. FMS)
40.83	16.59	30.38	32.39 % savings (over manual)

**** A Normal Temperature Year - annual degree days ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
25514.00	15603.96	10920.72	50779.56 yearly $ for F.M.S.
40318.64	18708.61	15687.19	74422.38 yearly $ for manual
14804.64	3104.65	4766.47	23642.82 $ saved (man. vs. FMS)
36.72	16.59	30.38	31.77 % savings (over manual)

**** Sample Year - annual degree days ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
25601.89	15603.96	10920.72	52139.01 yearly $ for F.M.S.
40367.02	18708.61	15687.19	76763.88 yearly $ for manual
14765.13	3104.65	4766.47	24624.86 $ saved (man. vs. FMS)
36.58	16.59	30.38	32.08 % savings (over manual)

**** NOAA (reference 1) - annual degree days ****

$ELEC	$ STEAM (htg)	$ STEAM (cool)	TOTAL dollars energy cost
25593.24	15603.96	10920.72	51453.82 yearly $ for F.M.S.
40362.25	18708.61	15687.19	75454.31 yearly $ for manual
14769.01	3104.65	4766.47	24000.49 $ saved (man. vs. FMS)
36.59	16.59	30.38	31.81 % savings (over manual)

**** Sample of daily output ****   APPENDIX THREE

date	temp	$elec	$heating	$cooling	total $	$yearly sum
** normal temperature year **						
1001	68.0	64.07	0.00	52.73	116.81	12364.76
1002	68.0	64.07	0.00	52.73	116.81	12481.57
1003	67.0	34.24	0.00	60.95	95.19	12576.75
1004	67.0	34.24	0.00	60.95	95.19	12671.94
1005	66.0	64.07	0.00	47.57	111.65	12783.59
1006	66.0	64.07	0.00	47.57	111.65	12895.23
1007	66.0	64.07	0.00	47.57	111.65	13006.88
1008	65.0	64.47	39.79	0.00	104.26	13111.14
1009	65.0	64.47	39.79	0.00	104.26	13215.40
1010	65.0	34.24	0.00	54.67	88.91	13304.31
1011	64.0	34.24	0.00	51.54	85.77	13390.08
1012	64.0	65.14	42.24	0.00	107.38	13497.46
1013	64.0	65.14	42.24	0.00	107.38	13604.85
1014	63.0	65.80	44.70	0.00	110.50	13715.35
1015	63.0	65.80	44.70	0.00	110.50	13825.86
1016	62.0	66.47	47.15	0.00	113.63	13939.48
1017	62.0	66.73	33.45	0.00	100.19	14039.67
1018	62.0	66.73	33.45	0.00	100.19	14139.86
1019	61.0	67.14	49.61	0.00	116.75	14256.60
1020	61.0	67.14	49.61	0.00	116.75	14373.35
1021	61.0	67.14	49.61	0.00	116.75	14490.09
1022	60.0	67.80	52.07	0.00	119.87	14609.96
1023	60.0	67.80	52.07	0.00	119.87	14729.83
1024	59.0	38.83	42.41	0.00	81.24	14811.07
1025	59.0	38.83	42.41	0.00	81.24	14892.30
1026	59.0	68.47	54.52	0.00	122.99	15015.30
** sample year **						
811001	75.0	64.07	0.00	70.80	134.88	12860.82
811002	62.0	66.47	47.15	0.00	113.63	12974.45
811003	56.0	44.13	51.36	0.00	95.49	13069.93
811004	64.0	34.24	0.00	51.54	85.77	13155.71
811005	70.0	64.07	0.00	57.90	121.97	13277.68
811006	75.0	64.07	0.00	70.80	134.88	13412.55
811007	66.0	64.07	0.00	47.57	111.65	13524.20
811008	64.0	65.14	42.24	0.00	107.38	13631.58
811009	57.0	69.80	59.43	0.00	129.23	13760.82
811010	56.0	44.13	51.36	0.00	95.49	13856.30
811011	63.0	34.24	0.00	48.40	82.64	13938.94
811012	62.0	66.47	47.15	0.00	113.63	14052.57
811013	59.0	68.47	54.52	0.00	122.99	14175.56
811014	57.0	69.80	59.43	0.00	129.23	14304.79
811015	63.0	65.80	44.70	0.00	110.50	14415.30
811016	68.0	64.07	32.42	0.00	96.49	14511.79
811017	71.0	66.73	6.59	0.00	73.32	14585.11
811018	61.0	35.30	36.44	0.00	71.74	14656.85
811019	50.0	74.46	76.63	0.00	151.09	14807.94
811020	53.0	72.46	69.26	0.00	141.72	14949.66
811021	60.0	67.80	52.07	0.00	119.87	15069.53
811022	66.0	64.07	37.33	0.00	101.40	15170.93
811023	55.0	71.13	64.35	0.00	135.48	15306.41
811024	44.0	65.31	87.18	0.00	152.49	15458.90
811025	45.0	63.55	84.19	0.00	147.74	15606.64
811026	57.0	69.80	59.43	0.00	129.23	15735.87

GEORGIA INSTITUTE OF TECHNOLOGY
A Unit of the University System of Georgia
PHYSICAL PLANT DIVISION

915 Atlantic Drive, N.W. – Atlanta, Georgia 30318 404 – 894–4106

16 December 1982

MEMORANDUM

TO: Donald P. Alexander
Manager Engineering

FROM: Stephen L. Peet
Utilities Engineer

SUBJECT: Energy Evaluation (Edge) Athletic Building

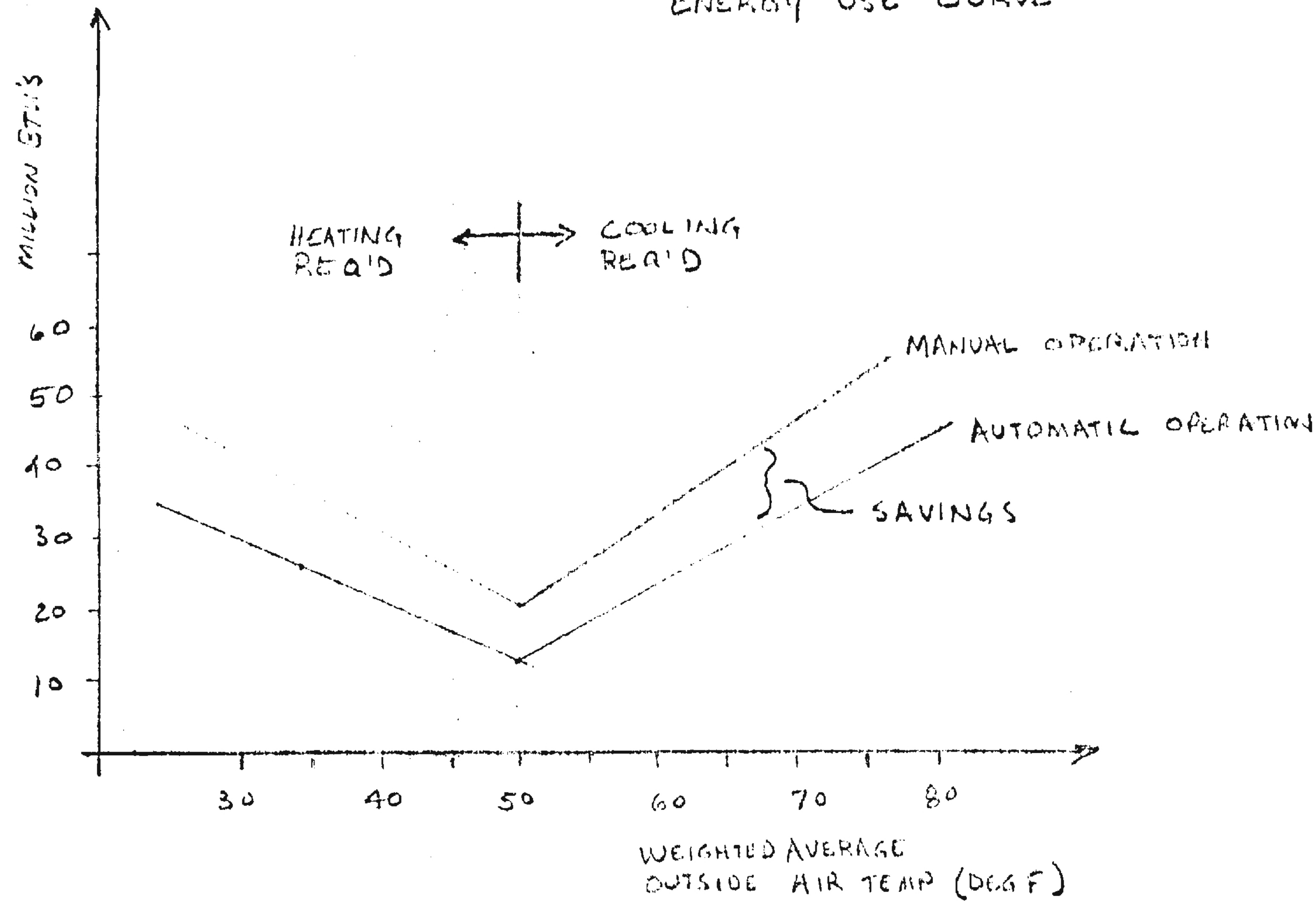
Starting Monday, 20 December 1982, I will be conducting an energy evaluation on the (Edge) Athletic Complex Building. Commencement of the test was delayed due to problems with both the automatic and manual portions of the HVAC controls. The test will consist of weekly operation of the building alternating between manual and automatic. Around 17 January 1983 preliminary data will be available. Each two week period after that, data will be updated. Conclusion of the test will be subject to a good variation of weather data in both operating modes.

Data will be collected daily, including but not limited to: Weighted Average Outside Air Temperature; Steam Consumption; and Electrical Consumption (data sheet attached). The method of evaluation will be comparison of the average outside air temperature to the total building energy consumption in BTU's and dollars (example attached). This information can then be applied to weather data to show savings over the heating season.

SLP/cams

xc: Mr. James Priest

TYPICAL BUILDING ENERGY USE CURVE



**** SAMPLE **** Data Sheet for building #18

FILE: AA.DAT

This file contains building information for energy management evaluation of the (Edge) Athletic Complex - Building 18. Data is collected daily. Data is gathered manually, or from the FMS information (file SENSVAL).

maintained by Stephen L. Peet

40.3=933.571
40.5=933.365
40.8=933.056
41.0=932.85
41.3=932.54
41.5=932.335
42.0=931.82

(STEAM CONS)X10 = (PRESS*(-1.03))+975.08

BTU = (KWH)3413/E6 *OR* (#)932.9/E6

$ = (KWH).041186 *OR* (#)6.218/E3

$12.07/E6 Btu $6.66/E6 Btu $7.00/E6 Btu (cooling)

MMDDYY	HHMM	HI	LO	BIN(A)		* KW	KWH (ELEC)X100	* PSI	CONSUM	DEM	* ELEC KWH	STEAM POUNDS	* ELEC E6BTU	STEAM E6BTU	TOTAL E6BTU	* ELEC$	STEAM$	TOTAL$	* DEG DAY
120282	1442	--	--	--.-		0.0	0160	--.-	-----	-.---									
120582	0947	--	--	--.-		1.4	0241	--.-	-----	-.---	2700								
120582	1230	--	--	--.-		1.4	0245	--.-	-----	-.---									
121482	0914	--	--	--.-		1.5	0314	42.0	44051	0.510									
121482	1411	--	--	--.-		1.5	0422	40.5	47764	1.174									
* DAILY DATA																			
121682	1025	--	--	--.-		1.3	0460	41.0	50183	0.721	1900	30660	6.485	28.601	35.086	78.2	190.64	268.89	
121782	1114	54	33	43	A	1.2	0482	41.0	51766	0.773	2200	15830	7.509	14.768	22.277	90.6	98.43	189.04	22
121882	1045	43	30	37	A	1.1	0501	41.0	53431	0.851	1900	16650	6.487	15.553	22.040	78.2	103.53	181.78	28
121982	1201	50	28	39	A	0.8	0519	41.3	55073	0.728	1800	16420	6.143	15.312	21.455	74.1	102.10	176.23	26
122082	0956	59	34	46	A	1.0	0534	41.0	56379	0.772	1500	13060	5.120	12.184	17.304	61.7	81.21	142.99	19
122182	0943	57	32	45	A	1.0	0552	41.0	57706	0.434	1800	13270	6.143	12.380	18.523	74.1	82.51	156.44	20
START FULL INFO																			
122282	1009	56	32	43		1.05	0571	41.0	59324	1.046	1900	16180	6.487	15.094	21.581	78.2	100.61	178.86	22
122382	0911	66	37	50		1.05	0589	41.0	60627	0.970	1800	13030	6.143	12.156	18.299	74.1	81.02	155.15	15
122482*	1011	66	37	54		0.9	0606	42.0	61631	0.239	1700	10040	5.802	9.355	15.157	70.0	62.43	132.45	11
MANUAL OPERATION																			
122582*	0951	69	47	58	A	0.8	0626	42.0	61751	0.142	2000	1200	6.826	1.118	7.944	82.3	7.46	89.83	7
122682*	0955	71	59	65	A	0.8	0644	42.0	61832	0.112	1800	810	6.143	0.755	6.899	74.1	5.04	79.17	0
122782*	NR*	71	59	65	A	-.-	----	--.-	-----	-.---	2000	165	6.826	0.154	6.980	82.3	1.03	83.43	0
122882*	1030	71	61	66	A	1.0	0684	42.0	61865	0.000	2000	165	6.826	0.154	6.980	82.3	1.03	83.40	-1
122982*	0955	70	45	58		0.95	0703	42.0	62553	0.479	1900	6880	6.487	6.411	12.898	78.2	42.78	121.03	7
123082	0930	57	33	43		1.0	0723	42.0	63901	0.719	2000	13480	6.826	12.561	19.387	82.3	83.82	166.19	22
123182	1101	51	35	42		1.0	0745	42.0	65138	0.509	2200	12370	7.509	11.527	19.036	90.6	76.92	167.53	23
010183	1200	51	37	45		1.0	.0760	42.0	66319	0.419	1500	11810	5.120	11.004	16.124	61.7	73.43	135.21	20
010283	1130	47	39	43	A	0.85	0785	42.0	67321	0.417	2500	10020	8.533	9.506	17.039	102.9	62.30	165.27	22
010383	NR*	47	38	45	A	-.-	----	--.-	-----	-.---	2400	16040	8.191	14.980	23.171	98.8	99.74	198.59	20
010483	0931	49	32	39		1.4	0833	42.0	70529	1.419	2400	16040	8.191	14.980	23.171	98.8	99.74	198.59	26
CLASSES STARTED - NORMAL BUILDING USE																			
010583	0933	51	30	39		1.4	0861	40.5	72930	1.744	2800	24010	9.556	22.410	31.966	115.3	149.29	264.61	26
010683	0922	56	32	44		1.45	0888	41.0	74976	1.719	2700	20460	9.215	19.086	28.301	111.2	127.11	238.42	21
010783	0930	61	39	48		1.5	0916	41.0	76718	0.505	2800	17420	9.556	16.250	25.806	115.3	108.32	223.64	17
010883	1115	66	36	49		1.5	0943	41.5	78120	0.318	2700	14020	9.215	13.071	22.286	111.2	87.17	198.37	16
010983	1032	66	41	53		1.25	0968	41.5	79185	0.628	2500	10650	8.533	9.929	18.462	102.9	66.22	169.19	12