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Fermilab Central Computing Facility

Energy Conservation Report
and
Mechanical Systems Design Optimization and
Cost Analysis Study

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FERMILAB CENTRAL COMPUTING FACILITY
ENERGY CONSERVATION REPORT
AND
MECHANICAL SYSTEMS DESIGN OPTIMIZATION AND COST ANALYSIS STUDY

12 NOVEMBER, 1986
S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

Energy Conservation Report and Mechanical Systems Design Optimization and Cost Analysis Study

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FERMILAB CENTRAL COMPUTING FACILITY

DATA SUMMARY

BUILDING MECHANICAL SYSTEMS OPTIMIZATION AND COST ANALYSIS

12 NOVEMBER, 1986

ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

ENERGY CONSERVATION REPORT

Analysis Data Summary

SCOPE: This report is developed as part of the Fermilab Central Computing Facility Project Title II Design Documentation Update under the provisions of D.O.E. Document 8430.1, Chapter XIII-21, Section 14, paragraph a. As such, it concentrates primarily on HVAC mechanical systems design optimization and cost analysis and should be considered as a supplement to the Title I Design Report dated March 1986 wherein energy related issues are discussed pertaining to building envelope and orientation as well as electrical systems design.

- a. Identification of Methods used for Building Energy Consumption Analysis: Carrier Corporation Model E20-II software run on an IBM PC-AT computer has been used to generate all loads, weather calculations, system simulations, life cycle costs, and payback data. This program has been used in conjunction with published data from:

1. ASHRAE Fundamentals - Chapter 24: Weather data and design considerations
2. Fermilab On-Site Records of ICW (Industrial Cold Water) cooling pond performance
3. Air Force Manual 88-29: Facility design and planning engineering weather data
4. Richardson Engineering Services Corporation: Construction costs data

Software documentation is provided in Section XII of this report.

- b. Methodology of Analysis: Life cycle cost analysis employs the unified present worth approach. Significant figures used in this exercise are 20 years reflecting minimum useful system life and 7.9% discount factor based upon projected outlooks from Chase, Data Resource Institute, Mellon and Evans. Project construction costs are paid off as a lump sum in the first year without amortization. The 8.8% electrical energy escalation costs, used in consideration of the same projected outlooks used for the discount factor, seem rather conservative in the light of Illinois Edison's particular problems with overbuilt nuclear facilities coming on line.

Payback analysis is based on the simple payback method with a maximum two (2) year return on investment period targeted.

Building energy analysis is based on the bin method with temperature/humidity projections made by algorithm from the ASHRAE design weather data. System performance is executed in an integrated dynamic fashion from selected points of rating.

To analyze a complex curved structure, like this facility, several methods of approach to the problem were employed. First, the general building structure was reduced to a polygon form of the same general orientation as the actual arc of the structure. Second, the total building was divided into four (4) subconstructions based upon the entirely different design conditions and systems employed in each of these zones. The physical layout of each of these subconstructions as well as the general building reduced form is presented in the "Building Computer Simulation Model" section of this report. In essence, each of these subconstructions is analyzed as a separate building except insofar as they affect one another at their thermodynamic boundaries (system as well as structure). The four (4) basic subconstructions are as follows:

Subcon 1/4: Describes the building office and tech areas

Subcon 2/4: Describes the building major computer room areas

Subcon 3/4: Describes the general building support areas and mechanical rooms

Subcon 4/4: Describes the chilled water cooled computer room EDP (Electronic Data Processing) equipment

Several applicable alternative mechanical systems were selected for each of the subconstructions and were then combined as total building combined systems into every possible arrangement. These were then each compared to the designed combined systems arrangement as well as a typical FY1975 combined systems arrangement to evaluate their merits. This results in 15 feasible alternative mechanical system arrangements being evaluated against the design basis arrangement and the typical FY1975 arrangement.

For subconstruction 1/4, four (4) modern alternative HVAC systems were evaluated in addition to a typical FY1975 system. The modern systems were:

1. Water source heat pumps
2. Variable air volume
3. Four (4) pipe fan coils

4. Bypass (or triple deck) multizone

The heat pump system was evaluated with the design options actually selected. The other three systems were evaluated with full blown energy conservation options included in the simulation models such as integrated enthalpy economizer cycles, free cooling ICW hydronic economizers, and high efficiency centrifugal chillers, even though preliminary studies indicate that it would be difficult to fit such options into the building space allotted. To further favor the alternative systems in this analysis, their construction costs were taken as the mean published costs for these types of systems while the design system was evaluated on the basis of actual estimated cost which is more at the high end of the published costs due to actual building conditions. This disparity is a true fiction when one considers that the alternate systems would also require the construction of a mechanical room mezzanine level, several large duct shafts, additional auxiliary steel, and several large fan rooms (not required for the design system) which are not even addressed in these costs. The net effect of this approach, however, is to place the calculated advantages of the design system beyond doubt. Due to its modular nature, the design system offers several other advantages such as easy capacity redistribution or addition to accommodate future area use modifications, acoustical/odor decoupling between spaces and individual room scheduling control. Actually, the construction costs used for the design system also include other energy conservation features (such as programmable stats) which are not credited in the simulations for simplicity. The FY1975 selected system is a standard dual-deck multizone with integrated enthalpy economizer, ICW free cooling hydronic economizer, and centrifugal chiller -- a good quality 1975 design. Due to the high cooling loads with need for individual room control, it was best to simulate a FY1975 design in these atypical conditions to establish our base.

For subconstruction 2/4, two (2) modern alternative HVAC systems were evaluated in addition to a typical FY1975 system. The modern systems were:

1. DX AC cooling with ICW free cooling coils and capacity staged high efficiency compressors
2. DX AC cooling with high efficiency compressors

The first system is evaluated with design options actually selected. The second system was evaluated as a high quality installation without the optional energy saving features. Again, design system construction costs reflect actual estimated costs while the alternate system costs are

established by simple option deductions. It should be noted here that Fermilab cooling ponds, on the basis of recorded historical data, are seen to be sensitive to weather conditions and are, therefore, modeled in all simulations after open cooling towers rather than stable groundwater sources. Several features of these systems will further enhance actual performance over FY1975 design but were not credited in the simulations for simplicity (such as humidity anticipation psychrometric correction to preclude units in the same room from simultaneous humidification and dehumidification, as well as free hot gas reheat during dehumidification modes). The FY1975 selected system is a standard DX AC (Direct Expansion Air Conditioning) cooling unit with typical FY1975 controls. In all cases DX AC systems must be employed to achieve design conditions of 68°F DB/45% RH. A 43°F apparatus dewpoint is beyond the effective range of chilled water units. Again, due to the requirements created in these areas by modern EDP equipment, it was best to simulate a FY1975 design in these atypical conditions to establish our base.

For subconstruction 3/4, only one (1) simple system was evaluated. This was electric unit heaters for this "heating only" area. No other evaluation was necessary since this is the lowest first cost system and because these areas are so well loaded with equipment waste heat that normally these units will use very little energy throughout the year. Within this subconstruction are also lumped the costs of the general utility systems common to all designs and therefore not germane to their individual cost analysis. These systems are identical for both the FY1975 arrangements as well as all modern configurations (alternate and design).

For subconstruction 4/4, two (2) modern alternative HVAC systems were evaluated in addition to a typical FY1975 system. The modern systems were:

1. Reciprocating chillers with ICW free cooling heat exchanger and capacity staged high efficiency compressors
2. Reciprocating chillers with capacity staged high efficiency compressors

The first system was evaluated with design options actually selected. The second system was evaluated as a high quality installation without some of the optional energy saving features. Again, design construction costs reflect actual estimated costs while alternate system costs are established by simple option deductions. The FY1975 selected system is a standard reciprocating chiller arrangement with typical FY1975 controls. In all cases, reciprocating chillers are

employed for low installed cost and effective low part load performance typical of the straight EDP CPU (Central Processing Unit) staging characteristics. In order to model all of the features of these systems in the software program used, it was necessary to represent these systems in a fictional manner to the computer. The EDP CPU's were modeled in the computer as a one square foot perimeter area with no exterior surface boundaries, no other load than the CPU wattages, and "cooling only" requirements. In the systems simulations the HVAC equipment is fictionally configured as a constant volume central air handler with virtually no SP drop on the air side, coupled to the reciprocating chillers, pumps, and options as actually configured. This effectively eliminates fictional fan energy from the equation and permits us to simulate all of the other features of the systems as desired.

- c. Description of the Major Energy Conservation Features Selected: The design building HVAC system arrangement constitutes a water source heat pump system in the office and tech areas with the capability to utilize waste building heat both in perimeter zones and in the makeup air systems from both interior zones and computer room areas. The makeup air systems are further enabled to recover both waste heat and cooling from exhaust air through heat wheels. The office and tech area ventilation system also has the capability to provide some free integrated enthalpy economizer cooling as determined necessary by looking at the heat pump water loop status. The computer room DX air handling equipment is provided with integrated hydronic economizer coils to permit full or partial free cooling in combination with the mechanical direct expansion system. This permits both total shutdown of the compressors at times, as well as prolonged periods of part loaded operation, thus greatly increasing the unit EER (Energy Efficiency Ratio) with unloaded condensers. Other features include humidity anticipation psychrometric correction and free dehumidification mode hot gas reheat. The building support areas employ electric unit heaters but are actually warmed by equipment waste heat most of the time. The EDP CPU chilled water cooled equipment is serviced by multi-staged reciprocating chillers coupled with an integrated hydronic heat exchanger economizer to permit both total shutdown of the compressors at times, as well as prolonged periods of part loaded operation, thus greatly increasing the unit EER with unloaded condensers.

System performance is further enhanced by the use of dynamic control through a direct digital control system employing proportional-integral-derivative response coupled to pulse width modulation for permanent calibration - high accuracy tracking. This technology also allows for sophisticated strategy through its boolean operatives. The system is of a

fully modular and distributed processing architecture which is expandable by adding to each subsystem as required. The DDC controls system consists of stand-alone intelligent local field processors for all building systems connected to one another and to a local front end computer to create a local area network. The system is modular both in design of software as well as hardware and shall allow for change of function and operation in the field without programming changes or changes to hardware. Control strategies and setpoints may be changed on line by Fermilab personnel to the end that integral energy management features (such as demand limiting) may be brought on line as historical data is generated.

- d. Evaluation of Solar Applications: The overwhelming balance of excess heat in this structure precludes the use of either active or passive solar energy applications. Solar absorption type chillers are likewise precluded by the need for DX systems as delineated above.
- e. Discussion of Evaluation of Non-Renewable Energy Supply Alternatives: Due to the electrically intensive nature of this facility, coupled with the abundance of waste heat and the need for DX systems as delineated above, the use of natural gas (the only other viable non-renewable energy supply on site) is precluded over electricity for either heating or absorption cooling.

Strong consideration has been made with a view to possible employment of fuel cell cogeneration technology at this facility in the future. If and when these types of units are perfected to the point of achieving installed costs approaching \$1,000/kw as opposed to \$3,000/kw today. In this event, the water source heat pumps and their ancillary systems are well suited to utilize the low quality thermal energy typical of fuel cell cogeneration.

In engineering the overall integrated mechanical systems configuration, the following considerations have been made to assure minimal utilization of non-renewable resources in the form of electrical energy and with respect to D.O.E. Document 4330.3.

The goal in recycling waste heat among the elements of any integrated thermodynamic system, such as the total Fermilab Central Computing Facility, is to lower the apparent overall system entropy. This is usually accomplished in one of two ways. First, by increasing available energy through evaporator access in a reversed Carnot cycle as we are doing in our designed system and, second, by artificially elevating condenser superheat in the cooling phase elements of the system. The major drawback with the second method is in its

effects on the compression mode which results in a reduced COP (Coefficient of Performance) through increased irreversibility rate at the compressor. This taxes the major cooling element of the entire building system to accommodate the minor heating component element. In actual practice, this also tends to reduce free cooling utilization. By contrast, the first method allows us to extract heat in just the quality range ideally matched to efficient cooling compressor operation, coupled with partial free cooling for additional EER elevation. This match of individual system boundary parameters conserves non-renewable resources both by reducing the annual resource utilization period and by increasing the COP.

- f. Estimates of Total HVAC Energy Input to the Building: The Fermilab Central Computing Facility is characterized by an exceptionally intense cooling load attributable primarily to high duty cycle, equipment packed office/tech areas coupled with high density computer rooms. Overall building design load intensity is calculated at 194.7 square feet per ton under the present occupancy scope, with provision to increase to 127.3 square feet per ton under the ultimate occupancy scope provided for in future equipment indicated on the design drawings.

Building Present Scope Annual Energy Input for Designed HVAC Systems:

KWH Per Year: 1,228,411
 Annual DOE Resource Impact Factor: 4,192,012 MBH
 Annual BTU/Gross Square Foot/Year: 51,804

Building Ultimate Scope Annual Energy Input for Designed HVAC Systems:

KWH Per Year: 2,093,235
 Annual DOE Resource Impact Factor: 7,142,118 MBH
 Annual BTU/Gross Square Foot/Year: 88,281

- g. 45% Energy Use Reduction Goal Data:

1. The following information represents the estimated total HVAC energy use of a representative building of the appropriate category in FY1975:

Building Present Scope Annual Energy Input for FY1975 HVAC Systems:

KWH Per Year: 3,840,459
 Annual DOE Resource Impact Factor: 13,103,646 MBH
 Annual BTU/Gross Square Foot/Year: 161,933

Building Ultimate Scope Annual Energy Input for FY1975 HVAC Systems:

KWH Per Year: 5,984,870

Annual DOE Resource Impact Factor: 20,420,376 MBH

Annual BTU/Gross Square Foot/Year: 252,353

2. The following is the estimated percentage of energy use reduction for the designed HVAC systems as opposed to typical FY1975 HVAC Systems:

Building Present Scope: 68% Reduction

Building Ultimate Scope: 65% Reduction

It is thus apparent that this HVAC design far exceeds the minimum DOE requirements for a 45% reduction in energy use over typical FY1975 systems.

3. Due to the atypical requirements, loads, and design of this building, the method of simulating by computer the performance of typical FY1975 HVAC systems in the as-designed structure has been used to estimate the baseline HVAC energy use of a representative building of the appropriate category in FY1975.
4. The estimated additional HVAC systems construction cost to achieve the 68/65% percentage of energy use reduction over the typical FY1975 systems is as follows:

Building Present Scope: \$54,922 additional costs (6%)

Building Ultimate Scope: \$91,722 additional costs (7%)

5. The estimated energy cost savings over the minimal 20-year projected HVAC systems life including additional HVAC systems construction cost, first year energy cost savings, and present worth energy source factors are as follows:

Building Present Scope: \$2,883,889 cost savings

Building Ultimate Scope: \$4,433,466 cost savings

- h. Outline of Metering Provisions: Due to the nature of DDC control systems and the need for metering data acquisition to execute the energy conservation strategies, virtually all major energy flows are intrinsically monitored, summarized, and printed at the local front end computer printer. This information will also be useful in generating site weather

data (temperature, humidity, solar intensity, and wind), evaluating much needed site wide cooling pond performance data (especially as it is related to weather and site operations), give Fermilab personnel data to evaluate alterations to initial energy management strategies and confirm HVAC systems performance in relation to estimated projections. Among the items metered are:

1. All cooling pond ICW flows.
 2. All energy BTU's wasted from building through both cooling water and exhaust air.
 3. All hours of free cooling for individual systems.
 4. All compressor run time hours for computer room air conditioners and chillers.
 5. All boiler stages run time hours.
 6. All general equipment status data.
- j. Comparison of Design HVAC System to 15 Alternate Modern HVAC Systems: Results of these comparisons may be summarized as follows (detailed system summary sheets are attached hereafter):
1. Six (6) of the 15 alternate systems are rejected on the basis that they do not meet DOE guidelines for a 45% energy reduction over typical FY1975 systems (in addition to costing more in some cases than the design system). These systems include one of the water source heat pump systems (Alternate C), one of the variable air volume systems (Alternate G), one of the four pipe fan coil systems (Alternate L), and three of the bypass multizone systems (Alternates N, P, and Q).
 2. An additional seven (7) of the 15 alternate systems are rejected because they cost as much or more than the design system and, in every case, were far less efficient. These systems include three of the variable air volume systems (Alternates D, E, and F), three of the four pipe fan coil systems (Alternates H, J, and K), and one of the bypass multizone systems (Alternate M).
 3. The remaining two (2) of the 15 alternate systems are rejected because although they cost slightly less than the design system (1% to 3%), they are less efficient and have short payback periods (between 0.8 and 1.2 years). These systems include two of the water source heat pump systems (Alternates A and B).

CONFIGURATION DESIGNATIONS TABLE

<u>DESIGNATION</u>	<u>DESCRIPTION</u>
<u>Subconstruction 1/4:</u>	<u>General Office & Tech Areas</u>
Subcon 1/4 Design System	Water Source Heat Pumps
Subcon 1/4 Alternate System 1	Variable Air Volume
Subcon 1/4 Alternate System 2	Four - Pipe Fan Coils
Subcon 1/4 Alternate System 3	Bypass Multizone
Subcon 1/4 Alternate System 4	FY1975 Multizone
<u>Subconstruction 2/4:</u>	<u>Computer Room Areas</u>
Subcon 2/4 Design System	DX AC Four-Step with Free Cooling
Subcon 2/4 Alternate System 1	DX AC High Efficiency
Subcon 2/4 Alternate System 2	DX AC FY1975
<u>Subconstruction 3/4:</u>	<u>General Utility Areas</u>
Subcon 3/4 Design System	Electric Unit Heaters
<u>Subconstruction 4/4:</u>	<u>Computer Room EDP Equipment</u>
Subcon 4/4 Design System	Reciprocating Chillers Eight-Step with Free Cooling
Subcon 4/4 Alternate System 1	Reciprocating Chillers Eight-Step
Subcon 4/4 Alternate System 2	Reciprocating Chillers FY1975

NOTE: These HVAC systems are individually simulated in Sections IV to IX of this Report. These simulations are then combined as shown in the "Permutations Table" on Page 11 of this Section, to arrive at the figures for each of the "Total Building Systems Combined Performance Summary" sheets (for Design, FY1975 and Alternates A to Q) on Pages 12 to 28 of this Section.

PERMUTATIONS TABLE
BUILDING MECHANICAL SYSTEMS CONFIGURATIONS

<u>Building System</u>	<u>Subconstructions Configurations</u>			
	<u>1/4</u>	<u>2/4</u>	<u>3/4</u>	<u>4/4</u>
DESIGN:	Design	Design	Design	Design
FY1975:	Alt. 4	Alt. 2	Design	Alt. 2
ALT. A:	Design	Design	Design	Alt. 1
ALT. B:	Design	Alt. 1	Design	Design
ALT. C:	Design	Alt. 1	Design	Alt. 1
ALT. D:	Alt. 1	Design	Design	Design
ALT. E:	Alt. 1	Design	Design	Alt. 1
ALT. F:	Alt. 1	Alt. 1	Design	Design
ALT. G:	Alt. 1	Alt. 1	Design	Alt. 1
ALT. H:	Alt. 2	Design	Design	Design
ALT. J:	Alt. 2	Design	Design	Alt. 1
ALT. K:	Alt. 2	Alt. 1	Design	Design
ALT. L:	Alt. 2	Alt. 1	Design	Alt. 1
ALT. M:	Alt. 3	Design	Design	Design
ALT. N:	Alt. 3	Design	Design	Alt. 1
ALT. P:	Alt. 3	Alt. 1	Design	Design
ALT. Q:	Alt. 3	Alt. 1	Design	Alt. 1

NOTE: This describes each of the combinations of HVAC systems (from Page 10 of this Section) comprising the "Total Building Systems Combined Performance Summary" sheets (for Design, FY1975 and Alternates A to Q) on Pages 12 to 28 of this Section. See Section III, Pages 15 to 17 for references to locate in the body of this Report each of the individual statistics which have been summed to yield the statistics listed on Pages 12 to 28 of this Section.

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYDESIGNED CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 64,580	\$ 107,821
Annual Op. Cost/SF:	\$ 0.80	\$ 1.33
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$972,500	\$1,238,300
20 Yr. Cumulative Cost:	\$2,616,171	\$3,890,989
<u>HVAC Energy</u>		
KWH/Yr.	1,228,411	2,093,235
DOE RUF MBH:	14,249,566	24,281,256
DOE RIF MBH:	4,192,012	7,142,118
BTU/SF/Yr.	51,804	88,261
Energy Reduction from 1975:	68%	65%
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,073,189	14,974,813
DOE RUF MBH:	93,649,003	172,779,569
DOE RIF MBH:	27,553,243	50,833,906
BTU/SF/Yr.	340,499	628,199

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYFY1975 CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$192,022	\$ 299,243
Annual Op. Cost/SF:	\$ 2.37	\$ 3.70
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$917,578	\$1,146,578
% of Design Constr. Cost:	94%	93%
Constr. Cost Difference:	-\$54,922	-\$ 91,722
Annual Op. Cost Diff.:	\$127,422	\$ 191,422
Design System Payback:	0.4 years	0.5 years
20 Yr. Cumulative Cost:	\$5,500,060	\$8,243,455
Cumulative Cost Diff.:	\$2,883,889	\$4,433,466
<u>HVAC Energy</u>		
KWH/Yr.	3,840,459	5,984,870
DOE RUF MBH:	44,549,324	69,424,492
DOE RIF MBH:	13,103,646	20,420,376
BTU/SF/Yr.	161,933	252,353
Energy Increase from Design:	313%	286%
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	10,685,237	18,866,448
DOE RUF MBH:	123,948,761	217,922,805
DOE RIF MBH:	36,464,877	64,112,164
BTU/SF/Yr.	450,628	792,291

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE A CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 77,940	\$ 131,198
Annual Op. Cost/SF:	\$ 0.96	\$ 1.62
Annual Maintenance Cost:	\$ 6,000	\$ 6,500
Construction Cost:	\$960,300	\$1,223,300
% of Design Constr. Cost:	99%	99%
Constr. Cost Difference:	-\$12,200	-\$ 15,000
Annual Op. Cost Diff.:	\$ 12,860	\$ 23,377
Design System Payback:	0.9 years	0.6 years
20 Yr. Cumulative Cost:	\$2,900,171	\$4,402,181
Cumulative Cost Diff.:	\$ 284,000	\$ 511,192
<u>HVAC Energy</u>		
KWH/Yr.	1,495,616	2,560,768
DOE RUF MBH:	17,349,145	29,704,908
DOE RIF MBH:	5,103,042	8,737,340
BTU/SF/Yr.	63,063	107,975
Energy Increase from Design:	122%	122%
Energy Reduction from 1975:	61%	57%
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,340,394	15,442,346
DOE RUF MBH:	96,748,582	178,203,221
DOE RIF MBH:	28,464,273	52,429,128
BTU/SF/Yr.	351,758	647,913

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYALTERNATE B CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 80,726	\$ 149,100
Annual Op. Cost/SF:	\$ 1.00	\$ 1.84
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$952,500	\$1,204,300
% of Design Constr. Cost:	98%	97%
Constr. Cost Difference:	-\$20,000	-\$ 34,000
Annual Op. Cost Diff.:	\$ 16,146	\$ 41,279
Design System Payback:	1.2 years	0.8 years
20 Yr. Cumulative Cost:	\$2,968,497	\$4,808,883
Cumulative Cost Diff.:	\$ 352,326	\$ 917,894
<u>HVAC Energy</u>		
KWH/Yr.	1,550,334	2,918,814
DOE RUF MBH:	17,983,874	33,858,242
DOE RIF MBH:	5,289,740	9,958,993
BTU/SF/Yr.	65,370	123,072
Energy Increase from Design:	127%	139%
Energy Reduction from 1975:	60%	51%
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,395,112	15,800,392
DOE RUF MBH:	97,383,311	182,356,555
DOE RIF MBH:	28,650,971	53,650,781
BTU/SF/Yr.	354,065	663,010

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE C CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 94,086	\$ 172,477
Annual Op. Cost/SF:	\$ 1.16	\$ 2.13
Annual Maintenance Cost:	\$ 6,000	\$ 6,500
Construction Cost:	\$940,300	\$1,188,300
% of Design Constr. Cost:	97%	96%
Constr. Cost Difference:	-\$32,200	-\$ 50,000
Annual Op. Cost Diff.:	\$ 29,006	\$ 65,156
Design System Payback:	1.1 years	0.8 years
20 Yr. Cumulative Cost:	\$3,252,497	\$5,320,075
Cumulative Cost Diff.:	\$ 636,326	\$1,429,086
<u>HVAC Energy</u>		
KWH/Yr.	1,818,539	3,386,347
DOE RUF MBH:	21,095,052	39,281,625
DOE RIF MBH:	6,204,855	11,554,215
BTU/SF/Yr.	76,679	142,786
Energy Increase from Design:	147%	161%
Energy Reduction from 1975:	53%	43%*
* Does not meet DOE guidelines		
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,663,317	16,267,925
DOE RUF MBH:	100,494,489	187,779,938
DOE RIF MBH:	29,566,086	55,246,003
BTU/SF/Yr.	365,374	682,724

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE D CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 77,719	\$ 120,960
Annual Op. Cost/SF:	\$ 0.96	\$ 1.49
Annual Maintenance Cost:	\$ 7,000	\$ 7,500
Construction Cost:	\$1,025,568	\$1,241,368
% of Design Constr. Cost:	105%*	100%*
Constr. Cost Difference:	\$ 53,068	\$ 3,068
Annual Op. Cost Diff.:	\$ 13,139	\$ 13,139
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$2,984,106	\$4,258,924
Cumulative Cost Diff.:	\$ 367,935	\$ 367,935
<u>HVAC Energy</u>		
KWH/Yr.	1,554,376	2,419,200
DOE RUF MBH:	18,030,761	28,062,720
DOE RIF MBH:	5,303,531	8,254,310
BTU/SF/Yr.	65,540	102,006
Energy Increase from Design:	127%	115%
Energy Reduction from 1975:	60	60%
* Construction costs greater than design		
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,399,154	15,300,778
DOE RUF MBH:	97,430,198	176,561,033
DOE RIF MBH:	28,664,762	51,946,098
BTU/SF/Yr.	354,235	641,944

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE E CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 91,079	\$ 144,337
Annual Op. Cost/SF:	\$ 1.13	\$ 1.78
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$1,013,368	\$1,275,368
% of Design Constr. Cost:	104%*	103%*
Constr. Cost Difference:	\$ 40,868	\$ 37,068
Annual Op. Cost Diff.:	\$ 26,499	\$ 36,516
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$3,268,106	\$4,770,116
Cumulative Cost Diff.:	\$ 651,935	\$ 879,127

HVAC Energy

KWH/Yr.	1,821,581	2,886,733
DOE RUF MBH:	21,130,339	33,486,102
DOE RIF MBH:	6,215,234	9,849,532
BTU/SF/Yr.	76,807	121,719
Energy Increase from Design:	149%	137%
Energy Reduction from 1975:	53%	52%

* Construction costs greater than design

Non-HVAC Energy

KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938

Total Building Energy

KWH/Yr.	8,666,359	15,768,311
DOE RUF MBH:	100,529,776	181,984,413
DOE RIF MBH:	29,576,465	53,541,320
BTU/SF/Yr.	365,502	661,657

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE F CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 93,865	\$ 162,239
Annual Op. Cost/SF:	\$ 1.16	\$ 2.00
Annual Maintenance Cost:	\$ 7,000	\$ 7,500
Construction Cost:	\$1,005,568	\$1,257,368
% of Design Constr. Cost:	103%*	102%*
Constr. Cost Difference:	\$ 33,068	\$ 19,068
Annual Op. Cost Diff.:	\$ 29,285	\$ 54,418
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$3,336,432	\$5,176,818
Cumulative Cost Diff.:	\$ 720,261	\$1,285,829

HVAC Energy

KWH/Yr.	1,877,299	3,244,779
DOE RUF MBH:	21,776,668	37,639,436
DOE RIF MBH:	6,405,344	11,071,185
BTU/SF/Yr.	79,157	136,816
Energy Increase from Design:	154%	154%
Energy Reduction from 1975:	51%	46%

* Construction costs greater than design

Non-HVAC Energy

KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938

Total Building Energy

KWH/Yr.	8,722,077	16,126,357
DOE RUF MBH:	101,176,105	186,137,749
DOE RIF MBH:	29,766,575	54,762,973
BTU/SF/Yr.	367,852	676,754

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE G CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 107,225	\$ 185,616
Annual Op. Cost/SF:	\$ 1.33	\$ 2.29
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$ 993,368	\$1,276,015
% of Design Constr. Cost:	102%*	103%*
Constr. Cost Difference:	\$ 20,868	\$ 37,715
Annual Op. Cost Diff.:	\$ 42,645	\$ 77,795
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$3,620,432	\$5,688,010
Cumulative Cost Diff.:	\$1,004,261	\$1,797,021

HVAC Energy

KWH/Yr.	2,144,504	3,712,312
DOE RUF MBH:	24,876,246	43,062,819
DOE RIF MBH:	7,317,048	12,666,408
BTU/SF/Yr.	90,423	156,530

Energy Increase from Design:	175%	179%
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Energy Reduction from 1975:	44%**	38%**
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* Construction costs greater than design

** Does not meet DOE guidelines

Non-HVAC Energy

KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938

Total Building Energy

KWH/Yr.	8,989,282	16,593,890
DOE RUF MBH:	104,275,683	191,561,132
DOE RIF MBH:	30,678,278	56,358,169
BTU/SF/Yr.	379,118	696,468

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE H CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 75,135	\$ 118,376
Annual Op. Cost/SF:	\$ 0.93	\$ 1.46
Annual Maintenance Cost:	\$ 7,000	\$ 7,500
Construction Cost:	\$1,152,708	\$1,418,508
% of Design Constr. Cost:	119%*	115%*
Constr. Cost Difference:	\$ 180,208	\$ 180,208
Annual Op. Cost Diff.:	\$ 10,555	\$ 10,555
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$3,039,778	\$4,314,596
Cumulative Cost Diff.:	\$ 423,607	\$ 423,607
<u>HVAC Energy</u>		
KWH/Yr.	1,502,701	2,367,525
DOE RUF MBH:	17,431,331	27,463,290
DOE RIF MBH:	5,127,216	8,077,995
BTU/SF/Yr.	63,362	99,827
Energy Increase from Design:	122%	114%
Energy Reduction from 1975:	61%	60%
* Construction costs greater than design		
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,347,479	15,249,103
DOE RUF MBH:	96,830,768	175,961,603
DOE RIF MBH:	28,488,447	51,769,783
BTU/SF/Yr.	352,057	639,765

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYALTERNATE J CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 88,495	\$ 141,753
Annual Op. Cost/SF:	\$ 1.09	\$ 1.75
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$1,140,508	\$1,402,508
% of Design Constr. Cost:	117%*	113%*
Constr. Cost Difference:	\$ 168,008	\$ 164,208
Annual Op. Cost Diff.:	\$ 23,915	\$ 33,932
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$3,323,778	\$4,825,788
Cumulative Cost Diff.:	\$ 707,607	\$ 934,799
<u>HVAC Energy</u>		
KWH/Yr.	1,769,906	2,835,058
DOE RUF MBH:	20,530,909	32,886,672
DOE RIF MBH:	6,038,919	9,673,218
BTU/SF/Yr.	74,628	119,541
Energy Increase from Design:	145%	135%
Energy Reduction from 1975:	54%	53%
* Construction costs greater than design		
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,614,684	15,716,636
DOE RUF MBH:	99,930,346	181,384,985
DOE RIF MBH:	29,400,150	53,365,006
BTU/SF/Yr.	363,323	659,479

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYALTERNATE K CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 91,281	\$ 159,655
Annual Op. Cost/SF:	\$ 1.13	\$ 1.97
Annual Maintenance Cost:	\$ 7,000	\$ 7,500
Construction Cost:	\$1,132,708	\$1,384,508
% of Design Constr. Cost:	116%*	112%*
Constr. Cost Difference:	\$ 160,208	\$ 146,208
Annual Op. Cost Diff.:	\$ 26,701	\$ 51,834
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$3,392,104	\$5,232,490
Cumulative Cost Diff.:	\$ 775,933	\$1,341,501
<u>HVAC Energy</u>		
KWH/Yr.	1,825,624	3,193,104
DOE RUF MBH:	21,177,238	37,040,006
DOE RIF MBH:	6,229,029	10,894,870
BTU/SF/Yr.	76,978	134,638
Energy Increase from Design:	149%	152%
Energy Reduction from 1975:	52%	47%
* Construction costs greater than design		
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,670,402	16,074,682
DOE RUF MBH:	100,576,675	185,538,319
DOE RIF MBH:	29,590,260	54,586,658
BTU/SF/Yr.	365,673	674,576

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYALTERNATE L CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 104,641	\$ 183,032
Annual Op. Cost/SF:	\$ 1.29	\$ 2.26
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$1,120,508	\$1,368,508
% of Design Constr. Cost:	115%*	111%*
Constr. Cost Difference:	\$ 148,008	\$ 130,208
Annual Op. Cost Diff.:	\$ 40,061	\$ 75,211
Design System Payback:	N/A*	N/A*
20 Yr. Cumulative Cost:	\$3,676,103	\$5,743,682
Cumulative Cost Diff.:	\$1,059,932	\$1,852,693

HVAC Energy

KWH/Yr.	2,092,829	3,660,637
DOE RUF MBH:	24,276,816	42,463,389
DOE RIF MBH:	7,140,733	12,490,093
BTU/SF/Yr.	88,244	154,351

Energy Increase from Design:	170%	175%
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Energy Reduction from 1975:	46%	39%**
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* Construction costs greater than design

** Does not meet DOE guidelines

Non-HVAC Energy

KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938

Total Building Energy

KWH/Yr.	8,937,607	16,542,215
DOE RUF MBH:	103,676,253	190,961,702
DOE RIF MBH:	30,501,964	56,181,881
BTU/SF/Yr.	376,939	694,289

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARY

ALTERNATE M CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 93,213	\$ 136,454
Annual Op. Cost/SF:	\$ 1.15	\$ 1.69
Annual Maintenance Cost:	\$ 7,000	\$ 7,500
Construction Cost:	\$971,778	\$1,237,578
% of Design Constr. Cost:	100%	100%
Constr. Cost Difference:	-\$ 722	-\$ 722
Annual Op. Cost Diff.:	\$ 29,133	\$ 29,133
Design System Payback:	0.0 years	0.0 years
20 Yr. Cumulative Cost:	\$3,287,589	\$4,562,407
Cumulative Cost Diff.:	\$ 671,418	\$ 671,418
<u>HVAC Energy</u>		
KWH/Yr.	1,864,257	2,729,081
DOE RUF MBH:	21,625,381	31,657,339
DOE RIF MBH:	6,360,845	9,311,624
BTU/SF/Yr.	78,607	115,072
Energy Increase from Design:	152%	130%
Energy Reduction from 1975:	51%	54%
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	8,709,035	15,610,659
DOE RUF MBH:	101,024,818	180,155,652
DOE RIF MBH:	29,722,076	53,003,412
BTU/SF/Yr.	367,302	655,010

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYALTERNATE N CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$106,573	\$ 159,831
Annual Op. Cost/SF:	\$ 1.32	\$ 1.98
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$959,578	\$1,221,578
% of Design Constr. Cost:	99%	99%
Constr. Cost Difference:	-\$12,922	-\$ 16,722
Annual Op. Cost Diff.:	\$ 41,933	\$ 52,010
Design System Payback:	0.3 years	0.3 years
20 Yr. Cumulative Cost:	\$3,571,589	\$5,073,599
Cumulative Cost Diff.:	\$ 955,418	\$1,182,610

HVAC Energy

KWH/Yr.	2,131,462	3,196,614
DOE RUF MBH:	24,724,959	37,080,722
DOE RIF MBH:	7,272,548	10,906,846
BTU/SF/Yr.	89,873	134,786

Energy Increase from Design:	172%	154%
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Energy Reduction from 1975:	44%*	47%
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* Does not meet DOE guidelines

Non-HVAC Energy

KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938

Total Building Energy

KWH/Yr.	8,976,240	16,078,192
DOE RUF MBH:	104,124,396	185,579,035
DOE RIF MBH:	30,633,779	54,598,634
BTU/SF/Yr.	378,568	674,724

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYALTERNATE P CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$109,359	\$ 177,733
Annual Op. Cost/SF:	\$ 1.35	\$ 2.20
Annual Maintenance Cost:	\$ 7,000	\$ 7,500
Construction Cost:	\$951,778	\$1,203,578
% of Design Constr. Cost:	98%	97%
Constr. Cost Difference:	-\$20,722	-\$ 34,722
Annual Op. Cost Diff.:	\$ 45,279	\$ 70,412
Design System Payback:	0.5 years	0.5 years
20 Yr. Cumulative Cost:	\$3,639,915	\$5,480,301
Cumulative Cost Diff.:	\$1,023,744	\$1,589,312
<u>HVAC Energy</u>		
KWH/Yr.	2,187,180	3,554,660
DOE RUF MBH:	25,371,288	41,234,056
DOE RIF MBH:	7,462,658	12,128,499
BTU/SF/Yr.	92,223	149,883
Energy Increase from Design:	179%	169%
Energy Reduction from 1975:	43%*	41%*
* Does not meet DOE guidelines		
<u>Non-HVAC Energy</u>		
KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938
<u>Total Building Energy</u>		
KWH/Yr.	9,031,958	16,436,238
DOE RUF MBH:	104,770,725	189,732,369
DOE RIF MBH:	30,823,889	55,820,287
BTU/SF/Yr.	380,918	689,821

TOTAL BUILDING SYSTEMS COMBINED PERFORMANCE SUMMARYALTERNATE Q CONFIGURATION

<u>Statistic</u>	<u>Present Scope</u>	<u>Ultimate Scope</u>
<u>HVAC Systems Parameters</u>		
Area:	80,920 SF	80,920 SF
Tons:	415.6	635.6
SF/Ton:	194.7	127.3
Annual Operating Cost:	\$ 122,719	\$ 201,110
Annual Op. Cost/SF:	\$ 1.52	\$ 2.49
Annual Maintenance Cost:	\$ 6,500	\$ 7,000
Construction Cost:	\$ 939,578	\$1,187,578
% of Design Constr. Cost:	97%	96%
Constr. Cost Difference:	-\$ 32,922	-\$ 50,722
Annual Op. Cost Diff.:	\$ 58,139	\$ 93,289
Design System Payback:	0.6 years	0.5 years
20 Yr. Cumulative Cost:	\$3,923,915	\$5,991,493
Cumulative Cost Diff.:	\$1,307,744	\$2,100,504

HVAC Energy

KWH/Yr.	2,454,385	4,022,193
DOE RUF MBH:	28,470,866	46,657,438
DOE RIF MBH:	8,374,362	13,723,722
BTU/SF/Yr.	103,489	169,596
Energy Increase from Design:	200%	192%
Energy Reduction from 1975:	36%*	33%*

* Does not meet D.O.E. Guidelines.

Non-HVAC Energy

KWH/Yr.	6,844,778	12,881,578
DOE RUF MBH:	79,399,437	148,498,313
DOE RIF MBH:	23,361,231	43,691,788
BTU/SF/Yr.	288,695	539,938

Total Building Energy

KWH/Yr.	9,299,163	16,903,771
DOE RUF MBH:	107,870,303	195,155,751
DOE RIF MBH:	31,735,593	57,415,510
BTU/SF/Yr.	392,184	709,534

FERMILAB CENTRAL COMPUTING FACILITY
SITE WEATHER DATA AND DESIGN PROFILES

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

WEATHER SUMMARY

Site Name : AURORA,IL FERMI, User Defined

Date : 11-10-86

TABLE 1. SITE DESIGN WEATHER DATA

Latitude	=	42 deg.	Elevation	=	744 Feet
Summer design dry bulb	=	93 F	Winter design dry bulb	=	-6 F
Summer design wet bulb	=	76 F	Daily range	=	20 F

TABLE 2. PEAK SOLAR GAINS (Btu/(hr-sqft))

Month	N	NE	E	SE	S	SW	W	NW	H
January	5.6	13.2	107.4	173.8	189.1	173.8	107.4	13.2	107.6
July	17.1	144.7	189.6	148.8	88.4	148.8	189.6	144.7	264.5

Carrier peak solar data used.

Values corrected for altitude (744 ft), design dewpoint (69.3 F)

% Available Sunshine : Average data: Summer = 73 % ; Winter = 35 %

TABLE 3. OCCUPANCY SCHEDULE DATA

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
Begin	OFF	7 A	7 A	7 A	7 A	7 A	9 A
End	OFF	6 P	6 P	6 P	6 P	6 P	2 P

Average occupancy : 10.0 hrs/day; 6.0 days/week

Number of summer shutdown days = 0

TABLE 4. TEMPERATURE BIN DATA

Bin	Bin	Bin	Bin Hours (hr/yr)		
Dry	Wet	Specific	Total	Occupied	Unoccupied
Bulb	Bulb	Humidity	Hours	Hours	Hours
(F)	(F)	(lb/lb)			
93	76.0	0.0153	0.0	0.0	0.0
90	71.8	0.0124	40.4	25.8	14.6
85	69.0	0.0114	95.7	59.4	36.3
80	66.3	0.0106	244.6	145.3	99.3
75	63.6	0.0099	453.0	237.7	215.3
70	60.9	0.0093	628.2	270.6	357.6
65	58.2	0.0087	727.8	264.5	463.3
60	55.4	0.0083	755.4	255.0	500.4
55	52.7	0.0079	726.7	244.7	482.0
50	50.0	0.0076	679.7	232.1	447.6
45	45.0	0.0063	652.2	229.5	422.7
40	40.0	0.0052	651.3	237.6	413.7
35	35.0	0.0043	655.5	238.5	417.0
30	30.0	0.0035	635.6	218.2	417.4
25	25.0	0.0028	569.7	174.5	395.2
20	20.0	0.0022	459.3	122.4	336.9
15	15.0	0.0017	330.9	78.1	252.8
10	10.0	0.0013	211.8	46.1	165.7
5	5.0	0.0010	121.4	25.1	96.3
0	0.0	0.0008	63.6	12.7	50.9
-5	-5.0	0.0006	31.5	6.2	25.3
-6	-6.0	0.0006	25.7	4.6	21.1
-6	-6.0	0.0006	0.0	0.0	0.0

BIN HOUR PROFILE

Site : AURORA, IL FERMI, User Defined
Date : 12-01-86

Summer Dry Bulb = 93 F
Winter Dry Bulb = -6 F
Daily Range = 20 F

FERMILAB CENTRAL COMPUTING FACILITY
SITE ICW COOLING POND DATA AND PROFILES

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

ENGINEERING NOTE

1 of 1

SUBJECT

NAME

S. F. KRSTULOVICH

DATE

7.31.85

REVISION DATE

WATER QUALITY TABULATION ESTIMATE

PARAMETER	PER D. BOWEN DOMESTIC WATER	PER D. BOWEN ICELY WATER	PER U.S. GEO SURVEY EST. LOCAL WELLS
SOURCE	2 DEEP WELLS	CASEY'S POND	PEORIA IL MOD. BY 7 STATE FACTORS
TOTAL HARDNESS AS CaCO_3			394-455 ppm
HCO_3 AS CaCO_3			292-348 ppm
Ca AS CaCO_3	300 ppm	200-250 ppm (INCREASES IN WINTER)	227-275 ppm
TOTAL ALKALINITY	350 ppm EST.	140 ppm	292-348 ppm
DISSOLVED SOLIDS	475-500 ppm	350 ppm	448-583 ppm
LANGELIER pCa	2.5	2.6 TO 2.4 EST.	2.6
LANGELIER pALK.	2.2	2.6	2.2
LANGELIER $\text{C AT } 120^\circ$	1.75	1.72	1.75
SWR pH	6.45	6.92 TO 6.72 EST.	6.55
ACTUAL pH	7.5	8.0 TO 8.5	7.5
LANGELIER SATURATION INDEX	+1.05	+1.08 TO +1.78 EST.	+0.95
WATER ANTICIPATED CHARACTERISTICS	MODERATELY SCALING	MODERATE TO HEAVY SCALING.	MODERATELY SCALING

ENGINEERING NOTE		SECTION	PROJECT	SERIAL-CATEGORY	PAGE
FERMILAB PONDS		NAME: M. PALMER			
SUBJECT: "1974" TEMPERATURE, HUMIDITY, & VAPOR PRESSURE		DATE: 8-5-85			
		REVISION DATE:			

TEMP. (°C)	WATER PRESS. (PSI)
104	1.6
96	1.5
88	1.4
80	1.3
72	1.2
64	1.1
56	1.0
48	.9
40	.8
32	.7
24	.6
16	.5
8	.4
0	.3
-8	.2
-16	.1
-24	0
DATE	
1/1	1/8
1/16	1/24
2/1	2/9
2/17	2/25
3/5	3/13
3/21	3/29
4/7	4/15
4/23	5/1

ENGINEERING NOTE

SUBJECT

FERMILAB PONDS

SECTION

PROJECT

SERIAL CATEGORY

PAGE

NAME

PER: M. PALMER

DATE

REVISION DATE

NOTE: SEE EU SCALES ON PREVIOUS SHEET

% RELATIVE HUMIDITY

MINIMUM OUTSIDE
AIR TEMPERATURE

MAXIMUM OUTSIDE
AIR TEMPERATURE

POND WATER TEMP.

INNER POND
WATER TEMP.

SHUT
DOWN

INNER POND WATER
VAPOR PRESSURE

POND WATER
VAPOR PRESSURE

VAPOR PRESSURE
OF AIR

QUESTIONABLE
TEMPERATURE →
DATA

5/1 5/8 5/15 5/22 5/29 6/5 6/12 6/19 6/26 7/3 7/10 7/17 7/24 7/31 8/7 8/15

ENGINEERING NOTE

FERMILAB PONDS

PROJECT	SECTION	SERIAL-CATEGORY	PAGE
PER: M. PALMER			
DATE	REVISION	DATE	

NOTE: SEE EU SCALES ON PREVIOUS PAGE

8/7 8/15 8/22 8/30 9/8 9/16 9/24 10/2 10/10 10/18 10/26 11/3 11/11 11/19 11/27 12/5 12/13

FERMILAB CENTRAL COMPUTING FACILITY
BASIC BUILDING COMPUTER SIMULATION MODEL

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SUBJECT

CCF - COMPUTER BASIC SIMULATION MODEL

NAME

S.F. KRSTULOVICH

DATE

11-12-86

REVISION DATE

CCF PHYSICAL SURFACE PARAMETERS

SURFACE	ORIENTATION	AREA (SF PER FLOOR)	GLASS COEFFICIENT	NON-GLASS COEFFICIENT
A	NORTH	1560	1.0 (1560)	0.0 (0)
B	EAST	2320	0.3 (690)	0.7 (1630)
C	SOUTHEAST	4640	0.3 (1380)	0.7 (3260)
D	SOUTH	4640	0.3 (1380)	0.7 (3260)
E	SOUTHWEST	4640	0.3 (1380)	0.7 (3260)
F	NORTHWEST	1560	1.0 (1560)	0.0 (0)
G	NORTHEAST	760	1.0 (760)	0.0 (0)
H	NORTH	760	1.0 (760)	0.0 (0)
J	NORTHWEST	760	1.0 (760)	0.0 (0)
K	WEST	380	1.0 (380)	0.0 (0)
ROOF	HORIZONTAL	25500 (3RD FL. ONLY)	0.0 (0)	1.0 (25500)

SUBJECT

SUBSTRUCT 1/4

(FIRST FLOOR)
OF THREE

NAME
S.F. KRSTULOVICH

DATE
11.12.86

REVISION DATE

SUBCONSTRUCT 1/4 PHYSICAL PARAMETERS

[illegible]

FERMILAB

ENGINEERING NOTE

SECTION

C.E.S.

PROJECT

10-5-3

SERIAL-CATEGORY

CCF

PAGE

SUBJECT

SUBCONSTRUCT 1/4

(SECOND FLOOR)
OF THREE

NAME

S.F. KRSTULOVICH

DATE

11-12-86

REVISION DATE

	INTERIOR
	PERIMETER

N
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SUBCONSTRUCT 1/4 PHYSICAL PARAMETERS

PERIMETER ZONE		INTERIOR ZONE	
LINE ITEM	DESCRIPTION	LINE ITEM	DESCRIPTION
FLOOR AREA	4010 SF	FLOOR AREA	1650 SF
UNCONDITIONED FLOOR	1800 SF		
NORTH GLASS	520 SF		
SOUTHWEST GLASS	960 SF		
NORTHWEST GLASS	1560 SF		
NORTHEAST GLASS	760 SF		
SOUTHWEST WALL	2280 SF

SUBJECT

SUBCONSTRUCT 1/4

(THIRD FLOOR)
OF THREE

NAME

S.F. KRSTULOVICH

DATE

11.12.86

REVISION DATE

SUBCONSTRUCT 1/4 PHYSICAL PARAMETERS

PERIMETER ZONE		INTERIOR ZONE	
LINE ITEM	DESCRIPTION	LINE ITEM	DESCRIPTION
FLOOR AREA	12740 SF	FLOOR AREA	14000 SF (w/MEZZ.) ¹²⁴⁰
ROOF AREA	12740 SF	ROOF AREA	12760 SF
NORTH GLASS	2320 SF		
EAST GLASS	690 SF		
SOUTHEAST GLASS	1380 SF		
SOUTH GLASS	1380 SF		
SOUTHWEST GLASS	1380 SF		
WEST GLASS	380 SF		
NORTHWEST GLASS	760 SF		
NORTHEAST GLASS	760 SF		
EAST WALL	1630 SF		
SOUTHEAST WALL	3260 SF		
SOUTHWEST WALL	3260 SF		
SOUTH WALL	3260 SF

SUBJECT

SUBCONSTRUCT 2/4

(FIRST FLOOR)
OF TWO

NAME

S.F. KESTULOVICH

DATE

11.12.86

REVISION DATE

SUBCONSTRUCT 2/4 PHYSICAL PARAMETERS

PERIMETER ZONE

INTERIOR ZONE

LINE ITEM	DESCRIPTION
FLOOR AREA	9920 SF
UNCONDITIONED WALLS	1980 SF
NORTH GLASS	260 SF
NORTHWEST GLASS	760 SF
WEST GLASS	380 SF

LINE ITEM	DESCRIPTION
-----------	-------------

SUBJECT

SUBCONSTRUCT 2/4

(SECOND FLOOR)
OF TWO

NAME

S.F. KESTULOVICH

DATE

11.12.86

REVISION DATE

SUBCONSTRUCT 2/4 PHYSICAL PARAMETERS

PERIMETER ZONE		INTERIOR ZONE	
LINE ITEM	DESCRIPTION	LINE ITEM	DESCRIPTION
FLOOR AREA	19840 SF		
UNCONDITIONED FLOOR	6450 SF		
NORTH GLASS	1800 SF		
EAST GLASS	690 SF		
SOUTHEAST GLASS	1380 SF		
SOUTH GLASS	1380 SF		
SOUTHWEST GLASS	420 SF		
NORTHWEST GLASS	760 SF		
WEST GLASS	380 SF		
EAST WALL	1630 SF		
SOUTHEAST WALL	3260 SF		
SOUTH WALL	3260 SF		
SOUTHWEST WALL	980 SF

FERMILAB

ENGINEERING NOTE

SECTION

C.E.S.

PROJECT

10-5-3

SERIAL-CATEGORY

CCF

PAGE

SUBJECT

SUBCONSTRUCT 3/4

(FIRST FLOOR)
OF ONE

NAME

S.F. KRSTULOVICH

DATE

11.12.86

REVISION DATE

	INTERIOR
	PERIMETER

SUBCONSTRUCT 3/4 PHYSICAL PARAMETERS

PERIMETER ZONE		INTERIOR ZONE	
LINE ITEM	DESCRIPTION	LINE ITEM	DESCRIPTION
FLOOR AREA	8250 SF		
NORTH GLASS	780 SF		
EAST GLASS	690 SF		
SOUTHEAST GLASS	1380 SF		
SOUTH GLASS	1380 SF		
SOUTHWEST GLASS	1380 SF		
NORTHWEST GLASS	660 SF		
EAST WALL	1630 SF		
SOUTHEAST WALL	3260 SF		
SOUTH WALL	3260 SF		
SOUTHWEST WALL	3260 SF

SUBJECT

SUBCONSTRUCT 4/4

(SECOND FLOOR)
OF ONE

NAME

S.F. KRSTULOVICH

DATE

11.12.86

REVISION DATE

SUBCONSTRUCT 4/4 PHYSICAL PARAMETERS

PERIMETER ZONE

INTERIOR ZONE

LINE ITEM

DESCRIPTION

LINE ITEM

DESCRIPTION

FLOOR AREA

1 SF

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF BUSCONSTRUCT 1/4

Date : 11-10-86

Site : A.RTRA,IL,FERMI, user Defined

60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 78 F; Heating = 68 F; Setback = 5 F
 Warm-up factor = 0 %; Room design relative humidity = 50 %
 Floor Areas: Perimeter = 19,900 Sqft; Interior = 23,010 Sqft
 Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	3,360	0.550
Northeast Wall	0	0.060	5,640	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	5,540	0.060	2,340	0.550
West Wall	0	0.060	380	0.550
Northwest Wall	0	0.060	3,220	0.550
Perimeter Roof	12,740	0.050	0	0.001
Interior Roof	12,760	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium
 BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed
 Shade Factors : Glass = 0.650 ; Skylights = 0.000
 Internal shades are used. ; A ceiling plenum is used.

3. LIGHTS:

Perimeter : 3.000 Watts/Sqft = 59,700 Watts Total
 Interior : 3.000 Watts/Sqft = 69,030 Watts Total
 Diversity Factors : Occupied = 95 %; Unoccupied = 20 %
 Perimeter Lights : Ballast , recessed
 Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = 2.198 Watts/Sqft = 43,750 Watts Total
 Unoccupied = 0.942 Watts/Sqft = 18,750 Watts Total
 Interior : Occupied = 3.839 Watts/Sqft = 88,340 Watts Total
 Unoccupied = 2.742 Watts/Sqft = 63,100 Watts Total

5. PEOPLE LOADS

Total Occupancy = 550 sqft/person = 78 people total
 Activity Level: 2. Office or retail
 Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person
 Diversity Factors : Occupied = 70 %; Unoccupied = 20 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr
 Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 2,640 Sqft; Interior = 5,500 Sqft
 Wall U-Factor = 0.380 BTU/(hr-sqft-F)
 Adjacent region heating temperature = 65 F
 Adjacent region is not cooled

III-9

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 600 cfm; Unoccupied = 200 cfm

COMPLEX BUILDING INFLT SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

6011786I.C

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 68 F; Heating = 68 F; Setback = 0 F
 Warm-up factor = 0 %; Room design relative humidity = 45 %
 Floor Areas: Perimeter = 29,760 Sqft; Interior = 0 Sqft
 Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	2,060	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	980	0.060	420	0.550
West Wall	0	0.060	760	0.550
Northwest Wall	0	0.060	1,520	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium
 BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed
 Shade Factors : Glass = 0.650 ; Skylights = 0.000
 Internal shades are used. ; A ceiling plenum is used.

3. LIGHTS:

Perimeter : 1.000 Watts/Sqft = 29,760 Watts Total
 Interior : 0.000 Watts/Sqft = 0 Watts Total
 Diversity Factors : Occupied = 100 %; Unoccupied = 90 %
 Perimeter Lights : Ballast , recessed
 Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = 6.720 Watts/Sqft = 200,000 Watts Total
 Unoccupied = 6.720 Watts/Sqft = 200,000 Watts Total
 Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total
 Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 1,488 sqft/person = 20 people total
 Activity Level: 2. Office or retail
 Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person
 Diversity Factors : Occupied = 80 %; Unoccupied = 50 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr
 Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 8,340 Sqft; Interior = 0 Sqft
 Wall U-Factor = 0.380 BTU/(hr-sqft-F)
 Adjacent region heating temperature = 65 F
 Adjacent region is not cooled

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 149 cfm; Unoccupied = 89 cfm

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 FUT Date : 11-25-86
 Site : AURORA, IL FERMI, User Defined 601178&2.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 68 F; Heating = 68 F; Setback = 0 F
 Warm-up factor = 0 %; Room design relative humidity = 45 %
 Floor Areas: Perimeter = 29,760 Sqft; Interior = 0 Sqft
 Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	2,060	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	980	0.060	420	0.550
West Wall	0	0.060	760	0.550
Northwest Wall	0	0.060	1,520	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium
 BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed
 Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are used. ; A ceiling plenum is used.

3. LIGHTS:

Perimeter : 1.000 Watts/Sqft = 29,760 Watts Total
 Interior : 0.000 Watts/Sqft = 0 Watts Total
 Diversity Factors : Occupied = 100 %; Unoccupied = 90 %
 Perimeter Lights : Ballast , recessed
 Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = 20.161 Watts/Sqft = 600,000 Watts Total
 Unoccupied = 20.161 Watts/Sqft = 600,000 Watts Total
 Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total
 Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 1,488 sqft/person = 20 people total
 Activity Level: 2. Office or retail
 Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person
 Diversity Factors : Occupied = 80 %; Unoccupied = 50 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr
 Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 8,340 Sqft; Interior = 0 Sqft
 Wall U-Factor = 0.380 BTU/(hr-sqft-F)
 Adjacent region heating temperature = 65 F
 Adjacent region is not cooled

III-11

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 149 cfm; Unoccupied = 89 cfm

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 3/4

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 90 F; Heating = 65 F; Setback = 0 F

Warm-up factor = 0 %; Room design relative humidity = 50 %

Floor Areas: Perimeter = 8,250 Sqft; Interior = 0 Sqft

No cooling during unoccupied period. (Pulldown cycle not considered)

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	780	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	3,260	0.060	1,380	0.550
West Wall	0	0.060	0	0.550
Northwest Wall	0	0.060	660	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium

BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed

Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are used. ; A ceiling plenum is not used.

3. LIGHTS:

Perimeter : 2.000 Watts/Sqft = 16,500 Watts Total

Interior : 0.000 Watts/Sqft = 0 Watts Total

Diversity Factors : Occupied = 100 %; Unoccupied = 100 %

Perimeter Lights : Ballast , exposed

Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = 3.273 Watts/Sqft = 27,000 Watts Total

Unoccupied = 3.273 Watts/Sqft = 27,000 Watts Total

Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total

Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 8,250 sqft/person = 1 people total

Activity Level: 2. Office or retail

Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person

Diversity Factors : Occupied = 100 %; Unoccupied = 0 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 0 Sqft; Interior = 0 Sqft

Wall U-Factor = 0.000 BTU/(hr-sqft-F)

Adjacent region is not heated

Adjacent region is not cooled

III-12

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 413 cfm; Unoccupied = 165 cfm

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 4/4

Date : 11-26-86

Site : AURORA, IL FERMI, User Defined

60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 85 F; Heating = 85 F; Setback = 0 F

Warm-up factor = 0 %; Room design relative humidity = 50 %

Floor Areas: Perimeter = 1 Sqft; Interior = 0 Sqft

Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	0	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	0	0.060	0	0.550
Southeast Wall	0	0.060	0	0.550
South Wall	0	0.060	0	0.550
Southwest Wall	0	0.060	0	0.550
West Wall	0	0.060	0	0.550
Northwest Wall	0	0.060	0	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium

BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed

Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are not used. ; A ceiling plenum is not used.

3. LIGHTS:

Perimeter : 0.000 Watts/Sqft = 0 Watts Total

Interior : 0.000 Watts/Sqft = 0 Watts Total

Diversity Factors : Occupied = 0 %; Unoccupied = 0 %

Perimeter Lights : Ballast , recessed

Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = %350000.000 Watts/Sqft = 350,000 Watts Total

Unoccupied = %350000.000 Watts/Sqft = 350,000 Watts Total

Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total

Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 0 sqft/person = 0 people total

Activity Level: 6. User defined activity level

Sensible = 0.0 BTU/hr/person; Latent = 0.0 BTU/hr/person

Diversity Factors : Occupied = 0 %; Unoccupied = 0 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 0 Sqft; Interior = 0 Sqft

Wall U-Factor = 0.000 BTU/(hr-sqft-F)

Adjacent region is not heated

Adjacent region is not cooled

8. INFILTRATION DATA:

COMPLEX BUILDING INPUT SUMMARY

Building Name : CDF SUBCONSTRUCT 4/4 FUT Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 85 F; Heating = 85 F; Setback = 0 F
 Warm-up factor = 0 %; Room design relative humidity = 50 %
 Floor Areas: Perimeter = 1 Sqft; Interior = 0 Sqft
 Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	0	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	0	0.060	0	0.550
Southeast Wall	0	0.060	0	0.550
South Wall	0	0.060	0	0.550
Southwest Wall	0	0.060	0	0.550
West Wall	0	0.060	0	0.550
Northwest Wall	0	0.060	0	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium
 BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed
 Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are not used. ; A ceiling plenum is not used.

3. LIGHTS:

Perimeter : 0.000 Watts/Sqft = 0 Watts Total
 Interior : 0.000 Watts/Sqft = 0 Watts Total
 Diversity Factors : Occupied = 0 %; Unoccupied = 0 %
 Perimeter Lights : Ballast , recessed
 Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = %630000.000 Watts/Sqft = 630,000 Watts Total
 Unoccupied = %630000.000 Watts/Sqft = 630,000 Watts Total
 Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total
 Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 0 sqft/person = 0 people total
 Activity Level: 6. User defined activity level
 Sensible = 0.0 BTU/hr/person; Latent = 0.0 BTU/hr/person
 Diversity Factors : Occupied = 0 %; Unoccupied = 0 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr
 Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 0 Sqft; Interior = 0 Sqft
 Wall U-Factor = 0.000 BTU/(hr-sqft-F)
 Adjacent region is not heated
 Adjacent region is not cooled

8. INFILTRATION DATA:

REFERENCE PAGES FOR STATISTICS USED TO
COMPLETE PERFORMANCE SUMMARY SHEETS

(Analysis Data Summary Section - Pages 12 to 28)

1. Designed Configuration

Present Scope: (IV-49)+(V-50)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-49)+(VI-7)+(VII-8)+(IX-5)

2. FY1975 Configuration

Present Scope: (IV-115)+(V-74)+(VII-8)+(VIII-25)
Ultimate Scope: (IV-115)+(VI-31)+(VII-8)+(IX-25)

3. Alterate A Configuration

Present Scope: (IV-49)+(V-50)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-49)+(VI-7)+(VII-8)+(IX-15)

4. Alternate B Configuration

Present Scope: (IV-49)+(V-62)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-49)+(VI-19)+(VII-8)+(IX-5)

5. Alternate C Configuration

Present Scope: (IV-49)+(V-62)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-49)+(VI-19)+(VII-8)+(IX-15)

6. Alternate D Configuration

Present Scope: (IV-70)+(V-50)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-70)+(VI-7)+(VII-8)+(IX-5)

7. Alternate E Configuration

Present Scope: (IV-70)+(V-50)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-70)+(VI-7)+(VII-8)+(IX-15)

8. Alternate F Configuration

Present Scope: (IV-70)+(V-62)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-70)+(VI-19)+(VII-8)+(IX-5)

9. Alternate G Configuration

Present Scope: (IV-70)+(V-62)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-70)+(VI-19)+(VII-8)+(IX-15)

10. Alternate H Configuration

Present Scope: (IV-85)+(V-50)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-85)+(VI-7)+(VII-8)+(IX-5)

11. Alternate J Configuration

Present Scope: (IV-85)+(V-50)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-85)+(VI-7)+(VII-8)+(IX-15)

12. Alternate K Configuration

Present Scope: (IV-85)+(V-62)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-85)+(VI-19)+(VII-8)+(IX-5)

13. Alternate L Configuration

Present Scope: (IV-85)+(V-62)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-85)+(V-19)+(VII-8)+(IX-15)

14. Alternate M Configuration

Present Scope: (IV-100)+(V-50)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-100)+(VI-7)+(VII-8)+(IX-5)

15. Alternate N Configuration

Present Scope: (IV-100)+(V-50)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-100)+(VI-7)+(VII-8)+(IX-15)

16. Alternate P Configuration

Present Scope: (IV-100)+(V-62)+(VII-8)+(VIII-5)
Ultimate Scope: (IV-100)+(VI-19)+(VII-8)+(IX-5)

17. Alternate Q Configuration

Present Scope: (IV-100)+(V-62)+(VII-8)+(VIII-15)
Ultimate Scope: (IV-100)+(VI-19)+(VII-8)+(IX-15)

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
SYSTEMS ANALYSIS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
BUILDING SECTOR PHYSICAL PARAMETERS AND DESCRIPTION

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4

Date : 11-10-86

Site : AURORA, IL FERMI, User Defined

60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 78 F; Heating = 68 F; Setback = 5 F

Warm-up factor = 0 %; Room design relative humidity = 50 %

Floor Areas: Perimeter = 19,900 Sqft; Interior = 23,010 Sqft

Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	3,360	0.550
Northeast Wall	0	0.060	5,640	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	5,540	0.060	2,340	0.550
West Wall	0	0.060	380	0.550
Northwest Wall	0	0.060	3,220	0.550
Perimeter Roof	12,740	0.050	0	0.001
Interior Roof	12,760	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium

BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed

Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are used. ; A ceiling plenum is used.

3. LIGHTS:

Perimeter : 3.000 Watts/Sqft = 59,700 Watts Total

Interior : 3.000 Watts/Sqft = 69,030 Watts Total

Diversity Factors : Occupied = 95 %; Unoccupied = 20 %

Perimeter Lights : Ballast , recessed

Interior Lights : Ballast , recessed

4. MISCELLANEDUS ELECTRICAL LOADS:

Perimeter : Occupied = 2.198 Watts/Sqft = 43,750 Watts Total

Unoccupied = 0.942 Watts/Sqft = 18,750 Watts Total

Interior : Occupied = 3.839 Watts/Sqft = 88,340 Watts Total

Unoccupied = 2.742 Watts/Sqft = 63,100 Watts Total

5. PEOPLE LOADS

Total Occupancy = 550 sqft/person = 78 people total

Activity Level: 2. Office or retail

Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person

Diversity Factors : Occupied = 70 %; Unoccupied = 20 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 2,640 Sqft; Interior = 5,900 Sqft

Wall U-Factor = 0.380 BTU/(hr-sqft-F)

Adjacent region heating temperature = 65 F

Adjacent region is not cooled

8. INFILTRATION DATA:

IV-1

Air Flow Rates: Occupied = 600 cfm; Unoccupied = 200 cfm

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
BUILDING LOAD CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

LOAD PROFILE SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-10-86

Site Name : AURORA, IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD (Load does not include vent. load, fan heat)

		<-----Perimeter Zone----->				<-----Interior Zone----->			
Bin	Bin	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum	Zone
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(tons)	(F)
93	0.0	85.96	1.82	7.50	78	46.45	0.71	8.49	78
90	25.8	69.45	0.94	6.85	78	44.63	0.50	7.80	78
85	59.4	62.67	0.71	6.66	78	43.61	0.50	7.60	78
80	145.3	55.89	0.50	6.46	78	42.59	0.50	7.41	78
75	237.7	49.11	0.33	6.26	78	41.57	0.50	7.21	78
70	270.6	42.32	0.17	6.07	78	40.56	0.50	7.01	78
65	264.5	35.54	0.05	5.87	78	39.54	0.50	6.81	78
60	255.0	29.18	-0.06	5.67	78	39.45	0.50	6.62	78
55	244.7	22.81	-0.15	5.47	78	39.37	0.50	6.42	78
50	232.1	16.45	-0.22	5.28	78	39.28	0.50	6.22	78
45	229.5	10.09	-0.53	5.08	78	39.20	0.50	6.02	78
40	237.6	3.72	-0.80	4.88	78	39.11	0.50	5.83	78
35	238.5	0.00	0.00	0.00	--	39.03	0.50	5.63	78
30	218.2	0.00	0.00	0.00	--	38.94	0.50	5.43	78
25	174.5	-4.71	-0.67	4.66	68	38.86	0.50	5.23	78
20	122.4	-11.07	-0.81	4.46	68	38.78	0.50	5.04	78
15	78.1	-17.44	-0.92	4.27	68	38.69	0.50	4.84	78
10	46.1	-23.80	-1.01	4.07	68	38.61	0.50	4.64	78
5	25.1	-30.17	-1.09	3.87	68	38.52	0.50	4.44	78
0	12.7	-36.53	-1.14	3.68	68	38.44	0.50	4.25	78
-5	6.2	-42.89	-1.19	3.48	68	38.35	0.50	4.05	78
-6	4.6	-44.17	-1.19	3.44	68	38.33	0.50	4.01	78

TABLE 2. UNOCCUPIED PERIOD (Load does not include vent. load, fan heat)

90	14.6	50.39	0.29	2.08	78	24.14	0.14	2.28	78
85	36.3	43.79	0.21	1.88	78	23.12	0.14	2.08	78
80	99.3	37.19	0.15	1.68	78	22.10	0.14	1.88	78
75	215.3	30.59	0.09	1.49	78	21.08	0.14	1.69	78
70	357.6	24.00	0.04	1.29	78	20.07	0.14	1.49	78
65	463.3	17.40	-0.01	1.09	78	19.05	0.14	1.29	78
60	500.4	11.22	-0.04	0.90	78	18.96	0.14	1.09	78
55	482.0	5.04	-0.07	0.70	78	18.88	0.14	0.90	78
50	447.6	0.00	0.00	0.00	--	18.79	0.14	0.70	78
45	422.7	0.00	0.00	0.00	--	18.71	0.14	0.50	78
40	413.7	0.00	0.00	0.00	--	18.62	0.14	0.30	78
35	417.0	-4.25	-0.02	0.47	63	18.54	0.14	0.11	78
30	417.4	-10.43	-0.09	0.27	63	18.45	0.14	-0.09	78
25	395.2	-16.61	-0.15	0.07	63	18.37	0.14	-0.29	78
20	336.9	-22.79	-0.19	-0.12	63	18.29	0.14	-0.49	78
15	252.8	-28.97	-0.23	-0.32	63	18.20	0.14	-0.68	78
10	165.7	-35.15	-0.26	-0.52	63	18.12	0.14	-0.88	78
5	96.3	-41.33	-0.29	-0.72	63	18.03	0.14	-1.08	78
0	50.9	-47.51	-0.31	-0.91	63	17.95	0.14	-1.28	78
-5	25.3	-53.69	-0.32	-1.11	63	17.86	0.14	-1.47	78
-6	21.1	-54.93	-0.32	-1.15	63	17.84	0.14	-1.51	78
-6	0.0	-65.08	-0.45	-2.56	63	-0.73	0.00	-2.57	63

SOLAR GAIN SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-10-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. SOLAR GAINS BY EXPOSURE

Bin Temp (F)	Solar Gains by Exposure (BTU/(hr-sqft))								Perim Horiz	Inter Horiz
	North	NE	East	SE	South	SW	West	NW		
93	9.7	15.0	22.2	23.2	33.9	67.7	66.5	32.0	0.0	0.0
90	6.9	10.7	15.7	16.5	24.1	48.0	47.1	22.6	0.0	0.0
85	6.5	10.1	14.9	15.7	23.0	45.7	44.8	21.5	0.0	0.0
80	6.2	9.6	14.2	14.9	21.8	43.3	42.4	20.3	0.0	0.0
75	5.8	9.0	13.4	14.2	20.7	40.9	40.0	19.1	0.0	0.0
70	5.5	8.5	12.6	13.4	19.6	38.6	37.7	18.0	0.0	0.0
65	5.1	7.9	11.8	12.6	18.5	36.2	35.3	16.8	0.0	0.0
60	4.8	7.4	11.0	11.8	17.4	33.9	32.9	15.6	0.0	0.0
55	4.4	6.8	10.3	11.0	16.2	31.5	30.6	14.4	0.0	0.0
50	4.1	6.3	9.5	10.3	15.1	29.2	28.2	13.3	0.0	0.0
45	3.7	5.7	8.7	9.5	14.0	26.8	25.8	12.1	0.0	0.0
40	3.4	5.2	7.9	8.7	12.9	24.4	23.5	10.9	0.0	0.0
35	3.0	4.6	7.1	7.9	11.8	22.1	21.1	9.8	0.0	0.0
30	2.7	4.1	6.4	7.2	10.6	19.7	18.8	8.6	0.0	0.0
25	2.3	3.5	5.6	6.4	9.5	17.4	16.4	7.4	0.0	0.0
20	2.0	3.0	4.8	5.6	8.4	15.0	14.0	6.3	0.0	0.0
15	1.6	2.4	4.0	4.8	7.3	12.7	11.7	5.1	0.0	0.0
10	1.2	1.9	3.2	4.1	6.2	10.3	9.3	3.9	0.0	0.0
5	0.9	1.3	2.5	3.3	5.0	8.0	6.9	2.8	0.0	0.0
0	0.5	0.8	1.7	2.5	3.9	5.6	4.6	1.6	0.0	0.0
-5	0.2	0.2	0.9	1.7	2.8	3.2	2.2	0.4	0.0	0.0
-6	0.1	0.1	0.7	1.6	2.6	2.8	1.7	0.2	0.0	0.0
-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ETD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-10-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD

Bin Temp (F)	Equivalent Temperature Differences (F)								Perim Roof	Inter Roof
	North	NE	East	SE	By Exposure		West	NW		
					South	SW				
93	8.0	9.9	11.2	16.5	20.0	18.5	15.0	9.3	30.4	30.4
90	5.4	6.7	7.6	11.4	13.9	12.8	10.3	6.3	21.7	21.7
85	1.0	2.2	3.1	6.7	9.1	8.1	5.7	1.8	16.4	16.4
80	-3.4	-2.2	-1.4	2.1	4.2	3.4	1.1	-2.6	11.1	11.1
75	-7.8	-6.7	-5.9	-2.6	-0.6	-1.4	-3.6	-7.1	5.8	5.8
70	-12.2	-11.2	-10.4	-7.3	-5.4	-6.1	-8.2	-11.5	0.5	0.5
65	-16.6	-15.6	-14.9	-11.9	-10.2	-10.8	-12.8	-15.9	-4.9	-4.9
60	-21.0	-20.1	-19.4	-16.6	-15.0	-15.5	-17.5	-20.4	-10.2	-10.2
55	-25.4	-24.5	-23.9	-21.3	-19.8	-20.3	-22.1	-24.8	-15.5	-15.5
50	-29.8	-29.0	-28.4	-25.9	-24.6	-25.0	-26.7	-29.3	-20.8	-20.8
45	-34.2	-33.5	-32.9	-30.6	-29.4	-29.7	-31.4	-33.7	-26.1	-26.1
40	-38.6	-37.9	-37.4	-35.3	-34.2	-34.4	-36.0	-38.1	-31.4	-31.4
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-36.7
30	-----	-----	-----	-----	-----	-----	-----	-----	-----	-42.0
25	-41.8	-41.3	-40.9	-39.3	-38.7	-38.6	-39.9	-41.5	-37.3	-47.3
20	-46.2	-45.8	-45.4	-43.9	-43.5	-43.4	-44.5	-45.9	-42.6	-52.6
15	-50.5	-50.2	-50.0	-48.6	-48.3	-48.1	-49.2	-50.3	-47.9	-57.9
10	-54.9	-54.7	-54.5	-53.3	-53.1	-52.8	-53.8	-54.8	-53.2	-63.2
5	-59.3	-59.2	-59.0	-57.9	-57.9	-57.5	-58.4	-59.2	-58.6	-68.6
0	-63.7	-63.6	-63.5	-62.6	-62.7	-62.3	-63.1	-63.7	-63.9	-73.9
-5	-68.1	-68.1	-68.0	-67.3	-67.5	-67.0	-67.7	-68.1	-69.2	-79.2
-6	-69.0	-69.0	-68.9	-68.2	-68.5	-67.9	-68.6	-69.0	-70.2	-80.2

TABLE 2. UNOCCUPIED PERIOD

90	5.4	6.7	7.6	11.4	13.9	12.8	10.3	6.3	21.7	21.7
85	1.0	2.2	3.1	6.7	9.1	8.1	5.7	1.8	16.4	16.4
80	-3.4	-2.2	-1.4	2.1	4.2	3.4	1.1	-2.6	11.1	11.1
75	-7.8	-6.7	-5.9	-2.6	-0.6	-1.4	-3.6	-7.1	5.8	5.8
70	-12.2	-11.2	-10.4	-7.3	-5.4	-6.1	-8.2	-11.5	0.5	0.5
65	-16.6	-15.6	-14.9	-11.9	-10.2	-10.8	-12.8	-15.9	-4.9	-4.9
60	-21.0	-20.1	-19.4	-16.6	-15.0	-15.5	-17.5	-20.4	-10.2	-10.2
55	-25.4	-24.5	-23.9	-21.3	-19.8	-20.3	-22.1	-24.8	-15.5	-15.5
50	-----	-----	-----	-----	-----	-----	-----	-----	-----	-20.8
45	-----	-----	-----	-----	-----	-----	-----	-----	-----	-26.1
40	-----	-----	-----	-----	-----	-----	-----	-----	-----	-31.4
35	-28.0	-27.4	-26.9	-24.9	-24.0	-24.2	-25.6	-27.6	-21.7	-36.7
30	-32.4	-31.9	-31.4	-29.6	-28.8	-28.9	-30.3	-32.0	-27.0	-42.0
25	-36.8	-36.3	-35.9	-34.3	-33.7	-33.6	-34.9	-36.5	-32.3	-47.3
20	-41.2	-40.8	-40.4	-38.9	-38.5	-38.4	-39.5	-40.9	-37.6	-52.6
15	-45.5	-45.2	-45.0	-43.6	-43.3	-43.1	-44.2	-45.3	-42.9	-57.9
10	-49.9	-49.7	-49.5	-48.3	-48.1	-47.8	-48.8	-49.8	-48.2	-63.2
5	-54.3	-54.2	-54.0	-52.9	-52.9	-52.5	-53.4	-54.2	-53.6	-68.6
0	-58.7	-58.6	-58.5	-57.6	-57.7	-57.3	-58.1	-58.7	-58.9	-73.9
-5	-63.1	-63.1	-63.0	-62.3	-62.5	-62.0	-62.7	-63.1	-64.2	-79.2
-6	-64.0	-64.0	-63.9	-63.2	-63.5	-62.9	-63.6	-64.0	-65.2	-80.2
-6	-69.0	-69.0	-69.0	-69.0	-69.0	-69.0	-69.0	-69.0	-69.0	-69.0

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0124
 Bin Number : 1 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 90 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
----------------	------------------	----------------

Solar Gain	353,112	0
Glass Transmission	121,374	0
Wall Transmission	9,948	0
Roof Transmission	8,294	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	38,942	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	7,920	6,071

Total Room Loads	1,369,005	17,264
Total Room Tons	114.08	1.44
Total Room sqft/ton	376.13	29,826.11
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	19,353 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	22,176	23,049
Northeast Glass	5,640	37,224	60,078
East Glass	690	4,554	10,848
Southeast Glass	1,380	9,108	22,745
South Glass	1,380	9,108	33,230
Southwest Glass	2,340	15,444	112,359
West Glass	380	2,508	17,917
Northwest Glass	3,220	21,252	72,886
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	745	-
Southeast Wall	3,260	2,233	-
South Wall	3,260	2,711	-
Southwest Wall	5,540	4,259	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	13,813	-
Interior Roof	12,760	13,835	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied D.A. Humidity Ratio = 0.0114
 Bin Number : 2 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 85 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
----------------	------------------	----------------

Solar Gain	335,496	0
Glass Transmission	70,802	0
Wall Transmission	6,082	0
Roof Transmission	6,264	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	22,716	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	4,620	3,276

Total Room Loads	1,275,395	14,469
Total Room Tons	106.28	1.21
Total Room sqft/ton	403.73	35,588.36
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	14,616 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
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North Glass	3,360	12,936	21,871
Northeast Glass	5,640	21,714	56,975
East Glass	690	2,657	10,309
Southeast Glass	1,380	5,313	21,674
South Glass	1,380	5,313	31,685
Southwest Glass	2,340	9,009	106,844
West Glass	380	1,463	17,018
Northwest Glass	3,220	12,397	69,120
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	304	-
Southeast Wall	3,260	1,320	-
South Wall	3,260	1,770	-
Southwest Wall	5,540	2,688	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	10,431	-
Interior Roof	12,760	10,448	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0106
 Bin Number : 3 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 80 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	317,881	0
Glass Transmission	20,229	0
Wall Transmission	2,217	0
Roof Transmission	4,233	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	6,490	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	1,320	833

Total Room Loads	1,181,785	12,026
Total Room Tons	98.48	1.00
Total Room sqft/ton	435.71	42,816.48
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	9,878 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	3,696	20,693
Northeast Glass	5,640	6,204	53,873
East Glass	690	759	9,771
Southeast Glass	1,380	1,518	20,603
South Glass	1,380	1,518	30,140
Southwest Glass	2,340	2,574	101,330
West Glass	380	418	16,118
Northwest Glass	3,220	3,542	65,354
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-136	-
Southeast Wall	3,260	407	-
South Wall	3,260	830	-
Southwest Wall	5,540	1,117	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	7,050	-
Interior Roof	12,760	7,061	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied D.A. Humidity Ratio = 0.0106
 Bin Number : 3 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 80 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	317,881	0
Glass Transmission	20,229	0
Wall Transmission	2,217	0
Roof Transmission	4,233	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	6,490	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	1,320	833

Total Room Loads	1,181,785	12,026
Total Room Tons	98.48	1.00
Total Room sqft/ton	435.71	42,816.48
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	9,878 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	3,696	20,693
Northeast Glass	5,640	6,204	53,873
East Glass	690	759	9,771
Southeast Glass	1,380	1,518	20,603
South Glass	1,380	1,518	30,140
Southwest Glass	2,340	2,574	101,330
West Glass	380	418	16,118
Northwest Glass	3,220	3,542	65,354
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-136	-
Southeast Wall	3,260	407	-
South Wall	3,260	830	-
Southwest Wall	5,540	1,117	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	7,050	-
Interior Roof	12,760	7,061	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0099
 Bin Number : 4 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 75 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	300,265	0
Glass Transmission	-30,344	0
Wall Transmission	-1,648	0
Roof Transmission	2,203	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,736	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-1,980	-1,284

Total Room Loads	1,088,175	9,909
Total Room Tons	90.68	0.83
Total Room sqft/ton	473.20	51,964.02
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	5,140 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-5,544	19,514
Northeast Glass	5,640	-9,306	50,770
East Glass	690	-1,139	9,232
Southeast Glass	1,380	-2,277	19,532
South Glass	1,380	-2,277	28,594
Southwest Glass	2,340	-3,861	95,815
West Glass	380	-627	15,219
Northwest Glass	3,220	-5,313	61,588
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-577	-
Southeast Wall	3,260	-506	-
South Wall	3,260	-111	-
Southwest Wall	5,540	-454	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	3,669	-
Interior Roof	12,760	3,675	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0093
 Bin Number : 5 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 70 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	282,649	0
Glass Transmission	-80,916	0
Wall Transmission	-5,513	0
Roof Transmission	173	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-25,962	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-5,280	-3,101

Total Room Loads	994,566	8,092
Total Room Tons	82.88	0.67
Total Room sqft/ton	517.73	63,631.09
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	403 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-14,784	18,336
Northeast Glass	5,640	-24,816	47,667
East Glass	690	-3,036	8,693
Southeast Glass	1,380	-6,072	18,461
South Glass	1,380	-6,072	27,049
Southwest Glass	2,340	-10,296	90,300
West Glass	380	-1,672	14,320
Northwest Glass	3,220	-14,168	57,822
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,017	-
Southeast Wall	3,260	-1,419	-
South Wall	3,260	-1,051	-
Southwest Wall	5,540	-2,025	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	287	-
Interior Roof	12,760	288	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0087
 Bin Number : 6 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 65 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	265,033	0
Glass Transmission	-131,489	0
Wall Transmission	-9,378	0
Roof Transmission	-1,858	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-8,580	-4,641

Total Room Loads	900,956	6,552
Total Room Tons	75.08	0.55
Total Room sqft/ton	571.53	78,584.82
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-4,335 Btu/hr	

***** TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE *****

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-24,024	17,157
Northeast Glass	5,640	-40,326	44,565
East Glass	690	-4,934	8,155
Southeast Glass	1,380	-9,867	17,390
South Glass	1,380	-9,867	25,504
Southwest Glass	2,340	-16,731	84,786
West Glass	380	-2,717	13,420
Northwest Glass	3,220	-23,023	54,056
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,458	-
Southeast Wall	3,260	-2,332	-
South Wall	3,260	-1,992	-
Southwest Wall	5,540	-3,596	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-3,094	-
Interior Roof	12,760	-3,099	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0083
 Bin Number : 7 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 60 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
----------------	------------------	----------------

Solar Gain	247,418	0
Glass Transmission	-182,061	0
Wall Transmission	-13,243	0
Roof Transmission	-3,888	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-11,880	-5,925

Total Room Loads	823,572	5,268
Total Room Tons	68.63	0.44
Total Room sqft/ton	625.23	97,745.88
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-9,073 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-33,264	15,979
Northeast Glass	5,640	-55,836	41,462
East Glass	690	-6,831	7,616
Southeast Glass	1,380	-13,662	16,319
South Glass	1,380	-13,662	23,959
Southwest Glass	2,340	-23,166	79,271
West Glass	380	-3,762	12,521
Northwest Glass	3,220	-31,878	50,290
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,898	-
Southeast Wall	3,260	-3,245	-
South Wall	3,260	-2,933	-
Southwest Wall	5,540	-5,167	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-6,475	-
Interior Roof	12,760	-6,486	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0079
 Bin Number : 8 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 55 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
----------------	------------------	----------------

Solar Gain	229,802	0
Glass Transmission	-232,634	0
Wall Transmission	-17,108	0
Roof Transmission	-5,919	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-15,180	-6,974

Total Room Loads	746,189	4,219
Total Room Tons	62.18	0.35
Total Room sqft/ton	690.07	122,044.56
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-13,810 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-42,504	14,801
Northeast Glass	5,640	-71,346	38,360
East Glass	690	-8,729	7,077
Southeast Glass	1,380	-17,457	15,248
South Glass	1,380	-17,457	22,414
Southwest Glass	2,340	-29,601	73,756
West Glass	380	-4,807	11,622
Northwest Glass	3,220	-40,733	46,524
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,339	-
Southeast Wall	3,260	-4,158	-
South Wall	3,260	-3,873	-
Southwest Wall	5,540	-6,738	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-9,857	-
Interior Roof	12,760	-9,872	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0076
 Bin Number : 9 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 50 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	212,186	0
Glass Transmission	-283,206	0
Wall Transmission	-20,973	0
Roof Transmission	-7,949	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-18,480	-7,806

Total Room Loads	668,805	3,387
Total Room Tons	55.73	0.28
Total Room sqft/ton	769.91	152,020.63
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-18,548 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-51,744	13,622
Northeast Glass	5,640	-86,856	35,257
East Glass	690	-10,626	6,539
Southeast Glass	1,380	-21,252	14,178
South Glass	1,380	-21,252	20,868
Southwest Glass	2,340	-36,036	68,242
West Glass	380	-5,852	10,722
Northwest Glass	3,220	-49,588	42,758
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,780	-
Southeast Wall	3,260	-5,071	-
South Wall	3,260	-4,814	-
Southwest Wall	5,540	-8,309	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-13,238	-
Interior Roof	12,760	-13,259	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0063
 Bin Number : 10 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 45 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	194,570	0
Glass Transmission	-333,779	0
Wall Transmission	-24,838	0
Roof Transmission	-9,980	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-21,780	-11,595
Total Room Loads	591,421	-402
Total Room Tons	49.29	-0.03
Total Room sqft/ton	870.65	%1,281,128.88
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-23,286 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-60,984	12,444
Northeast Glass	5,640	-102,366	32,154
East Glass	690	-12,524	6,000
Southeast Glass	1,380	-25,047	13,107
South Glass	1,380	-25,047	19,323
Southwest Glass	2,340	-42,471	62,727
West Glass	380	-6,897	9,823
Northwest Glass	3,220	-58,443	38,992
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,220	-
Southeast Wall	3,260	-5,984	-
South Wall	3,260	-5,755	-
Southwest Wall	5,540	-9,880	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-16,619	-
Interior Roof	12,760	-16,646	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0052
 Bin Number : 11 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 40 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	176,955	0
Glass Transmission	-384,351	0
Wall Transmission	-28,703	0
Roof Transmission	-12,010	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-25,080	-14,788

Total Room Loads	514,037	-3,595
Total Room Tons	42.84	-0.30
Total Room sqft/ton	1,001.72	143,237.09
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-28,023 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-70,224	11,266
Northeast Glass	5,640	-117,876	29,052
East Glass	690	-14,421	5,461
Southeast Glass	1,380	-28,842	12,036
South Glass	1,380	-28,842	17,778
Southwest Glass	2,340	-48,906	57,212
West Glass	380	-7,942	8,924
Northwest Glass	3,220	-67,298	35,226
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,661	-
Southeast Wall	3,260	-6,897	-
South Wall	3,260	-6,695	-
Southwest Wall	5,540	-11,451	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-20,001	-
Interior Roof	12,760	-20,032	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0043
 Bin Number : 12 Perimeter Zone Indoor DB = n/a
 Outdoor Dry Bulb = 35 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	0	0
Glass Transmission	0	0
Wall Transmission	0	0
Roof Transmission	-7,026	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-29,146	0
Lighting (65,579 W Total)	195,842	0
Misc. Elec. (88,340 W Total)	301,504	0
People (29 People Total)	7,173	6,002
Miscellaneous Internal Loads	0	0
Infiltration	0	0

Total Room Loads	468,348	6,002
Total Room Tons	39.03	0.50
Total Room sqft/ton	589.56	46,003.76
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	83,932 Btu/hr	
Roof Load to Plenum	-16,393 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	0	0
Northeast Glass	5,640	0	0
East Glass	690	0	0
Southeast Glass	1,380	0	0
South Glass	1,380	0	0
Southwest Glass	2,340	0	0
West Glass	380	0	0
Northwest Glass	3,220	0	0
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	0	-
Southeast Wall	3,260	0	-
South Wall	3,260	0	-
Southwest Wall	5,540	0	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	0	-
Interior Roof	12,760	-23,419	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0035
 Bin Number : 13 Perimeter Zone Indoor DB = n/a
 Outdoor Dry Bulb = 30 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	0	0
Glass Transmission	0	0
Wall Transmission	0	0
Roof Transmission	-8,042	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-29,146	0
Lighting (65,579 W Total)	195,842	0
Misc. Elec. (88,340 W Total)	301,504	0
People (29 People Total)	7,173	6,002
Miscellaneous Internal Loads	0	0
Infiltration	0	0

Total Room Loads	467,332	6,002
Total Room Tons	38.94	0.50
Total Room sqft/ton	590.84	46,003.76
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	83,932 Btu/hr	
Roof Load to Plenum	-18,764 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	0	0
Northeast Glass	5,640	0	0
East Glass	690	0	0
Southeast Glass	1,380	0	0
South Glass	1,380	0	0
Southwest Glass	2,340	0	0
West Glass	380	0	0
Northwest Glass	3,220	0	0
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	0	-
Southeast Wall	3,260	0	-
South Wall	3,260	0	-
Southwest Wall	5,540	0	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	0	-
Interior Roof	12,760	-26,806	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0028
 Bin Number : 14 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 25 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	124,107	0
Glass Transmission	-434,924	0
Wall Transmission	-32,085	0
Roof Transmission	-16,190	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-28,380	-13,199

Total Room Loads	409,788	-2,006
Total Room Tons	34.15	-0.17
Total Room sqft/ton	1,256.55	256,677.19
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-37,777 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-79,464	7,730
Northeast Glass	5,640	-133,386	19,744
East Glass	690	-16,319	3,845
Southeast Glass	1,380	-32,637	8,823
South Glass	1,380	-32,637	13,142
Southwest Glass	2,340	-55,341	40,668
West Glass	380	-8,987	6,226
Northwest Glass	3,220	-76,153	23,929
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,004	-
Southeast Wall	3,260	-7,679	-
South Wall	3,260	-7,561	-
Southwest Wall	5,540	-12,840	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-23,775	-
Interior Roof	12,760	-30,192	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0022
 Bin Number : 15 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 20 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	106,492	0
Glass Transmission	-485,496	0
Wall Transmission	-35,950	0
Roof Transmission	-18,221	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-31,680	-14,898

Total Room Loads	332,404	-3,705
Total Room Tons	27.70	-0.31
Total Room sqft/ton	1,549.08	138,994.70
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-42,515 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-88,704	6,552
Northeast Glass	5,640	-148,896	16,641
East Glass	690	-18,216	3,307
Southeast Glass	1,380	-36,432	7,752
South Glass	1,380	-36,432	11,597
Southwest Glass	2,340	-61,776	35,154
West Glass	380	-10,032	5,326
Northwest Glass	3,220	-85,008	20,163
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,445	-
Southeast Wall	3,260	-8,592	-
South Wall	3,260	-8,502	-
Southwest Wall	5,540	-14,411	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-27,156	-
Interior Roof	12,760	-33,579	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0017
 Bin Number : 16 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 15 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	88,876	0
Glass Transmission	-536,069	0
Wall Transmission	-39,815	0
Roof Transmission	-20,251	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-34,980	-16,260

Total Room Loads	255,020	-5,067
Total Room Tons	21.25	-0.42
Total Room sqft/ton	2,019.13	101,618.56
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-47,252 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-97,944	5,374
Northeast Glass	5,640	-164,406	13,539
East Glass	690	-20,114	2,768
Southeast Glass	1,380	-40,227	6,681
South Glass	1,380	-40,227	10,052
Southwest Glass	2,340	-68,211	29,639
West Glass	380	-11,077	4,427
Northwest Glass	3,220	-93,863	16,397
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,885	-
Southeast Wall	3,260	-9,505	-
South Wall	3,260	-9,443	-
Southwest Wall	5,540	-15,982	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-30,538	-
Interior Roof	12,760	-36,966	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0013
 Bin Number : 17 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 10 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	71,260	0
Glass Transmission	-586,641	0
Wall Transmission	-43,680	0
Roof Transmission	-22,281	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-38,280	-17,348

Total Room Loads	177,637	-6,155
Total Room Tons	14.80	-0.51
Total Room sqft/ton	2,898.72	83,653.88
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-51,990 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-107,184	4,195
Northeast Glass	5,640	-179,916	10,436
East Glass	690	-22,011	2,229
Southeast Glass	1,380	-44,022	5,610
South Glass	1,380	-44,022	8,507
Southwest Glass	2,340	-74,646	24,124
West Glass	380	-12,122	3,528
Northwest Glass	3,220	-102,718	12,631
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,326	-
Southeast Wall	3,260	-10,418	-
South Wall	3,260	-10,383	-
Southwest Wall	5,540	-17,553	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-33,919	-
Interior Roof	12,760	-40,352	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0010
 Bin Number : 18 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 5 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	53,644	0
Glass Transmission	-637,214	0
Wall Transmission	-47,545	0
Roof Transmission	-24,312	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-41,580	-18,213

Total Room Loads	100,253	-7,020
Total Room Tons	8.35	-0.59
Total Room sqft/ton	5,136.20	73,347.33
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-56,728 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-116,424	3,017
Northeast Glass	5,640	-195,426	7,334
East Glass	690	-23,909	1,691
Southeast Glass	1,380	-47,817	4,539
South Glass	1,380	-47,817	6,961
Southwest Glass	2,340	-81,081	18,609
West Glass	380	-13,167	2,628
Northwest Glass	3,220	-111,573	8,865
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,767	-
Southeast Wall	3,260	-11,331	-
South Wall	3,260	-11,324	-
Southwest Wall	5,540	-19,124	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-37,300	-
Interior Roof	12,760	-43,739	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0008
 Bin Number : 19 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 0 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	36,029	0
Glass Transmission	-687,786	0
Wall Transmission	-51,410	0
Roof Transmission	-26,342	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-44,880	-18,897

Total Room Loads	22,869	-7,704
Total Room Tons	1.91	-0.64
Total Room sqft/ton	22,515.79	66,834.60
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-61,465 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-125,664	1,839
Northeast Glass	5,640	-210,936	4,231
East Glass	690	-25,806	1,152
Southeast Glass	1,380	-51,612	3,468
South Glass	1,380	-51,612	5,416
Southwest Glass	2,340	-87,516	13,095
West Glass	380	-14,212	1,729
Northwest Glass	3,220	-120,428	5,099
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,207	-
Southeast Wall	3,260	-12,244	-
South Wall	3,260	-12,264	-
Southwest Wall	5,540	-20,695	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-40,682	-
Interior Roof	12,760	-47,126	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0006
 Bin Number : 20 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = -5 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	18,413	0
Glass Transmission	-738,359	0
Wall Transmission	-55,275	0
Roof Transmission	-28,373	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-48,180	-19,436

Total Room Loads	-54,514	-8,243
Total Room Tons	-4.54	-0.69
Total Room sqft/ton	9,445.58	62,469.99
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-66,203 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-134,904	660
Northeast Glass	5,640	-226,446	1,128
East Glass	690	-27,704	613
Southeast Glass	1,380	-55,407	2,397
South Glass	1,380	-55,407	3,871
Southwest Glass	2,340	-93,951	7,580
West Glass	380	-15,257	830
Northwest Glass	3,220	-129,283	1,333
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,648	-
Southeast Wall	3,260	-13,157	-
South Wall	3,260	-13,205	-
Southwest Wall	5,540	-22,266	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-44,063	-
Interior Roof	12,760	-50,512	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0006
 Bin Number : 21 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = -6 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	14,890	0
Glass Transmission	-748,473	0
Wall Transmission	-56,048	0
Roof Transmission	-28,779	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-32,156	0
Lighting (122,294 W Total)	365,214	0
Misc. Elec. (132,090 W Total)	450,823	0
People (55 People Total)	13,377	11,193
Miscellaneous Internal Loads	0	0
Infiltration	-48,840	-19,528

Total Room Loads	-69,991	-8,335
Total Room Tons	-5.83	-0.69
Total Room sqft/ton	7,356.93	61,774.57
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	156,520 Btu/hr	
Roof Load to Plenum	-67,150 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-136,752	425
Northeast Glass	5,640	-229,548	508
East Glass	690	-28,083	506
Southeast Glass	1,380	-56,166	2,183
South Glass	1,380	-56,166	3,562
Southwest Glass	2,340	-95,238	6,477
West Glass	380	-15,466	650
Northwest Glass	3,220	-131,054	580
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,736	-
Southeast Wall	3,260	-13,339	-
South Wall	3,260	-13,393	-
Southwest Wall	5,540	-22,580	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-44,739	-
Interior Roof	12,760	-51,190	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0124
 Bin Number : 1 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 90 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	353,112	0
Glass Transmission	121,374	0
Wall Transmission	9,948	0
Roof Transmission	8,294	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	38,942	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	2,640	2,024

Total Room Loads	894,373	5,222
Total Room Tons	74.53	0.44
Total Room sqft/ton	575.73	98,611.77
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	19,353 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	22,176	23,049
Northeast Glass	5,640	37,224	60,078
East Glass	690	4,554	10,848
Southeast Glass	1,380	9,108	22,745
South Glass	1,380	9,108	33,230
Southwest Glass	2,340	15,444	112,359
West Glass	380	2,508	17,917
Northwest Glass	3,220	21,252	72,886
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	745	-
Southeast Wall	3,260	2,233	-
South Wall	3,260	2,711	-
Southwest Wall	5,540	4,259	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	13,813	-
Interior Roof	12,760	13,835	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0114
 Bin Number : 2 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 85 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	335,496	0
Glass Transmission	70,802	0
Wall Transmission	6,082	0
Roof Transmission	6,264	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	22,716	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	1,540	1,092

Total Room Loads	802,964	4,290
Total Room Tons	66.91	0.36
Total Room sqft/ton	641.27	120,030.02
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	14,616 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	12,936	21,871
Northeast Glass	5,640	21,714	56,975
East Glass	690	2,657	10,309
Southeast Glass	1,380	5,313	21,674
South Glass	1,380	5,313	31,685
Southwest Glass	2,340	9,009	106,844
West Glass	380	1,463	17,018
Northwest Glass	3,220	12,397	69,120
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	304	-
Southeast Wall	3,260	1,320	-
South Wall	3,260	1,770	-
Southwest Wall	5,540	2,688	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	10,431	-
Interior Roof	12,760	10,448	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0106
 Bin Number : 3 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 80 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	317,881	0
Glass Transmission	20,229	0
Wall Transmission	2,217	0
Roof Transmission	4,233	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	6,490	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	440	278

Total Room Loads	711,554	3,476
Total Room Tons	59.30	0.29
Total Room sqft/ton	723.66	148,146.98
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	9,878 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	3,696	20,693
Northeast Glass	5,640	6,204	53,873
East Glass	690	759	9,771
Southeast Glass	1,380	1,518	20,603
South Glass	1,380	1,518	30,140
Southwest Glass	2,340	2,574	101,330
West Glass	380	418	16,118
Northwest Glass	3,220	3,542	65,354
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-136	-
Southeast Wall	3,260	407	-
South Wall	3,260	830	-
Southwest Wall	5,540	1,117	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	7,050	-
Interior Roof	12,760	7,061	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0099
 Bin Number : 4 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 75 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	300,265	0
Glass Transmission	-30,344	0
Wall Transmission	-1,648	0
Roof Transmission	2,203	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,736	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-660	-428

Total Room Loads	620,144	2,770
Total Room Tons	51.68	0.23
Total Room sqft/ton	830.32	185,888.00
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	5,140 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
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North Glass	3,360	-5,544	19,514
Northeast Glass	5,640	-9,306	50,770
East Glass	690	-1,139	9,232
Southeast Glass	1,380	-2,277	19,532
South Glass	1,380	-2,277	28,594
Southwest Glass	2,340	-3,861	95,815
West Glass	380	-627	15,219
Northwest Glass	3,220	-5,313	61,588
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-577	-
Southeast Wall	3,260	-506	-
South Wall	3,260	-111	-
Southwest Wall	5,540	-454	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	3,669	-
Interior Roof	12,760	3,675	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0093
 Bin Number : 5 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 70 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	282,649	0
Glass Transmission	-80,916	0
Wall Transmission	-5,513	0
Roof Transmission	173	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-25,962	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-1,760	-1,034

Total Room Loads	528,735	2,164
Total Room Tons	44.06	0.18
Total Room sqft/ton	973.87	237,901.66
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	403 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-14,784	18,336
Northeast Glass	5,640	-24,816	47,667
East Glass	690	-3,036	8,693
Southeast Glass	1,380	-6,072	18,461
South Glass	1,380	-6,072	27,049
Southwest Glass	2,340	-10,296	90,300
West Glass	380	-1,672	14,320
Northwest Glass	3,220	-14,168	57,822
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,017	-
Southeast Wall	3,260	-1,419	-
South Wall	3,260	-1,051	-
Southwest Wall	5,540	-2,025	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	287	-
Interior Roof	12,760	288	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0087
 Bin Number : 6 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 65 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	265,033	0
Glass Transmission	-131,489	0
Wall Transmission	-9,378	0
Roof Transmission	-1,858	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-2,860	-1,547

Total Room Loads	437,325	1,651
Total Room Tons	36.44	0.14
Total Room sqft/ton	1,177.43	311,857.84
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-4,335 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-24,024	17,157
Northeast Glass	5,640	-40,326	44,565
East Glass	690	-4,934	8,155
Southeast Glass	1,380	-9,867	17,390
South Glass	1,380	-9,867	25,504
Southwest Glass	2,340	-16,731	84,786
West Glass	380	-2,717	13,420
Northwest Glass	3,220	-23,023	54,056
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,458	-
Southeast Wall	3,260	-2,332	-
South Wall	3,260	-1,992	-
Southwest Wall	5,540	-3,596	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-3,094	-
Interior Roof	12,760	-3,099	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0083
 Bin Number : 7 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 60 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	247,418	0
Glass Transmission	-182,061	0
Wall Transmission	-13,243	0
Roof Transmission	-3,888	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-3,960	-1,975

Total Room Loads	362,141	1,223
Total Room Tons	30.18	0.10
Total Room sqft/ton	1,421.88	421,036.25
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-9,073 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-33,264	15,979
Northeast Glass	5,640	-55,836	41,462
East Glass	690	-6,831	7,616
Southeast Glass	1,380	-13,662	16,319
South Glass	1,380	-13,662	23,959
Southwest Glass	2,340	-23,166	79,271
West Glass	380	-3,762	12,521
Northwest Glass	3,220	-31,878	50,290
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,898	-
Southeast Wall	3,260	-3,245	-
South Wall	3,260	-2,933	-
Southwest Wall	5,540	-5,167	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-6,475	-
Interior Roof	12,760	-6,486	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0079
 Bin Number : 8 Perimeter Zone Indoor DB = 78 F
 Outdoor Dry Bulb = 55 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
----------------	------------------	----------------

Solar Gain	229,802	0
Glass Transmission	-232,634	0
Wall Transmission	-17,108	0
Roof Transmission	-5,919	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-42,188	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-5,060	-2,325

Total Room Loads	286,957	873
Total Room Tons	23.91	0.07
Total Room sqft/ton	1,794.41	589,576.88
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-13,810 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-42,504	14,801
Northeast Glass	5,640	-71,346	38,360
East Glass	690	-8,729	7,077
Southeast Glass	1,380	-17,457	15,248
South Glass	1,380	-17,457	22,414
Southwest Glass	2,340	-29,601	73,756
West Glass	380	-4,807	11,622
Northwest Glass	3,220	-40,733	46,524
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,339	-
Southeast Wall	3,260	-4,158	-
South Wall	3,260	-3,873	-
Southwest Wall	5,540	-6,738	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-9,857	-
Interior Roof	12,760	-9,872	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0076
 Bin Number : 9 Perimeter Zone Indoor DB = n/a
 Outdoor Dry Bulb = 50 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	0	0
Glass Transmission	0	0
Wall Transmission	0	0
Roof Transmission	-3,978	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-29,146	0
Lighting (13,806 W Total)	41,230	0
Misc. Elec. (63,100 W Total)	215,360	0
People (8 People Total)	2,050	1,715
Miscellaneous Internal Loads	0	0
Infiltration	0	0

Total Room Loads	225,516	1,715
Total Room Tons	18.79	0.14
Total Room sqft/ton	1,224.39	161,013.16
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	17,670 Btu/hr	
Roof Load to Plenum	-9,281 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	0	0
Northeast Glass	5,640	0	0
East Glass	690	0	0
Southeast Glass	1,380	0	0
South Glass	1,380	0	0
Southwest Glass	2,340	0	0
West Glass	380	0	0
Northwest Glass	3,220	0	0
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	0	-
Southeast Wall	3,260	0	-
South Wall	3,260	0	-
Southwest Wall	5,540	0	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	0	-
Interior Roof	12,760	-13,259	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied D.A. Humidity Ratio = 0.0063
 Bin Number : 10 Perimeter Zone Indoor DB = n/a
 Outdoor Dry Bulb = 45 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	0	0
Glass Transmission	0	0
Wall Transmission	0	0
Roof Transmission	-4,994	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-29,146	0
Lighting (13,806 W Total)	41,230	0
Misc. Elec. (63,100 W Total)	215,360	0
People (8 People Total)	2,050	1,715
Miscellaneous Internal Loads	0	0
Infiltration	0	0

Total Room Loads	224,500	1,715
Total Room Tons	18.71	0.14
Total Room sqft/ton	1,229.93	161,013.16
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	17,670 Btu/hr	
Roof Load to Plenum	-11,652 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	0	0
Northeast Glass	5,640	0	0
East Glass	690	0	0
Southeast Glass	1,380	0	0
South Glass	1,380	0	0
Southwest Glass	2,340	0	0
West Glass	380	0	0
Northwest Glass	3,220	0	0
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	0	-
Southeast Wall	3,260	0	-
South Wall	3,260	0	-
Southwest Wall	5,540	0	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	0	-
Interior Roof	12,760	-16,646	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0052
 Bin Number : 11 Perimeter Zone Indoor DB = n/a
 Outdoor Dry Bulb = 40 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	0	0
Glass Transmission	0	0
Wall Transmission	0	0
Roof Transmission	-6,010	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-29,146	0
Lighting (13,806 W Total)	41,230	0
Misc. Elec. (63,100 W Total)	215,360	0
People (8 People Total)	2,050	1,715
Miscellaneous Internal Loads	0	0
Infiltration	0	0

Total Room Loads	223,484	1,715
Total Room Tons	18.62	0.14
Total Room sqft/ton	1,235.52	161,013.16
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	17,670 Btu/hr	
Roof Load to Plenum	-14,023 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	0	0
Northeast Glass	5,640	0	0
East Glass	690	0	0
Southeast Glass	1,380	0	0
South Glass	1,380	0	0
Southwest Glass	2,340	0	0
West Glass	380	0	0
Northwest Glass	3,220	0	0
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	0	-
Southeast Wall	3,260	0	-
South Wall	3,260	0	-
Southwest Wall	5,540	0	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	0	-
Interior Roof	12,760	-20,032	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0043
 Bin Number : 12 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 35 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	159,339	0
Glass Transmission	-283,206	0
Wall Transmission	-20,247	0
Roof Transmission	-11,174	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-6,160	-1,759

Total Room Loads	171,475	1,439
Total Room Tons	14.29	0.12
Total Room sqft/ton	3,002.88	357,909.47
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-26,072 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-51,744	10,087
Northeast Glass	5,640	-86,856	25,949
East Glass	690	-10,626	4,923
Southeast Glass	1,380	-21,252	10,965
South Glass	1,380	-21,252	16,233
Southwest Glass	2,340	-36,036	51,698
West Glass	380	-5,852	8,024
Northwest Glass	3,220	-49,588	31,461
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,634	-
Southeast Wall	3,260	-4,875	-
South Wall	3,260	-4,702	-
Southwest Wall	5,540	-8,036	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-13,827	-
Interior Roof	12,760	-23,419	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0035
 Bin Number : 13 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 30 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	141,723	0
Glass Transmission	-333,779	0
Wall Transmission	-24,113	0
Roof Transmission	-13,204	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-7,260	-2,552

Total Room Loads	96,292	646
Total Room Tons	8.02	0.05
Total Room sqft/ton	5,347.51	797,153.94
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-30,810 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-60,984	8,909
Northeast Glass	5,640	-102,366	22,847
East Glass	690	-12,524	4,384
Southeast Glass	1,380	-25,047	9,894
South Glass	1,380	-25,047	14,687
Southwest Glass	2,340	-42,471	46,183
West Glass	380	-6,897	7,125
Northwest Glass	3,220	-58,443	27,695
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,075	-
Southeast Wall	3,260	-5,788	-
South Wall	3,260	-5,643	-
Southwest Wall	5,540	-9,607	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-17,209	-
Interior Roof	12,760	-26,806	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0028
 Bin Number : 14 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 25 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	124,107	0
Glass Transmission	-384,351	0
Wall Transmission	-27,978	0
Roof Transmission	-15,235	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-8,360	-3,255
Total Room Loads	21,108	-57
Total Room Tons	1.76	-0.00
Total Room sqft/ton	24,394.74	29,070,280.00
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-35,548 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-70,224	7,730
Northeast Glass	5,640	-117,876	19,744
East Glass	690	-14,421	3,845
Southeast Glass	1,380	-28,842	8,823
South Glass	1,380	-28,842	13,142
Southwest Glass	2,340	-48,906	40,668
West Glass	380	-7,942	6,226
Northwest Glass	3,220	-67,298	23,929
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,515	-
Southeast Wall	3,260	-6,701	-
South Wall	3,260	-6,583	-
Southwest Wall	5,540	-11,178	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-20,590	-
Interior Roof	12,760	-30,192	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0022
 Bin Number : 15 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 20 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	106,492	0
Glass Transmission	-434,924	0
Wall Transmission	-31,843	0
Roof Transmission	-17,265	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-9,460	-3,821

Total Room Loads	-54,076	-623
Total Room Tons	-4.51	-0.05
Total Room sqft/ton	9,522.18	826,600.44
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-40,285 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-79,464	6,552
Northeast Glass	5,640	-133,386	16,641
East Glass	690	-16,319	3,307
Southeast Glass	1,380	-32,637	7,752
South Glass	1,380	-32,637	11,597
Southwest Glass	2,340	-55,341	35,154
West Glass	380	-8,987	5,326
Northwest Glass	3,220	-76,153	20,163
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,956	-
Southeast Wall	3,260	-7,614	-
South Wall	3,260	-7,524	-
Southwest Wall	5,540	-12,749	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-23,971	-
Interior Roof	12,760	-33,579	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0017
 Bin Number : 16 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 15 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	88,876	0
Glass Transmission	-485,496	0
Wall Transmission	-35,708	0
Roof Transmission	-19,296	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-10,560	-4,275

Total Room Loads	-129,260	-1,077
Total Room Tons	-10.77	-0.09
Total Room sqft/ton	3,983.61	478,047.66
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-45,023 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-88,704	5,374
Northeast Glass	5,640	-148,896	13,539
East Glass	690	-18,216	2,768
Southeast Glass	1,380	-36,432	6,681
South Glass	1,380	-36,432	10,052
Southwest Glass	2,340	-61,776	29,639
West Glass	380	-10,032	4,427
Northwest Glass	3,220	-85,008	16,397
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,396	-
Southeast Wall	3,260	-8,527	-
South Wall	3,260	-8,465	-
Southwest Wall	5,540	-14,320	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-27,353	-
Interior Roof	12,760	-36,966	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0013
 Bin Number : 17 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 10 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	71,260	0
Glass Transmission	-536,069	0
Wall Transmission	-39,573	0
Roof Transmission	-21,326	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-11,660	-4,638

Total Room Loads	-204,443	-1,440
Total Room Tons	-17.04	-0.12
Total Room sqft/ton	2,518.64	357,618.69
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-49,760 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-97,944	4,195
Northeast Glass	5,640	-164,406	10,436
East Glass	690	-20,114	2,229
Southeast Glass	1,380	-40,227	5,610
South Glass	1,380	-40,227	8,507
Southwest Glass	2,340	-68,211	24,124
West Glass	380	-11,077	3,528
Northwest Glass	3,220	-93,863	12,631
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,837	-
Southeast Wall	3,260	-9,440	-
South Wall	3,260	-9,405	-
Southwest Wall	5,540	-15,891	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-30,734	-
Interior Roof	12,760	-40,352	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0010
 Bin Number : 18 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 5 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	53,644	0
Glass Transmission	-586,641	0
Wall Transmission	-43,438	0
Roof Transmission	-23,356	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-12,760	-4,926

Total Room Loads	-279,627	-1,728
Total Room Tons	-23.30	-0.14
Total Room sqft/ton	1,841.45	297,957.03
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-54,498 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-107,184	3,017
Northeast Glass	5,640	-179,916	7,334
East Glass	690	-22,011	1,691
Southeast Glass	1,380	-44,022	4,539
South Glass	1,380	-44,022	6,961
Southwest Glass	2,340	-74,646	18,609
West Glass	380	-12,122	2,628
Northwest Glass	3,220	-102,718	8,865
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,278	-
Southeast Wall	3,260	-10,353	-
South Wall	3,260	-10,346	-
Southwest Wall	5,540	-17,462	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-34,115	-
Interior Roof	12,760	-43,739	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied D.A. Humidity Ratio = 0.0008
 Bin Number : 19 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = 0 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	36,029	0
Glass Transmission	-637,214	0
Wall Transmission	-47,303	0
Roof Transmission	-25,387	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-13,860	-5,154

Total Room Loads	-354,811	-1,956
Total Room Tons	-29.57	-0.16
Total Room sqft/ton	1,451.25	263,224.56
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-59,236 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-116,424	1,839
Northeast Glass	5,640	-195,426	4,231
East Glass	690	-23,909	1,152
Southeast Glass	1,380	-47,817	3,468
South Glass	1,380	-47,817	5,416
Southwest Glass	2,340	-81,081	13,095
West Glass	380	-13,167	1,729
Northwest Glass	3,220	-111,573	5,099
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,718	-
Southeast Wall	3,260	-11,266	-
South Wall	3,260	-11,286	-
Southwest Wall	5,540	-19,033	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-37,497	-
Interior Roof	12,760	-47,126	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied D.A. Humidity Ratio = 0.0006
 Bin Number : 20 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = -5 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	18,413	0
Glass Transmission	-687,786	0
Wall Transmission	-51,168	0
Roof Transmission	-27,417	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-14,960	-5,334
Total Room Loads	-429,995	-2,136
Total Room Tons	-35.83	-0.18
Total Room sqft/ton	1,197.50	241,109.22
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-63,973 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-125,664	660
Northeast Glass	5,640	-210,936	1,128
East Glass	690	-25,806	613
Southeast Glass	1,380	-51,612	2,397
South Glass	1,380	-51,612	3,871
Southwest Glass	2,340	-87,516	7,580
West Glass	380	-14,212	830
Northwest Glass	3,220	-120,428	1,333
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,159	-
Southeast Wall	3,260	-12,179	-
South Wall	3,260	-12,227	-
Southwest Wall	5,540	-20,604	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-40,878	-
Interior Roof	12,760	-50,512	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 1/4 Date : 11-10-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0006
 Bin Number : 21 Perimeter Zone Indoor DB = 63 F
 Outdoor Dry Bulb = -6 F Interior Zone Indoor DB = 78 F

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	14,890	0
Glass Transmission	-697,901	0
Wall Transmission	-51,941	0
Roof Transmission	-27,823	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-27,140	0
Lighting (25,746 W Total)	76,887	0
Misc. Elec. (81,850 W Total)	279,354	0
People (16 People Total)	3,822	3,198
Miscellaneous Internal Loads	0	0
Infiltration	-15,180	-5,365

Total Room Loads	-445,031	-2,167
Total Room Tons	-37.09	-0.18
Total Room sqft/ton	1,157.04	237,667.11
Perimeter Zone Floor Area	19,900 sqft	
Interior Zone Floor Area	23,010 sqft	
Lighting Load to Plenum	32,952 Btu/hr	
Roof Load to Plenum	-64,921 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	3,360	-127,512	425
Northeast Glass	5,640	-214,038	508
East Glass	690	-26,186	506
Southeast Glass	1,380	-52,371	2,183
South Glass	1,380	-52,371	3,562
Southwest Glass	2,340	-88,803	6,477
West Glass	380	-14,421	650
Northwest Glass	3,220	-122,199	580
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,247	-
Southeast Wall	3,260	-12,361	-
South Wall	3,260	-12,415	-
Southwest Wall	5,540	-20,918	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	12,740	-41,554	-
Interior Roof	12,760	-51,190	-

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 1/4
SYSTEM COMPARISON PERFORMANCE SIMULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
OPERATIONAL PERFORMANCE SIMULATION

DESIGN BASIS SYSTEM
WATER SOURCE HEAT PUMPS WITH EDP WASTE HEAT RECOVERY

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 DESIGN SYS Page 1
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex) Date : 11-11-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

Are perimeter and interior zone on same supply fan ? <N>

>1. PERIMETER TERMINAL TYPE :

Supply fan type : Forward curved with 2-speed motor

Supply fan total static pressure = 1.50 in. wg.

Low speed = 50 % of high speed

Return fan type : Forward curved with 2-speed motor

Return fan total static pressure = 1.50 in. wg.

Low speed % of full speed = 50 %

Design supply air= 5336 cfm @ 79.8 F; Vent. air= 2668 cfm

Minimum zone air flow = 50 % of design supply cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Fan coil units

Fan coil fan avg. efficiency = 60 % ; tot. static = 1.00 in wg

Economizer type : Integrated, dry-bulb controlled

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 45 % ; Input power = 0.1 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

>2. INTERIOR TERMINAL TYPE :

Supply fan type : Forward curved with 2-speed motor

Supply fan total static pressure = 1.50 in. wg.

Low speed = 50 % of high speed

Return fan type : Forward curved with 2-speed motor

Return fan total static pressure = 1.50 in. wg.

Low speed % of full speed = 50 %

Design supply air= 3344 cfm @ 74 F; Vent. air= 1672 cfm

Minimum zone air flow = 50 % of design supply cfm

Economizer type : Integrated, dry-bulb controlled

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 45 % ; Input power = 0.1 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

> 1 b. BLOCK AUXILIARY PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 DESIGN SYS Page 2
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex) Date : 11-11-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS

Does one plant serve perimeter and interior ? <N>

>1. PERIMETER PLANT : WATER SOURCE HEAT PUMPS

Cooling:

Capacity @ 85 F entering water = 120.2 tons

KW/Ton @ 85 F entering water = 1.09 kw/ton

Heating:

Capacity @ 70 F entering water = 1721 MBH

Compressor KW @ 70 F entering water = 140.1 KW

Heat sink type = Open cooling tower

Entering water temperatures: Minimum = 60 F; Maximum = 90 F

Is condenser performance altitude adjusted ? <Y>

Outdoor air temperature for economizer cutoff = 30 F

>2. INTERIOR PLANT : WATER SOURCE HEAT PUMPS

Cooling:

Capacity @ 85 F entering water = 75.4 tons

KW/Ton @ 85 F entering water = 0.98 kw/ton

Heating:

Capacity @ 70 F entering water = 1078 MBH

Compressor KW @ 70 F entering water = 1056.0 KW

D. PUMPING SYSTEMS

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. Period			>2. OTHER FUELS		Unit Cost
ELECTRICAL ENERGY USE	Occupied (\$/kwh)	Unoccupied (\$/kwh)			
Compressor	0.050	0.050	Natural Gas		n/a \$/therm
Resistance	0.050	0.050	Fuel Oil		n/a \$/U.S.gal
Inductive	0.050	0.050	Propane		n/a \$/lb
			Remote Heating	0.000	\$/MBTU
			Remote Cooling		n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 1/4 DESIGN SYS

Period : All

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Zone : Block

Site : AURORA,IL FERMI, User Defined

Serial Number:

Date : 11-11-86

60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	10786	206805 kwh/yr	2398933	705824
Electric (Unocc)	12136	188441 kwh/yr	2185918	643150
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	22922		4584851	1348974

NON-HVAC ENERGY

Electric (Occ)	39793	795864 kwh/yr	9232025	2716285
Electric (Unocc)	30296	605916 kwh/yr	7028627	2067992
Non-HVAC Total	70089		16260652	4784276
Grand Total	93011		20845503	6133250
Total/Sq.Ft.	2.17		485.80	142.93

HVAC Summary:

HVAC Total Cost	=	0.53 \$/Sq.Ft./yr
	=	24.64 % of Total Cost
Total HVAC Electrical Energy	=	9.21 kwh/Sq.Ft./yr
	=	21.99 % of Total Electrical Energy
Non-Electrical HVAC Energy	=	0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 DESIGN SYS Page 1
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex) Date : 11-11-86
 Site : AURORA, IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$550)

Are perimeter and interior zone on same supply fan ? <N>

>1. PERIMETER TERMINAL TYPE : VAV

Supply fan type : Forward curved with 2-speed motor

Supply fan total static pressure = 1.50 in. wg.

Low speed = 50 % of high speed

Return fan type : Forward curved with 2-speed motor

Return fan total static pressure = 1.50 in. wg.

Low speed % of full speed = 50 %

Design supply air= 5336 cfm @ 78 F; Vent. air= 2668 cfm

Minimum zone air flow = 50 % of design supply cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Fan coil units

Fan coil fan avg. efficiency = 60 % ; tot. static = 1.00 in wg

Economizer type : Integrated, dry-bulb controlled

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 45 % ; Input power = 0.1 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

>2. INTERIOR TERMINAL TYPE : VAV

Supply fan type : Forward curved with 2-speed motor

Supply fan total static pressure = 1.50 in. wg.

Low speed = 50 % of high speed

Return fan type : Forward curved with 2-speed motor

Return fan total static pressure = 1.50 in. wg.

Low speed % of full speed = 50 %

Design supply air= 3344 cfm @ 74 F; Vent. air= 1672 cfm

Minimum zone air flow = 50 % of design supply cfm

Economizer type : Integrated, dry-bulb controlled

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 45 % ; Input power = 0.1 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$3,159)

> 1 b. BLOCK AUXILIARY PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 DESIGN SYS Page 2
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex) Date : 11-11-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$14,423)

Does one plant serve perimeter and interior ? <N>

>1. PERIMETER PLANT : WATER SOURCE HEAT PUMPS

Cooling:

Capacity @ 85 F entering water = 120.2 tons

KW/Ton @ 85 F entering water = 1.09 kw/ton

Heating:

Capacity @ 70 F entering water = 1721 MBH

Compressor KW @ 70 F entering water = 140.1 KW

Heat sink type = Open cooling tower

Entering water temperatures: Minimum = 60 F; Maximum = 90 F

Is condenser performance altitude adjusted ? <Y>

Outdoor air temperature for economizer cutoff = 30 F

>2. INTERIOR PLANT : WATER SOURCE HEAT PUMPS

Cooling:

Capacity @ 85 F entering water = 75.4 tons

KW/Ton @ 85 F entering water = 0.98 kw/ton

Heating:

Capacity @ 70 F entering water = 1078 MBH

Compressor KW @ 70 F entering water = 1056.0 KW

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$4,789)

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$70,089)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$93,011)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	0.000 \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 1/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-11-86
 Serial Number :
 60117862.0

Bin		Perimeter Cooling Plant			Interior Cooling Plant		
Temp	Hours	Coil Load	Input	Cost	Coil Load	Input	Cost
(F)	hr/yr	MBH	KW	\$/yr	MBH	KW	\$/yr
-----OCCUPIED PERIOD-----							
90	25.8	1153.2	99.0	127.7	773.7	57.5	74.1
85	59.4	1000.8	83.4	247.8	724.1	51.5	153.1
80	145.3	859.1	69.4	504.3	677.8	46.1	334.9
75	237.7	727.2	56.9	676.0	634.5	41.1	488.6
70	270.6	603.9	45.7	618.7	594.0	36.6	494.6
65	264.5	500.4	36.7	485.3	556.1	32.5	429.2
60	255.0	401.9	28.7	366.2	533.2	29.4	374.9
55	244.7	301.5	21.9	267.6	511.5	27.4	335.6
50	232.1	193.3	15.2	176.6	490.9	26.4	306.5
45	229.5	47.4	6.0	69.1	456.5	24.7	283.3
40	237.6	0.0	0.0	0.0	425.0	26.1	309.9
35	238.5	0.0	0.0	0.0	396.0	24.6	293.5
30	218.2	0.0	0.0	0.0	368.6	23.2	253.1
25	174.5	0.0	0.0	0.0	441.7	26.9	235.0
20	122.4	0.0	0.0	0.0	428.0	26.2	160.6
15	78.1	0.0	0.0	0.0	415.1	25.6	99.9
10	46.1	0.0	0.0	0.0	402.9	25.0	57.5
5	25.1	0.0	0.0	0.0	391.3	24.4	30.6
0	12.7	0.0	0.0	0.0	380.1	23.8	15.1
-5	6.2	0.0	0.0	0.0	369.3	23.2	7.2
-6	4.6	0.0	0.0	0.0	367.2	20.1	4.6
Total Costs				\$3539.5	\$4741.7		
-----UNOCCUPIED PERIOD-----							
90	14.6	734.1	63.9	46.7	418.0	31.4	22.9
85	36.3	698.9	58.5	106.1	382.7	27.5	50.0
80	99.3	588.8	47.6	236.5	354.4	24.2	120.2
75	215.3	484.2	38.0	408.6	326.9	21.1	227.7
70	357.6	378.4	28.9	517.1	300.1	18.3	327.6
65	463.3	266.3	20.2	468.8	274.1	15.7	364.0
60	500.4	141.4	12.0	299.7	260.3	14.5	362.9
55	482.0	0.0	0.0	0.0	247.1	16.8	404.5
50	447.6	0.0	0.0	0.0	234.5	16.1	360.5
45	422.7	0.0	0.0	0.0	213.7	15.0	316.6
40	413.7	0.0	0.0	0.0	194.5	13.9	288.3
35	417.0	0.0	0.0	0.0	176.8	13.0	270.3
30	417.4	0.0	0.0	0.0	159.9	12.0	251.1
25	395.2	0.0	0.0	0.0	181.4	13.2	261.2
20	336.9	0.0	0.0	0.0	172.2	9.7	163.8
15	252.8	0.0	0.0	0.0	163.5	9.2	116.8
10	165.7	0.0	0.0	0.0	155.2	8.8	72.8
5	96.3	0.0	0.0	0.0	147.1	8.3	40.2
0	50.9	0.0	0.0	0.0	139.4	7.9	20.1
-5	25.3	0.0	0.0	0.0	131.8	7.5	9.5
-6	21.1	0.0	0.0	0.0	130.3	7.4	7.8
Total Costs				\$2083.5	\$4058.7		

PERIMETER AND BLOCK AUXILIARY HEATING PLANT COSTS

Job Name : CCF SUBCON 1/4 DESIGN SYS

Date : 11-11-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Coil	Primary Plant			Auxiliary Plant		
Temp	Hours	Load	Output	Input	Cost	Output	Input	Cost
(F)	hr/yr	MBH	MBH	KW	\$/yr	MBH	MBH	\$/yr
-----OCCUPIED PERIOD-----								
90	25.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85	59.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	145.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	237.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	270.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	264.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	255.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	244.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	232.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	229.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40	237.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	238.5	24.8	24.8	2.0	24.4	0.0	0.0	0.0
30	218.2	28.7	28.7	2.4	25.8	0.0	0.0	0.0
25	174.5	87.3	87.3	7.2	62.8	0.0	0.0	0.0
20	122.4	172.2	172.2	14.2	86.9	0.0	0.0	0.0
15	78.1	257.1	257.1	21.2	82.8	0.0	0.0	0.0
10	46.1	342.0	342.0	28.2	65.0	0.0	0.0	0.0
5	25.1	426.9	426.9	35.2	44.2	0.0	0.0	0.0
0	12.7	511.8	511.8	42.2	26.8	0.0	0.0	0.0
-5	6.2	596.7	596.7	49.2	15.3	0.0	0.0	0.0
-6	4.6	613.6	613.6	50.6	11.6	5.0	5.0	0.0
Total Costs					\$445.7	\$0.0		
-----UNOCCUPIED PERIOD-----								
90	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85	36.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80	99.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75	215.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70	357.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65	463.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60	500.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	482.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	447.6	16.3	16.3	1.3	30.2	0.0	0.0	0.0
45	422.7	22.8	22.8	1.9	39.7	0.0	0.0	0.0
40	413.7	29.2	29.2	2.4	49.9	0.0	0.0	0.0
35	417.0	84.9	84.9	7.0	146.1	0.0	0.0	0.0
30	417.4	167.6	167.6	13.8	288.6	0.0	0.0	0.0
25	395.2	250.3	250.3	20.6	408.0	0.0	0.0	0.0
20	336.9	333.0	333.0	27.5	462.7	33.8	33.8	0.0
15	252.8	415.7	415.7	34.3	433.4	103.6	103.6	0.0
10	165.7	498.4	498.4	41.1	340.6	172.9	172.9	0.0
5	96.3	581.1	581.1	47.9	230.8	241.9	241.9	0.0
0	50.9	663.8	663.8	54.8	139.3	310.5	310.5	0.0
-5	25.3	746.5	746.5	61.6	77.9	379.0	379.0	0.0
-6	21.1	763.0	763.0	62.9	66.4	392.6	392.6	0.0
Total Costs					\$2713.6	\$0.0		

INTERIOR HEATING PLANT COSTS

Job Name : CCF SUBCON 1/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11 11-86
 Serial Number:
 60117862.0

Bin	Bin	Coil	Primary	Plant	No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost
(F)	hr/yr	MBH	MBH	KW	\$/yr
-----OCCUPIED PERIOD-----					
90	25.8	0.0	0.0	0.0	0.0
85	59.4	0.0	0.0	0.0	0.0
80	145.3	0.0	0.0	0.0	0.0
75	237.7	0.0	0.0	0.0	0.0
70	270.6	0.0	0.0	0.0	0.0
65	264.5	0.0	0.0	0.0	0.0
60	255.0	0.0	0.0	0.0	0.0
55	244.7	0.0	0.0	0.0	0.0
50	232.1	0.0	0.0	0.0	0.0
45	229.5	0.0	0.0	0.0	0.0
40	237.6	0.0	0.0	0.0	0.0
35	238.5	0.0	0.0	0.0	0.0
30	218.2	0.0	0.0	0.0	0.0
25	174.5	0.0	0.0	0.0	0.0
20	122.4	0.0	0.0	0.0	0.0
15	78.1	0.0	0.0	0.0	0.0
10	46.1	0.0	0.0	0.0	0.0
5	25.1	0.0	0.0	0.0	0.0
0	12.7	0.0	0.0	0.0	0.0
-5	6.2	0.0	0.0	0.0	0.0
-6	4.6	0.0	0.0	0.0	0.0
Total Costs					\$0.0
-----UNOCCUPIED PERIOD-----					
90	14.6	0.0	0.0	0.0	0.0
85	34.3	0.0	0.0	0.0	0.0
80	99.3	0.0	0.0	0.0	0.0
75	215.3	0.0	0.0	0.0	0.0
70	357.6	0.0	0.0	0.0	0.0
65	463.3	0.0	0.0	0.0	0.0
60	500.4	0.0	0.0	0.0	0.0
55	482.0	0.0	0.0	0.0	0.0
50	447.6	0.0	0.0	0.0	0.0
45	422.7	0.0	0.0	0.0	0.0
40	413.7	0.0	0.0	0.0	0.0
35	417.0	0.0	0.0	0.0	0.0
30	417.4	0.0	0.0	0.0	0.0
25	395.2	0.0	0.0	0.0	0.0
20	336.9	0.0	0.0	0.0	0.0
15	252.8	0.0	0.0	0.0	0.0
10	165.7	0.0	0.0	0.0	0.0
5	96.3	0.0	0.0	0.0	0.0
0	50.9	0.0	0.0	0.0	0.0
-5	25.3	0.0	0.0	0.0	0.0
-6	21.1	0.0	0.0	0.0	0.0
Total Costs					\$0.0

FAN AND PUMP COSTS

Job Name : CCF SUBCON 1/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-11-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	Interior Fans	All	Pumps
Temp	Hours	Input	Cost	Input	Cost	Input
(F)	hr/yr	KW	\$/yr	KW	\$/yr	KW
						Cost
						\$/yr
OCCUPIED PERIOD						
90	25.8	2.5	3.2	2.0	2.6	10.9
85	59.4	2.1	6.2	2.0	5.8	10.9
80	145.3	1.8	12.8	1.9	13.7	10.9
75	237.7	1.5	17.3	1.8	21.6	10.9
70	270.6	0.1	2.0	1.7	23.7	10.9
65	264.5	0.1	2.0	1.7	22.2	10.9
60	255.0	0.1	1.9	1.7	21.4	10.9
55	244.7	0.1	1.8	1.7	20.4	10.9
50	232.1	0.1	1.7	1.7	19.3	10.9
45	229.5	0.1	1.7	1.7	19.0	10.9
40	237.6	0.1	1.8	1.7	19.6	10.9
35	238.5	0.1	1.8	1.6	19.6	11.0
30	218.2	0.1	1.6	1.6	17.9	11.0
25	174.5	1.3	11.4	1.6	14.3	11.0
20	122.4	1.3	8.0	1.6	10.0	11.0
15	78.1	1.3	5.1	1.6	6.3	11.0
10	46.1	1.3	3.0	1.6	3.7	11.0
5	25.1	1.3	1.6	1.6	2.0	11.0
0	12.7	1.3	0.8	1.6	1.0	11.0
-5	6.2	1.3	0.4	1.6	0.5	11.0
-6	4.6	1.3	0.3	1.6	0.4	11.0
Total Costs			\$86.5		\$265.2	\$1707.2
UNOCCUPIED PERIOD						
90	14.6	1.5	1.1	0.8	0.6	11.0
85	36.3	1.2	2.2	0.1	0.2	10.9
80	99.3	0.1	0.7	0.1	0.5	10.9
75	215.3	0.1	1.6	0.1	1.0	10.9
70	357.6	0.1	2.7	0.1	1.7	10.9
65	463.3	0.1	3.5	0.1	2.2	10.9
60	500.4	0.1	3.7	0.1	2.3	10.9
55	482.0	0.1	3.6	0.1	2.3	10.9
50	447.6	0.1	3.3	0.1	2.1	11.0
45	422.7	0.1	3.2	0.1	2.0	11.0
40	413.7	0.1	3.1	0.1	1.9	11.0
35	417.0	1.3	27.2	0.1	1.9	11.0
30	417.4	1.3	27.3	0.1	2.0	11.0
25	395.2	1.3	25.8	0.1	1.8	11.0
20	336.9	1.3	22.0	0.1	1.6	11.0
15	252.8	1.3	16.5	0.1	1.2	11.0
10	165.7	1.3	10.8	0.1	0.8	11.0
5	96.3	1.3	6.3	0.1	0.5	11.0
0	50.9	1.3	3.3	0.1	0.2	11.0
-5	25.3	1.3	1.7	0.1	0.1	11.0
-6	21.1	1.3	1.4	0.1	0.1	11.0
Total Costs			\$171.0		\$26.8	\$3082.0

COOLING COIL LOADS

Job : CCF SUBCON 1/4 DESIGN SYS
 Building : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Perimeter
 Period : All
 Date : 11-26-86

COOLING COIL LOADS

Job : CCF SUBCON 1/4 DESIGN SYS
Building : CCF SUBCONSTRUCT 1/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Interior
Period : All
Date : 11-26-86

COOLING COIL LOADS

Job : CCF SUBCON 1/4 DESIGN SYS
 Building : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-11-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 1/4 DESIGN SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 DESIGN SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

PRIMARY HEATING PLANT LOADS

Job : CCF SUBCON 1/4 DESIGN SYS
Building : CCF SUBCONSTRUCT 1/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-11-86

PRIMARY HEATING PLANT INPUT POWER

Job : CCF SUBCON 1/4 DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

PRIMARY HEATING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

AUXILIARY HEATING PLANT LOADS

Job : CCF SUBCON 1/4 DESIGN SYS
Building : CCF SUBCONSTRUCT 1/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-11-86

AUXILIARY HEATING PLANT INPUT POWER

Job : CCF SUBCON 1/4 DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

AUXILIARY HEATING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

FAN OPERATING COSTS

Job : CCF SUBCON 1/4 DESIGN SYS
 Building : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-11-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 1
VARIABLE AIR VOLUME WITH CENTRIFUGAL CHILLERS AND ICW FREE COOLING ECONOMIZER

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 VAV SYS

Page 1

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-21-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

Are perimeter and interior zone on same supply fan ? <N>

>1. PERIMETER TERMINAL TYPE : VAV REHEAT

Supply fan type : Backward inclined or airfoil with inlet vanes

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil with inlet vanes

Return fan total static pressure = 2.00 in. wg.

Design supply air= 40771 cfm @ 55 F; Vent. air= 2668 cfm

Minimum zone air flow = 30 % of design supply cfm

Economizer type : Integrated, enthalpy controlled

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

>2. INTERIOR TERMINAL TYPE : VAV

Supply fan type : Backward inclined or airfoil with inlet vanes

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil with inlet vanes

Return fan total static pressure = 2.00 in. wg.

Design supply air= 22029 cfm @ 55 F; Vent. air= 1672 cfm

Minimum zone air flow = 30 % of design supply cfm

Economizer type : Integrated, enthalpy controlled

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

Does one primary heating plant serve perimeter and interior ? <Y>

> 1. BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 VAV SYS

Page 2

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-21-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 195.6 tons

kW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	60.00	0.00	0.00
Condenser water	10.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. Period			>2. OTHER FUELS		Unit Cost
ELECTRICAL ENERGY USE	Occupied (\$/kwh)	Unoccupied (\$/kwh)			
Compressor	0.050	0.050	Natural Gas	n/a	\$/therm
Resistance	0.050	0.050	Fuel Oil	n/a	\$/U.S.gal
Inductive	0.050	0.050	Propane	n/a	\$/lb
			Remote Heating	n/a	\$/MBTU
			Remote Cooling	n/a	\$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 1/4 VAV SYS

Period : All

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Zone : Block

Site : AURORA, IL FERMI, User Defined

Serial Number:

Date : 11-11-86

60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	13911	278213 kwh/yr	3227266	949540
Electric (Unocc)	22150	442998 kwh/yr	5136778	1511952
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	36061		8366044	2461492
NON-HVAC ENERGY				
Electric (Occ)	39793	795864 kwh/yr	9232025	2716285
Electric (Unocc)	30296	605916 kwh/yr	7028627	2067992
Non-HVAC Total	70089		16260652	4784276
Grand Total	106150		24626696	7245768
Total/Sq.Ft.	2.47		573.92	168.86

HVAC Summary:

HVAC Total Cost	=	0.84 \$/Sq.Ft./yr
	=	33.97 % of Total Cost
Total HVAC Electrical Energy	=	16.81 kwh/Sq.Ft./yr
	=	33.97 % of Total Electrical Energy
Non-Electrical HVAC Energy	=	0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 VAV SYS

Page 1

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-11-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$9,370)

Are perimeter and interior zone on same supply fan ? <N>

>1. PERIMETER TERMINAL TYPE : VAV REHEAT

Supply fan type : Backward inclined or airfoil with inlet vanes

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil with inlet vanes

Return fan total static pressure = 2.00 in. wg.

Design supply air= 40771 cfm @ 55 F; Vent. air= 2668 cfm

Minimum zone air flow = 30 % of design supply cfm

Economizer type : Integrated, enthalpy controlled

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

>2. INTERIOR TERMINAL TYPE : VAV

Supply fan type : Backward inclined or airfoil with inlet vanes

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil with inlet vanes

Return fan total static pressure = 2.00 in. wg.

Design supply air= 22029 cfm @ 55 F; Vent. air= 1672 cfm

Minimum zone air flow = 30 % of design supply cfm

Economizer type : Integrated, enthalpy controlled

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$14,567)

Does one primary heating plant serve perimeter and interior ? <Y>

> 1 . BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 VAV SYS

Page 2

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-11-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$8,402)

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 193.5 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$3,721)

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	120.00	0.00	0.00
Condenser water	10.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$70,089)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$106,150)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 1/4 VAV SYS

Date : 11-11-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number :

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Block Cooling Plant		
Temp	Hours	Coil Load	Input	Cost
(F)	hr/yr	MBH	KW	\$/yr
-----OCCUPIED PERIOD-----				
90	25.8	1897.2	119.8	154.5
85	59.4	1724.2	101.5	301.4
80	145.3	1562.3	86.7	630.2
75	237.7	1410.5	75.0	891.0
70	270.6	922.6	59.5	805.4
65	264.5	528.9	44.6	590.0
60	255.0	250.0	36.3	462.3
55	244.7	67.8	31.7	387.9
50	232.1	0.0	0.0	0.0
45	229.5	0.0	0.0	0.0
40	237.6	0.0	0.0	0.0
35	238.5	0.0	0.0	0.0
30	218.2	0.0	0.0	0.0
25	174.5	0.0	0.0	0.0
20	122.4	0.0	0.0	0.0
15	78.1	0.0	0.0	0.0
10	46.1	0.0	0.0	0.0
5	25.1	0.0	0.0	0.0
0	12.7	0.0	0.0	0.0
-5	6.2	0.0	0.0	0.0
-6	4.6	0.0	0.0	0.0
Total Costs				\$4222.8
-----UNOCCUPIED PERIOD-----				
90	14.6	1127.0	74.1	54.1
85	36.3	984.1	63.6	115.4
80	99.3	849.7	55.3	274.7
75	215.3	722.9	48.9	526.4
70	357.6	474.5	43.0	768.5
65	463.3	282.9	37.1	858.5
60	500.4	149.4	33.5	839.2
55	482.0	32.6	30.8	742.8
50	447.6	0.0	0.0	0.0
45	422.7	0.0	0.0	0.0
40	413.7	0.0	0.0	0.0
35	417.0	0.0	0.0	0.0
30	417.4	0.0	0.0	0.0
25	395.2	0.0	0.0	0.0
20	336.9	0.0	0.0	0.0
15	252.8	0.0	0.0	0.0
10	165.7	0.0	0.0	0.0
5	96.3	0.0	0.0	0.0
0	50.9	0.0	0.0	0.0
-5	25.3	0.0	0.0	0.0
-6	21.1	0.0	0.0	0.0
Total Costs				\$4179.5

BLOCK HEATING PLANT COSTS

Job Name : CCF SUBCON 1/4 VAV SYS

Date : 11-11-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number :

Site Name : AURORA, IL FERMI, User Defined

60117862.0

Bin Temp (F)	Bin Hours hr/yr	Coil Load MBH	Primary Output MBH	Plant Input KW	No Auxiliary Plant Used Cost \$/yr
OCCUPIED PERIOD					
90	25.8	0.0	0.0	0.0	0.0
85	59.4	0.0	0.0	0.0	0.0
80	145.3	0.0	0.0	0.0	0.0
75	237.7	0.0	0.0	0.0	0.0
70	270.6	0.0	0.0	0.0	0.0
65	264.5	0.0	0.0	0.0	0.0
60	255.0	0.0	0.0	0.0	0.0
55	244.7	35.7	35.7	10.5	127.9
50	232.1	112.0	112.0	32.8	381.0
45	229.5	188.4	188.4	55.2	633.5
40	237.6	264.8	264.8	77.6	921.6
35	238.5	2.3	2.3	0.7	8.1
30	218.2	6.7	6.7	2.0	21.4
25	174.5	15.4	15.4	4.5	39.2
20	122.4	98.3	98.3	28.8	176.3
15	78.1	181.3	181.3	53.1	207.5
10	46.1	264.3	264.3	77.4	178.5
5	25.1	347.3	347.3	101.8	127.7
0	12.7	430.3	430.3	126.1	80.1
-5	6.2	513.2	513.2	150.4	46.6
-6	4.6	529.8	529.8	155.2	35.7
Total Costs					\$2985.1
UNOCCUPIED PERIOD					
90	14.6	0.0	0.0	0.0	0.0
85	36.3	0.0	0.0	0.0	0.0
80	99.3	0.0	0.0	0.0	0.0
75	215.3	0.0	0.0	0.0	0.0
70	357.6	21.5	21.5	6.3	112.7
65	463.3	100.7	100.7	29.5	683.4
60	500.4	174.9	174.9	51.2	1281.8
55	482.0	249.0	249.0	73.0	1758.4
50	447.6	0.0	0.0	0.0	0.0
45	422.7	0.0	0.0	0.0	0.0
40	413.7	0.0	0.0	0.0	0.0
35	417.0	43.7	43.7	12.8	266.7
30	417.4	124.4	124.4	36.5	760.9
25	395.2	205.2	205.2	60.1	1188.2
20	336.9	286.0	286.0	83.8	1411.6
15	252.8	366.8	366.8	107.5	1358.4
10	165.7	447.6	447.6	131.1	1086.5
5	96.3	528.4	528.4	154.8	745.4
0	50.9	609.1	609.1	178.5	454.2
-5	25.3	689.9	689.9	202.1	255.7
-6	21.1	706.1	706.1	206.9	218.3
Total Costs					\$11582.2

FAN AND PUMP COSTS

Job Name : CCF SUBCON 1/4 VAV SYS

Date : 11-11-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Perimeter	Fans	Interior Fans	All	Pumps	
Temp	Hours	Input	Cost	Input	Cost	Input	Cost
(F)	hr/yr	KW	\$/yr	KW	\$/yr	KW	\$/yr
OCCUPIED PERIOD							
90	25.8	36.6	47.2	28.6	36.9	15.4	19.8
85	59.4	29.6	88.7	27.2	80.7	15.4	45.7
80	145.3	24.2	175.5	25.8	187.4	15.4	111.7
75	237.7	19.4	230.2	24.5	290.9	15.4	182.7
70	270.6	15.4	207.7	23.2	314.0	15.4	208.0
65	264.5	12.0	158.4	22.0	290.9	15.4	203.3
60	255.0	9.3	118.5	21.9	279.2	15.4	196.0
55	244.7	8.0	98.0	21.8	266.7	18.4	225.7
50	232.1	8.0	93.0	21.7	251.8	3.1	35.6
45	229.5	8.0	91.9	21.6	247.9	3.1	35.2
40	237.6	8.0	95.2	21.5	255.5	3.1	36.5
35	238.5	8.0	95.5	21.4	255.3	3.1	36.6
30	218.2	8.0	87.4	21.3	232.5	3.1	33.5
25	174.5	8.0	69.9	21.2	185.1	3.1	26.8
20	122.4	8.0	49.0	21.1	129.3	3.1	18.8
15	78.1	8.0	31.3	21.0	82.1	3.1	12.0
10	46.1	8.0	18.5	20.9	48.2	3.1	7.1
5	25.1	8.0	10.1	20.8	26.2	3.1	3.9
0	12.7	8.0	5.1	20.7	13.2	3.1	1.9
-5	6.2	8.0	2.5	20.6	6.4	3.1	1.0
-6	4.6	8.0	1.8	20.6	4.7	3.1	0.7
Total Costs			\$1775.4	\$3484.9		\$1442.5	
UNOCCUPIED PERIOD							
90	14.6	20.2	14.8	9.0	6.6	15.4	11.2
85	36.3	16.2	29.3	8.4	15.3	15.4	27.9
80	99.3	12.7	63.3	7.9	39.2	15.4	76.3
75	215.3	9.9	106.1	7.4	79.3	15.4	165.5
70	357.6	8.0	143.3	6.9	122.9	18.4	329.8
65	463.3	8.0	185.6	6.4	148.3	18.4	427.3
60	500.4	8.0	200.5	6.4	159.2	18.4	461.5
55	482.0	8.0	193.1	6.3	152.4	18.4	444.5
50	447.6	8.0	179.3	6.3	140.7	0.0	0.0
45	422.7	8.0	169.3	6.2	132.1	0.0	0.0
40	413.7	8.0	165.7	6.2	128.5	0.0	0.0
35	417.0	8.0	167.1	6.2	128.7	3.1	64.0
30	417.4	8.0	167.2	6.1	128.1	3.1	64.0
25	395.2	8.0	158.3	6.1	120.5	3.1	60.6
20	336.9	8.0	135.0	6.1	102.1	3.1	51.7
15	252.8	8.0	101.3	6.0	76.2	3.1	38.8
10	165.7	8.0	66.4	6.0	49.6	3.1	25.4
5	96.3	8.0	38.6	6.0	28.7	3.1	14.8
0	50.9	8.0	20.4	5.9	15.1	3.1	7.6
-5	25.3	8.0	10.1	5.9	7.4	3.1	3.9
-6	21.1	8.0	8.5	5.9	6.2	3.1	3.2
Total Costs			\$2323.0	\$1786.8		\$2278.4	

COOLING COIL LOADS

Job : CCF SUBCON 1/4 VAV SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 1/4 VAV SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 UAV SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

PRIMARY HEATING PLANT LOADS

Job : CCF SUBCON 1/4 VAV SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

PRIMARY HEATING PLANT INPUT POWER

Job : CCF SUBCON 1/4 UAV SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

PRIMARY HEATING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 VAV SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

FAN OPERATING COSTS

Job : CCF SUBCON 1/4 UAV SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 2
FOUR PIPE FAN COILS WITH CENTRIFUGAL CHILLERS, OA HX & ICW FREE COOLING ECON.

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 4PFC SYS

Page 1

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-21-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

Are perimeter and interior zone on same supply fan ? <N>

>1. PERIMETER TERMINAL TYPE : 4-PIPE FAN COIL

Supply fan avg. efficiency = 60 %

Supply fan total static pressure = 1.00 in. wg.

Design supply air= 44326 cfm @ 55 F; Vent. air= 2668 cfm

Is variable supply temperature control used ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

>2. INTERIOR TERMINAL TYPE : PARALLEL FAN POWERED MIXING BOXES

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 4.00 in. wg.

Secondary supply fan avg efficiency = 60 %

Secondary supply fan total static pressure = 1.00 in. wg.

Design supply air= 22029 cfm @ 55 F; Vent. air= 1672 cfm

Minimum zone air flow = 30 % of design supply cfm

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

Does one primary heating plant serve perimeter and interior ? <Y>

> 1 . BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 4PFC SYS

Page 2

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-21-86

Site : AURORA, IL FERM1, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 195.6 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <Y>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	60.00	0.00	0.00
Condenser water	10.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 1/4 4PFC SYS

Period : All

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Zone : Block

Site : AURORA,IL FERMI, User Defined

Serial Number:

Date : 11-21-86

60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
(\$/yr)	Consumed			
Electric (Occ)	12282	245639 kwh/yr	2849408	838365
Electric (Unocc)	21195	423897 kwh/yr	4917204	1446760
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	33477		7766611	2285124
NON-HVAC ENERGY				
Electric (Occ)	39793	795864 kwh/yr	9232025	2716285
Electric (Unocc)	30296	605916 kwh/yr	7028627	2067992
Non-HVAC Total	70089		16260652	4784276
Grand Total	103566		24027263	7069401
Total/Sq.Ft.	2.41		559.95	164.75

HVAC Summary:

HVAC Total Cost	=	0.78 \$/Sq.Ft./yr
	=	32.32 % of Total Cost
Total HVAC Electrical Energy	=	15.60 kwh/Sq.Ft./yr
	=	32.32 % of Total Electrical Energy
Non-Electrical HVAC Energy	=	0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 4PFC SYS

Page 1

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-21-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$8,532)

Are perimeter and interior zone on same supply fan ? <N>

>1. PERIMETER TERMINAL TYPE : 4-PIPE FAN COIL

Supply fan avg. efficiency = 60 %

Supply fan total static pressure = 1.00 in. wg.

Design supply air= 44326 cfm @ 55 F; Vent. air= 2668 cfm

Is variable supply temperature control used ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

>2. INTERIOR TERMINAL TYPE : PARALLEL FAN POWERED MIXING BOXES

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 4.00 in. wg.

Secondary supply fan avg efficiency = 60 %

Secondary supply fan total static pressure = 1.00 in. wg.

Design supply air= 22029 cfm @ 55 F; Vent. air= 1672 cfm

Minimum zone air flow = 30 % of design supply cfm

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$12,572)

Does one primary heating plant serve perimeter and interior ? <Y>

> 1 . BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 4PFC SYS

Page 2

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-21-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$5,211)

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 195.6 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <Y>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$7,162)

	PERIMETER		INTERIOR	
System	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	60.00	0.00	0.00
Condenser water	10.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$70,089)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw; Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw ; Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw ; Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$103,566)

>1. Period		>2. OTHER FUELS		Unit Cost
ELECTRICAL	Occupied	Unoccupied		
ENERGY USE	(\$/kwh)	(\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 1/4 4PFC SYS

Date : 11-21-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number:

Site Name : AURORA, IL FERMI, User Defined

60117862.0

Block Cooling Plant				
Bin	Bin	Coil Load	Input	Cost
(F)	hr/yr	MBH	KW	\$/yr
OCCUPIED PERIOD				
90	25.8	1767.2	113.3	146.1
85	59.4	1411.0	93.3	277.2
80	145.3	1469.2	76.9	558.5
75	337.7	1340.6	63.4	753.2
70	270.6	1213.3	51.9	701.8
65	264.5	1088.1	42.2	558.2
60	255.0	980.5	34.6	443.9
55	244.7	873.5	2.9	35.0
50	232.1	767.0	2.9	33.2
45	229.5	659.0	2.9	32.8
40	237.6	554.6	2.9	34.0
35	236.5	519.1	2.9	34.1
30	218.2	508.2	2.9	31.2
25	174.5	497.4	2.9	24.9
20	122.4	466.5	2.9	17.5
15	76.1	475.8	2.9	11.2
10	46.1	465.0	2.9	6.6
5	25.1	454.3	2.9	3.6
0	12.7	443.6	2.9	1.8
-5	6.2	432.9	2.9	0.9
-6	4.6	430.8	2.9	0.7
Total Costs				\$3706.3
UNOCCUPIED PERIOD				
90	14.6	1075.6	66.7	48.7
85	36.3	953.1	54.5	99.0
80	99.3	832.0	44.2	219.7
75	215.3	711.9	35.7	384.6
70	357.6	592.9	2.9	51.1
65	463.3	474.9	2.9	66.2
60	500.4	375.1	2.9	71.5
55	482.0	275.6	2.9	68.9
50	447.6	233.6	2.9	64.0
45	422.7	226.6	2.9	60.4
40	413.7	219.7	2.9	59.1
35	417.0	212.8	2.9	59.6
30	417.4	205.9	2.9	59.7
25	395.2	199.1	2.9	56.5
20	336.9	192.3	2.9	48.2
15	252.8	185.5	2.9	36.1
10	165.7	178.8	2.9	23.7
5	96.3	172.1	2.9	13.8
0	50.9	165.4	2.9	7.3
-5	25.3	158.8	2.9	3.6
-6	21.1	157.4	2.9	3.0
Total Costs				\$1504.7

BLOCK HEATING PLANT COSTS

Job Name : CCF SUBCON 1/4 4PFC SYS

Date : 11-21-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Coil	Primary Plant			No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost	
(F)	hr/yr	MBH	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----						
90	25.8	0.0	0.0	0.0	0.0	
85	59.4	0.0	0.0	0.0	0.0	
80	145.3	0.0	0.0	0.0	0.0	
75	237.7	0.0	0.0	0.0	0.0	
70	270.6	0.0	0.0	0.0	0.0	
65	264.5	0.0	0.0	0.0	0.0	
60	255.0	0.0	0.0	0.0	0.0	
55	244.7	0.0	0.0	0.0	0.0	
50	232.1	0.0	0.0	0.0	0.0	
45	229.5	0.0	0.0	0.0	0.0	
40	237.6	0.0	0.0	0.0	0.0	
35	238.5	64.0	64.0	18.8	223.7	
30	218.2	78.7	78.7	23.1	251.6	
25	174.5	94.0	94.0	27.5	240.2	
20	122.4	187.4	187.4	54.9	336.0	
15	78.1	280.8	280.8	82.3	321.3	
10	46.1	374.2	374.2	109.6	252.7	
5	25.1	467.6	467.6	137.0	171.9	
0	12.7	561.0	561.0	164.4	104.4	
-5	6.2	654.4	654.4	191.7	59.4	
-6	4.6	673.1	673.1	197.2	45.4	
Total Costs					\$2006.6	
-----UNOCCUPIED PERIOD-----						
90	14.6	0.0	0.0	0.0	0.0	
85	36.3	0.0	0.0	0.0	0.0	
80	99.3	0.0	0.0	0.0	0.0	
75	215.3	0.0	0.0	0.0	0.0	
70	357.6	0.0	0.0	0.0	0.0	
65	463.3	0.0	0.0	0.0	0.0	
60	500.4	0.0	0.0	0.0	0.0	
55	482.0	0.0	0.0	0.0	0.0	
50	447.6	5.3	5.3	1.6	35.0	
45	422.7	20.0	20.0	5.9	123.9	
40	413.7	34.7	34.7	10.2	210.2	
35	417.0	94.7	94.7	27.8	578.8	
30	417.4	186.0	186.0	54.5	1137.1	
25	395.2	277.2	277.2	81.2	1604.7	
20	336.9	368.4	368.4	107.9	1818.1	
15	252.8	459.6	459.6	134.7	1702.1	
10	165.7	550.8	550.8	161.4	1337.0	
5	96.3	642.0	642.0	188.1	905.7	
0	50.9	733.2	733.2	214.8	546.7	
-5	25.3	824.4	824.4	241.6	305.6	
-6	21.1	842.7	842.7	246.9	260.5	
Total Costs					\$10565.4	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 1/4 4PFC SYS

Date : 11-21-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117362.0

Bin	Bin	Perimeter	Fans	Interior	Fans	All	Pumps
Temp	Hours	Input	Cost	Input	Cost	Input	Cost
(F)	hr/yr	KW	\$/yr	KW	\$/yr	KW	\$/yr
OCCUPIED PERIOD							
90	25.8	9.6	12.4	18.4	23.7	15.5	20.1
85	59.4	9.6	28.6	17.9	53.3	15.5	46.2
80	145.3	9.6	69.9	17.5	127.4	15.5	112.9
75	237.7	9.6	114.3	17.1	203.4	15.5	184.7
70	270.6	9.6	130.1	16.7	225.8	15.5	210.3
65	264.5	9.6	127.2	16.3	215.2	15.5	205.6
60	255.0	9.6	122.6	16.2	207.0	15.5	198.2
55	244.7	9.6	117.6	16.2	198.2	15.5	190.2
50	232.1	9.6	111.6	16.2	187.6	15.5	180.4
45	229.5	9.6	110.3	16.1	185.1	15.5	178.4
40	237.6	9.6	114.2	16.1	191.2	15.5	184.7
35	238.5	9.6	114.7	16.1	191.5	17.2	204.6
30	218.2	9.6	104.9	16.0	174.9	17.2	187.2
25	174.5	9.6	83.9	16.0	139.5	17.2	149.7
20	122.4	9.6	58.8	16.0	97.7	17.2	105.0
15	78.1	9.6	37.5	15.9	62.2	17.2	67.0
10	46.1	9.6	22.2	15.9	36.6	17.2	39.5
5	25.1	9.6	12.1	15.9	19.9	17.2	21.5
0	12.7	9.6	6.1	15.8	10.0	17.2	10.9
-5	6.2	9.6	3.0	15.8	4.9	17.2	5.3
-6	4.6	9.6	2.2	15.8	3.6	17.2	3.9
Total Costs			\$1504.1	\$2558.8		\$2506.1	
UNOCCUPIED PERIOD							
90	14.6	9.6	7.0	9.1	6.7	15.5	11.3
85	36.3	9.6	17.5	8.5	15.5	15.5	28.2
80	99.3	9.6	47.7	8.0	39.6	15.5	77.2
75	215.3	9.6	103.5	7.4	79.9	15.5	167.3
70	357.6	9.6	171.9	6.9	122.8	15.5	277.9
65	463.3	9.6	222.7	6.3	146.6	15.5	360.1
60	500.4	9.6	240.6	6.3	157.2	15.5	388.9
55	482.0	9.6	231.7	6.2	150.3	15.5	374.6
50	447.6	9.6	215.2	6.2	138.6	17.2	383.9
45	422.7	9.6	203.2	6.1	130.0	17.2	362.6
40	413.7	9.6	198.9	6.1	126.3	17.2	354.9
35	417.0	9.6	200.5	6.1	126.4	17.2	357.7
30	417.4	9.6	200.7	6.0	125.6	17.2	358.0
25	395.2	9.6	190.0	6.0	118.0	17.2	339.0
20	336.9	9.6	162.0	5.9	99.9	17.2	289.0
15	252.8	9.6	121.5	5.9	74.4	17.2	216.8
10	165.7	9.6	79.7	5.8	48.4	17.2	142.1
5	96.3	9.6	46.3	5.8	27.9	17.2	82.6
0	50.9	9.6	24.5	5.8	14.6	17.2	43.7
-5	25.3	9.6	12.2	5.7	7.2	17.2	21.7
-6	21.1	9.6	10.1	5.7	6.0	17.2	18.1
Total Costs			\$2707.4	\$1761.8		\$4655.6	

COOLING COIL LOADS

Job : CCF SUBCON 1/4 4PFC SYS
Building : CCF SUBCONSTRUCT 1/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-21-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 1/4 4PFC SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-21-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 4PFC SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-21-86

PRIMARY HEATING PLANT LOADS

Job : CCF SUBCON 1/4 4PFC SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-21-86

PRIMARY HEATING PLANT INPUT POWER

Job : CCF SUBCON 1/4 4PFC SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-21-86

PRIMARY HEATING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 4PFC SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-21-86

FAN OPERATING COSTS

Job : CCF SUBCON 1/4 4PFC SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-21-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 3
TRIPLE DECK MULTIZONE WITH CENTRIFUGAL CHILLERS AND ICW FREE COOLING ECON.

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 3DMZ SYS

Page 1

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-26-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

4. AIR HANDLING SYSTEMS

Are perimeter and interior zone on same supply fan ? <Y>

1. BLOCK TERMINAL TYPE : BYPASS MULTIZONE

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil

Return fan total static pressure = 2.00 in. wg.

Design supply air= 62800 cfm @ 55 F; Vent. air= 4340 cfm

Hot deck supply air temperature = 100 F

Economizer type : Integrated, enthalpy controlled

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

5. HEATING PLANTS

Does one primary heating plant serve perimeter and interior ? <Y>

1. BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 3DMZ SYS

Page 2

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-26-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 195.6 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	60.00	0.00	0.00
Condenser water	0.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 1/4 3DMZ SYS
Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
Site : AURORA,IL FERMI, User Defined
Date : 11-11-86

Period : All
Zone : Block
Serial Number:
60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	19168	383364 kwh/yr	4447022	1308421
Electric (Unocc)	32386	647728 kwh/yr	7513647	2210696
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	51555		11960669	3519118

NON-HVAC ENERGY

Electric (Occ)	39793	795864 kwh/yr	9232025	2716285
Electric (Unocc)	30296	605916 kwh/yr	7028627	2067992
Non-HVAC Total	70089		16260652	4784276
Grand Total	121644		28221321	8303394
Total/Sq.Ft.	2.83		657.69	193.51

HVAC Summary:

HVAC Total Cost = 1.20 \$/Sq.Ft./yr
= 42.38 % of Total Cost
Total HVAC Electrical Energy = 24.03 kwh/Sq.Ft./yr
= 42.38 % of Total Electrical Energy
Non-Electrical HVAC Energy = -0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 3DMZ SYS

Page 1

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-11-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$35,801)

Are perimeter and interior zone on same supply fan ? <Y>

>1. BLOCK TERMINAL TYPE : BYPASS MULTIZONE

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil

Return fan total static pressure = 2.00 in. wg.

Design supply air= 62800 cfm @ 55 F; Vent. air= 4340 cfm

Hot deck supply air temperature = 100 F

Economizer type : Integrated, enthalpy controlled

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$2,477)

Does one primary heating plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 3DMZ SYS

Page 2

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-11-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$7,250)

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 191.3 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$6,028)

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	60.00	0.00	0.00
Condenser water	10.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$70,089)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$121,644)

Period	Occupied	Unoccupied	>2. OTHER FUELS		Unit Cost
			ENERGY USE	(\$/kwh)	
Compressor	0.050	0.050	Natural Gas	n/a	\$/therm
Resistance	0.050	0.050	Fuel Oil	n/a	\$/U.S.gal
Inductive	0.050	0.050	Propane	n/a	\$/lb
			Remote Heating	n/a	\$/MBTU
			Remote Cooling	n/a	\$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 1/4 3DMZ SYS

Date : 11-11-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number :

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Block Cooling Plant
Temp	Hours	Coil Load
(F)	hr/yr	MBH
		Input
		KW
		Cost
		\$/yr

OCCUPIED PERIOD

90	25.8	1955.8	107.4	138.5
85	59.4	1810.8	89.7	266.5
80	145.3	1668.9	75.1	545.9
75	237.7	1283.8	65.4	777.7
70	270.6	680.1	43.5	589.1
65	264.5	244.0	33.4	442.0
60	255.0	284.2	32.0	408.2
55	244.7	324.5	30.7	375.1
50	232.1	364.7	2.8	32.4
45	229.5	405.0	2.8	32.1
40	237.6	445.2	2.8	33.2
35	238.5	226.0	2.8	33.3
30	218.2	225.0	2.8	30.5
25	174.5	254.5	2.8	24.4
20	122.4	294.8	2.8	17.1
15	78.1	335.0	2.8	10.9
10	46.1	332.7	2.8	6.4
5	25.1	321.7	2.8	3.5
0	12.7	310.8	2.8	1.8
-5	6.2	299.9	2.8	0.9
-6	4.6	297.7	2.8	0.6

Total Costs \$3770.3

UNOCCUPIED PERIOD

90	14.6	1352.1	77.2	56.4
85	36.3	1211.4	65.0	118.0
80	99.3	1073.5	55.2	273.9
75	215.3	720.6	46.0	495.6
70	357.6	175.6	33.7	602.0
65	463.3	115.8	31.8	736.5
60	500.4	154.8	31.1	778.1
55	482.0	193.9	2.8	67.4
50	447.6	255.3	2.8	62.6
45	422.7	257.2	2.8	59.1
40	413.7	259.1	2.8	57.8
35	417.0	210.0	2.8	58.3
30	417.4	137.7	2.8	58.4
25	395.2	65.4	2.8	55.2
20	336.9	0.0	0.0	0.0
15	252.8	0.0	0.0	0.0
10	165.7	0.0	0.0	0.0
5	96.3	0.0	0.0	0.0
0	50.9	0.0	0.0	0.0
-5	25.3	0.0	0.0	0.0
-6	21.1	0.0	0.0	0.0

Total Costs \$3479.3

BLOCK HEATING PLANT COSTS

Job Name : CCF SUBCON 1/4 3DMZ SYS

Date : 11-11-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Coil	Primary Plant			No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost	
(F)	hr/yr	MBH	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----						
90	25.8	0.0	0.0	0.0	0.0	
85	59.4	0.0	0.0	0.0	0.0	
80	145.3	0.0	0.0	0.0	0.0	
75	237.7	0.0	0.0	0.0	0.0	
70	270.6	0.0	0.0	0.0	0.0	
65	264.5	0.0	0.0	0.0	0.0	
60	255.0	0.0	0.0	0.0	0.0	
55	244.7	0.0	0.0	0.0	0.0	
50	232.1	0.0	0.0	0.0	0.0	
45	229.5	0.0	0.0	0.0	0.0	
40	237.6	0.0	0.0	0.0	0.0	
35	238.5	0.0	0.0	0.0	0.0	
30	218.2	0.0	0.0	0.0	0.0	
25	174.5	0.0	0.0	0.0	0.0	
20	122.4	0.0	0.0	0.0	0.0	
15	78.1	0.0	0.0	0.0	0.0	
10	46.1	78.8	78.8	23.1	53.2	
5	25.1	173.6	173.6	50.9	63.8	
0	12.7	268.3	268.3	78.6	49.9	
-5	6.2	363.0	363.0	106.4	33.0	
-6	4.6	382.0	382.0	111.9	25.7	
Total Costs					\$225.7	
-----UNOCCUPIED PERIOD-----						
90	14.6	0.0	0.0	0.0	0.0	
85	36.3	0.0	0.0	0.0	0.0	
80	99.3	0.0	0.0	0.0	0.0	
75	215.3	0.0	0.0	0.0	0.0	
70	357.6	0.0	0.0	0.0	0.0	
65	463.3	0.0	0.0	0.0	0.0	
60	500.4	0.0	0.0	0.0	0.0	
55	482.0	0.0	0.0	0.0	0.0	
50	447.6	0.0	0.0	0.0	0.0	
45	422.7	0.0	0.0	0.0	0.0	
40	413.7	0.0	0.0	0.0	0.0	
35	417.0	0.0	0.0	0.0	0.0	
30	417.4	0.0	0.0	0.0	0.0	
25	395.2	0.0	0.0	0.0	0.0	
20	336.9	18.8	18.8	5.5	92.6	
15	252.8	122.2	122.2	35.8	452.7	
10	165.7	225.7	225.7	66.1	547.9	
5	96.3	329.2	329.2	96.4	464.4	
0	50.9	432.6	432.6	126.8	322.6	
-5	25.3	536.1	536.1	157.1	198.7	
-6	21.1	556.8	556.8	163.1	172.1	
Total Costs					\$2250.9	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 1/4 3DMZ SYS

Date : 11-11-86

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Serial Number :

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Block Fans			All	Pumps
Temp	Hours	Input	Cost		Input	Cost
(F)	hr/yr	KW	\$/yr		KW	\$/yr
OCCUPIED PERIOD						
90	25.8	81.7	105.4		15.2	19.6
85	59.4	81.7	242.8		15.2	45.1
80	145.3	81.7	593.8		15.2	110.4
75	237.7	81.7	971.4		15.2	180.7
70	270.6	81.7	1105.9		15.2	205.7
65	264.5	81.7	1081.0		15.2	201.0
60	255.0	81.7	1042.1		15.2	193.8
55	244.7	81.7	1000.0		15.2	186.0
50	232.1	81.7	948.6		15.2	176.4
45	229.5	81.7	937.9		15.2	174.4
40	237.6	81.7	971.0		15.2	180.6
35	238.5	81.7	974.7		15.2	181.3
30	218.2	81.7	891.7		15.2	165.8
25	174.5	81.7	713.2		15.2	132.6
20	122.4	81.7	500.2		15.2	93.0
15	78.1	81.7	319.2		15.2	59.4
10	46.1	81.7	188.4		16.9	39.1
5	25.1	81.7	102.6		16.9	21.3
0	12.7	81.7	51.9		16.9	10.8
-5	6.2	81.7	25.3		16.9	5.3
-6	4.6	81.7	18.8		16.9	3.9
Total Costs			\$12786.0			\$2386.2
UNOCCUPIED PERIOD						
90	14.6	81.7	59.7		15.2	11.1
85	36.3	81.7	148.4		15.2	27.6
80	99.3	81.7	405.8		15.2	75.5
75	215.3	81.7	879.9		15.2	163.6
70	357.6	81.7	1461.4		15.2	271.8
65	463.3	81.7	1893.4		15.2	352.1
60	500.4	81.7	2045.0		15.2	380.3
55	482.0	81.7	1969.8		15.2	366.4
50	447.6	81.7	1829.3		15.2	340.2
45	422.7	81.7	1727.5		15.2	321.3
40	413.7	81.7	1690.7		15.2	314.4
35	417.0	81.7	1704.2		15.2	316.9
30	417.4	81.7	1705.8		15.2	317.3
25	395.2	81.7	1615.1		15.2	300.4
20	336.9	81.7	1376.9		1.7	29.4
15	252.8	81.7	1033.1		1.7	22.0
10	165.7	81.7	677.2		1.7	14.4
5	96.3	81.7	393.6		1.7	8.4
0	50.9	81.7	208.0		1.7	4.4
-5	25.3	81.7	103.4		1.7	2.2
-6	21.1	81.7	86.2		1.7	1.8
Total Costs			\$23014.5			\$3641.7

COOLING COIL LOADS

Job : CCF SUBCON 1/4 3DMZ SYS
 Building : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-11-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 1/4 3DMZ SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 3DMZ SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

PRIMARY HEATING PLANT LOADS

Job : CCF SUBCON 1/4 3DMZ SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

PRIMARY HEATING PLANT INPUT POWER

Job : CCF SUBCON 1/4 3DMZ SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

PRIMARY HEATING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 3DMZ SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

FAN OPERATING COSTS

Job : CCF SUBCON 1/4 3DMZ SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 4
TYPICAL FY1975 DESIGN
MULTIZONE WITH CENTRIFUGAL CHILLERS AND ICW FREE COOLING ECONOMIZER

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 1975MZ SYS
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA,IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

Page 1

Date : 11-26-86

60117862.0

A. AIR HANDLING SYSTEMS

Are perimeter and interior zone on same supply fan ? <Y>

>1. BLOCK TERMINAL TYPE : MULTIZONE

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil

Return fan total static pressure = 2.00 in. wg.

Design supply air= 62800 cfm @ 55 F; Vent. air= 4340 cfm

Hot deck supply air temperature = 100 F

Outdoor air temperature at which heating begins = 55 F

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

Does one primary heating plant serve perimeter and interior ? <Y>

> 1 . BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 1/4 1975MZ SYS
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA,IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

Page 2
 Date : 11-26-86
 60117862.0

C. COOLING PLANTS

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 195.6 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	60.00	0.00	0.00
Condenser water	0.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CDF SUBCON 1/4 1975MZ SYS
Building Name : CDF SUBCONSTRUCT 1/4 (Complex)
Site : AURORA,IL FERMI, User Defined
Date : 11-11-86

Period : All
Zone : Block
Serial Number:
60117862.0

HVAC ENERGY	Annual Cost (\$/yr)	Energy or Fuel Units Consumed	DOE RUF (1000 BTU)	DOE RIF (1000 BTU)
Electric (Occ)	31420	628391 kwh/yr	7289338	2144699
Electric (Unocc)	65340	1306799 kwh/yr	15158866	4460104
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	96759		22448204	6604803

NON-HVAC ENERGY

Electric (Occ)	39793	795864 kwh/yr	9232025	2716285
Electric (Unocc)	30296	605916 kwh/yr	7028627	2067992
Non-HVAC Total	70089		16260652	4784276
Grand Total	166849		38708856	11389080
Total/Sq.Ft.	3.89		902.09	265.42

HVAC Summary:

HVAC Total Cost	=	2.25 \$/Sq.Ft./yr
	=	57.99 % of Total Cost
Total HVAC Electrical Energy	=	45.10 kwh/Sq.Ft./yr
	=	57.99 % of Total Electrical Energy
Non-Electrical HVAC Energy	=	0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 1975MZ SYS Page 1
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex) Date : 11-11-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$35,801)

Are perimeter and interior zone on same supply fan ? <Y>

>1. BLOCK TERMINAL TYPE : MULTIZONE

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 4.00 in. wg.

Return fan type : Backward inclined or airfoil

Return fan total static pressure = 2.00 in. wg.

Design supply air= 62800 cfm @ 55 F; Vent. air= 4340 cfm

Hot deck supply air temperature = 100 F

Outdoor air temperature at which heating begins = 55 F

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$44,447)

Does one primary heating plant serve perimeter and interior ? <Y>

> 1 . BLOCK PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 1/4 1975MZ SYS

Page 2

Building Name : CCF SUBCONSTRUCT 1/4 (Complex)

Date : 11-11-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$9,347)

Does one plant serve perimeter and interior ? <Y>

>1. BLOCK PLANT : CENTRIFUGAL WATER COOLED CHILLER

Capacity @ 85 F entering water = 191.3 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is condenser performance altitude adjusted ? <Y>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 100 %

Number of sequenced chillers = 1

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$7,165)

System	PERIMETER		INTERIOR	
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	60.00	0.00	0.00
Hot water	20.00	60.00	0.00	0.00
Condenser water	10.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$70,089)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 122.3 kw; Unoccupied = 25.7 kw

Misc. kw : Occupied = 132.1 kw; Unoccupied = 81.9 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$166,849)

ELECTRICAL ENERGY USE	Period			Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 1/4 1975M2 SYS
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-11-86
 Serial Number:
 60117862.0

Bin	Rin	Block	Cooling Plant	
Temp	Hours	Coil Load	Input	Cost
(F)	hr/yr	MBH	KW	\$/yr
OCCUPIED PERIOD				
90	25.8	1955.8	107.4	138.5
85	59.4	1810.8	89.7	266.5
80	145.3	1668.9	75.1	545.9
75	237.7	1529.6	63.2	750.8
70	270.6	1393.0	53.5	723.8
65	264.5	1258.7	45.8	605.4
60	255.0	1147.4	40.1	511.6
55	244.7	1373.6	40.3	492.6
50	232.1	1306.8	33.6	389.9
45	229.5	1241.4	2.8	32.1
40	237.6	1177.4	2.8	33.2
35	238.5	1020.1	2.8	33.3
30	218.2	999.3	2.8	30.5
25	174.5	995.6	2.8	24.4
20	122.4	942.2	2.8	17.1
15	78.1	890.3	2.8	10.9
10	46.1	839.8	2.8	6.4
5	25.1	790.7	2.8	3.5
0	12.7	743.0	2.8	1.8
-5	6.2	696.7	2.8	0.9
-6	4.6	687.6	2.8	0.6
Total Costs				\$4619.9
UNOCCUPIED PERIOD				
90	14.6	1352.1	77.2	56.4
85	34.3	1211.4	65.0	118.0
80	99.3	1073.5	55.2	273.9
75	215.3	938.3	47.3	509.5
70	357.6	805.5	41.2	736.9
65	463.3	675.0	36.6	846.7
60	500.4	571.0	33.5	837.6
55	482.0	1028.4	35.9	864.2
50	447.6	862.9	2.8	62.6
45	422.7	842.2	2.8	59.1
40	413.7	821.6	2.8	57.8
35	417.0	788.0	2.8	58.3
30	417.4	742.2	2.8	58.4
25	395.2	697.6	2.8	55.2
20	336.9	654.5	2.8	47.1
15	252.8	612.7	2.8	35.3
10	165.7	572.3	2.8	23.2
5	96.3	533.3	2.8	13.5
0	50.9	495.6	2.8	7.1
-5	25.3	459.3	2.8	3.5
-6	21.1	452.2	2.8	2.9
Total Costs				\$4727.1

BLOCK HEATING PLANT COSTS

Job Name : CDF SUBCON 1/4 1975MZ SYS
 Building Name : CDF SUBCONSTRUCT 1/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-11-86
 Serial Number:
 60117862.0

Bin Temp (F)	Bin Hours hr/yr	Coil Load MBH	Primary Output MBH	Plant Input KW	Cost \$/yr	No Auxiliary Plant Used
-----OCCUPIED PERIOD-----						
90	25.8	0.0	0.0	0.0	0.0	
85	59.4	0.0	0.0	0.0	0.0	
80	145.3	0.0	0.0	0.0	0.0	
75	237.7	0.0	0.0	0.0	0.0	
70	270.6	0.0	0.0	0.0	0.0	
65	264.5	0.0	0.0	0.0	0.0	
60	255.0	0.0	0.0	0.0	0.0	
55	244.7	331.8	331.8	97.2	1189.6	
50	232.1	370.7	370.7	108.6	1260.4	
45	229.5	410.9	410.9	120.4	1381.6	
40	237.6	452.6	452.6	132.6	1575.4	
35	238.5	390.7	390.7	114.5	1365.0	
30	218.2	396.9	396.9	116.3	1268.7	
25	174.5	424.7	424.7	124.4	1085.8	
20	122.4	477.1	477.1	139.8	855.4	
15	78.1	530.8	530.8	155.5	607.3	
10	46.1	586.0	586.0	171.7	395.7	
5	25.1	642.5	642.5	188.3	236.3	
0	12.7	700.5	700.5	205.2	130.3	
-5	6.2	759.9	759.9	222.6	69.0	
-6	4.6	771.9	771.9	226.2	52.0	
Total Costs					\$11472.6	
-----UNOCCUPIED PERIOD-----						
90	14.6	0.0	0.0	0.0	0.0	
85	36.3	0.0	0.0	0.0	0.0	
80	99.3	0.0	0.0	0.0	0.0	
75	215.3	0.0	0.0	0.0	0.0	
70	357.6	0.0	0.0	0.0	0.0	
65	463.3	0.0	0.0	0.0	0.0	
60	500.4	0.0	0.0	0.0	0.0	
55	482.0	560.9	560.9	164.3	3960.4	
50	447.6	444.2	444.2	130.1	2912.5	
45	422.7	450.6	450.6	132.0	2790.5	
40	413.7	457.1	457.1	133.9	2770.3	
35	417.0	496.4	496.4	145.4	3032.6	
30	417.4	554.0	554.0	162.3	3387.6	
25	395.2	612.9	612.9	179.6	3548.7	
20	336.9	673.3	673.3	197.3	3322.9	
15	252.8	734.9	734.9	215.3	2721.8	
10	165.7	798.0	798.0	233.8	1937.1	
5	96.3	862.4	862.4	252.7	1216.7	
0	50.9	928.2	928.2	272.0	692.1	
-5	25.3	995.4	995.4	291.6	368.9	
-6	21.1	1008.9	1008.9	295.6	311.9	
Total Costs					\$32974.1	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 1/4 1975MZ SYS
 Building Name : CCF SUBCONSTRUCT 1/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-11-86
 Serial Number:
 60117862.0

Bin Temp (F)	Bin Hours hr/yr	Block Fans Input KW	Fans Cost \$/yr	OCCUPIED PERIOD	
90	25.8	81.7	105.4	15.2	19.6
85	59.4	81.7	242.0	15.2	45.1
80	145.3	81.7	593.8	15.2	110.4
75	237.7	81.7	971.4	15.2	180.7
70	270.6	81.7	1105.9	15.2	205.7
65	264.5	81.7	1081.0	15.2	201.0
60	255.0	81.7	1042.1	15.2	193.8
55	244.7	81.7	1000.0	16.9	207.3
50	232.1	81.7	948.6	16.9	196.6
45	229.5	81.7	937.9	16.9	194.4
40	237.6	81.7	971.0	16.9	201.3
35	238.5	81.7	974.7	16.9	202.1
30	218.2	81.7	891.7	16.9	184.9
25	174.5	81.7	713.2	16.9	147.8
20	122.4	81.7	500.2	16.9	103.7
15	78.1	81.7	319.2	16.9	66.2
10	46.1	81.7	188.4	16.9	39.1
5	25.1	81.7	102.6	16.9	21.3
0	12.7	81.7	51.9	16.9	10.8
-5	6.2	81.7	25.3	16.9	5.3
-6	4.6	81.7	18.8	16.9	3.9
Total Costs			\$12786.0	\$2541.0	
UNOCCUPIED PERIOD					
90	14.6	81.7	59.7	15.2	11.1
85	36.3	81.7	148.4	15.2	27.6
80	99.3	81.7	405.8	15.2	75.5
75	215.3	81.7	879.9	15.2	163.6
70	357.6	81.7	1461.4	15.2	271.8
65	463.3	81.7	1893.4	15.2	352.1
60	500.4	81.7	2045.0	15.2	380.3
55	482.0	81.7	1969.8	16.9	408.4
50	447.6	81.7	1829.3	16.9	379.2
45	422.7	81.7	1727.5	16.9	358.1
40	413.7	81.7	1690.7	16.9	350.5
35	417.0	81.7	1704.2	16.9	353.3
30	417.4	81.7	1705.8	16.9	353.6
25	395.2	81.7	1615.1	16.9	334.8
20	336.9	81.7	1376.9	16.9	285.4
15	252.8	81.7	1033.1	16.9	214.2
10	165.7	81.7	677.2	16.9	140.4
5	96.3	81.7	393.6	16.9	81.6
0	50.9	81.7	208.0	16.9	43.1
-5	25.3	81.7	103.4	16.9	21.4
-6	21.1	81.7	86.2	16.9	17.9
Total Costs			\$23014.5	\$4624.1	

COOLING COIL LOADS

Job : CCF SUBCON 1/4 1975MZ SYS
 Building : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-11-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 1/4 1975MZ SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 1975MZ SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

PRIMARY HEATING PLANT LOADS

Job : CCF SUBCON 1/4 1975MZ SYS

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-11-86

PRIMARY HEATING PLANT INPUT POWER

Job : CCF SUBCON 1/4 1975MZ SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

PRIMARY HEATING PLANT OPERATING COSTS

Job : CCF SUBCON 1/4 1975MZ SYS

Zone : Block

Building : CCF SUBCONSTRUCT 1/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-11-86

FAN OPERATING COSTS

Job : CCF SUBCON 1/4 1975MZ SYS
 Building : CCF SUBCONSTRUCT 1/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-11-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
SYSTEMS LIFE CYCLE COST ANALYSIS
AND
PAYBACK CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
LIFE CYCLE COST ANALYSIS
FOR
DESIGN BASIS SYSTEM
WATER SOURCE HEAT PUMPS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 1/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$344000/195.6 = \$1759/TON

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 344000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 22922.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 1/4 DESIGN SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$344000/195.6 = \$1759/TON

YEAR		1986	1987	1988	1989	1990
CASH	\$	344000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	23134.93	23327.90	23522.48
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	344000.00	0.00	25175.91	25389.69	25605.29
CUM.	\$	344000.00	344000.00	369175.91	394565.59	420170.88

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	23718.68	23916.52	24116.02	24317.17	24520.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	25822.73	26042.02	26263.18	26486.22	26711.17
CUM.	\$	445593.59	472035.62	498298.81	524785.06	551496.25

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	24724.52	24930.75	25138.70	25348.38	25559.82
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	26938.03	27166.82	27397.57	27630.28	27864.97
CUM.	\$	578434.25	605601.06	632798.62	660628.88	688493.88

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	25773.02	25987.99	26204.76	26423.34	26643.73
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$	28101.68	28340.39	28581.14	28823.94	29068.81
CUM.	\$	716595.56	744935.94	773517.06	802341.00	831409.81

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	26865.97	27090.06	27316.02	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$	29315.77	29564.84	29816.03	0.00	0.00
CUM.	\$	860725.56	890290.38	920106.38	920106.38	920106.38

FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE		PROJECT NO. 10-5-3		DATE 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 19/27		
SECTION	CES	QUANTITIES BY	JG	PRICES BY	JG	CHECKED BY	WIN	DISTRIBUTION OF ITEMIZED COST				
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1)		(2)		(3)		AMOUNT	UNIT	AMOUNT
8.3	COOLING/HEATING WATER SYSTEM	2	CA	3/1000	62,000							
	CHILLERS 100 TON KCCIP.	2	CA	6000	12,000							
	HEATING CHILLERS	1	CA		6,000							
	HT. EXCHANGER, CWD. HEAT EX. 300GPM, 20	1	CA									
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FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE		PROJECT NO. DATE 10-5-3 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 20/27	
SECTION	CES	QUANTITIES BY JG	PRICES BY JG	CHECKED BY WN		DISTRIBUTION OF ITEMIZED COST			
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1) UNIT	AMOUNT	(2) UNIT	AMOUNT	(3) UNIT	AMOUNT
	GENL. VENTILATION UNITS								
	FAN, AXIAL, SURGE, 8000 CFM	1	EA		3000	2 SPD			
	FAN, " EXHAUST 4000 CFM	1	EA		2500	2 SPD			
	HT. RECOVERY WHEEL	1	EA		8000				
	FREE HTG. COIL	2	EA	1500	1500		1500		
	HUMIDIFIER	2	EA	2500	5000		5000		
	FILTER SET (PREHE)	1	EA	1000	1000		1000		
	ELEC. BUSBARBUS, ATRS NO WART	2	EA	100	200				
	EXHAUST FAN, VENT. UNITS								
	FANS, AXIAL, S.E. 4000 CFM	2	EA	2500	5000	2 SPD			
	HT. RECOVERY WHEEL	1	EA		5000				
	FREE HTG. COILS	1	EA		1000				
	HUMIDIFIER 100 LB.	2	EA	2500	5000		5000		
	FILTER SET, (PREHE)	1	EA		1000				
	WALL FANS, 8"	3	EA	150	450		500		
	TOILET EXH. FAN, AXIAL, 4000 CFM	1	EA		2500	2 SPD			
	WALL EXH. FANS, 11000 CFM	2	EA	500	1000				
	WALL LOUVERLS, 42x42	3	EA	200	600				
	UNIT HEATERS 25 KW	2	EA	1200	2400				
	UNIT HEATERS 5 KW	10	EA	400	4000		44,000		
	HEAT PUMP UNITS								
	2 TON 1 TON	6	EA	1200	7200				
	1 1/2 TON	9	EA	1400	12600		12,600		
	2 TON	21	EA	1500	31500		31,500		
	3 TON	24	EA	1800	43200		43,200		
	5 TON	13	EA	3500	45500		45,500		

FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2		PROJECT NO. DATE 10-5-3 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 21/27	
SECTION		QUANTITIES BY JG		PRICES BY JG		CHECKED BY			
CES		JG		JG		WIN			
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	DISTRIBUTION OF ITEMIZED COST					
				(1)	(2)	(3)	UNIT	AMOUNT	AMOUNT
8.7	HVAC DUCTWORK								
	TOILET EXH. DUCTWORK 12x12x200'	1200	LB	3.50	4200			4200	
	GRILLES 12x12	14	EA	25	300			300	
	FIRE DAMPERS 12x12	4	EA	25	100			100	
	CAMP. ROOM DUCTWORK, 16x16x400'	3400	LB	3.50	11900			11900	
	LABORANT UNIT DUCT ELBOWS	12	EA	500	6000			6000	
	PEX DOCT 12" d	70	L.F.	500	400			400	
	DOCT INSUL. 1"	2200	S.F.	1.75	3800			3800	
	FIRE DAMPERS	7	EA	25	1700			1700	
	GRILLES	12	EA	25	300			300	
	GENI. VENT. DOCTS, 16x16x250'	2200	LB	3.50	7700			7700	
	" 8x12x100'	3300	LB	3.50	11600			11600	
	" 8x8x250'	3000	LB	3.50	10500			10500	
	ABSOLUTE DOCT 1"	4300	S.F.	1.75	7500			7500	
	FIX. DOCT 6" d	400	L.F.	400	1600			1600	
	DAMPERS 6" d	78	EA	15	1200			1200	
	VOLUME DAMPERS, MOTOR 12x12	60	EA	150	600			600	
	HEAT PUMP DUCTWORK	13	EA	100	1300			1300	
	RETURN PLenum 24x24	240	EA	100	2400			2400	
	OUTLET DOCTS 16x16x850'	8300	LB	3.50	29100			29100	
	PEX DOCT 12" d	1800	L.F.	500	9000			9000	
	DOCT INSUL. 1"	5000	S.F.	1.75	8800			8800	
	GRILLES	200	EA	25	5000			5000	
	FIRE DAMPERS	21	EA	25	525			525	
	FIRE SMOKE DAMPERS	14	EA	500	7000			7000	

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FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE		PROJECT NO. DATE 10-5-3 10 SEPT, 86		REVISION DATE 16 SEPT, 86		PAGE 23/27	
SECTION CES		QUANTITIES BY JG		PRICES BY JG		CHECKED BY JG		WN	
ITEM NO.		DESCRIPTION OF WORK ITEMS		QUANTITY		UNIT		WN	

Building Designation	Air Conditioning, Heating And Ventilating System Description	Subcontract Standard Unit Price Per Ton Of Cooling Capacity	
		Range	Average
A, D, E, I, P, S, U, X, Y	1. <u>Packaged Thru Wall Unit.</u> Self contained Air Conditioning Unit with auxillary electric heating coil. Complete with wall sleeve, electric cord and plug and exterior caulking. (3/4 thru 2 Ton increments).	\$ 775.00 To \$ 945.00	\$ 860.00
A, D, E, I, P, S, U, X, Y	2. <u>Packaged Heat Pump.</u> Thru wall self contained unit with auxiliary electric heating coil. Complete with wall sleeve, electric cord, plug and exterior caulking. (3/4 thru 2 Ton increments).	\$1050.00 To \$1280.00	\$1165.00
A, D, E, G, H, I, K, M, Q, S, X, Y	3. <u>Residential Electric Furnaces.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. System complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1205.00 To \$1475.00	\$1340.00
B, C, D, E, F, G, H, I, J, K, O, Q, S, V, X, Z	4. <u>Roof Top Packaged Units.</u> Combination heating-cooling unit (electric or gas) complete with curb, starters, controls and prefabricated supply-return air duct assembly. (2 thru 15 Ton increments).	\$1235.00 To \$1505.00	\$1370.00
B, D, E, F, G, K, L, M, N, O, Q, X, Z	5. <u>Self-Contained Water Cooled Draw-Thru Units.</u> Air handling unit with integral compressor, condensing section, coils, filters and cabinet for mounting directly in space. System complete with cooling tower, pump, piping, controls and air diffuser discharge head. Heating by use of electric heaters. (20 thru 60 Tons).	\$1245.00 To \$1525.00	\$1385.00
A, D, E, G, H, I, K, M, Q, S, X, Y	6. <u>Residential Gas Furnace.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. Complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1290.00 To \$1580.00	\$1435.00
B, F, G, H, I, K, M, N, O, Q, V, W, Z	7. <u>Self-Contained Water Cooled Multizone Units.</u> Using electric duct heaters. System complete with cooling tower, pumps, piping, controls, starters, insulated duct system. Average 350 CFM Per Outlet. (15 thru 50 Tons).	\$1425.00 To \$1745.00	\$1585.00
A, I, P, Q, S, T, U, V	8. <u>Incremental Heat Pump Units.</u> Closed water loop system using floor mounted units, cast iron hot water boilers, liquid cooler, piping, controls and interior self-contained central air handling units. (3/4 thru 2 Ton increments).	\$1440.00 To \$1760.00	\$1600.00
H, I, J, M, N, O, U, V, Z	(electric or gas) complete with curb, starters, controls and fiberglass ductwork based on 400 CFM Per Outlet. (10 thru 50 Ton increments).	\$1805.00	\$1640.00
B, C, F, G, I, M, N, O, R, V, W, Z	10. <u>Multizone Two Pipe All Electric System.</u> Complete with chillers and electric duct heaters, pump, piping, expansion tank, controls and insulated duct system based on 350 CFM Per Outlet. (50 thru 1000 Tons).	\$1500.00 To \$1830.00	\$1665.00
B, C, F, G, I, M, N, O, R, V, W, Z	11. <u>Multizone Four Pipe System.</u> Chilled and hot water system complete with chillers, cast iron hot water boilers, pumps, expansion tanks, piping, controls, starters and insulated ductwork based on 350 CFM Per Outlet. (50 thru 1000 Tons).	\$1580.00 To \$1931.00	\$1755.00
C, F, I, V	12. <u>Low Pressure Variable Air Volume System.</u> Using chilled water draw thru air handling units with ceiling boxes delivering air to space or to return air ceiling plenum. Heating by baseboard electric perimeter heat and electric unit heaters below roof area. (50 thru 200 Tons).	\$1825.00 To \$2235.00	\$2030.00
C, J, V, W	13. <u>High Pressure Variable Air Volume Reheat All Electric System.</u> Using central built up fan-coil system with high velocity ductwork to Variable Air Volume boxes containing electric duct coils and flexible duct to slot type ceiling diffusers, centrifugal chillers, cooling towers, piping, controls, starters, pumps and expansion tank. Average box size 500 CFM. (200 thru 1000 Tons).	\$1930.00 To \$2360.00	\$2145.00
C, R, W	14. <u>High Pressure Variable Air Volume Induction Box Electric Reheat System.</u> All electric, using central built up Fan-Coil System with high velocity duct to above the ceiling type air induction boxes containing electric duct coils and low pressure fiberglass ductwork serving flexible duct run to ceiling diffusers. Complete with centrifugal chillers, cooling towers, piping, pumps, controls, starters and expansion tanks. Average box size 750 CFM. (200 thru 1000 Tons).	\$2010.00 To \$2460.00	\$2235.00

BALLPARK COSTS (BY COMPARISON)

See Notes on Page 4.
(Continued on following page)

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 1
VARIABLE AIR VOLUME

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 1/4 VAV SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$397068/195.6 = \$2030/TON

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 397068.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 36061.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2500.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		DISC.	LOAN1	LOAN2	FUEL1	FUEL2	FUEL3
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 1/4 VAV SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$397068/195.6 = \$2030/TON

YEAR		1986	1987	1988	1989	1990
CASH	\$	397068.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	36395.98	36699.56	37005.68
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2551.23	2577.24	2603.52
YEAR'S	\$	397068.00	0.00	38947.22	39276.81	39609.20
CUM.	\$	397068.00	397068.00	436015.22	475292.03	514901.22

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	37314.35	37625.59	37939.43	38255.89	38574.98
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2630.06	2656.87	2683.96	2711.32	2738.96
YEAR'S	\$	39944.41	40282.46	40623.39	40967.21	41313.95
CUM.	\$	554845.62	595128.06	635751.44	676718.62	718032.56

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	38896.74	39221.18	39548.33	39878.20	40210.83
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2766.88	2795.09	2823.58	2852.37	2881.45
YEAR'S	\$	41663.62	42016.27	42371.91	42730.57	43092.28
CUM.	\$	759696.19	801712.44	844084.38	886814.94	929907.19

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	40546.23	40884.43	41225.45	41569.32	41916.05
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2910.82	2940.50	2970.48	3000.76	3031.35
YEAR'S	\$	43457.06	43824.93	44195.93	44570.08	44947.40
CUM.	\$	973364.25	1017189.19	1061385.12	1105955.25	1150902.62

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	42265.68	42618.22	42973.70	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	3062.25	3093.47	3125.01	0.00	0.00
YEAR'S	\$	45327.93	45711.69	46098.71	0.00	0.00
CUM.	\$	1196230.50	1241942.25	1288041.00	1288041.00	1288041.00

Building Designation	Air Conditioning, Heating And Ventilating System Description	Subcontract Standard Unit Price Per Ton Of Cooling Capacity	
		Range	Average
A, D, E, I, P, S, U, X, Y	1. <u>Packaged Thru Wall Unit.</u> Self contained Air Conditioning Unit with auxillary electric heating coil. Complete with wall sleeve, electric cord and plug and exterior caulking. (3/4 thru 2 Ton increments).	\$ 775.00 To \$ 945.00	\$ 860.00
A, D, E, I, P, S, U, X, Y	2. <u>Packaged Heat Pump.</u> Thru wall self contained unit with auxillary electric heating coil. Complete with wall sleeve, electric cord, plug and exterior caulking. (3/4 thru 2 Ton increments).	\$1050.00 To \$1280.00	\$1165.00
A, D, E, G, H, I, K, M, Q, S, X, Y	3. <u>Residential Electric Furnaces.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. System complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1205.00 To \$1475.00	\$1340.00
B, C, D, E, F, G, H, I, J, K, O, Q, S, V, X, Z	4. <u>Roof Top Packaged Units.</u> Combination heating-cooling unit (electric or gas) complete with curb, starters, controls and prefabricated supply-return air duct assembly. (2 thru 15 Ton increments).	\$1235.00 To \$1505.00	\$1370.00
B, D, E, F, G, K, L, M, N, O, Q, X, Z	5. <u>Self-Contained Water Cooled Draw-Thru Units.</u> Air handling unit with integral compressor, condensing section, coils, filters and cabinet for mounting directly in space. System complete with cooling tower, pump, piping, controls and air diffuser discharge head. Heating by use of electric heaters. (20 thru 60 Tons).	\$1245.00 To \$1525.00	\$1385.00
A, D, E, G, H, I, K, M, Q, S, X, Y	6. <u>Residential Gas Furnace.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. Complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1290.00 To \$1580.00	\$1435.00
B, F, G, H, I, K, M, N, O, Q, V, W, Z	7. <u>Self-Contained Water Cooled Multizone Units.</u> Using electric duct heaters. System complete with cooling tower, pumps, piping, controls, starters, insulated duct system. Average 350 CFM Per Outlet. (15 thru 50 Tons).	\$1425.00 To \$1745.00	\$1585.00
A, I, P, Q, S, T, U, V	8. <u>Incremental Heat Pump Units.</u> Closed water loop system using floor mounted units, cast iron hot water boilers, liquid cooler, piping, controls and interior self-contained central air handling units. (3/4 thru 2 Ton increments).	\$1440.00 To \$1760.00	\$1600.00
B, C, F, G, H, I, J, M, N, O, U, V, Z	9. <u>Roof Top Multizone System.</u> Packaged combination heating-cooling unit (electric or gas) complete with curb, starters, controls and fiberglass ductwork based on 400 CFM Per Outlet. (10 thru 50 Ton increments).	\$1475.00 To \$1805.00	\$1640.00
B, C, F, G, I, M, N, O, R, V, W, Z	10. <u>Multizone Two Pipe All Electric System.</u> Complete with chillers and electric duct heaters, pump, piping, expansion tank, controls and insulated duct system based on 350 CFM Per Outlet. (50 thru 1000 Tons).	\$1500.00 To \$1830.00	\$1665.00
B, C, F, G, I, M, N, O, R, V, W, Z	11. <u>Multizone Four Pipe System.</u> Chilled and hot water system complete with chillers, cast iron hot water boilers, pumps, expansion tanks, piping, controls, starters and insulated ductwork based on 350 CFM	\$1580.00 To \$1931.00	\$1755.00
C, F, I, V	12. <u>Low Pressure Variable Air Volume System.</u> Using chilled water draw thru air handling units with ceiling boxes delivering air to space or to return air ceiling plenum. Heating by baseboard electric perimeter heat and electric unit heaters below roof area. (50 thru 200 Tons).	\$1825.00 To \$2235.00	\$2030.00
	central built up fan-coil system with high velocity ductwork to Variable Air Volume boxes containing electric duct coils and flexible duct to slot type ceiling diffusers, centrifugal chillers, cooling towers, piping, controls, starters, pumps and expansion tank. Average box size 500 CFM. (200 thru 1000 Tons).	\$1930.00 To \$2360.00	\$2145.00
C, R, W	14. <u>High Pressure Variable Air Volume Induction Box Electric Reheat System.</u> All electric, using central built up Fan-Coil System with high velocity duct to above the ceiling type air induction boxes containing electric duct coils and low pressure fiberglass ductwork serving flexible duct run to ceiling diffusers. Complete with centrifugal chillers, cooling towers, piping, pumps, controls, starters and expansion tanks. Average box size 750 CFM. (200 thru 1000 Tons).	\$2010.00 To \$2460.00	\$2235.00

BALLPARK COSTS (AVG. USED)

See Notes on Page 4.
(Continued on following page)

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 2
FOUR PIPE FAN COIL

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CDF SUBCON 1/4 4PFC SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$524208/195.6 = \$2680/TON

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 524208.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 33477.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 1/4 4PFC SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$524208/195.6 = \$2680/TON

YEAR		1986	1987	1988	1989	1990
CASH	\$	524208.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	33787.98	34069.80	34353.98
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	524208.00	0.00	35828.96	36131.60	36436.80
CUM.	\$	524208.00	524208.00	560036.94	596168.56	632605.38

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	34640.53	34929.47	35220.82	35514.61	35810.84
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	36744.58	37054.97	37367.99	37683.66	38002.00
CUM.	\$	669349.94	706404.88	743772.88	781456.56	819458.56

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	36109.54	36410.73	36714.43	37020.67	37329.47
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	38323.04	38646.80	38973.30	39302.57	39634.62
CUM.	\$	857781.62	896428.44	935401.75	974704.31	1014338.94

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	37640.83	37954.80	38271.38	38590.61	38912.49
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$	39969.49	40307.20	40647.76	40991.21	41337.57
CUM.	\$	1054308.38	1094615.62	1135263.38	1176254.62	1217592.25

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	39237.06	39564.34	39894.35	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$	41686.87	42039.12	42394.36	0.00	0.00
CUM.	\$	1259279.12	1301318.25	1343712.62	1343712.62	1343712.62

BALLPARK COSTS (AVG. USED)

Building Designation	Air Conditioning, Heating And Ventilating System Description	Subcontract Standard Unit Price Per Ton Of Cooling Capacity	
		Range	Average
C, J, V, W	15. High Pressure Variable Air Volume Hot Water Reheat System. Using central built up fan-coil system with high velocity duct to variable air volume boxes containing hot water coils. System complete with hot water boilers flexible duct run to slot type ceiling diffusers, centrifugal chillers, cooling towers, piping, pumps, starters and expansion tanks. Average box size 500 CFM. (200 thru 1000 Tons).	\$2150.00 To 2630.00	\$2390.00
C, R, W	16. High Pressure Variable Air Volume Induction Box Hot Water Reheat System. Using central built up fan-coil system with high velocity duct to above ceiling air induction boxes containing hot water reheat coils and low pressure ductwork serving flexible duct run out to ceiling diffusers. Complete with centrifugal chillers, cooling towers, hot water boilers, pumps, piping, starters, controls and expansion tank. Average box size 750 CFM. (200 thru 1000 Tons).	\$2165.00 To \$2645.00	\$2405.00
A, C, I, J, P, R, S, T, U, V, W	17. Fan-Coil Two Pipe All Electric System. Complete with chillers, concealed type Fan-Coil Units using integral electric strip heaters, piping, controls and central Air Handling Units on each floor for interior ventilation. (50 thru 1000 Tons).	\$2185.00 To \$2670.00	\$2425.00
C, J, N, R, W	18. High Pressure Dual-Duct Variable Air Volume System. Using built up air handling units and high velocity duct to dual inlet boxes. The cold duct is a Variable Air Volume duct and the hot duct connects to a cold duct in peak cooling requirements. System complete with centrifugal chillers, cooling towers, hot water boilers, pumps, piping, starters, controls, expansion tanks and flexible duct to slot type ceiling diffusers. Average box size 750 CFM. (200 thru 1000 Tons).	\$2225.00 To \$2715.00	\$2470.00
C, J, N, R, W	19. High Pressure Dual-Duct System. Using built up air handling units and high velocity duct to dual inlet boxes and low pressure ductwork serving flexible duct run to standard ceiling diffusers. System complete with centrifugal chillers, cooling towers, hot water boilers, pumps, piping, starters, controls and expansion tanks. Average box size 750 CFM.	\$2275.00 To \$2785.00	\$2530.00
A, C, I, J, P, R, S, T, U, V, W	20. Fan-Coil Four Pipe Chilled And Hot Water System. Complete with chillers, cooling towers, hot water boilers, pumps, expansion tanks, piping, controls and concealed type (2 coil) Fan-Coil Units with central Air Handling Units on each floor for interior ventilation. (50 thru 1000 Tons).	\$2410.00 To \$2950.00	\$2680.00
P, R, S, I, U, V, W	Condensers in centrifugal chillers and 105° F Hot Water Boilers. System complete with cooling towers, chillers, boilers, concealed type (2 coil) fan-coil units, piping, controls, expansion tanks, pumps, with central Air Handling Units on each floor for interior ventilators. Note: Storage tanks are not included. (200 thru 1000 Tons).	\$2545.00 To \$3115.00	\$2830.00
C, R, S, W	22. High Pressure Induction System. Two pipe all electric type using high pressure primary air and secondary chilled water cooling and integral electric strip heaters in each concealed type induction box. System complete with High Pressure Primary fan-coil, High Pressure ductwork, piping, controls, centrifugal chillers, cooling towers, expansion tanks and central high pressure double duct system for interior. (200 thru 1000 Tons).	\$2680.00 To \$3275.00	\$2975.00
C, R, S, U, W	23. High Pressure Induction System. Four pipe using high pressure primary air and secondary chilled and/or hot water in each concealed type induction box. System complete with High Pressure Primary fan-coil, High Pressure ductwork, piping, controls, centrifugal chillers, cooling towers, steam boiler with hot water convertor, feed water system, pumps and piping and central high pressure constant volume double duct system for interior. (200 thru 1000 Tons).	\$2960.00 To \$3620.00	\$3290.00

Notes:

- All systems based on the following design conditions:
 Inside Temperature @ 75°F
 Outside Summer Temperature @ 100°F Dry Bulb (78°F Wet Bulb)
 Outside Winter Temperature @ 0°F
- Motor Starters are included in System Costs shown. Motor Starters to be installed by Electrical Contractor as part of the scope of work covered in Account 16-101.
- Controls and Wiring are included in System Costs shown.
- Electrical Power Wiring is not included; see Account 16-101 and add for same.

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 3
BYPASS MULTIZONE

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 1/4 30MZ SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$343278/195.6 = \$1755/TON

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 343278.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 51555.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2500.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 1/4 3DMZ SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$343278/195.6 = \$1755/TON

YEAR		1986	1987	1988	1989	1990
CASH	\$	343278.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	52033.91	52467.93	52905.57
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2551.23	2577.24	2603.52
YEAR'S	\$	343278.00	0.00	54585.14	55045.17	55509.09
CUM.	\$	343278.00	343278.00	397863.12	452908.28	508417.38

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	53346.86	53791.83	54240.52	54692.94	55149.14
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2630.06	2656.87	2683.96	2711.32	2738.96
YEAR'S	\$	55976.92	56448.70	56924.47	57404.26	57888.10
CUM.	\$	564394.31	620843.00	677767.50	735171.75	793059.88

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	55609.14	56072.98	56540.69	57012.30	57487.84
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2766.88	2795.09	2823.58	2852.37	2881.45
YEAR'S	\$	58376.02	58868.07	59364.27	59864.67	60369.29
CUM.	\$	651435.88	710303.94	769668.19	829532.88	889902.12

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	57967.35	58450.86	58938.40	59430.01	59925.72
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2910.82	2940.50	2970.48	3000.76	3031.35
YEAR'S	\$	60878.18	61391.36	61908.88	62430.77	62957.07
CUM.	\$	1150780.25	1212171.62	1274080.50	1336511.25	1399468.38

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	60425.57	60929.58	61437.80	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	3062.25	3093.47	3125.01	0.00	0.00
YEAR'S	\$	63487.82	64023.06	64562.81	0.00	0.00
CUM.	\$	1462956.25	1526979.25	1591542.00	1591542.00	1591542.00

Building Designation	Air Conditioning, Heating And Ventilating System Description	Subcontract Standard Unit Price Per Ton Of Cooling Capacity	
		Range	Average
A, D, E, I, P, S, U, X, Y	1. <u>Packaged Thru Wall Unit.</u> Self contained Air Conditioning Unit with auxillary electric heating coil. Complete with wall sleeve, electric cord and plug and exterior caulking. (3/4 thru 2 Ton increments).	\$ 775.00 To \$ 945.00	\$ 860.00
A, D, E, I, P, S, U, X, Y	2. <u>Packaged Heat Pump.</u> Thru wall self contained unit with auxillary electric heating coil. Complete with wall sleeve, electric cord, plug and exterior caulking. (3/4 thru 2 Ton increments).	\$1050.00 To \$1280.00	\$1165.00
A, D, E, G, H, I, K, M, Q, S, X, Y	3. <u>Residential Electric Furnaces.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. System complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1205.00 To \$1475.00	\$1340.00
B, C, D, E, F, G, H, I, J, K, O, Q, S, V, X, Z	4. <u>Roof Top Packaged Units.</u> Combination heating-cooling unit (electric or gas) complete with curb, starters, controls and prefabricated supply-return air duct assembly. (2 thru 15 Ton increments).	\$1235.00 To \$1505.00	\$1370.00
B, D, E, F, G, K, L, M, N, O, Q, X, Z	5. <u>Self-Contained Water Cooled Draw-Thru Units.</u> Air handling unit with integral compressor, condensing section, coils, filters and cabinet for mounting directly in space. System complete with cooling tower, pump, piping, controls and air diffuser discharge head. Heating by use of electric heaters. (20 thru 60 Tons).	\$1245.00 To \$1525.00	\$1385.00
A, D, E, G, H, I, K, M, Q, S, X, Y	6. <u>Residential Gas Furnace.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. Complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1290.00 To \$1580.00	\$1435.00
B, F, G, H, I, K, M, N, O, Q, V, W, Z	7. <u>Self-Contained Water Cooled Multizone Units.</u> Using electric duct heaters. System complete with cooling tower, pumps, piping, controls, starters, insulated duct system. Average 350 CFM Per Outlet. (15 thru 50 Tons).	\$1425.00 To \$1745.00	\$1585.00
A, I, P, Q, S, T, U, V	8. <u>Incremental Heat Pump Units.</u> Closed water loop system using floor mounted units, cast iron hot water boilers, liquid cooler, piping, controls and interior self-contained central air handling units. (3/4 thru 2 Ton increments).	\$1440.00 To \$1760.00	\$1600.00
B, C, F, G, H, I, J, M, N, O, U, V, Z	9. <u>Roof Top Multizone System.</u> Packaged combination heating-cooling unit (electric or gas) complete with curb, starters, controls and fiberglass ductwork based on 400 CFM Per Outlet. (10 thru 50 Ton increments).	\$1475.00 To \$1805.00	\$1640.00
B, C, F, G, I, M, N, O,	10. <u>Multizone Two Pipe All Electric System.</u> Complete with chillers and electric duct heaters, pump, piping, expansion tank, controls and	\$1500.00 To	\$1665.00
B, C, F, G, I, M, N, O, R, V, W, Z	11. <u>Multizone Four Pipe System.</u> Chilled and hot water system complete with chillers, cast iron hot water boilers, pumps, expansion tanks, piping, controls, starters and insulated ductwork based on 350 CFM Per Outlet. (50 thru 1000 Tons).	\$1580.00 To \$1931.00	\$1755.00
	air handling units with ceiling boxes delivering air to space or to return air ceiling plenum. Heating by baseboard electric perimeter heat and electric unit heaters below roof area. (50 thru 200 Tons).	To \$2235.00	\$2030.00
C, J, V, W	13. <u>High Pressure Variable Air Volume Reheat All Electric System.</u> Using central built up fan-coil system with high velocity ductwork to Variable Air Volume boxes containing electric duct coils and flexible duct to slot type ceiling diffusers, centrifugal chillers, cooling towers, piping, controls, starters, pumps and expansion tank. Average box size 500 CFM. (200 thru 1000 Tons).	\$1930.00 To \$2360.00	\$2145.00
C, R, W	14. <u>High Pressure Variable Air Volume Induction Box Electric Reheat System.</u> All electric, using central built up Fan-Coil System with high velocity duct to above the ceiling type air induction boxes containing electric duct coils and low pressure fiberglass ductwork serving flexible duct run to ceiling diffusers. Complete with centrifugal chillers, cooling towers, piping, pumps, controls, starters and expansion tanks. Average box size 750 CFM. (200 thru 1000 Tons).	\$2010.00 To \$2460.00	\$2235.00

BALLPARK COSTS (AVG. USED)

See Notes on Page 4.
(Continued on following page)

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 4
FY1975 MULTIZONE

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 1/4 1975MZ SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$343278/195.6 = \$1755/TON

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 343278.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 96759.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2500.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

***** UNIFIED PRESENT WORTH LIFE CYCLE COST *****

PROJECT NAME : CCF SUBCON 1/4 1975MZ SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$343278/195.6 = \$1755/TDN

YEAR		1986	1987	1988	1989	1990
CASH	\$	343278.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	97657.82	98472.40	99293.77
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2551.23	2577.24	2603.52
YEAR'S	\$	343278.00	0.00	100209.06	101049.63	101897.28
CUM.	\$	343278.00	343278.00	443487.06	544536.69	646434.00

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	100121.99	100957.12	101799.22	102648.33	103504.53
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2630.06	2656.87	2683.96	2711.32	2738.96
YEAR'S	\$	102752.05	103613.99	104483.17	105359.65	106243.48
CUM.	\$	749186.06	852800.06	957283.25	1062642.88	1168886.38

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	104367.87	105238.41	106116.21	107001.33	107893.84
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2766.88	2795.09	2823.58	2852.37	2881.45
YEAR'S	\$	107134.75	108033.49	108939.79	109853.70	110775.28
CUM.	\$	1276021.12	1384054.62	1492994.38	1602848.12	1713623.38

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	108793.80	109701.26	110616.28	111538.95	112469.30
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2910.82	2940.50	2970.48	3000.76	3031.35
YEAR 'S	\$	111704.63	112641.76	113586.76	114539.70	115500.65
CUM.	\$	1825328.00	1937969.75	2051556.50	2166096.20	2281597.00

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	113407.41	114353.35	115307.17	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	3062.25	3093.47	3125.01	0.00	0.00
YEAR 'S	\$	116469.66	117446.81	118432.18	0.00	0.00
CUM.	\$	2398066.80	2515513.50	2633945.80	2633945.80	2633945.80

Building Designation	Air Conditioning, Heating And Ventilating System Description	Subcontract Standard Unit Price Per Ton Of Cooling Capacity	
		Range	Average
A, D, E, I, P, S, U, X, Y	1. <u>Packaged Thru Wall Unit.</u> Self contained Air Conditioning Unit with auxillary electric heating coil. Complete with wall sleeve, electric cord and plug and exterior caulking. (3/4 thru 2 Ton increments).	\$ 775.00 To \$ 945.00	\$ 860.00
A, D, E, I, P, S, U, X, Y	2. <u>Packaged Heat Pump.</u> Thru wall self contained unit with auxiliary electric heating coil. Complete with wall sleeve, electric cord, plug and exterior caulking. (3/4 thru 2 Ton increments).	\$1050.00 To \$1280.00	\$1165.00
A, D, E, G, H, I, K, M, Q, S, X, Y	3. <u>Residential Electric Furnaces.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. System complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1205.00 To \$1475.00	\$1340.00
B, C, D, E, F, G, H, I, J, K, O, Q, S, V, X, Z	4. <u>Roof Top Packaged Units.</u> Combination heating-cooling unit (electric or gas) complete with curb, starters, controls and prefabricated supply-return air duct assembly. (2 thru 15 Ton increments).	\$1235.00 To \$1505.00	\$1370.00
B, D, E, F, G, K, L, M, N, O, Q, X, Z	5. <u>Self-Contained Water Cooled Draw-Thru Units.</u> Air handling unit with integral compressor, condensing section, coils, filters and cabinet for mounting directly in space. System complete with cooling tower, pump, piping, controls and air diffuser discharge head. Heating by use of electric heaters. (20 thru 60 Tons).	\$1245.00 To \$1525.00	\$1385.00
A, D, E, G, H, I, K, M, Q, S, X, Y	6. <u>Residential Gas Furnace.</u> With top mounted evaporator and remote air cooled electrically operated condensing unit. Complete with piping, forced air ductwork, controls and electrical connections. (2 thru 10 Tons).	\$1290.00 To \$1580.00	\$1435.00
B, F, G, H, I, K, M, N, O, Q, V, W, Z	7. <u>Self-Contained Water Cooled Multizone Units.</u> Using electric duct heaters. System complete with cooling tower, pumps, piping, controls, starters, insulated duct system. Average 350 CFM Per Outlet. (15 thru 50 Tons).	\$1425.00 To \$1745.00	\$1585.00
A, I, P, Q, S, T, U, V	8. <u>Incremental Heat Pump Units.</u> Closed water loop system using floor mounted units, cast iron hot water boilers, liquid cooler, piping, controls and interior self-contained central air handling units. (3/4 thru 2 Ton increments).	\$1440.00 To \$1760.00	\$1600.00
B, C, F, G, H, I, J, M, N, O, U, V, Z	9. <u>Roof Top Multizone System.</u> Packaged combination heating-cooling unit (electric or gas) complete with curb, starters, controls and fiberglass ductwork based on 400 CFM Per Outlet. (10 thru 50 Ton increments).	\$1475.00 To \$1805.00	\$1640.00
B, C, F, G, I, M, N, O	10. <u>Multizone Two Pipe All Electric System.</u> Complete with chillers and electric duct heaters, pump, piping, expansion tank, controls and	\$1500.00 To	\$1665.00
B, C, F, G, I, M, N, O, R, V, W, Z	11. <u>Multizone Four Pipe System.</u> Chilled and hot water system complete with chillers, cast iron hot water boilers, pumps, expansion tanks, piping, controls, starters and insulated ductwork based on 350 CFM Per Outlet. (50 thru 1000 Tons).	\$1580.00 To \$1931.00	\$1755.00
	air handling units with ceiling boxes delivering air to space or to return air ceiling plenum. Heating by baseboard electric perimeter heat and electric unit heaters below roof area. (50 thru 200 Tons).	\$2235.00	\$2050.00
C, J, V, W	13. <u>High Pressure Variable Air Volume Reheat All Electric System.</u> Using central built up fan-coil system with high velocity ductwork to Variable Air Volume boxes containing electric duct coils and flexible duct to slot type ceiling diffusers, centrifugal chillers, cooling towers, piping, controls, starters, pumps and expansion tank. Average box size 500 CFM. (200 thru 1000 Tons).	\$1930.00 To \$2360.00	\$2145.00
C, R, W	14. <u>High Pressure Variable Air Volume Induction Box Electric Reheat System.</u> All electric, using central built up Fan-Coil System with high velocity duct to above the ceiling type air induction boxes containing electric duct coils and low pressure fiberglass ductwork serving flexible duct run to ceiling diffusers. Complete with centrifugal chillers, cooling towers, piping, pumps, controls, starters and expansion tanks. Average box size 750 CFM. (200 thru 1000 Tons).	\$2010.00 To \$2460.00	\$2235.00

**BALLPARK COSTS
(AVG. USED)**

See Notes on Page 4.
(Continued on following page)

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
LIFE CYCLE COST ANALYSIS
UNIFIED PRESENT WORTH COMPARISONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC1.DAT
 PROJECT : CCF SUBCON 1/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$344000/195.6 = \$1759/TON

FILE NO. : LCC2.DAT
 PROJECT : CCF SUBCON 1/4 VAV SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$397068/195.6 = \$2030/TON

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	344000.00	397068.00	-53068.00	-53068.00
1987	0.00	0.00	0.00	-53068.00
1988	25175.91	38947.22	-13771.31	-66839.31
1989	25389.69	39276.81	-13887.12	-80726.44
1990	25605.29	39609.20	-14003.91	-94730.35
1991	25822.73	39944.41	-14121.68	-108852.03
1992	26042.02	40282.46	-14240.44	-123092.48
1993	26263.18	40623.39	-14360.21	-137452.69
1994	26486.22	40967.21	-14480.99	-151933.69
1995	26711.17	41313.95	-14602.78	-166536.47
1996	26938.03	41663.62	-14725.59	-181262.06
1997	27166.82	42016.27	-14849.45	-196111.50
1998	27397.57	42371.91	-14974.34	-211085.84
1999	27630.28	42730.57	-15100.29	-226186.13
2000	27864.97	43092.28	-15227.31	-241413.44
2001	28101.68	43457.06	-15355.38	-256768.81
2002	28340.39	43824.93	-15484.54	-272253.38
2003	28581.14	44195.93	-15614.79	-287868.19
2004	28823.94	44570.08	-15746.14	-303614.31
2005	29068.81	44947.40	-15878.59	-319492.91
2006	29315.77	45327.93	-16012.16	-335505.06
2007	29564.84	45711.69	-16146.85	-351651.91
2008	29816.03	46098.71	-16282.68	-367934.59

*** APPARENT BREAK-EVEN YEAR = 1988 ***

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC1.DAT
 PROJECT : CCF SUBCON 1/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$344000/195.6 = \$1759/TON

FILE NO. : LCC3.DAT
 PROJECT : CCF SUBCON 1/4 4PFC SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$524208/195.6 = \$2680/TON

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	344000.00	524208.00	-180208.00	-180208.00
1987	0.00	0.00	0.00	-180208.00
1988	25175.91	35828.96	-10653.05	-190861.06
1989	25389.69	36131.60	-10741.91	-201602.97
1990	25605.29	36436.80	-10831.51	-212434.47
1991	25822.73	36744.58	-10921.85	-223356.31
1992	26042.02	37054.97	-11012.95	-234369.27
1993	26263.18	37367.99	-11104.81	-245474.06
1994	26486.22	37683.66	-11197.44	-256671.50
1995	26711.17	38002.00	-11290.83	-267962.34
1996	26938.03	38323.04	-11385.01	-279347.34
1997	27166.82	38646.80	-11479.98	-290827.34
1998	27397.57	38973.30	-11575.73	-302403.09
1999	27630.28	39302.57	-11672.29	-314075.38
2000	27864.97	39634.62	-11769.65	-325845.03
2001	28101.68	39969.49	-11867.81	-337712.84
2002	28340.39	40307.20	-11966.81	-349679.62
2003	28581.14	40647.76	-12066.62	-361746.25
2004	28823.94	40991.21	-12167.27	-373913.53
2005	29068.81	41337.57	-12268.76	-386182.28
2006	29315.77	41686.87	-12371.10	-398553.38
2007	29564.84	42039.12	-12474.28	-411027.66
2008	29816.03	42394.36	-12578.33	-423605.97

*** APPARENT BREAK-EVEN YEAR = 1988 ***

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC1.DAT
 PROJECT : CDF SUBCON 1/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$344000/195.6 = \$1759/TON

FILE NO. : LCC4.DAT
 PROJECT : CDF SUBCON 1/4 3DMZ SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$343278/195.6 = \$1755/TON

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	344000.00	343278.00	722.00	722.00
1987	0.00	0.00	0.00	722.00
1988	25175.91	54585.14	-29409.23	-28687.23
1989	25389.69	55045.17	-29655.48	-58342.72
1990	25605.29	55509.09	-29903.80	-88246.52
1991	25822.73	55976.92	-30154.19	-118400.70
1992	26042.02	56448.70	-30406.68	-148807.39
1993	26263.18	56924.47	-30661.29	-179468.69
1994	26486.22	57404.26	-30918.04	-210386.73
1995	26711.17	57888.10	-31176.93	-241563.67
1996	26938.03	58376.02	-31437.99	-273001.66
1997	27166.82	58868.07	-31701.25	-304702.91
1998	27397.57	59364.27	-31966.70	-336669.62
1999	27630.28	59864.67	-32234.39	-368904.03
2000	27864.97	60369.29	-32504.32	-401408.34
2001	28101.68	60878.18	-32776.50	-434184.84
2002	28340.39	61391.36	-33050.97	-467235.81
2003	28581.14	61908.88	-33327.74	-500563.56
2004	28823.94	62430.77	-33606.83	-534170.38
2005	29068.81	62957.07	-33888.26	-568058.62
2006	29315.77	63487.82	-34172.05	-602230.69
2007	29564.84	64023.06	-34458.22	-636688.94
2008	29816.03	64562.81	-34746.78	-671435.75

*** APPARENT BREAK-EVEN YEAR = 1988 ***

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC1.DAT
 PROJECT : CCF SUBCON 1/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$344000/195.6 = \$1759/TON

FILE NO. : LCC5.DAT
 PROJECT : CCF SUBCON 1/4 1975MZ SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$343278/195.6 = \$1755/TON

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	344000.00	343278.00	722.00	722.00
1987	0.00	0.00	0.00	722.00
1988	25175.91	100209.10	-75033.19	-74311.19
1989	25389.69	101049.60	-75659.91	-149971.09
1990	25605.29	101897.30	-76292.01	-226263.09
1991	25822.73	102752.00	-76929.27	-303192.38
1992	26042.02	103614.00	-77571.98	-380764.34
1993	26263.18	104483.20	-78220.02	-458984.38
1994	26486.22	105359.60	-78873.38	-537857.75
1995	26711.17	106243.50	-79532.33	-617390.06
1996	26938.03	107134.80	-80196.77	-697586.88
1997	27166.82	108033.50	-80866.68	-778453.56
1998	27397.57	108939.80	-81542.23	-859995.81
1999	27630.28	109853.70	-82223.42	-942219.25
2000	27864.97	110775.30	-82910.33	-1025129.50
2001	28101.68	111704.60	-83602.92	-1108732.50
2002	28340.39	112641.80	-84301.41	-1193033.88
2003	28581.14	113586.80	-85005.66	-1278039.50
2004	28823.94	114539.70	-85715.77	-1363755.25
2005	29068.81	115500.60	-86431.79	-1450187.12
2006	29315.77	116469.70	-87153.94	-1537341.12
2007	29564.84	117446.80	-87881.95	-1625223.00
2008	29816.03	118432.20	-88616.17	-1713839.25

*** APPARENT BREAK-EVEN YEAR = 1988 ***

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 1/4
SIMPLE PAYBACK CALCULATIONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

CCF SUBCONSTRUCT 1/4
SIMPLE PAYBACK

INPUT VALUES			DESIGN SYS		VAV SYS	
INITIAL TOTAL COST			\$	344,000	\$	397,068
ANNUAL OPERATING COST			\$	22,922	\$	36,061
ANNUAL MAINTENANCE COST			\$	2,000	\$	2,500
SALVAGE VALUE AT YEAR 20			\$	0	\$	0

YEAR	DESIGN SYS EXPENSES		VAV SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 344,000	\$ 344,000	\$ 397,068	\$ 397,068
1	\$ 24,922	\$ 368,922	\$ 38,561	\$ 435,629
2	\$ 24,922	\$ 393,844	\$ 38,561	\$ 474,190
3	\$ 24,922	\$ 418,766	\$ 38,561	\$ 512,751
4	\$ 24,922	\$ 443,688	\$ 38,561	\$ 551,312
5	\$ 24,922	\$ 468,610	\$ 38,561	\$ 589,873
6	\$ 24,922	\$ 493,532	\$ 38,561	\$ 628,434
7	\$ 24,922	\$ 518,454	\$ 38,561	\$ 666,995
8	\$ 24,922	\$ 543,376	\$ 38,561	\$ 705,556
9	\$ 24,922	\$ 568,298	\$ 38,561	\$ 744,117
10	\$ 24,922	\$ 593,220	\$ 38,561	\$ 782,678
11	\$ 24,922	\$ 618,142	\$ 38,561	\$ 821,239
12	\$ 24,922	\$ 643,064	\$ 38,561	\$ 859,800
13	\$ 24,922	\$ 667,986	\$ 38,561	\$ 898,361
14	\$ 24,922	\$ 692,908	\$ 38,561	\$ 936,922
15	\$ 24,922	\$ 717,830	\$ 38,561	\$ 975,483
16	\$ 24,922	\$ 742,752	\$ 38,561	\$1,014,044
17	\$ 24,922	\$ 767,674	\$ 38,561	\$1,052,605
18	\$ 24,922	\$ 792,596	\$ 38,561	\$1,091,166
19	\$ 24,922	\$ 817,518	\$ 38,561	\$1,129,727
20	\$ 24,922	\$ 842,440	\$ 38,561	\$1,168,288
SALVAGE (\$	0)	\$ 842,440	(\$ 0)	\$1,168,288

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 842,440
TOTAL COST OF VAV SYS FOR 20 YEARS IS \$1,168,288

CCF SUBCONSTRUCT 1/4
SIMPLE PAYBACK

INPUT VALUES			DESIGN SYS		4PFC SYS	
INITIAL TOTAL COST			\$	344,000	\$	524,208
ANNUAL OPERATING COST			\$	22,922	\$	33,477
ANNUAL MAINTENANCE COST			\$	2,000	\$	2,000
SALVAGE VALUE AT YEAR 20			\$	0	\$	0

YEAR	DESIGN SYS EXPENSES			4PFC SYS EXPENSES		
	ANNUAL	CUMULATIVE		ANNUAL	CUMULATIVE	
INITIAL	\$ 344,000	\$ 344,000		\$ 524,208	\$ 524,208	
1	\$ 24,922	\$ 368,922		\$ 35,477	\$ 559,685	
2	\$ 24,922	\$ 393,844		\$ 35,477	\$ 595,162	
3	\$ 24,922	\$ 418,766		\$ 35,477	\$ 630,639	
4	\$ 24,922	\$ 443,688		\$ 35,477	\$ 666,116	
5	\$ 24,922	\$ 468,610		\$ 35,477	\$ 701,593	
6	\$ 24,922	\$ 493,532		\$ 35,477	\$ 737,070	
7	\$ 24,922	\$ 518,454		\$ 35,477	\$ 772,547	
8	\$ 24,922	\$ 543,376		\$ 35,477	\$ 808,024	
9	\$ 24,922	\$ 568,298		\$ 35,477	\$ 843,501	
10	\$ 24,922	\$ 593,220		\$ 35,477	\$ 878,978	
11	\$ 24,922	\$ 618,142		\$ 35,477	\$ 914,455	
12	\$ 24,922	\$ 643,064		\$ 35,477	\$ 949,932	
13	\$ 24,922	\$ 667,986		\$ 35,477	\$ 985,409	
14	\$ 24,922	\$ 692,908		\$ 35,477	\$1,020,886	
15	\$ 24,922	\$ 717,830		\$ 35,477	\$1,056,363	
16	\$ 24,922	\$ 742,752		\$ 35,477	\$1,091,840	
17	\$ 24,922	\$ 767,674		\$ 35,477	\$1,127,317	
18	\$ 24,922	\$ 792,596		\$ 35,477	\$1,162,794	
19	\$ 24,922	\$ 817,518		\$ 35,477	\$1,198,271	
20	\$ 24,922	\$ 842,440		\$ 35,477	\$1,233,748	
SALVAGE (\$	0)	\$ 842,440	(\$	0)	\$1,233,748	

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 842,440
TOTAL COST OF 4PFC SYS FOR 20 YEARS IS \$1,233,748

CCF SUBCONSTRUCT 1/4
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	3DMZ SYS
INITIAL TOTAL COST	\$ 344,000	\$ 343,278
ANNUAL OPERATING COST	\$ 22,922	\$ 51,555
ANNUAL MAINTENANCE COST	\$ 2,000	\$ 2,500
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

YEAR	DESIGN SYS EXPENSES		3DMZ SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 344,000	\$ 344,000	\$ 343,278	\$ 343,278

1	\$ 24,922	\$ 368,922	\$ 54,055	\$ 397,333
2	\$ 24,922	\$ 393,844	\$ 54,055	\$ 451,388
3	\$ 24,922	\$ 418,766	\$ 54,055	\$ 505,443
4	\$ 24,922	\$ 443,688	\$ 54,055	\$ 559,498
5	\$ 24,922	\$ 468,610	\$ 54,055	\$ 613,553
6	\$ 24,922	\$ 493,532	\$ 54,055	\$ 667,608
7	\$ 24,922	\$ 518,454	\$ 54,055	\$ 721,663
8	\$ 24,922	\$ 543,376	\$ 54,055	\$ 775,718
9	\$ 24,922	\$ 568,298	\$ 54,055	\$ 829,773
10	\$ 24,922	\$ 593,220	\$ 54,055	\$ 883,828
11	\$ 24,922	\$ 618,142	\$ 54,055	\$ 937,883
12	\$ 24,922	\$ 643,064	\$ 54,055	\$ 991,938
13	\$ 24,922	\$ 667,986	\$ 54,055	\$1,045,993
14	\$ 24,922	\$ 692,908	\$ 54,055	\$1,100,048
15	\$ 24,922	\$ 717,830	\$ 54,055	\$1,154,103
16	\$ 24,922	\$ 742,752	\$ 54,055	\$1,208,158
17	\$ 24,922	\$ 767,674	\$ 54,055	\$1,262,213
18	\$ 24,922	\$ 792,596	\$ 54,055	\$1,316,268
19	\$ 24,922	\$ 817,518	\$ 54,055	\$1,370,323
20	\$ 24,922	\$ 842,440	\$ 54,055	\$1,424,378
SALVAGE (\$	0)	\$ 842,440	(\$ 0)	\$1,424,378

PAYBACK FOR DESIGN SYS OCCURS AFTER 0.0 YEARS (\$ 344,618)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 842,440
TOTAL COST OF 3DMZ SYS FOR 20 YEARS IS \$1,424,378

CCF SUBCONSTRUCT 1/4
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	1975MZ SYS
INITIAL TOTAL COST	\$ 344,000	\$ 343,278
ANNUAL OPERATING COST	\$ 22,922	\$ 96,759
ANNUAL MAINTENANCE COST	\$ 2,000	\$ 2,500
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

YEAR	DESIGN SYS EXPENSES		1975MZ SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 344,000	\$ 344,000	\$ 343,278	\$ 343,278

1	\$ 24,922	\$ 368,922	\$ 99,259	\$ 442,537
2	\$ 24,922	\$ 393,844	\$ 99,259	\$ 541,796
3	\$ 24,922	\$ 418,766	\$ 99,259	\$ 641,055
4	\$ 24,922	\$ 443,688	\$ 99,259	\$ 740,314
5	\$ 24,922	\$ 468,610	\$ 99,259	\$ 839,573
6	\$ 24,922	\$ 493,532	\$ 99,259	\$ 938,832
7	\$ 24,922	\$ 518,454	\$ 99,259	\$1,038,091
8	\$ 24,922	\$ 543,376	\$ 99,259	\$1,137,350
9	\$ 24,922	\$ 568,298	\$ 99,259	\$1,236,609
10	\$ 24,922	\$ 593,220	\$ 99,259	\$1,335,868
11	\$ 24,922	\$ 618,142	\$ 99,259	\$1,435,127
12	\$ 24,922	\$ 643,064	\$ 99,259	\$1,534,386
13	\$ 24,922	\$ 667,986	\$ 99,259	\$1,633,645
14	\$ 24,922	\$ 692,908	\$ 99,259	\$1,732,904
15	\$ 24,922	\$ 717,830	\$ 99,259	\$1,832,163
16	\$ 24,922	\$ 742,752	\$ 99,259	\$1,931,422
17	\$ 24,922	\$ 767,674	\$ 99,259	\$2,030,681
18	\$ 24,922	\$ 792,596	\$ 99,259	\$2,129,940
19	\$ 24,922	\$ 817,518	\$ 99,259	\$2,229,199
20	\$ 24,922	\$ 842,440	\$ 99,259	\$2,328,458
SALVAGE (\$ 0)	\$ 842,440	(\$ 0)	\$2,328,458	

PAYBACK FOR DESIGN SYS OCCURS AFTER 0.0 YEARS (\$ 344,242)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 842,440
TOTAL COST OF 1975MZ SYS FOR 20 YEARS IS \$2,328,458

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
SYSTEMS ANALYSIS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4

BUILDING SECTOR PHYSICAL PARAMETERS AND DESCRIPTION

12 NOVEMBER, 1986

ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site : AURORA, IL FERMI, User Defined 60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 68 F; Heating = 68 F; Setback = 0 F
 Warm-up factor = 0 %; Room design relative humidity = 45 %
 Floor Areas: Perimeter = 29,760 Sqft; Interior = 0 Sqft
 Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	2,060	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	980	0.060	420	0.550
West Wall	0	0.060	760	0.550
Northwest Wall	0	0.060	1,520	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium
 BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed
 Shade Factors : Glass = 0.650 ; Skylights = 0.000
 Internal shades are used. ; A ceiling plenum is used.

3. LIGHTS:

Perimeter : 1.000 Watts/Sqft = 29,760 Watts Total
 Interior : 0.000 Watts/Sqft = 0 Watts Total
 Diversity Factors : Occupied = 100 %; Unoccupied = 90 %
 Perimeter Lights : Ballast , recessed
 Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = 6.720 Watts/Sqft = 200,000 Watts Total
 Unoccupied = 6.720 Watts/Sqft = 200,000 Watts Total
 Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total
 Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 1,488 sqft/person = 20 people total
 Activity Level: 2. Office or retail
 Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person
 Diversity Factors : Occupied = 80 %; Unoccupied = 50 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr
 Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 8,340 Sqft; Interior = 0 Sqft
 Wall U-Factor = 0.380 BTU/(hr-sqft-F)
 Adjacent region heating temperature = 65 F
 Adjacent region is not cooled

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 149 cfm; Unoccupied = 89 cfm

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
BUILDING LOAD CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

LOAD PROFILE SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site Name : AURORA, IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD (Load does not include vent. load, fan heat)

Bin	Bin	<-----Perimeter Zone----->			<-----Interior Zone----->			Bin
Temp	Hours	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(F)
93	0.0	102.42	0.86	3.17	68	0.00	0.00	0.00
90	25.8	94.28	0.62	3.17	68	0.00	0.00	0.00
85	59.4	90.09	0.57	3.17	68	0.00	0.00	0.00
80	145.3	85.90	0.52	3.17	68	0.00	0.00	0.00
75	237.7	81.71	0.47	3.17	68	0.00	0.00	0.00
70	270.6	77.53	0.43	3.17	68	0.00	0.00	0.00
65	264.5	73.34	0.40	3.17	68	0.00	0.00	0.00
60	255.0	70.47	0.38	3.17	68	0.00	0.00	0.00
55	244.7	67.60	0.35	3.17	68	0.00	0.00	0.00
50	232.1	64.73	0.34	3.17	68	0.00	0.00	0.00
45	229.5	61.87	0.26	3.17	68	0.00	0.00	0.00
40	237.6	59.00	0.19	3.17	68	0.00	0.00	0.00
35	238.5	56.13	0.14	3.17	68	0.00	0.00	0.00
30	218.2	53.26	0.09	3.17	68	0.00	0.00	0.00
25	174.5	50.40	0.04	3.17	68	0.00	0.00	0.00
20	122.4	47.53	0.01	3.17	68	0.00	0.00	0.00
15	78.1	44.66	-0.02	3.17	68	0.00	0.00	0.00
10	46.1	41.79	-0.04	3.17	68	0.00	0.00	0.00
5	25.1	38.93	-0.06	3.17	68	0.00	0.00	0.00
0	12.7	36.06	-0.07	3.17	68	0.00	0.00	0.00
-5	6.2	33.19	-0.08	3.17	68	0.00	0.00	0.00
-6	4.6	32.62	-0.09	3.17	68	0.00	0.00	0.00

TABLE 2. UNOCCUPIED PERIOD (Load does not include vent. load, fan heat)

Bin	Bin	<-----Perimeter Zone----->			<-----Interior Zone----->			Bin
Temp	Hours	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(F)
90	14.6	93.30	0.38	2.86	68	0.00	0.00	0.00
85	36.3	89.13	0.35	2.86	68	0.00	0.00	0.00
80	99.3	84.97	0.32	2.86	68	0.00	0.00	0.00
75	215.3	80.81	0.29	2.86	68	0.00	0.00	0.00
70	357.6	76.65	0.27	2.86	68	0.00	0.00	0.00
65	463.3	72.49	0.25	2.86	68	0.00	0.00	0.00
60	500.4	69.65	0.23	2.86	68	0.00	0.00	0.00
55	482.0	66.81	0.22	2.86	68	0.00	0.00	0.00
50	447.6	63.97	0.21	2.86	68	0.00	0.00	0.00
45	422.7	61.13	0.16	2.86	68	0.00	0.00	0.00
40	413.7	58.29	0.12	2.86	68	0.00	0.00	0.00
35	417.0	55.45	0.09	2.86	68	0.00	0.00	0.00
30	417.4	52.61	0.06	2.86	68	0.00	0.00	0.00
25	395.2	49.77	0.03	2.86	68	0.00	0.00	0.00
20	336.9	46.93	0.01	2.86	68	0.00	0.00	0.00
15	252.8	44.09	-0.00	2.86	68	0.00	0.00	0.00
10	165.7	41.25	-0.02	2.86	68	0.00	0.00	0.00
5	96.3	38.41	-0.03	2.86	68	0.00	0.00	0.00
0	50.9	35.57	-0.04	2.86	68	0.00	0.00	0.00
-5	25.3	32.73	-0.04	2.86	68	0.00	0.00	0.00
-6	21.1	32.16	-0.05	2.86	68	0.00	0.00	0.00
-6	0.0	-32.62	-0.22	0.00	68	0.00	0.00	0.00

SOLAR GAIN SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. SOLAR GAINS BY EXPOSURE

Bin Temp (F)	Solar Gains by Exposure (BTU/(hr-sqft))								Perim Horiz	Inter Horiz
	North	NE	East	SE	South	SW	West	NW		
93	9.7	15.0	22.2	23.2	33.9	67.7	66.5	32.0	0.0	0.0
90	6.9	10.7	15.7	16.5	24.1	48.0	47.1	22.6	0.0	0.0
85	6.5	10.1	14.9	15.7	23.0	45.7	44.8	21.5	0.0	0.0
80	6.2	9.6	14.2	14.9	21.8	43.3	42.4	20.3	0.0	0.0
75	5.8	9.0	13.4	14.2	20.7	40.9	40.0	19.1	0.0	0.0
70	5.5	8.5	12.6	13.4	19.6	38.6	37.7	18.0	0.0	0.0
65	5.1	7.9	11.8	12.6	18.5	36.2	35.3	16.8	0.0	0.0
60	4.8	7.4	11.0	11.8	17.4	33.9	32.9	15.6	0.0	0.0
55	4.4	6.8	10.3	11.0	16.2	31.5	30.6	14.4	0.0	0.0
50	4.1	6.3	9.5	10.3	15.1	29.2	28.2	13.3	0.0	0.0
45	3.7	5.7	8.7	9.5	14.0	26.8	25.8	12.1	0.0	0.0
40	3.4	5.2	7.9	8.7	12.9	24.4	23.5	10.9	0.0	0.0
35	3.0	4.6	7.1	7.9	11.8	22.1	21.1	9.8	0.0	0.0
30	2.7	4.1	6.4	7.2	10.6	19.7	18.8	8.6	0.0	0.0
25	2.3	3.5	5.6	6.4	9.5	17.4	16.4	7.4	0.0	0.0
20	2.0	3.0	4.8	5.6	8.4	15.0	14.0	6.3	0.0	0.0
15	1.6	2.4	4.0	4.8	7.3	12.7	11.7	5.1	0.0	0.0
10	1.2	1.9	3.2	4.1	6.2	10.3	9.3	3.9	0.0	0.0
5	0.9	1.3	2.5	3.3	5.0	8.0	6.9	2.8	0.0	0.0
0	0.5	0.8	1.7	2.5	3.9	5.6	4.6	1.6	0.0	0.0
-5	0.2	0.2	0.9	1.7	2.8	3.2	2.2	0.4	0.0	0.0
-6	0.1	0.1	0.7	1.6	2.6	2.8	1.7	0.2	0.0	0.0
-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ETD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site Name : AURORA, IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD

Bin Temp (F)	Equivalent Temperature Differences (F)								Perim Roof	Inter Roof
	North	NE	East	SE	By Exposure		West	NW		
					South	SW				
93	18.0	19.9	21.2	26.5	30.0	28.5	25.0	19.3	40.4	-----
90	15.4	16.7	17.6	21.4	23.9	22.8	20.3	16.3	31.7	-----
85	11.0	12.2	13.1	16.7	19.1	18.1	15.7	11.8	26.4	-----
80	6.6	7.8	8.6	12.1	14.2	13.4	11.1	7.4	21.1	-----
75	2.2	3.3	4.1	7.4	9.4	8.6	6.4	2.9	15.8	-----
70	-2.2	-1.2	-0.4	2.7	4.6	3.9	1.8	-1.5	10.5	-----
65	-6.6	-5.6	-4.9	-1.9	-0.2	-0.8	-2.8	-5.9	5.1	-----
60	-11.0	-10.1	-9.4	-6.6	-5.0	-5.5	-7.5	-10.4	-0.2	-----
55	-15.4	-14.5	-13.9	-11.3	-9.8	-10.3	-12.1	-14.8	-5.5	-----
50	-19.8	-19.0	-18.4	-15.9	-14.6	-15.0	-16.7	-19.3	-10.8	-----
45	-24.2	-23.5	-22.9	-20.6	-19.4	-19.7	-21.4	-23.7	-16.1	-----
40	-28.6	-27.9	-27.4	-25.3	-24.2	-24.4	-26.0	-28.1	-21.4	-----
35	-33.0	-32.4	-31.9	-29.9	-29.0	-29.2	-30.6	-32.6	-26.7	-----
30	-37.4	-36.9	-36.4	-34.6	-33.8	-33.9	-35.3	-37.0	-32.0	-----
25	-41.8	-41.3	-40.9	-39.3	-38.7	-38.6	-39.9	-41.5	-37.3	-----
20	-46.2	-45.8	-45.4	-43.9	-43.5	-43.4	-44.5	-45.9	-42.6	-----
15	-50.5	-50.2	-50.0	-48.6	-48.3	-48.1	-49.2	-50.3	-47.9	-----
10	-54.9	-54.7	-54.5	-53.3	-53.1	-52.8	-53.8	-54.8	-53.2	-----
5	-59.3	-59.2	-59.0	-57.9	-57.9	-57.5	-58.4	-59.2	-58.6	-----
0	-63.7	-63.6	-63.5	-62.6	-62.7	-62.3	-63.1	-63.7	-63.9	-----
-5	-68.1	-68.1	-68.0	-67.3	-67.5	-67.0	-67.7	-68.1	-69.2	-----
-6	-69.0	-69.0	-68.9	-68.2	-68.5	-67.9	-68.6	-69.0	-70.2	-----

TABLE 2. UNOCCUPIED PERIOD

90	15.4	16.7	17.6	21.4	23.9	22.8	20.3	16.3	31.7	-----
85	11.0	12.2	13.1	16.7	19.1	18.1	15.7	11.8	26.4	-----
80	6.6	7.8	8.6	12.1	14.2	13.4	11.1	7.4	21.1	-----
75	2.2	3.3	4.1	7.4	9.4	8.6	6.4	2.9	15.8	-----
70	-2.2	-1.2	-0.4	2.7	4.6	3.9	1.8	-1.5	10.5	-----
65	-6.6	-5.6	-4.9	-1.9	-0.2	-0.8	-2.8	-5.9	5.1	-----
60	-11.0	-10.1	-9.4	-6.6	-5.0	-5.5	-7.5	-10.4	-0.2	-----
55	-15.4	-14.5	-13.9	-11.3	-9.8	-10.3	-12.1	-14.8	-5.5	-----
50	-19.8	-19.0	-18.4	-15.9	-14.6	-15.0	-16.7	-19.3	-10.8	-----
45	-24.2	-23.5	-22.9	-20.6	-19.4	-19.7	-21.4	-23.7	-16.1	-----
40	-28.6	-27.9	-27.4	-25.3	-24.2	-24.4	-26.0	-28.1	-21.4	-----
35	-33.0	-32.4	-31.9	-29.9	-29.0	-29.2	-30.6	-32.6	-26.7	-----
30	-37.4	-36.9	-36.4	-34.6	-33.8	-33.9	-35.3	-37.0	-32.0	-----
25	-41.8	-41.3	-40.9	-39.3	-38.7	-38.6	-39.9	-41.5	-37.3	-----
20	-46.2	-45.8	-45.4	-43.9	-43.5	-43.4	-44.5	-45.9	-42.6	-----
15	-50.5	-50.2	-50.0	-48.6	-48.3	-48.1	-49.2	-50.3	-47.9	-----
10	-54.9	-54.7	-54.5	-53.3	-53.1	-52.8	-53.8	-54.8	-53.2	-----
5	-59.3	-59.2	-59.0	-57.9	-57.9	-57.5	-58.4	-59.2	-58.6	-----
0	-63.7	-63.6	-63.5	-62.6	-62.7	-62.3	-63.1	-63.7	-63.9	-----
-5	-68.1	-68.1	-68.0	-67.3	-67.5	-67.0	-67.7	-68.1	-69.2	-----
-6	-69.0	-69.0	-68.9	-68.2	-68.5	-67.9	-68.6	-69.0	-70.2	-----
-6	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-----

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0153
 Bin Number : 0 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 93 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	241,681	0
Glass Transmission	112,888	0
Wall Transmission	14,796	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	79,230	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (20 People Total)	4,900	4,100
Miscellaneous Internal Loads	0	0
Infiltration	4,092	6,274

Total Room Loads	1,229,061	10,374
Total Room Tons	102.42	0.86
Total Room sqft/ton	290.56	34,424.13
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	28,325	19,952
Northeast Glass	0	0	0
East Glass	690	9,488	15,303
Southeast Glass	1,380	18,975	32,038
South Glass	1,380	18,975	46,791
Southwest Glass	420	5,775	28,440
West Glass	760	10,450	50,566
Northwest Glass	1,520	20,900	48,592
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	2,071	-
Southeast Wall	3,260	5,186	-
South Wall	3,260	5,864	-
Southwest Wall	980	1,674	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0124
 Bin Number : 1 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 90 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	171,361	0
Glass Transmission	99,341	0
Wall Transmission	11,920	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	69,722	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	3,601	4,204

Total Room Loads	1,131,340	7,484
Total Room Tons	94.28	0.62
Total Room sqft/ton	315.66	47,719.48
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	24,926	14,131
Northeast Glass	0	0	0
East Glass	690	8,349	10,848
Southeast Glass	1,380	16,698	22,745
South Glass	1,380	16,698	33,230
Southwest Glass	420	5,082	20,167
West Glass	760	9,196	35,834
Northwest Glass	1,520	18,392	34,406
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	1,723	-
Southeast Wall	3,260	4,189	-
South Wall	3,260	4,667	-
Southwest Wall	980	1,341	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0114
 Bin Number : 2 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 85 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	162,918	0
Glass Transmission	76,764	0
Wall Transmission	9,348	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	53,876	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	2,783	3,511

Total Room Loads	1,081,083	6,791
Total Room Tons	90.09	0.57
Total Room sqft/ton	330.34	52,591.08
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	19,261	13,409
Northeast Glass	0	0	0
East Glass	690	6,452	10,309
Southeast Glass	1,380	12,903	21,674
South Glass	1,380	12,903	31,685
Southwest Glass	420	3,927	19,177
West Glass	760	7,106	34,035
Northwest Glass	1,520	14,212	32,628
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	1,282	-
Southeast Wall	3,260	3,276	-
South Wall	3,260	3,726	-
Southwest Wall	980	1,063	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0106
 Bin Number : 3 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 80 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	154,474	0
Glass Transmission	54,186	0
Wall Transmission	6,776	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	38,030	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	1,964	2,905

Total Room Loads	1,030,825	6,185
Total Room Tons	85.90	0.52
Total Room sqft/ton	346.44	57,742.04
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	13,596	12,686
Northeast Glass	0	0	0
East Glass	690	4,554	9,771
Southeast Glass	1,380	9,108	20,603
South Glass	1,380	9,108	30,140
Southwest Glass	420	2,772	18,187
West Glass	760	5,016	32,236
Northwest Glass	1,520	10,032	30,850
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	842	-
Southeast Wall	3,260	2,363	-
South Wall	3,260	2,786	-
Southwest Wall	980	786	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied D.A. Humidity Ratio = 0.0099
 Bin Number : 4 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 75 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	146,031	0
Glass Transmission	31,609	0
Wall Transmission	4,204	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	22,184	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	1,146	2,380

Total Room Loads	980,568	5,660
Total Room Tons	81.71	0.47
Total Room sqft/ton	364.20	63,098.52
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	7,931	11,964
Northeast Glass	0	0	0
East Glass	690	2,657	9,232
Southeast Glass	1,380	5,313	19,532
South Glass	1,380	5,313	28,594
Southwest Glass	420	1,617	17,198
West Glass	760	2,926	30,438
Northwest Glass	1,520	5,852	29,073
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	401	-
Southeast Wall	3,260	1,450	-
South Wall	3,260	1,845	-
Southwest Wall	980	508	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied D.A. Humidity Ratio = 0.0093
 Bin Number : 5 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 70 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	137,587	0
Glass Transmission	9,031	0
Wall Transmission	1,632	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	6,338	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	327	1,929

Total Room Loads	930,311	5,209
Total Room Tons	77.53	0.43
Total Room sqft/ton	383.87	68,556.54
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	2,266	11,242
Northeast Glass	0	0	0
East Glass	690	759	8,693
Southeast Glass	1,380	1,518	18,461
South Glass	1,380	1,518	27,049
Southwest Glass	420	462	16,208
West Glass	760	836	28,639
Northwest Glass	1,520	1,672	27,295
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-39	-
Southeast Wall	3,260	537	-
South Wall	3,260	905	-
Southwest Wall	980	230	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0087
 Bin Number : 6 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 65 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	129,144	0
Glass Transmission	-13,547	0
Wall Transmission	-940	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-491	1,547

Total Room Loads	880,053	4,827
Total Room Tons	73.34	0.40
Total Room sqft/ton	405.79	73,980.08
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-3,399	10,519
Northeast Glass	0	0	0
East Glass	690	-1,139	8,155
Southeast Glass	1,380	-2,277	17,390
South Glass	1,380	-2,277	25,504
Southwest Glass	420	-693	15,218
West Glass	760	-1,254	26,841
Northwest Glass	1,520	-2,508	25,517
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-480	-
Southeast Wall	3,260	-376	-
South Wall	3,260	-36	-
Southwest Wall	980	-48	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0083
 Bin Number : 7 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 60 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	120,700	0
Glass Transmission	-36,124	0
Wall Transmission	-3,512	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-1,309	1,229

Total Room Loads	845,642	4,509
Total Room Tons	70.47	0.38
Total Room sqft/ton	422.31	79,206.89
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-9,064	9,797
Northeast Glass	0	0	0
East Glass	690	-3,036	7,616
Southeast Glass	1,380	-6,072	16,319
South Glass	1,380	-6,072	23,959
Southwest Glass	420	-1,848	14,228
West Glass	760	-3,344	25,042
Northwest Glass	1,520	-6,688	23,739
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-920	-
Southeast Wall	3,260	-1,289	-
South Wall	3,260	-977	-
Southwest Wall	980	-326	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0079
 Bin Number : 8 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 55 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	112,257	0
Glass Transmission	-58,702	0
Wall Transmission	-6,084	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-2,128	969

Total Room Loads	811,230	4,249
Total Room Tons	67.60	0.35
Total Room sqft/ton	440.22	84,056.15
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-14,729	9,074
Northeast Glass	0	0	0
East Glass	690	-4,934	7,077
Southeast Glass	1,380	-9,867	15,248
South Glass	1,380	-9,867	22,414
Southwest Glass	420	-3,003	13,238
West Glass	760	-5,434	23,243
Northwest Glass	1,520	-10,868	21,962
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,361	-
Southeast Wall	3,260	-2,202	-
South Wall	3,260	-1,917	-
Southwest Wall	980	-604	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied D.A. Humidity Ratio = 0.0076
 Bin Number : 9 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 50 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	103,813	0
Glass Transmission	-81,279	0
Wall Transmission	-8,656	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-2,946	762

Total Room Loads	776,819	4,042
Total Room Tons	64.73	0.34
Total Room sqft/ton	459.72	88,346.48
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-20,394	8,352
Northeast Glass	0	0	0
East Glass	690	-6,831	6,539
Southeast Glass	1,380	-13,662	14,178
South Glass	1,380	-13,662	20,868
Southwest Glass	420	-4,158	12,248
West Glass	760	-7,524	21,445
Northwest Glass	1,520	-15,048	20,184
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,802	-
Southeast Wall	3,260	-3,115	-
South Wall	3,260	-2,858	-
Southwest Wall	980	-882	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0063
 Bin Number : 10 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 45 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	95,370	0
Glass Transmission	-103,857	0
Wall Transmission	-11,228	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-3,765	-177

Total Room Loads	742,408	3,103
Total Room Tons	61.87	0.26
Total Room sqft/ton	481.03	115,104.57
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-26,059	7,629
Northeast Glass	0	0	0
East Glass	690	-8,729	6,000
Southeast Glass	1,380	-17,457	13,107
South Glass	1,380	-17,457	19,323
Southwest Glass	420	-5,313	11,259
West Glass	760	-9,614	19,646
Northwest Glass	1,520	-19,228	18,406
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,242	-
Southeast Wall	3,260	-4,028	-
South Wall	3,260	-3,799	-
Southwest Wall	980	-1,160	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0052
 Bin Number : 11 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 40 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	86,927	0
Glass Transmission	-126,434	0
Wall Transmission	-13,800	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-4,583	-969

Total Room Loads	707,996	2,311
Total Room Tons	59.00	0.19
Total Room sqft/ton	504.41	154,549.36
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-31,724	6,907
Northeast Glass	0	0	0
East Glass	690	-10,626	5,461
Southeast Glass	1,380	-21,252	12,036
South Glass	1,380	-21,252	17,778
Southwest Glass	420	-6,468	10,269
West Glass	760	-11,704	17,847
Northwest Glass	1,520	-23,408	16,629
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,683	-
Southeast Wall	3,260	-4,941	-
South Wall	3,260	-4,739	-
Southwest Wall	980	-1,438	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0043
 Bin Number : 12 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 35 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	78,483	0
Glass Transmission	-149,012	0
Wall Transmission	-16,372	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-5,401	-1,635

Total Room Loads	673,585	1,645
Total Room Tons	56.13	0.14
Total Room sqft/ton	530.18	217,037.84
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-37,389	6,184
Northeast Glass	0	0	0
East Glass	690	-12,524	4,923
Southeast Glass	1,380	-25,047	10,965
South Glass	1,380	-25,047	16,233
Southwest Glass	420	-7,623	9,279
West Glass	760	-13,794	16,049
Northwest Glass	1,520	-27,588	14,851
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,123	-
Southeast Wall	3,260	-5,853	-
South Wall	3,260	-5,680	-
Southwest Wall	980	-1,715	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0035
 Bin Number : 13 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 30 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	70,040	0
Glass Transmission	-171,589	0
Wall Transmission	-18,944	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-6,220	-2,224

Total Room Loads	639,174	1,056
Total Room Tons	53.26	0.09
Total Room sqft/ton	558.72	338,300.69
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-43,054	5,462
Northeast Glass	0	0	0
East Glass	690	-14,421	4,384
Southeast Glass	1,380	-28,842	9,894
South Glass	1,380	-28,842	14,687
Southwest Glass	420	-8,778	8,289
West Glass	760	-15,884	14,250
Northwest Glass	1,520	-31,768	13,073
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,564	-
Southeast Wall	3,260	-6,766	-
South Wall	3,260	-6,621	-
Southwest Wall	980	-1,993	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0028
 Bin Number : 14 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 25 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	61,596	0
Glass Transmission	-194,167	0
Wall Transmission	-21,516	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-7,038	-2,747

Total Room Loads	604,762	533
Total Room Tons	50.40	0.04
Total Room sqft/ton	590.51	670,261.94
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-48,719	4,740
Northeast Glass	0	0	0
East Glass	690	-16,319	3,845
Southeast Glass	1,380	-32,637	8,823
South Glass	1,380	-32,637	13,142
Southwest Glass	420	-9,933	7,299
West Glass	760	-17,974	12,451
Northwest Glass	1,520	-35,948	11,296
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,004	-
Southeast Wall	3,260	-7,679	-
South Wall	3,260	-7,561	-
Southwest Wall	980	-2,271	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied D.A. Humidity Ratio = 0.0022
 Bin Number : 15 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 20 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	53,153	0
Glass Transmission	-216,744	0
Wall Transmission	-24,088	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-7,857	-3,168

Total Room Loads	570,351	112
Total Room Tons	47.53	0.01
Total Room sqft/ton	626.14	%3,200,620.20
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-54,384	4,017
Northeast Glass	0	0	0
East Glass	690	-18,216	3,307
Southeast Glass	1,380	-36,432	7,752
South Glass	1,380	-36,432	11,597
Southwest Glass	420	-11,088	6,310
West Glass	760	-20,064	10,653
Northwest Glass	1,520	-40,128	9,518
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,445	-
Southeast Wall	3,260	-8,592	-
South Wall	3,260	-8,502	-
Southwest Wall	980	-2,549	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0017
 Bin Number : 16 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 15 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	44,709	0
Glass Transmission	-239,322	0
Wall Transmission	-26,660	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-8,675	-3,506
Total Room Loads	535,939	-226
Total Room Tons	44.66	-0.02
Total Room sqft/ton	666.34	%1,577,787.38
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-60,049	3,295
Northeast Glass	0	0	0
East Glass	690	-20,114	2,768
Southeast Glass	1,380	-40,227	6,681
South Glass	1,380	-40,227	10,052
Southwest Glass	420	-12,243	5,320
West Glass	760	-22,154	8,854
Northwest Glass	1,520	-44,308	7,740
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,885	-
Southeast Wall	3,260	-9,505	-
South Wall	3,260	-9,443	-
Southwest Wall	980	-2,827	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0013
 Bin Number : 17 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 10 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	36,266	0
Glass Transmission	-261,899	0
Wall Transmission	-29,232	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-9,493	-3,776

Total Room Loads	501,528	-496
Total Room Tons	41.79	-0.04
Total Room sqft/ton	712.06	719,694.31
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-65,714	2,572
Northeast Glass	0	0	0
East Glass	690	-22,011	2,229
Southeast Glass	1,380	-44,022	5,610
South Glass	1,380	-44,022	8,507
Southwest Glass	420	-13,398	4,330
West Glass	760	-24,244	7,055
Northwest Glass	1,520	-48,488	5,962
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,326	-
Southeast Wall	3,260	-10,418	-
South Wall	3,260	-10,383	-
Southwest Wall	980	-3,105	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied D.A. Humidity Ratio = 0.0010
 Bin Number : 18 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 5 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	27,822	0
Glass Transmission	-284,477	0
Wall Transmission	-31,804	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-10,312	-3,991

Total Room Loads	467,117	-711
Total Room Tons	38.93	-0.06
Total Room sqft/ton	764.52	502,480.69
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-71,379	1,850
Northeast Glass	0	0	0
East Glass	690	-23,909	1,691
Southeast Glass	1,380	-47,817	4,539
South Glass	1,380	-47,817	6,961
Southwest Glass	420	-14,553	3,340
West Glass	760	-26,334	5,257
Northwest Glass	1,520	-52,668	4,185
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,767	-
Southeast Wall	3,260	-11,331	-
South Wall	3,260	-11,324	-
Southwest Wall	980	-3,383	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0008
 Bin Number : 19 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 0 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	19,379	0
Glass Transmission	-307,054	0
Wall Transmission	-34,376	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-11,130	-4,160

Total Room Loads	432,705	-880
Total Room Tons	36.06	-0.07
Total Room sqft/ton	825.32	405,647.78
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
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North Glass	2,060	-77,044	1,127
Northeast Glass	0	0	0
East Glass	690	-25,806	1,152
Southeast Glass	1,380	-51,612	3,468
South Glass	1,380	-51,612	5,416
Southwest Glass	420	-15,708	2,350
West Glass	760	-28,424	3,458
Northwest Glass	1,520	-56,848	2,407
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,207	-
Southeast Wall	3,260	-12,244	-
South Wall	3,260	-12,264	-
Southwest Wall	980	-3,661	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0006
 Bin Number : 20 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = -5 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	10,936	0
Glass Transmission	-329,632	0
Wall Transmission	-36,948	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-11,949	-4,294

Total Room Loads	398,294	-1,014
Total Room Tons	33.19	-0.08
Total Room sqft/ton	896.62	352,236.34
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-82,709	405
Northeast Glass	0	0	0
East Glass	690	-27,704	613
Southeast Glass	1,380	-55,407	2,397
South Glass	1,380	-55,407	3,871
Southwest Glass	420	-16,863	1,361
West Glass	760	-30,514	1,659
Northwest Glass	1,520	-61,028	629
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,648	-
Southeast Wall	3,260	-13,157	-
South Wall	3,260	-13,205	-
Southwest Wall	980	-3,939	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Occupied O.A. Humidity Ratio = 0.0006
 Bin Number : 21 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = -6 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	9,247	0
Glass Transmission	-334,147	0
Wall Transmission	-37,463	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (29,760 W Total)	88,875	0
Misc. Elec. (200,000 W Total)	682,600	0
People (16 People Total)	3,920	3,280
Miscellaneous Internal Loads	0	0
Infiltration	-12,112	-4,317

Total Room Loads	391,412	-1,037
Total Room Tons	32.62	-0.09
Total Room sqft/ton	912.39	344,418.88
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	38,089 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-83,842	260
Northeast Glass	0	0	0
East Glass	690	-28,083	506
Southeast Glass	1,380	-56,166	2,183
South Glass	1,380	-56,166	3,562
Southwest Glass	420	-17,094	1,163
West Glass	760	-30,932	1,300
Northwest Glass	1,520	-61,864	274
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,736	-
Southeast Wall	3,260	-13,339	-
South Wall	3,260	-13,393	-
Southwest Wall	980	-3,994	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0124
 Bin Number : 1 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 90 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	171,361	0
Glass Transmission	99,341	0
Wall Transmission	11,920	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	69,722	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	2,161	2,522

Total Room Loads	1,119,542	4,572
Total Room Tons	93.30	0.38
Total Room sqft/ton	318.99	78,106.10
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	24,926	14,131
Northeast Glass	0	0	0
East Glass	690	8,349	10,848
Southeast Glass	1,380	16,698	22,745
South Glass	1,380	16,698	33,230
Southwest Glass	420	5,082	20,167
West Glass	760	9,196	35,834
Northwest Glass	1,520	18,392	34,406
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	1,723	-
Southeast Wall	3,260	4,189	-
South Wall	3,260	4,667	-
Southwest Wall	980	1,341	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0114
 Bin Number : 2 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 85 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	162,918	0
Glass Transmission	76,764	0
Wall Transmission	9,348	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	53,876	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	1,670	2,106

Total Room Loads	1,069,612	4,156
Total Room Tons	89.13	0.35
Total Room sqft/ton	333.88	85,922.51
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	19,261	13,409
Northeast Glass	0	0	0
East Glass	690	6,452	10,309
Southeast Glass	1,380	12,903	21,674
South Glass	1,380	12,903	31,685
Southwest Glass	420	3,927	19,177
West Glass	760	7,106	34,035
Northwest Glass	1,520	14,212	32,628
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	1,282	-
Southeast Wall	3,260	3,276	-
South Wall	3,260	3,726	-
Southwest Wall	980	1,063	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied D.A. Humidity Ratio = 0.0106
 Bin Number : 3 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 80 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	154,474	0
Glass Transmission	54,186	0
Wall Transmission	6,776	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	38,030	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	1,178	1,743

Total Room Loads	1,019,682	3,793
Total Room Tons	84.97	0.32
Total Room sqft/ton	350.23	94,156.13
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	13,596	12,686
Northeast Glass	0	0	0
East Glass	690	4,554	9,771
Southeast Glass	1,380	9,108	20,603
South Glass	1,380	9,108	30,140
Southwest Glass	420	2,772	18,187
West Glass	760	5,016	32,236
Northwest Glass	1,520	10,032	30,850
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	842	-
Southeast Wall	3,260	2,363	-
South Wall	3,260	2,786	-
Southwest Wall	980	786	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0099
 Bin Number : 4 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 75 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	146,031	0
Glass Transmission	31,609	0
Wall Transmission	4,204	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	22,184	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	687	1,428

Total Room Loads	969,752	3,478
Total Room Tons	80.81	0.29
Total Room sqft/ton	368.26	102,684.65
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	7,931	11,964
Northeast Glass	0	0	0
East Glass	690	2,657	9,232
Southeast Glass	1,380	5,313	19,532
South Glass	1,380	5,313	28,594
Southwest Glass	420	1,617	17,198
West Glass	760	2,926	30,438
Northwest Glass	1,520	5,852	29,073
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	401	-
Southeast Wall	3,260	1,450	-
South Wall	3,260	1,845	-
Southwest Wall	980	508	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0093
 Bin Number : 5 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 70 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	137,587	0
Glass Transmission	9,031	0
Wall Transmission	1,632	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	6,338	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	196	1,157

Total Room Loads	919,822	3,207
Total Room Tons	76.65	0.27
Total Room sqft/ton	388.25	111,339.79
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	2,266	11,242
Northeast Glass	0	0	0
East Glass	690	759	8,693
Southeast Glass	1,380	1,518	18,461
South Glass	1,380	1,518	27,049
Southwest Glass	420	462	16,208
West Glass	760	836	28,639
Northwest Glass	1,520	1,672	27,295
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-39	-
Southeast Wall	3,260	537	-
South Wall	3,260	905	-
Southwest Wall	980	230	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0087
 Bin Number : 6 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 65 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	129,144	0
Glass Transmission	-13,547	0
Wall Transmission	-940	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-295	928

Total Room Loads	869,892	2,978
Total Room Tons	72.49	0.25
Total Room sqft/ton	410.53	119,905.42
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-3,399	10,519
Northeast Glass	0	0	0
East Glass	690	-1,139	8,155
Southeast Glass	1,380	-2,277	17,390
South Glass	1,380	-2,277	25,504
Southwest Glass	420	-693	15,218
West Glass	760	-1,254	26,841
Northwest Glass	1,520	-2,508	25,517
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-480	-
Southeast Wall	3,260	-376	-
South Wall	3,260	-36	-
Southwest Wall	980	-48	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0083
 Bin Number : 7 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 60 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	120,700	0
Glass Transmission	-36,124	0
Wall Transmission	-3,512	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-786	737

Total Room Loads	835,808	2,787
Total Room Tons	69.65	0.23
Total Room sqft/ton	427.28	128,127.70
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-9,064	9,797
Northeast Glass	0	0	0
East Glass	690	-3,036	7,616
Southeast Glass	1,380	-6,072	16,319
South Glass	1,380	-6,072	23,959
Southwest Glass	420	-1,848	14,228
West Glass	760	-3,344	25,042
Northwest Glass	1,520	-6,688	23,739
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-920	-
Southeast Wall	3,260	-1,289	-
South Wall	3,260	-977	-
Southwest Wall	980	-326	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0079
 Bin Number : 8 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 55 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	112,257	0
Glass Transmission	-58,702	0
Wall Transmission	-6,084	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-1,277	581

Total Room Loads	801,724	2,631
Total Room Tons	66.81	0.22
Total Room sqft/ton	445.44	135,727.56
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-14,729	9,074
Northeast Glass	0	0	0
East Glass	690	-4,934	7,077
Southeast Glass	1,380	-9,867	15,248
South Glass	1,380	-9,867	22,414
Southwest Glass	420	-3,003	13,238
West Glass	760	-5,434	23,243
Northwest Glass	1,520	-10,868	21,962
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,361	-
Southeast Wall	3,260	-2,202	-
South Wall	3,260	-1,917	-
Southwest Wall	980	-604	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0076
 Bin Number : 9 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 50 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	103,813	0
Glass Transmission	-81,279	0
Wall Transmission	-8,656	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-1,768	457

Total Room Loads	767,640	2,507
Total Room Tons	63.97	0.21
Total Room sqft/ton	465.22	142,428.69
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-20,394	8,352
Northeast Glass	0	0	0
East Glass	690	-6,831	6,539
Southeast Glass	1,380	-13,662	14,178
South Glass	1,380	-13,662	20,868
Southwest Glass	420	-4,158	12,248
West Glass	760	-7,524	21,445
Northwest Glass	1,520	-15,048	20,184
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-1,802	-
Southeast Wall	3,260	-3,115	-
South Wall	3,260	-2,858	-
Southwest Wall	980	-882	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0063
 Bin Number : 10 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 45 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	95,370	0
Glass Transmission	-103,857	0
Wall Transmission	-11,228	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-2,259	-106

Total Room Loads	733,556	1,944
Total Room Tons	61.13	0.16
Total Room sqft/ton	486.83	183,746.98
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-26,059	7,629
Northeast Glass	0	0	0
East Glass	690	-8,729	6,000
Southeast Glass	1,380	-17,457	13,107
South Glass	1,380	-17,457	19,323
Southwest Glass	420	-5,313	11,259
West Glass	760	-9,614	19,646
Northwest Glass	1,520	-19,228	18,406
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,242	-
Southeast Wall	3,260	-4,028	-
South Wall	3,260	-3,799	-
Southwest Wall	980	-1,160	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied D.A. Humidity Ratio = 0.0052
 Bin Number : 11 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 40 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	86,927	0
Glass Transmission	-126,434	0
Wall Transmission	-13,800	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-2,750	-582

Total Room Loads	699,472	1,468
Total Room Tons	58.29	0.12
Total Room sqft/ton	510.56	243,198.38
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-31,724	6,907
Northeast Glass	0	0	0
East Glass	690	-10,626	5,461
Southeast Glass	1,380	-21,252	12,036
South Glass	1,380	-21,252	17,778
Southwest Glass	420	-6,468	10,269
West Glass	760	-11,704	17,847
Northwest Glass	1,520	-23,408	16,629
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-2,683	-
Southeast Wall	3,260	-4,941	-
South Wall	3,260	-4,739	-
Southwest Wall	980	-1,438	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0043
 Bin Number : 12 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 35 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	78,483	0
Glass Transmission	-149,012	0
Wall Transmission	-16,372	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-3,241	-981

Total Room Loads	665,388	1,069
Total Room Tons	55.45	0.09
Total Room sqft/ton	536.71	333,989.09
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-37,389	6,184
Northeast Glass	0	0	0
East Glass	690	-12,524	4,923
Southeast Glass	1,380	-25,047	10,965
South Glass	1,380	-25,047	16,233
Southwest Glass	420	-7,623	9,279
West Glass	760	-13,794	16,049
Northwest Glass	1,520	-27,588	14,851
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,123	-
Southeast Wall	3,260	-5,853	-
South Wall	3,260	-5,680	-
Southwest Wall	980	-1,715	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0035
 Bin Number : 13 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 30 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	70,040	0
Glass Transmission	-171,589	0
Wall Transmission	-18,944	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-3,732	-1,335

Total Room Loads	631,304	715
Total Room Tons	52.61	0.06
Total Room sqft/ton	565.69	499,205.09
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-43,054	5,462
Northeast Glass	0	0	0
East Glass	690	-14,421	4,384
Southeast Glass	1,380	-28,842	9,894
South Glass	1,380	-28,842	14,687
Southwest Glass	420	-8,778	8,289
West Glass	760	-15,884	14,250
Northwest Glass	1,520	-31,768	13,073
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-3,564	-
Southeast Wall	3,260	-6,766	-
South Wall	3,260	-6,621	-
Southwest Wall	980	-1,993	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0028
 Bin Number : 14 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 25 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	61,596	0
Glass Transmission	-194,167	0
Wall Transmission	-21,516	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-4,223	-1,648

Total Room Loads	597,220	402
Total Room Tons	49.77	0.03
Total Room sqft/ton	597.97	889,056.88
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-48,719	4,740
Northeast Glass	0	0	0
East Glass	690	-16,319	3,845
Southeast Glass	1,380	-32,637	8,823
South Glass	1,380	-32,637	13,142
Southwest Glass	420	-9,933	7,299
West Glass	760	-17,974	12,451
Northwest Glass	1,520	-35,948	11,296
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,004	-
Southeast Wall	3,260	-7,679	-
South Wall	3,260	-7,561	-
Southwest Wall	980	-2,271	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied D.A. Humidity Ratio = 0.0022
 Bin Number : 15 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 20 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	53,153	0
Glass Transmission	-216,744	0
Wall Transmission	-24,088	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-4,714	-1,901

Total Room Loads	563,136	149
Total Room Tons	46.93	0.01
Total Room sqft/ton	634.16	%2,397,631.00
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-54,384	4,017
Northeast Glass	0	0	0
East Glass	690	-18,216	3,307
Southeast Glass	1,380	-36,432	7,752
South Glass	1,380	-36,432	11,597
Southwest Glass	420	-11,088	6,310
West Glass	760	-20,064	10,653
Northwest Glass	1,520	-40,128	9,518
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,445	-
Southeast Wall	3,260	-8,592	-
South Wall	3,260	-8,502	-
Southwest Wall	980	-2,549	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA,IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0017
 Bin Number : 16 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 15 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
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Solar Gain	44,709	0
Glass Transmission	-239,322	0
Wall Transmission	-26,660	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-5,205	-2,104

Total Room Loads	529,052	-54
Total Room Tons	44.09	-0.00
Total Room sqft/ton	675.02	%6,637,279.50
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-60,049	3,295
Northeast Glass	0	0	0
East Glass	690	-20,114	2,768
Southeast Glass	1,380	-40,227	6,681
South Glass	1,380	-40,227	10,052
Southwest Glass	420	-12,243	5,320
West Glass	760	-22,154	8,854
Northwest Glass	1,520	-44,308	7,740
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-4,885	-
Southeast Wall	3,260	-9,505	-
South Wall	3,260	-9,443	-
Southwest Wall	980	-2,827	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0013
 Bin Number : 17 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 10 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	36,266	0
Glass Transmission	-261,899	0
Wall Transmission	-29,232	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-5,696	-2,266
Total Room Loads	494,968	-216
Total Room Tons	41.25	-0.02
Total Room sqft/ton	721.50	%1,655,430.88
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-65,714	2,572
Northeast Glass	0	0	0
East Glass	690	-22,011	2,229
Southeast Glass	1,380	-44,022	5,610
South Glass	1,380	-44,022	8,507
Southwest Glass	420	-13,398	4,330
West Glass	760	-24,244	7,055
Northwest Glass	1,520	-48,488	5,962
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,326	-
Southeast Wall	3,260	-10,418	-
South Wall	3,260	-10,383	-
Southwest Wall	980	-3,105	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0010
 Bin Number : 18 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 5 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	27,822	0
Glass Transmission	-284,477	0
Wall Transmission	-31,804	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-6,187	-2,394
Total Room Loads	460,884	-344
Total Room Tons	38.41	-0.03
Total Room sqft/ton	774.86	71,036,848.12
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-71,379	1,850
Northeast Glass	0	0	0
East Glass	690	-23,909	1,691
Southeast Glass	1,380	-47,817	4,539
South Glass	1,380	-47,817	6,961
Southwest Glass	420	-14,553	3,340
West Glass	760	-26,334	5,257
Northwest Glass	1,520	-52,668	4,185
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0
North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-5,767	-
Southeast Wall	3,260	-11,331	-
South Wall	3,260	-11,324	-
Southwest Wall	980	-3,383	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0008
 Bin Number : 19 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = 0 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
----------------	------------------	----------------

Solar Gain	19,379	0
Glass Transmission	-307,054	0
Wall Transmission	-34,376	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-6,678	-2,496

Total Room Loads	426,800	-446
Total Room Tons	35.57	-0.04
Total Room sqft/ton	836.74	800,319.25
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-77,044	1,127
Northeast Glass	0	0	0
East Glass	690	-25,806	1,152
Southeast Glass	1,380	-51,612	3,468
South Glass	1,380	-51,612	5,416
Southwest Glass	420	-15,708	2,350
West Glass	760	-28,424	3,458
Northwest Glass	1,520	-56,848	2,407
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,207	-
Southeast Wall	3,260	-12,244	-
South Wall	3,260	-12,264	-
Southwest Wall	980	-3,661	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0006
 Bin Number : 20 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = -5 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component Sensible(Btu/hr) Latent(Btu/hr)

Solar Gain	10,936	0
Glass Transmission	-329,632	0
Wall Transmission	-36,948	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-7,169	-2,576

Total Room Loads	392,716	-526
Total Room Tons	32.73	-0.04
Total Room sqft/ton	909.36	678,524.38
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-82,709	405
Northeast Glass	0	0	0
East Glass	690	-27,704	613
Southeast Glass	1,380	-55,407	2,397
South Glass	1,380	-55,407	3,871
Southwest Glass	420	-16,863	1,361
West Glass	760	-30,514	1,659
Northwest Glass	1,520	-61,028	629
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,648	-
Southeast Wall	3,260	-13,157	-
South Wall	3,260	-13,205	-
Southwest Wall	980	-3,939	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

SINGLE BIN LOAD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 Date : 11-25-86
 Site: AURORA, IL FERMI, User Defined 60117862.0

BIN DATA

Period : Unoccupied O.A. Humidity Ratio = 0.0006
 Bin Number : 21 Perimeter Zone Indoor DB = 68 F
 Outdoor Dry Bulb = -6 F Interior Zone Indoor DB = n/a

BLOCK THERMAL LOAD SUMMARY

Load Component	Sensible(Btu/hr)	Latent(Btu/hr)
Solar Gain	9,247	0
Glass Transmission	-334,147	0
Wall Transmission	-37,463	0
Roof Transmission	0	0
Transmission Load For Wall		
Adjacent to Non-Cond Region	-9,508	0
Lighting (26,784 W Total)	79,987	0
Misc. Elec. (200,000 W Total)	682,600	0
People (10 People Total)	2,450	2,050
Miscellaneous Internal Loads	0	0
Infiltration	-7,267	-2,590

Total Room Loads	385,899	-540
Total Room Tons	32.16	-0.05
Total Room sqft/ton	925.42	661,179.06
Perimeter Zone Floor Area	29,760 sqft	
Interior Zone Floor Area	0 sqft	
Lighting Load to Plenum	34,280 Btu/hr	
Roof Load to Plenum	0 Btu/hr	

TRANSMISSION LOADS AND SOLAR GAINS BY EXPOSURE

Exposure	Area (Sqft)	Transmission (Btu/hr)	Solar Gain (Btu/hr)
North Glass	2,060	-83,842	260
Northeast Glass	0	0	0
East Glass	690	-28,083	506
Southeast Glass	1,380	-56,166	2,183
South Glass	1,380	-56,166	3,562
Southwest Glass	420	-17,094	1,163
West Glass	760	-30,932	1,300
Northwest Glass	1,520	-61,864	274
Perimeter Skylight	0	0	0
Interior Skylight	0	0	0

North Wall	0	0	-
Northeast Wall	0	0	-
East Wall	1,630	-6,736	-
Southeast Wall	3,260	-13,339	-
South Wall	3,260	-13,393	-
Southwest Wall	980	-3,994	-
West Wall	0	0	-
Northwest Wall	0	0	-
Perimeter Roof	0	0	-
Interior Roof	0	0	-

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 2/4
SYSTEM COMPARISON PERFORMANCE SIMULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
OPERATIONAL PERFORMANCE SIMULATION

DESIGN BASIS SYSTEM
DX AC UNITS WITH FREE COOLING COILS AND HI EFFICIENCY 4-STEP COMPRESORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4 DESIGN SYS

Page 1

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 72000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 90 % ; Input power = 0.2 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA,IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

Page 2
 Date : 11-25-86
 60117862.0

 C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 120.0 tons
 KW/Ton @ 85 F entering water = 0.58 kw/ton
 Is hydronic cooling used ? <N>
 Is hot gas bypass used ? <N>
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <Y> ; Economizer efficiency = 65 %

 D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

 E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw
 Misc. kw : Occupied = 200.0 kw; Unoccupied = 200.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

 F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 2/4 DESIGN SYS

Period : All

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Zone : Block

Site : AURORA, IL FERMI, User Defined

Serial Number:

Date : 11-25-86

60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	10360	207207 kwh/yr	2403600	707197
Electric (Unocc)	17338	346768 kwh/yr	4022509	1183519
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	27699		6426109	1890716

NON-HVAC ENERGY

Electric (Occ)	35941	718827 kwh/yr	8338395	2453357
Electric (Unocc)	63856	1277111 kwh/yr	14814491	4358781
Non-HVAC Total	99797		23152886	6812138
Grand Total	127496		29578995	8702854
Total/Sq.Ft.	4.28		993.92	292.43

HVAC Summary:

HVAC Total Cost	=	0.93 \$/Sq.Ft./yr
	=	21.73 % of Total Cost
Total HVAC Electrical Energy	=	18.61 kwh/Sq.Ft./yr
	=	21.73 % of Total Electrical Energy
Non-Electrical HVAC Energy	=	0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA, IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

Page 1
 Date : 11-25-86
 60117862.0

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$17,102)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 72000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 90 % ; Input power = 0.2 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4 DESIGN SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$6,350)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 120.0 tons

KW/Ton @ 85 F entering water = 0.58 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <N>

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 65 %

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$4,247)

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$99,797)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 200.0 kw; Unoccupied = 200.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$127,496)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 2/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant	No Interior Zone Exists	
Temp	Hours	Coil Load	Input	Cost
(F)	hr/yr	MBH	KW	\$/yr
-----OCCUPIED PERIOD-----				
90	25.8	1366.0	59.2	76.3
85	59.4	1300.4	52.5	155.9
80	145.3	1236.3	46.6	338.2
75	237.7	1173.4	41.3	490.4
70	270.6	1111.8	36.5	494.5
65	264.5	1043.1	30.8	407.6
60	255.0	995.0	23.4	298.1
55	244.7	947.6	17.2	210.7
50	232.1	900.2	10.0	115.9
45	229.5	852.8	4.3	49.9
40	237.6	805.4	1.6	19.5
35	238.5	758.0	1.6	19.6
30	218.2	710.6	1.6	18.0
25	174.5	663.2	1.6	14.4
20	122.4	615.8	1.6	10.1
15	78.1	568.5	1.6	6.4
10	46.1	521.1	1.6	3.8
5	25.1	473.7	1.6	2.1
0	12.7	426.3	1.6	1.0
-5	6.2	378.9	1.6	0.5
-6	4.6	369.4	1.6	0.4
Total Costs				\$2733.5
-----UNOCCUPIED PERIOD-----				
90	14.6	1347.0	57.8	42.2
85	36.3	1282.1	51.3	93.1
80	99.3	1218.5	45.5	225.6
75	215.3	1156.2	40.3	434.0
70	357.6	1095.0	35.7	638.6
65	463.3	1028.5	30.1	696.4
60	500.4	981.5	22.8	569.8
55	482.0	934.4	16.7	403.2
50	447.6	887.3	9.6	214.9
45	422.7	840.3	4.0	84.9
40	413.7	793.2	1.6	34.0
35	417.0	746.1	1.6	34.3
30	417.4	699.1	1.6	34.3
25	395.2	652.0	1.6	32.5
20	336.9	604.9	1.6	27.7
15	252.8	557.9	1.6	20.8
10	165.7	510.8	1.6	13.6
5	96.3	463.8	1.6	7.9
0	50.9	416.7	1.6	4.2
-5	25.3	369.6	1.6	2.1
-6	21.1	360.2	1.6	1.7
Total Costs				\$3616.3

PERIMETER HEATING PLANT COSTS

Job Name : CCF SUBCON 2/4 DESIGN SYS

Date : 11-25-86

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Coil	Primary Plant			No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost	
(F)	hr/yr	MBH	MBH	KW	\$/yr	

-----OCCUPIED PERIOD-----

90	25.8	0.0	0.0	0.0	0.0	
85	59.4	0.0	0.0	0.0	0.0	
80	145.3	0.0	0.0	0.0	0.0	
75	237.7	0.0	0.0	0.0	0.0	
70	270.6	0.0	0.0	0.0	0.0	
65	264.5	0.0	0.0	0.0	0.0	
60	255.0	0.0	0.0	0.0	0.0	
55	244.7	0.0	0.0	0.0	0.0	
50	232.1	0.0	0.0	0.0	0.0	
45	229.5	0.0	0.0	0.0	0.0	
40	237.6	0.0	0.0	0.0	0.0	
35	238.5	0.0	0.0	0.0	0.0	
30	218.2	0.0	0.0	0.0	0.0	
25	174.5	0.0	0.0	0.0	0.0	
20	122.4	0.0	0.0	0.0	0.0	
15	78.1	0.0	0.0	0.0	0.0	
10	46.1	0.0	0.0	0.0	0.0	
5	25.1	0.0	0.0	0.0	0.0	
0	12.7	0.0	0.0	0.0	0.0	
-5	6.2	0.0	0.0	0.0	0.0	
-6	4.6	0.0	0.0	0.0	0.0	
Total Costs					\$0.0	

-----UNOCCUPIED PERIOD-----

90	14.6	0.0	0.0	0.0	0.0	
85	36.3	0.0	0.0	0.0	0.0	
80	99.3	0.0	0.0	0.0	0.0	
75	215.3	0.0	0.0	0.0	0.0	
70	357.6	0.0	0.0	0.0	0.0	
65	463.3	0.0	0.0	0.0	0.0	
60	500.4	0.0	0.0	0.0	0.0	
55	482.0	0.0	0.0	0.0	0.0	
50	447.6	0.0	0.0	0.0	0.0	
45	422.7	0.0	0.0	0.0	0.0	
40	413.7	0.0	0.0	0.0	0.0	
35	417.0	0.0	0.0	0.0	0.0	
30	417.4	0.0	0.0	0.0	0.0	
25	395.2	0.0	0.0	0.0	0.0	
20	336.9	0.0	0.0	0.0	0.0	
15	252.8	0.0	0.0	0.0	0.0	
10	165.7	0.0	0.0	0.0	0.0	
5	96.3	0.0	0.0	0.0	0.0	
0	50.9	0.0	0.0	0.0	0.0	
-5	25.3	0.0	0.0	0.0	0.0	
-6	21.1	0.0	0.0	0.0	0.0	
Total Costs					\$0.0	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 2/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	39.0	50.4		9.9
85	59.4	39.0	116.0		9.9
80	145.3	39.0	283.7		9.9
75	237.7	39.0	464.1		9.9
70	270.6	39.0	528.3		9.9
65	264.5	39.0	516.4		9.7
60	255.0	39.0	497.8		9.7
55	244.7	39.0	477.7		9.7
50	232.1	39.0	453.1		9.7
45	229.5	39.0	448.1		9.7
40	237.6	39.0	463.9		9.7
35	238.5	39.0	465.6		9.7
30	218.2	39.0	426.0		9.7
25	174.5	39.0	340.7		9.7
20	122.4	39.0	239.0		9.7
15	78.1	39.0	152.5		9.7
10	46.1	39.0	90.0		9.7
5	25.1	39.0	49.0		9.7
0	12.7	39.0	24.8		9.7
-5	6.2	39.0	12.1		9.7
-6	4.6	39.0	9.0		9.7
Total Costs			\$6107.9		\$1518.9
UNOCCUPIED PERIOD					
90	14.6	39.0	28.5		9.9
85	36.3	39.0	70.9		9.9
80	99.3	39.0	193.9		9.9
75	215.3	39.0	420.3		9.9
70	357.6	39.0	698.1		9.9
65	463.3	39.0	904.5		9.7
60	500.4	39.0	976.9		9.7
55	482.0	39.0	941.0		9.7
50	447.6	39.0	873.8		9.7
45	422.7	39.0	825.2		9.7
40	413.7	39.0	807.7		9.7
35	417.0	39.0	814.1		9.7
30	417.4	39.0	814.9		9.7
25	395.2	39.0	771.5		9.7
20	336.9	39.0	657.7		9.7
15	252.8	39.0	493.5		9.7
10	165.7	39.0	323.5		9.7
5	96.3	39.0	188.0		9.7
0	50.9	39.0	99.4		9.7
-5	25.3	39.0	49.4		9.7
-6	21.1	39.0	41.2		9.7
Total Costs			\$10994.2		\$2728.0

COOLING COIL LOADS

Job : CCF SUBCON 2/4 DESIGN SYS

Building : CCF SUBCONSTRUCT 2/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 2/4 DESIGN SYS

Building : CCF SUBCONSTRUCT 2/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 2/4 DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

FAN OPERATING COSTS

Job : CCF SUBCON 2/4 DESIGN SYS
 Building : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-25-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 1
DX AC UNITS WITH HI EFFICIENCY COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4 STD AC SYS
Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
Site : AURORA, IL FERMI, User Defined
Scope of Analysis : Cooling and Heating Systems

Page 1
Date : 11-25-86
60117862.0

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 72000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4 STD AC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA, IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

 C. COOLING PLANTS

Page 2
 Date : 11-25-86
 60117862.0

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 120.0 tons
 KW/Ton @ 85 F entering water = 0.76 kw/ton
 Is hydronic cooling used ? <N>
 Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <Y>
 Are compressors cycled ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <N>

***** D. PUMPING SYSTEMS

System	PERIMETER			
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

***** E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw
 Misc. kw : Occupied = 200.0 kw; Unoccupied = 200.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

***** F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 2/4 STD AC SYS
Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
Site : AURORA, IL FERMI, User Defined
Date : 11-25-86

Period : All
Zone : Block
Serial Number :
60117862.0

HVAC ENERGY	Annual Cost (\$/yr)	Energy or Fuel Units Consumed	DOE RUF (1000 BTU)	DOE RIF (1000 BTU)
Component				
Electric (Occ)	16101	322015 kwh/yr	3735375	1099037
Electric (Unocc)	27745	554894 kwh/yr	6436773	1893854
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	43845		10172147	2992891

NON-HVAC ENERGY

Electric (Occ)	35941	718827 kwh/yr	8338395	2453357
Electric (Unocc)	63856	1277111 kwh/yr	14814491	4358781
Non-HVAC Total	99797		23152886	6812138
Grand Total	143642		33325033	9805029
Total/Sq.Ft.	4.83		1119.79	329.47

HVAC Summary:

HVAC Total Cost = 1.47 \$/Sq.Ft./yr
= 30.52 % of Total Cost
Total HVAC Electrical Energy = 29.47 kwh/Sq.Ft./yr
= 30.52 % of Total Electrical Energy
Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4 STD AC SYS

Page 1

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$17,102)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 72000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4 STD AC SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$22,325)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 120.0 tons

KW/Ton @ 85 F entering water = 0.76 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$4,418)

System	PERIMETER		dT, F	dP, ft wg	dT, F	dP, ft wg
	dT, F	dP, ft wg				
Chilled water	0.00	0.00	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$99,797)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 200.0 kw; Unoccupied = 200.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$143,642)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 2/4 STD AC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Perimeter Cooling Plant					No Interior Zone Exists
Bin	Bin	Coil Load	Input	Cost	
Temp	Hours	MBH	KW	\$/yr	
(F)	hr/yr				
-----OCCUPIED PERIOD-----					
90	25.8	1416.4	83.0	107.1	
85	59.4	1339.1	78.0	231.7	
80	145.3	1263.3	73.7	535.4	
75	237.7	1188.7	69.5	825.4	
70	270.6	1115.4	65.3	883.1	
65	264.5	1043.1	61.2	808.8	
60	255.0	995.0	58.4	744.8	
55	244.7	947.6	55.7	681.6	
50	232.1	900.2	53.0	615.2	
45	229.5	852.8	50.3	577.3	
40	237.6	805.4	47.6	565.6	
35	238.5	758.0	44.9	535.6	
30	218.2	710.6	42.2	460.5	
25	174.5	663.2	39.5	344.7	
20	122.4	615.8	36.8	225.3	
15	78.1	568.5	34.1	133.2	
10	46.1	521.1	31.4	72.4	
5	25.1	473.7	28.7	36.0	
0	12.7	426.3	26.3	16.7	
-5	6.2	378.9	26.3	8.2	
-6	4.6	369.4	26.3	6.1	
Total Costs				\$8414.8	
-----UNOCCUPIED PERIOD-----					
90	14.6	1397.5	81.8	59.7	
85	36.3	1320.9	77.0	139.7	
80	99.3	1245.6	72.7	360.9	
75	215.3	1171.6	68.5	737.1	
70	357.6	1098.7	64.3	1150.1	
65	463.3	1028.5	60.3	1397.4	
60	500.4	981.5	57.6	1442.2	
55	482.0	934.4	55.0	1324.6	
50	447.6	887.3	52.3	1170.0	
45	422.7	840.3	49.6	1048.2	
40	413.7	793.2	46.9	970.5	
35	417.0	746.1	44.2	922.3	
30	417.4	699.1	41.6	867.2	
25	395.2	652.0	38.9	768.1	
20	336.9	604.9	36.2	609.6	
15	252.8	557.9	33.5	423.5	
10	165.7	510.8	30.8	255.4	
5	96.3	463.8	28.1	135.5	
0	50.9	416.7	26.3	67.0	
-5	25.3	369.6	26.3	33.3	
-6	21.1	360.2	26.3	27.8	
Total Costs				\$13910.2	

PERIMETER HEATING PLANT COSTS

Job Name : CCF SUBCON 2/4 STD AC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin	Bin	Coil	Primary Plant			No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost	
(F)	hr/yr	MBH	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----						
90	25.8	0.0	0.0	0.0	0.0	
85	59.4	0.0	0.0	0.0	0.0	
80	145.3	0.0	0.0	0.0	0.0	
75	237.7	0.0	0.0	0.0	0.0	
70	270.6	0.0	0.0	0.0	0.0	
65	264.5	0.0	0.0	0.0	0.0	
60	255.0	0.0	0.0	0.0	0.0	
55	244.7	0.0	0.0	0.0	0.0	
50	232.1	0.0	0.0	0.0	0.0	
45	229.5	0.0	0.0	0.0	0.0	
40	237.6	0.0	0.0	0.0	0.0	
35	238.5	0.0	0.0	0.0	0.0	
30	218.2	0.0	0.0	0.0	0.0	
25	174.5	0.0	0.0	0.0	0.0	
20	122.4	0.0	0.0	0.0	0.0	
15	78.1	0.0	0.0	0.0	0.0	
10	46.1	0.0	0.0	0.0	0.0	
5	25.1	0.0	0.0	0.0	0.0	
0	12.7	0.0	0.0	0.0	0.0	
-5	6.2	0.0	0.0	0.0	0.0	
-6	4.6	0.0	0.0	0.0	0.0	
Total Costs					\$0.0	
-----UNOCCUPIED PERIOD-----						
90	14.6	0.0	0.0	0.0	0.0	
85	36.3	0.0	0.0	0.0	0.0	
80	99.3	0.0	0.0	0.0	0.0	
75	215.3	0.0	0.0	0.0	0.0	
70	357.6	0.0	0.0	0.0	0.0	
65	463.3	0.0	0.0	0.0	0.0	
60	500.4	0.0	0.0	0.0	0.0	
55	482.0	0.0	0.0	0.0	0.0	
50	447.6	0.0	0.0	0.0	0.0	
45	422.7	0.0	0.0	0.0	0.0	
40	413.7	0.0	0.0	0.0	0.0	
35	417.0	0.0	0.0	0.0	0.0	
30	417.4	0.0	0.0	0.0	0.0	
25	395.2	0.0	0.0	0.0	0.0	
20	336.9	0.0	0.0	0.0	0.0	
15	252.8	0.0	0.0	0.0	0.0	
10	165.7	0.0	0.0	0.0	0.0	
5	96.3	0.0	0.0	0.0	0.0	
0	50.9	0.0	0.0	0.0	0.0	
-5	25.3	0.0	0.0	0.0	0.0	
-6	21.1	0.0	0.0	0.0	0.0	
Total Costs					\$0.0	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 2/4 STD AC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin Temp (F)	Bin Hours hr/yr	Perimeter Input KW	Fans Cost \$/yr	No Interior Zone	All Pumps Input KW	Cost \$/yr
OCCUPIED PERIOD						
90	25.8	39.0	50.4		10.1	13.0
85	59.4	39.0	116.0		10.1	30.0
80	145.3	39.0	283.7		10.1	73.3
75	237.7	39.0	464.1		10.1	119.9
70	270.6	39.0	528.3		10.1	136.5
65	264.5	39.0	516.4		10.1	133.4
60	255.0	39.0	497.8		10.1	128.6
55	244.7	39.0	477.7		10.1	123.4
50	232.1	39.0	453.1		10.1	117.1
45	229.5	39.0	448.1		10.1	115.8
40	237.6	39.0	463.9		10.1	119.8
35	238.5	39.0	465.6		10.1	120.3
30	218.2	39.0	426.0		10.1	110.1
25	174.5	39.0	340.7		10.1	88.0
20	122.4	39.0	239.0		10.1	61.7
15	78.1	39.0	152.5		10.1	39.4
10	46.1	39.0	90.0		10.1	23.3
5	25.1	39.0	49.0		10.1	12.7
0	12.7	39.0	24.8		10.1	6.4
-5	6.2	39.0	12.1		10.1	3.1
-6	4.6	39.0	9.0		10.1	2.3
Total Costs			\$6107.9			\$1578.0
UNOCCUPIED PERIOD						
90	14.6	39.0	28.5		10.1	7.4
85	36.3	39.0	70.9		10.1	18.3
80	99.3	39.0	193.9		10.1	50.1
75	215.3	39.0	420.3		10.1	108.6
70	357.6	39.0	698.1		10.1	180.4
65	463.3	39.0	904.5		10.1	233.7
60	500.4	39.0	976.9		10.1	252.4
55	482.0	39.0	941.0		10.1	243.1
50	447.6	39.0	873.8		10.1	225.8
45	422.7	39.0	825.2		10.1	213.2
40	413.7	39.0	807.7		10.1	208.7
35	417.0	39.0	814.1		10.1	210.3
30	417.4	39.0	814.9		10.1	210.5
25	395.2	39.0	771.5		10.1	199.3
20	336.9	39.0	657.7		10.1	169.9
15	252.8	39.0	493.5		10.1	127.5
10	165.7	39.0	323.5		10.1	83.6
5	96.3	39.0	188.0		10.1	48.6
0	50.9	39.0	99.4		10.1	25.7
-5	25.3	39.0	49.4		10.1	12.8
-6	21.1	39.0	41.2		10.1	10.6
Total Costs			\$10994.2			\$2840.3

COOLING COIL LOADS

Job : CCF SUBCON 2/4 STD AC SYS
Building : CCF SUBCONSTRUCT 2/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-25-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 2/4 STD AC SYS

Building : CCF SUBCONSTRUCT 2/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 2/4 STD AC SYS
Building : CCF SUBCONSTRUCT 2/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-25-86

FAN OPERATING COSTS

Job : CCF SUBCON 2/4 STD AC SYS
Building : CCF SUBCONSTRUCT 2/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-25-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 2
TYPICAL FY1975 DESIGN
DX AC UNITS WITH STANDARD COMPRESSORS AND COILS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4 1975S SYS

Page 1

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 3.00 in. wg.

A return fan is not used.

Design supply air= 72000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4 1975S SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 120.0 tons

KW/Ton @ 85 F entering water = 0.95 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 200.0 kw; Unoccupied = 200.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 2/4 1975S SYS
Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
Site : AURORA,IL FERMI, User Defined
Date : 11-25-86

Period : All
Zone : Block
Serial Number:
60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	19742	394831 kwh/yr	4580044	1347559
Electric (Unocc)	33979	679575 kwh/yr	7883073	2319390
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	53720		12463117	3666950

NON-HVAC ENERGY

Electric (Occ)	35941	718827 kwh/yr	8338395	2453357
Electric (Unocc)	63856	1277111 kwh/yr	14814491	4358781
Non-HVAC Total	99797		23152886	6812138
Grand Total	153517		35616003	10479088
Total/Sq.Ft.	5.16		1196.77	352.12

HVAC Summary:

HVAC Total Cost = 1.81 \$/Sq.Ft./yr
= 34.99 % of Total Cost
Total HVAC Electrical Energy = 36.10 kwh/Sq.Ft./yr
= 34.99 % of Total Electrical Energy
Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4 1975S SYS
Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
Site : AURORA,IL FERMI, User Defined
Scope of Analysis : Cooling and Heating Systems

Page 1

Date : 11-25-86

60117862.0

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$20,523)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 3.00 in. wg.

A return fan is not used.

Design supply air= 72000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1. PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4 1975S SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$28,583)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 120.0 tons

KW/Ton @ 85 F entering water = 0.95 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$4,615)

System	PERIMETER			
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$99,797)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 200.0 kw; Unoccupied = 200.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$153,517)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 2/4 1975S SYS
 Building Name : CCF SUBCONSTRUCT 2/4 (Complex)
 Site Name : AURORA, IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant	No Interior Zone Exists
Temp (F)	Hours hr/yr	Coil Load MBH Input KW Cost \$/yr	

OCCUPIED PERIOD

90	25.8	1444.2	105.6	136.2
85	59.4	1367.0	99.2	294.5
80	145.3	1291.2	93.8	681.2
75	237.7	1216.7	88.5	1051.3
70	270.6	1143.3	83.2	1126.1
65	264.5	1071.1	78.1	1032.7
60	255.0	1021.6	74.6	950.7
55	244.7	974.2	71.2	871.0
50	232.1	926.8	67.8	786.9
45	229.5	879.5	64.4	739.4
40	237.6	832.1	61.1	725.4
35	238.5	784.7	57.7	687.9
30	218.2	737.3	54.3	592.5
25	174.5	689.9	50.9	444.4
20	122.4	642.5	47.6	291.1
15	78.1	595.1	44.2	172.5
10	46.1	547.7	40.8	94.1
5	25.1	500.3	37.4	47.0
0	12.7	452.9	34.1	21.6
-5	6.2	405.5	32.6	10.1
-6	4.6	396.1	32.6	7.5

Total Costs \$10763.9

UNOCCUPIED PERIOD

90	14.6	1425.4	104.1	76.0
85	36.3	1348.8	97.9	177.6
80	99.3	1273.5	92.5	459.3
75	215.3	1199.5	87.2	939.1
70	357.6	1126.7	82.0	1467.0
65	463.3	1055.2	77.0	1782.6
60	500.4	1008.1	73.6	1841.4
55	482.0	961.0	70.2	1692.9
50	447.6	914.0	66.9	1497.1
45	422.7	866.9	63.5	1343.0
40	413.7	819.9	60.2	1245.0
35	417.0	772.8	56.8	1185.1
30	417.4	725.7	53.5	1116.2
25	395.2	678.7	50.1	990.6
20	336.9	631.6	46.8	788.0
15	252.8	584.5	43.4	548.9
10	165.7	537.5	40.1	332.0
5	96.3	490.4	36.7	176.8
0	50.9	443.3	33.4	84.9
-5	25.3	396.3	32.6	41.2
-6	21.1	386.9	32.6	34.4

Total Costs \$17819.3

PERIMETER HEATING PLANT COSTS

Job Name : CCF SUBCON 2/4 1975S SYS

Date : 11-25-86

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Serial Number:

Site Name : AURORA, IL FERMI, User Defined

60117862.0

Bin	Bin	Coil	Primary	Plant	No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost
(F)	hr/yr	MBH	MBH	KW	\$/yr
-----OCCUPIED PERIOD-----					
90	25.8	0.0	0.0	0.0	0.0
85	59.4	0.0	0.0	0.0	0.0
80	145.3	0.0	0.0	0.0	0.0
75	237.7	0.0	0.0	0.0	0.0
70	270.6	0.0	0.0	0.0	0.0
65	264.5	0.0	0.0	0.0	0.0
60	255.0	0.0	0.0	0.0	0.0
55	244.7	0.0	0.0	0.0	0.0
50	232.1	0.0	0.0	0.0	0.0
45	229.5	0.0	0.0	0.0	0.0
40	237.6	0.0	0.0	0.0	0.0
35	238.5	0.0	0.0	0.0	0.0
30	218.2	0.0	0.0	0.0	0.0
25	174.5	0.0	0.0	0.0	0.0
20	122.4	0.0	0.0	0.0	0.0
15	78.1	0.0	0.0	0.0	0.0
10	46.1	0.0	0.0	0.0	0.0
5	25.1	0.0	0.0	0.0	0.0
0	12.7	0.0	0.0	0.0	0.0
-5	6.2	0.0	0.0	0.0	0.0
-6	4.6	0.0	0.0	0.0	0.0
Total Costs					\$0.0
-----UNOCCUPIED PERIOD-----					
90	14.6	0.0	0.0	0.0	0.0
85	36.3	0.0	0.0	0.0	0.0
80	99.3	0.0	0.0	0.0	0.0
75	215.3	0.0	0.0	0.0	0.0
70	357.6	0.0	0.0	0.0	0.0
65	463.3	0.0	0.0	0.0	0.0
60	500.4	0.0	0.0	0.0	0.0
55	482.0	0.0	0.0	0.0	0.0
50	447.6	0.0	0.0	0.0	0.0
45	422.7	0.0	0.0	0.0	0.0
40	413.7	0.0	0.0	0.0	0.0
35	417.0	0.0	0.0	0.0	0.0
30	417.4	0.0	0.0	0.0	0.0
25	395.2	0.0	0.0	0.0	0.0
20	336.9	0.0	0.0	0.0	0.0
15	252.8	0.0	0.0	0.0	0.0
10	165.7	0.0	0.0	0.0	0.0
5	96.3	0.0	0.0	0.0	0.0
0	50.9	0.0	0.0	0.0	0.0
-5	25.3	0.0	0.0	0.0	0.0
-6	21.1	0.0	0.0	0.0	0.0
Total Costs					\$0.0

FAN AND PUMP COSTS

Job Name : CCF SUBCON 2/4 1975S SYS

Date : 11-25-86

Building Name : CCF SUBCONSTRUCT 2/4 (Complex)

Serial Number:

Site Name : AURORA, IL FERMI, User Defined

60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
-----OCCUPIED PERIOD-----					
90	25.8	46.9	60.4		10.5 13.6
85	59.4	46.9	139.2		10.5 31.3
80	145.3	46.9	340.4		10.5 76.5
75	237.7	46.9	556.9		10.5 125.2
70	270.6	46.9	633.9		10.5 142.5
65	264.5	46.9	619.7		10.5 139.3
60	255.0	46.9	597.4		10.5 134.3
55	244.7	46.9	573.3		10.5 128.9
50	232.1	46.9	543.8		10.5 122.3
45	229.5	46.9	537.7		10.5 120.9
40	237.6	46.9	556.6		10.5 125.2
35	238.5	46.9	558.7		10.5 125.6
30	218.2	46.9	511.2		10.5 114.9
25	174.5	46.9	408.8		10.5 91.9
20	122.4	46.9	286.8		10.5 64.5
15	78.1	46.9	183.0		10.5 41.1
10	46.1	46.9	108.0		10.5 24.3
5	25.1	46.9	58.8		10.5 13.2
0	12.7	46.9	29.8		10.5 6.7
-5	6.2	46.9	14.5		10.5 3.3
-6	4.6	46.9	10.8		10.5 2.4
Total Costs			\$7329.5		\$1648.1
-----UNOCCUPIED PERIOD-----					
90	14.6	46.9	34.2		10.5 7.7
85	36.3	46.9	85.0		10.5 19.1
80	99.3	46.9	232.6		10.5 52.3
75	215.3	46.9	504.4		10.5 113.4
70	357.6	46.9	837.8		10.5 188.4
65	463.3	46.9	1085.4		10.5 244.1
60	500.4	46.9	1172.3		10.5 263.6
55	482.0	46.9	1129.2		10.5 253.9
50	447.6	46.9	1048.6		10.5 235.8
45	422.7	46.9	990.3		10.5 222.7
40	413.7	46.9	969.2		10.5 217.9
35	417.0	46.9	976.9		10.5 219.7
30	417.4	46.9	977.9		10.5 219.9
25	395.2	46.9	925.9		10.5 208.2
20	336.9	46.9	789.3		10.5 177.5
15	252.8	46.9	592.2		10.5 133.2
10	165.7	46.9	388.2		10.5 87.3
5	96.3	46.9	225.6		10.5 50.7
0	50.9	46.9	119.2		10.5 26.8
-5	25.3	46.9	59.3		10.5 13.3
-6	21.1	46.9	49.4		10.5 11.1
Total Costs			\$13193.0		\$2966.5

COOLING COIL LOADS

Job : CCF SUBCON 2/4 1975S SYS
 Building : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-25-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 2/4 1975S SYS

Building : CCF SUBCONSTRUCT 2/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 2/4 1975\$ SYS
 Building : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-25-86

FAN OPERATING COSTS

Job : CCF SUBCON 2/4 1975\$ SYS

Building : CCF SUBCONSTRUCT 2/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
SYSTEMS LIFE CYCLE COST ANALYSIS
AND
PAYBACK CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
LIFE CYCLE COST ANALYSIS
FOR

DESIGN BASIS SYSTEM
DX AC UNITS WITH FREE COOLING AND FOUR STEP HI-EFF. COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 2/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$387000 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 387000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 27699.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

***** UNIFIED PRESENT WORTH LIFE CYCLE COST *****

PROJECT NAME : CCF SUBCON 2/4 DESIGN SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$387000 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	387000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	27956.30	28189.49	28424.62
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	387000.00	0.00	29997.29	30251.28	30507.43
CUM.	\$	387000.00	387000.00	416997.28	447248.56	477756.00

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	28661.71	28900.78	29141.85	29384.92	29630.02
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	30765.76	31026.28	31289.01	31553.98	31821.19
CUM.	\$	508521.75	539548.00	570837.00	602391.00	634212.19

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	29877.17	30126.38	30377.67	30631.05	30886.55
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	32090.68	32362.45	32636.54	32912.95	33191.70
CUM.	\$	666302.88	698665.31	731301.88	764214.81	797406.50

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	31144.17	31403.95	31665.89	31930.02	32196.35
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$	33472.83	33756.35	34042.27	34330.63	34621.43
CUM.	\$	830879.31	864635.69	898677.94	933008.56	967630.00

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	32464.90	32735.69	33008.74	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$	34914.70	35210.47	35508.75	0.00	0.00
CUM.	\$	1002544.69	1037755.12	1073263.88	1073263.88	1073263.88

FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE			PROJECT NO. DATE 10-5-3 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 19/27	
SECTION CES		QUANTITIES BY JG	PRICES BY JG	CHECKED BY WN	DISTRIBUTION OF ITEMIZED COST					
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1)		(2)		(3)		
				UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	
8.3	COOLING/HEATING WATER SYSTEM									
	CHILLERS 100TON RECIPI.	2	CA	3,000	62,000					
	INSTAL CHILLERS	2	CA	6,000	12,000					
	HT. EXCHANGER, CW, R.H. & PR. 300GPM /	1	CA		6,000					
	HT. EXCH. CW, R.H. & PR. 1500GPM	1	CA		15,000		20,000		✓	
	AUX. CIRC. BOILER, 210 KW	1	EA		8,100					
	CW FILTER, 30 MICRON, 1000 GPM	1	CA		18,000		29,000			
	COOLING WATER PUMP	2	CA	2800	5,600		7000			
	EXPANSION TANKS 50 GNL.	2	CA	300	600		300			
	AUXILIARY STEEL SUPPORTS	601			30,000		18,000			
8.4	COMPUTER RM, A/C UNIT									
	PACKAGE SELF CONT. 10TON	12	EA	14,700	176,400					
	INSTALL SELFCONT. UNITS	12	CA	1,100	13,200					
	CEILING A/C UNITS, SELFCONT. 2TON	2	CA	4,200	8,400		7000			
	WATER DETECTORS	24	CA	150	3,600		3600			
TOTAL COSTS = \$ 387,000 -										
(ACTUAL EST.)										

FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE			PROJECT NO. 10-5-3		DATE 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 20/27	
SECTION CES		QUANTITIES BY JG		PRICES BY JG		CHECKED BY WN		DISTRIBUTION OF ITEMIZED COST				
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1)		(2)		(3)		UNIT	AMOUNT	
				UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT			
8.5	AIR HANDLING UNITS											
	GEN'L. VENTILATION UNITS											
	FAN, AXIAL, SUPPLY, 8000 CFM	1	EA		3000		2500					
	FAN, " EXHAUST 4000 CFM	1	EA		2500		2500					
	HT. RECOVERY WHEEL	1	DA		8000							
	FREE HTG. COIL	2	EA	1500	1500						1500	
	HUMIDIFIER	2	EA	2500	2500						5000	
	FILTER SET (PRE & HE)	1	EA	1000	1000						1000	
	COMPUTER RM. VENT. UNITS											
	FANS, AXIAL, S&E 4000 CFM	2	EA	2500	5000		2500					
	HT. RECOVERY WHEEL	1	DA		5000							
	FREE HTG. COILS	1	DA		1000							
	HUMIDIFIER 100 LB.	2	EA	2500	2500		5000					
	FILTER SET, (PRE & HE)	1	EA		1000							
	TOILET EXH. FAN, AXIAL, 4000 CFM	1	EA		2500		2500					
	WALL EXH. FANS, 11000 CFM	2	EA	500	1000							
	WALL LOUVERS 42x42	3	EA	200	600							
	UNIT HEATERS 25 KW	2	EA	1200	2400							
	UNIT HEATERS 5 KW	10	EA	400	4000						44,000	
8.6	HEAT PUMP UNITS											
	3/4 TON 1 TON	6	EA	1200	7200							
	1 1/4 TON 1 1/2 TON	9	EA	1400	12,600							
	2 TON	21	EA	1500	31,500							
	3 TON	24	EA	1800	43,200							
	5 TON	13	EA	3500	45,500						101,700	

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FERMILAB
COST
ESTIMATE

PROJECT TITLE
CENTRAL COMPUTING FACILITY - TITLE 2
PHASE 2 - SUPERSTRUCTURE

PROJECT NO. 10-5-3 DATE 10 SEPT. 86 REVISION DATE 16 SEPT. 86 PAGE 21/27

SECTION CES QUANTITIES BY JG PRICES BY JG CHECKED BY WN

DISTRIBUTION OF ITEMIZED COST

ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1)		(2)		(3)	
				UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
8.7	HVAC DUCTWORK								
	TOILET EXH. DUCTWORK 12x12x200'	1200	LB	3.50	4200	UNLINED			
	GRILLES 12x12	14	EA	25	300				
	FIRE DAMPERS 12x12	4	EA	25	100				
	COMP. ROOM DUCTWORK 16x16x400'	3600	LB	3.50	11900	INTERN. LINED			
	LIEBERT UNIT OUTLET ELBOWS	12	EA	500	6000				
	FLEX DOCT 12" d	70	L.F.	500	400				
	DOCT INSUL. 1"	2200	S.F.	1.75	3800				
	FIRE DAMPERS	7	EA	25	200				
	GRILLES	12	EA	25	300				
	GEN'L. VENT. DOCTS, 16x16x250'	2200	LB	3.50	7700		1300		
	" 8x12x600'	3300	LB	3.50	11600		2000		
	" 96x8x250	3000	LB	3.50	10500		2000		
	INSULATE DOCT 1"	4300	S.F.	1.75	7500				
	FLEX DOCT 6" d	1100	L.F.	400	1600				
	DAMPERS 6" d	78	EA	15	1200				
	VOLUME DAMPERS, MOTORIZED	6	EA	150	600				
	FIRE DAMPERS, MOTORIZED	8	EA	200	1600				
	ACAT FAN DUCTWORK	73							
	RETURN PLENUM 24x24	700	EA	100	6000	7300			
	OUTLET DOCTS 16x16x850'	8300	LB	3.50	29100	29100	1800		
	FLEX DOCT 12" d	1800	L.F.	500	8000	9000			
	DOCT INSUL. 1"	5000	S.F.	1.75	8750	8800			
	GRILLES	300	EA	25	7500	7500			
	FIRE DAMPERS	21	EA	25	500	500	125400		
	FIRE/SMOKE DAMPERS	14	EA	500	7000

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**FERMILAB
COST
ESTIMATE**

PROJECT TITLE
**CENTRAL COMPUTING FACILITY - TITLE 2
PHASE 2 - SUPERSTRUCTURE**

PROJECT NO.
10-5-3

DATE

10 SEPT, 86

REVISION DATE

16 SEPT, 86

PAGE

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SECTION **CES** QUANTITIES BY **JG** PRICES BY **JG** CHECKED BY **WN**

DISTRIBUTION OF ITEMIZED COST

ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1)		(2)		(3)	
				UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
8.8	COOLING/HEATING WATER PIPING								
	RWD PIPING	100							
	8" SCHED. 10 VICTOLIC	50	L.F.	38	1900	38	3800		
	6" " "	200	L.F.	28	5600				
	2" φ " "	60	L.F.	10	600				
	VALVES, 8" BUTT. FLY	10	DA	450	4500				
	" 6" "	10	DA	350	3500				
	" 2 1/2" "	8	DA	250	2000				
	" 2" BALL	10	DA	40	400				
	" 8 PRESS. FGD.	1	DA		2500				
	ACCESSORIES	LOT			5000				
	INSULATION 8" PIPE	100	L.F.	800	400	800			
	" 6" "	200	L.F.	600	1200				
	CHW PIPING, SCHED. 10 VICT. 4" φ	100	L.F.	17	1700				
	VALVES, 4" φ BUTT.	16	DA	250	4000				
	ACCESSORIES & MISC. VALVES	LOT			3000				
	PIPE INSUL. 4" φ	100	L.F.	500	500				
	CW PIPING, SCHED. VICT. 6" φ	300	L.F.	28	8400				
	" " 4" φ	300	L.F.	17	5100				
	" " 3" φ	100	L.F.	14	1400				
	" " 1 1/2" φ	350	L.F.	800	2800				
	VALVES, 6" BUTT.	10	DA	350	3500				
	1 1/2" BALL	24	DA	35	800				
	ACCESSORIES & MISC. VALVES	LOT			3000				
	PIPE INSUL. 4" φ	700	L.F.	500	3500				
	" 1 1/2" φ	350	L.F.	300	1100				

06-90

FERMILAB
COST
ESTIMATE

PROJECT TITLE
CENTRAL COMPUTING FACILITY - TITLE 2
PHASE 2 - SUPERSTRUCTURE

PROJECT NO. DATE
10-5-3 10 SEPT. 86

REVISION DATE
16 SEPT. 86

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SECTION CES QUANTITIES BY JG PRICES BY JG CHECKED BY WN

DISTRIBUTION OF ITEMIZED COST

ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1)		(2)		(3)	
				UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
B.8	COOLING/HTG. WTL. PIPING, CONT.	1000							
	H.R. PIPING, SCH. 10 VLT. 6" d	700	L.F.	28	19600	28,000			
	" " 4" d	500	L.F.	17	8500				
	" " 3" d	400	L.F.	13	5200				
	" " 2 1/2" d	200	L.F.	12	2400				
	" " 2" d	800	L.F.	10	2000	8000			
	" SCH. 40, BLK 1 1/2" d	200	L.F.	8	1600				
	" " 1" d	300	L.F.	5	1500				
	" " 3/4" d	600	L.F.	4	2400				
	VALVES, 6" d BUTT.	10	EA	350	3500				
	3/4" d BALL	200	EA	15	3000	3000			
	ACCESS. & MISC. VALVES	LOT			4000				

HUMIDIFIER WATER PIPING

1/2" d COPPER "K"

1/2" d INSUL.

1/2" d BALL VALVES

1400

L.F.

600

~~1200~~

8400

L.F.

300

~~1500~~

4200

EA

25

~~3000~~

800

CONDENSATE DRAIN PIPING

1 1/4" d COPPER "K"

1/2" d COPPER "K"

1600

L.F.

1100

~~17600~~

17,600

L.F.

600

~~3600~~

6000

147,300

B.9 HVAC CONTROLS

D.D.C. CONTROLS

LICBERT CONTROLS

~~15000~~

~~15000~~

20000

~~15000~~

15000

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 1
DX AC UNITS WITH HI-EFFICIENCY COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F. KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 2/4 STD AC SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 367000 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 367000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 43845.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 2/4 STD AC SYS

ANALYST NAME : S.F.KRSTULOVICH

COMMENTS : 367000 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	367000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	44252.29	44621.40	44993.59
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	367000.00	0.00	46293.28	46683.20	47076.41
CUM.	\$	367000.00	367000.00	413293.28	459976.47	507052.88

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	45368.89	45747.32	46128.90	46513.67	46901.64
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	47472.94	47872.82	48276.07	48682.72	49092.81
CUM.	\$	554525.81	602398.62	650674.69	699357.44	748450.25

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	47292.85	47687.32	48085.09	48486.17	48890.60
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	49506.36	49923.40	50343.96	50768.07	51195.76
CUM.	\$	797956.62	847880.00	898223.94	948992.00	1000187.75

YEAR	2001	2002	2003	2004	2005
CASH	\$ 0.00	0.00	0.00	0.00	0.00
MORT.1	\$ 0.00	0.00	0.00	0.00	0.00
MORT.2	\$ 0.00	0.00	0.00	0.00	0.00
FUEL 1	\$ 49298.40	49709.60	50124.23	50542.32	50963.90
FUEL 2	\$ 0.00	0.00	0.00	0.00	0.00
FUEL 3	\$ 0.00	0.00	0.00	0.00	0.00
MAINT.	\$ 2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$ 51627.06	52062.00	52500.61	52942.93	53388.98
CUM.	\$ 1051814.75	1103876.75	1156377.38	1209320.25	1262709.25

YEAR	2006	2007	2008	2009	2010
CASH	\$ 0.00	0.00	0.00	0.00	0.00
MORT.1	\$ 0.00	0.00	0.00	0.00	0.00
MORT.2	\$ 0.00	0.00	0.00	0.00	0.00
FUEL 1	\$ 51388.99	51817.63	52249.85	0.00	0.00
FUEL 2	\$ 0.00	0.00	0.00	0.00	0.00
FUEL 3	\$ 0.00	0.00	0.00	0.00	0.00
MAINT.	\$ 2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$ 53838.79	54292.41	54749.86	0.00	0.00
CUM.	\$ 1316548.00	1370840.38	1425590.25	1425590.25	1425590.25

FERMILAB CENTRAL COMPUTING FACILITY

SUBCINSTRUCTION 2/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 2
FY1975 DX AC UNITS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 2/4 1975S SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 353000

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 353000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 53720.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
	DISC.	LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 2/4 1975S SYS

ANALYST NAME : S.F.KRSTULOVICH

COMMENTS : 353000

YEAR		1986	1987	1988	1989	1990
CASH	\$	353000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	54219.02	54671.26	55127.28
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	353000.00	0.00	56260.01	56733.06	57210.10
CUM.	\$	353000.00	353000.00	409260.00	465993.06	523203.16

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	55587.11	56050.76	56518.29	56989.72	57465.07
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	57691.15	58176.26	58665.45	59158.77	59656.24
CUM.	\$	580894.31	639070.56	697736.00	756894.75	816551.00

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	57944.39	58427.71	58915.06	59406.47	59901.99
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	60157.90	60663.78	61173.93	61688.37	62207.15
CUM.	\$	876708.88	937372.62	998546.56	1060234.88	1122442.00

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	60401.64	60905.45	61413.47	61925.72	62442.25
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$	62730.30	63257.85	63789.85	64326.33	64867.32
CUM.	\$	1185172.25	1248430.12	1312220.00	1376546.38	1441413.75

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	62963.09	63488.27	64017.83	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$	65412.88	65963.05	66517.84	0.00	0.00
CUM.	\$	1506826.62	1572789.62	1639307.50	1639307.50	1639307.50

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
LIFE CYCLE COST ANALYSIS
UNIFIED PRESENT WORTH COMPARISONS
FOR ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC6.DAT
 PROJECT : CCF SUBCON 2/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$387000 PER UNIT COSTS

FILE NO. : LCC7.DAT
 PROJECT : CCF SUBCON 2/4 STD AC SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 367000 PER UNIT COSTS

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	387000.00	367000.00	20000.00	20000.00
1987	0.00	0.00	0.00	20000.00
1988	29997.29	46293.28	-16295.99	3704.01
1989	30251.28	46683.20	-16431.92	-12727.91
1990	30507.43	47076.41	-16568.98	-29296.89
1991	30765.76	47472.94	-16707.18	-46004.07
1992	31026.28	47872.82	-16846.54	-62850.61
1993	31289.01	48276.07	-16987.06	-79837.67
1994	31553.98	48682.72	-17128.74	-96966.41
1995	31821.19	49092.81	-17271.62	-114238.03
1996	32090.68	49506.36	-17415.68	-131653.72
1997	32362.45	49923.40	-17560.95	-149214.67
1998	32636.54	50343.96	-17707.42	-166922.09
1999	32912.95	50768.07	-17855.12	-184777.20
2000	33191.70	51195.76	-18004.06	-202781.27
2001	33472.83	51627.06	-18154.23	-220935.50
2002	33756.35	52062.00	-18305.65	-239241.16
2003	34042.27	52500.61	-18458.34	-257699.48
2004	34330.63	52942.93	-18612.30	-276311.78
2005	34621.43	53388.98	-18767.55	-295079.31
2006	34914.70	53838.79	-18924.09	-314003.41
2007	35210.47	54292.41	-19081.94	-333085.34
2008	35508.75	54749.86	-19241.11	-352326.44

*** APPARENT BREAK-EVEN YEAR = 1989 ***

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC6.DAT
 PROJECT : CCF SUBCON 2/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$387000 PER UNIT COSTS

FILE NO. : LCC8.DAT
 PROJECT : CCF SUBCON 2/4 1975S SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 353000

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	387000.00	353000.00	34000.00	34000.00
1987	0.00	0.00	0.00	34000.00
1988	29997.29	56260.01	-26262.72	7737.28
1989	30251.28	56733.06	-26481.78	-18744.50
1990	30507.43	57210.10	-26702.67	-45447.17
1991	30765.76	57691.15	-26925.39	-72372.56
1992	31026.28	58176.26	-27149.98	-99522.55
1993	31289.01	58665.45	-27376.44	-126898.99
1994	31553.98	59158.77	-27604.79	-154503.78
1995	31821.19	59656.24	-27835.05	-182338.83
1996	32090.68	60157.90	-28067.22	-210406.03
1997	32362.45	60663.78	-28301.33	-238707.36
1998	32636.54	61173.93	-28537.39	-267244.75
1999	32912.95	61688.37	-28775.42	-296020.19
2000	33191.70	62207.15	-29015.45	-325035.66
2001	33472.83	62730.30	-29257.47	-354293.12
2002	33756.35	63257.85	-29501.50	-383794.62
2003	34042.27	63789.85	-29747.58	-413542.19
2004	34330.63	64326.33	-29995.70	-443537.88
2005	34621.43	64867.32	-30245.89	-473783.75
2006	34914.70	65412.88	-30498.18	-504281.94
2007	35210.47	65963.05	-30752.58	-535034.50
2008	35508.75	66517.84	-31009.09	-566043.62

*** APPARENT BREAK-EVEN YEAR = 1989 ***

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
SIMPLE PAYBACK CALCULATIONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

CCF SUBCONSTRUCT 2/4
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	STD AC SYS
INITIAL TOTAL COST	\$ 387,000	\$ 367,000
ANNUAL OPERATING COST	\$ 27,699	\$ 43,845
ANNUAL MAINTENANCE COST	\$ 2,000	\$ 2,000
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

DESIGN SYS			STD AC SYS		
EXPENSES			EXPENSES		
YEAR	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	
INITIAL	\$ 387,000	\$ 387,000	\$ 367,000	\$ 367,000	
1	\$ 29,699	\$ 416,699	\$ 45,845	\$ 412,845	

2	\$ 29,699	\$ 446,398	\$ 45,845	\$ 458,690	
3	\$ 29,699	\$ 476,097	\$ 45,845	\$ 504,535	
4	\$ 29,699	\$ 505,796	\$ 45,845	\$ 550,380	
5	\$ 29,699	\$ 535,495	\$ 45,845	\$ 596,225	
6	\$ 29,699	\$ 565,194	\$ 45,845	\$ 642,070	
7	\$ 29,699	\$ 594,893	\$ 45,845	\$ 687,915	
8	\$ 29,699	\$ 624,592	\$ 45,845	\$ 733,760	
9	\$ 29,699	\$ 654,291	\$ 45,845	\$ 779,605	
10	\$ 29,699	\$ 683,990	\$ 45,845	\$ 825,450	
11	\$ 29,699	\$ 713,689	\$ 45,845	\$ 871,295	
12	\$ 29,699	\$ 743,388	\$ 45,845	\$ 917,140	
13	\$ 29,699	\$ 773,087	\$ 45,845	\$ 962,985	
14	\$ 29,699	\$ 802,786	\$ 45,845	\$1,008,830	
15	\$ 29,699	\$ 832,485	\$ 45,845	\$1,054,675	
16	\$ 29,699	\$ 862,184	\$ 45,845	\$1,100,520	
17	\$ 29,699	\$ 891,883	\$ 45,845	\$1,146,365	
18	\$ 29,699	\$ 921,582	\$ 45,845	\$1,192,210	
19	\$ 29,699	\$ 951,281	\$ 45,845	\$1,238,055	
20	\$ 29,699	\$ 980,980	\$ 45,845	\$1,283,900	
SALVAGE	(\$ 0)	\$ 980,980	(\$ 0)	\$1,283,900	

PAYBACK FOR DESIGN SYS OCCURS AFTER 1.2 YEARS (\$ 423,788)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 980,980
TOTAL COST OF STD AC SYS FOR 20 YEARS IS \$1,283,900

CCF SUBCONSTRUCT 2/4
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	1975S SYS
INITIAL TOTAL COST	\$ 387,000	\$ 353,000
ANNUAL OPERATING COST	\$ 27,699	\$ 53,720
ANNUAL MAINTENANCE COST	\$ 2,000	\$ 2,000
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

DESIGN SYS EXPENSES			1975S SYS EXPENSES		
YEAR	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	
INITIAL	\$ 387,000	\$ 387,000	\$ 353,000	\$ 353,000	
1	\$ 29,699	\$ 416,699	\$ 55,720	\$ 408,720	

2	\$ 29,699	\$ 446,398	\$ 55,720	\$ 464,440	
3	\$ 29,699	\$ 476,097	\$ 55,720	\$ 520,160	
4	\$ 29,699	\$ 505,796	\$ 55,720	\$ 575,880	
5	\$ 29,699	\$ 535,495	\$ 55,720	\$ 631,600	
6	\$ 29,699	\$ 565,194	\$ 55,720	\$ 687,320	
7	\$ 29,699	\$ 594,893	\$ 55,720	\$ 743,040	
8	\$ 29,699	\$ 624,592	\$ 55,720	\$ 798,760	
9	\$ 29,699	\$ 654,291	\$ 55,720	\$ 854,480	
10	\$ 29,699	\$ 683,990	\$ 55,720	\$ 910,200	
11	\$ 29,699	\$ 713,689	\$ 55,720	\$ 965,920	
12	\$ 29,699	\$ 743,388	\$ 55,720	\$1,021,640	
13	\$ 29,699	\$ 773,087	\$ 55,720	\$1,077,360	
14	\$ 29,699	\$ 802,786	\$ 55,720	\$1,133,080	
15	\$ 29,699	\$ 832,485	\$ 55,720	\$1,188,800	
16	\$ 29,699	\$ 862,184	\$ 55,720	\$1,244,520	
17	\$ 29,699	\$ 891,883	\$ 55,720	\$1,300,240	
18	\$ 29,699	\$ 921,582	\$ 55,720	\$1,355,960	
19	\$ 29,699	\$ 951,281	\$ 55,720	\$1,411,680	
20	\$ 29,699	\$ 980,980	\$ 55,720	\$1,467,400	
SALVAGE	(\$ 0)	\$ 980,980	(\$ 0)	\$1,467,400	

PAYBACK FOR DESIGN SYS OCCURS AFTER 1.3 YEARS (\$ 425,806)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 980,980
TOTAL COST OF 1975S SYS FOR 20 YEARS IS \$1,467,400

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4
DX AC UNITS OPERATIONAL DATA

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

TYPICAL OPERATING EFFICIENCIES FOR COMPUTER ROOM AIR CONDITIONERS
(DX SYSTEMS MANDATORY TO ATTAIN 42F DEWPOINT FOR 68F DB AT 45% RH)

TYPICAL STATE-OF-THE-ART UNITS WITH COMPRESSOR UNLOADERS AND A-COIL
COMPRESSOR PERFORMANCE PROFILE

4 STEPS FULL LOADED:	0.76KW/TON	100% CAPACITY
FIRST STEP UNLOADED:	0.67KW/TON	88% CAPACITY
SECOND STEP UNLOADED:	0.54KW/TON	76% CAPACITY
THIRD STEP UNLOADED:	0.57KW/TON	38% CAPACITY

FAN PERFORMANCE PROFILE

STATIC PRESSURE DROP WITH A-COIL CONFIGURATION: 2.50 INCHES WC

TYPICAL STATE-OF-THE-ART UNITS W/ STANDARD HI EFFICIENCY COMPRESSORS AND A-COIL
COMPRESSOR PERFORMANCE PROFILE

COMPRESSORS LOADED: 0.76KW/TON 100% capacity

FAN PERFORMANCE PROFILE

STATIC PRESSURE DROP WITH A-COIL CONFIGURATION: 2.50 INCHES WC

TYPICAL 1975 STYLE UNITS WITH STANDARD COMPRESSORS AND SLAB-COIL
COMPRESSOR PERFORMANCE PROFILE

COMPRESSORS LOADED: 0.95KW/TON 100% CAPACITY

FAN PERFORMANCE PROFILE

STATIC PRESSURE DROP WITH SLAB-COIL CONFIGURATION: 3.00 INCHES WC

COOLING PLANT INPUT POWER

Job : CCF SUBCON 2/4 DESIGN SYS
 Building : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 2/4 DESIGN SVS
 Building : CCF SUBCONSTRUCT 2/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-25-86

$$2300 \times .57 = 1311$$

$$3160 \times .54 = 1706$$

$$700 \times .67 = 469$$

$$260 \times .76 = 198$$

$$\text{TOTAL} = 3684 \div 6420 = \underline{\underline{.57 \text{ KW/TON AVG.}}}$$

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
SYSTEMS ANALYSIS

12 NOVEMBER, 1986
ANALYST: S.F. KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 2/4 FUTURE
BUILDING SECTOR PHYSICAL PARAMETERS AND DESCRIPTION

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 FUT

Date : 11-25-86

Site : AURORA,IL FERMI, User Defined

60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 68 F; Heating = 68 F; Setback = 0 F

Warm-up factor = 0 %; Room design relative humidity = 45 %

Floor Areas: Perimeter = 29,760 Sqft; Interior = 0 Sqft

Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	2,060	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	980	0.060	420	0.550
West Wall	0	0.060	760	0.550
Northwest Wall	0	0.060	1,520	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium

BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed

Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are used. ; A ceiling plenum is used.

3. LIGHTS:

Perimeter : 1.000 Watts/Sqft = 29,760 Watts Total

Interior : 0.000 Watts/Sqft = 0 Watts Total

Diversity Factors : Occupied = 100 %; Unoccupied = 90 %

Perimeter Lights : Ballast , recessed

Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = 20.161 Watts/Sqft = 600,000 Watts Total

Unoccupied = 20.161 Watts/Sqft = 600,000 Watts Total

Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total

Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 1,488 sqft/person = 20 people total

Activity Level: 2. Office or retail

Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person

Diversity Factors : Occupied = 80 %; Unoccupied = 50 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 8,340 Sqft; Interior = 0 Sqft

Wall U-Factor = 0.380 BTU/(hr-sqft-F)

Adjacent region heating temperature = 65 F

Adjacent region is not cooled

VI-1

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 149 cfm; Unoccupied = 89 cfm

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
BUILDING LOAD CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

LOAD PROFILE SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD (Load does not include vent. load, fan heat)

Bin	Bin	<-----Perimeter Zone----->				<-----Interior Zone----->			
Temp	Hours	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum	Zone
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(tons)	(F)
93	0.0	216.19	0.86	3.17	68	0.00	0.00	0.00	--
90	25.8	208.05	0.62	3.17	68	0.00	0.00	0.00	--
85	59.4	203.86	0.57	3.17	68	0.00	0.00	0.00	--
80	145.3	199.67	0.52	3.17	68	0.00	0.00	0.00	--
75	237.7	195.48	0.47	3.17	68	0.00	0.00	0.00	--
70	270.6	191.29	0.43	3.17	68	0.00	0.00	0.00	--
65	264.5	187.10	0.40	3.17	68	0.00	0.00	0.00	--
60	255.0	184.24	0.38	3.17	68	0.00	0.00	0.00	--
55	244.7	181.37	0.35	3.17	68	0.00	0.00	0.00	--
50	232.1	178.50	0.34	3.17	68	0.00	0.00	0.00	--
45	229.5	175.63	0.26	3.17	68	0.00	0.00	0.00	--
40	237.6	172.77	0.19	3.17	68	0.00	0.00	0.00	--
35	238.5	169.90	0.14	3.17	68	0.00	0.00	0.00	--
30	218.2	167.03	0.09	3.17	68	0.00	0.00	0.00	--
25	174.5	164.16	0.04	3.17	68	0.00	0.00	0.00	--
20	122.4	161.30	0.01	3.17	68	0.00	0.00	0.00	--
15	78.1	158.43	-0.02	3.17	68	0.00	0.00	0.00	--
10	46.1	155.56	-0.04	3.17	68	0.00	0.00	0.00	--
5	25.1	152.69	-0.06	3.17	68	0.00	0.00	0.00	--
0	12.7	149.83	-0.07	3.17	68	0.00	0.00	0.00	--
-5	6.2	146.96	-0.08	3.17	68	0.00	0.00	0.00	--
-6	4.6	146.38	-0.09	3.17	68	0.00	0.00	0.00	--

TABLE 2. UNOCCUPIED PERIOD (Load does not include vent. load, fan heat)

Bin	Bin	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum	Zone
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(tons)	(F)
90	14.6	207.06	0.38	2.86	68	0.00	0.00	0.00	--
85	36.3	202.90	0.35	2.86	68	0.00	0.00	0.00	--
80	99.3	198.74	0.32	2.86	68	0.00	0.00	0.00	--
75	215.3	194.58	0.29	2.86	68	0.00	0.00	0.00	--
70	357.6	190.42	0.27	2.86	68	0.00	0.00	0.00	--
65	463.3	186.26	0.25	2.86	68	0.00	0.00	0.00	--
60	500.4	183.42	0.23	2.86	68	0.00	0.00	0.00	--
55	482.0	180.58	0.22	2.86	68	0.00	0.00	0.00	--
50	447.6	177.74	0.21	2.86	68	0.00	0.00	0.00	--
45	422.7	174.90	0.16	2.86	68	0.00	0.00	0.00	--
40	413.7	172.06	0.12	2.86	68	0.00	0.00	0.00	--
35	417.0	169.22	0.09	2.86	68	0.00	0.00	0.00	--
30	417.4	166.38	0.06	2.86	68	0.00	0.00	0.00	--
25	395.2	163.54	0.03	2.86	68	0.00	0.00	0.00	--
20	336.9	160.69	0.01	2.86	68	0.00	0.00	0.00	--
15	252.8	157.85	-0.00	2.86	68	0.00	0.00	0.00	--
10	165.7	155.01	-0.02	2.86	68	0.00	0.00	0.00	--
5	96.3	152.17	-0.03	2.86	68	0.00	0.00	0.00	--
0	50.9	149.33	-0.04	2.86	68	0.00	0.00	0.00	--
-5	25.3	146.49	-0.04	2.86	68	0.00	0.00	0.00	--
-6	21.1	145.92	-0.05	2.86	68	0.00	0.00	0.00	--
-6	0.0	-32.62	-0.22	0.00	68	0.00	0.00	0.00	--

SOLAR GAIN SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. SOLAR GAINS BY EXPOSURE

Bin Temp (F)	Solar Gains by Exposure (BTU/(hr-sqft))								Perim Horiz	Inter Horiz
	North	NE	East	SE	South	SW	West	NW		
93	9.7	15.0	22.2	23.2	33.9	67.7	66.5	32.0	0.0	0.0
90	6.9	10.7	15.7	16.5	24.1	48.0	47.1	22.6	0.0	0.0
85	6.5	10.1	14.9	15.7	23.0	45.7	44.8	21.5	0.0	0.0
80	6.2	9.6	14.2	14.9	21.8	43.3	42.4	20.3	0.0	0.0
75	5.8	9.0	13.4	14.2	20.7	40.9	40.0	19.1	0.0	0.0
70	5.5	8.5	12.6	13.4	19.6	38.6	37.7	18.0	0.0	0.0
65	5.1	7.9	11.8	12.6	18.5	36.2	35.3	16.8	0.0	0.0
60	4.8	7.4	11.0	11.8	17.4	33.9	32.9	15.6	0.0	0.0
55	4.4	6.8	10.3	11.0	16.2	31.5	30.6	14.4	0.0	0.0
50	4.1	6.3	9.5	10.3	15.1	29.2	28.2	13.3	0.0	0.0
45	3.7	5.7	8.7	9.5	14.0	26.8	25.8	12.1	0.0	0.0
40	3.4	5.2	7.9	8.7	12.9	24.4	23.5	10.9	0.0	0.0
35	3.0	4.6	7.1	7.9	11.8	22.1	21.1	9.8	0.0	0.0
30	2.7	4.1	6.4	7.2	10.6	19.7	18.8	8.6	0.0	0.0
25	2.3	3.5	5.6	6.4	9.5	17.4	16.4	7.4	0.0	0.0
20	2.0	3.0	4.8	5.6	8.4	15.0	14.0	6.3	0.0	0.0
15	1.6	2.4	4.0	4.8	7.3	12.7	11.7	5.1	0.0	0.0
10	1.2	1.9	3.2	4.1	6.2	10.3	9.3	3.9	0.0	0.0
5	0.9	1.3	2.5	3.3	5.0	8.0	6.9	2.8	0.0	0.0
0	0.5	0.8	1.7	2.5	3.9	5.6	4.6	1.6	0.0	0.0
-5	0.2	0.2	0.9	1.7	2.8	3.2	2.2	0.4	0.0	0.0
-6	0.1	0.1	0.7	1.6	2.6	2.8	1.7	0.2	0.0	0.0
-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ETD SUMMARY

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD

Bin Temp (F)	Equivalent Temperature Differences (F)								Perim Roof	Inter Roof
	North	NE	East	SE	By Exposure South	SW	West	NW		
93	18.0	19.9	21.2	26.5	30.0	28.5	25.0	19.3	40.4	-----
90	15.4	16.7	17.6	21.4	23.9	22.8	20.3	16.3	31.7	-----
85	11.0	12.2	13.1	16.7	19.1	18.1	15.7	11.8	26.4	-----
80	6.6	7.8	8.6	12.1	14.2	13.4	11.1	7.4	21.1	-----
75	2.2	3.3	4.1	7.4	9.4	8.6	6.4	2.9	15.8	-----
70	-2.2	-1.2	-0.4	2.7	4.6	3.9	1.8	-1.5	10.5	-----
65	-6.6	-5.6	-4.9	-1.9	-0.2	-0.8	-2.8	-5.9	5.1	-----
60	-11.0	-10.1	-9.4	-6.6	-5.0	-5.5	-7.5	-10.4	-0.2	-----
55	-15.4	-14.5	-13.9	-11.3	-9.8	-10.3	-12.1	-14.8	-5.5	-----
50	-19.8	-19.0	-18.4	-15.9	-14.6	-15.0	-16.7	-19.3	-10.8	-----
45	-24.2	-23.5	-22.9	-20.6	-19.4	-19.7	-21.4	-23.7	-16.1	-----
40	-28.6	-27.9	-27.4	-25.3	-24.2	-24.4	-26.0	-28.1	-21.4	-----
35	-33.0	-32.4	-31.9	-29.9	-29.0	-29.2	-30.6	-32.6	-26.7	-----
30	-37.4	-36.9	-36.4	-34.6	-33.8	-33.9	-35.3	-37.0	-32.0	-----
25	-41.8	-41.3	-40.9	-39.3	-38.7	-38.6	-39.9	-41.5	-37.3	-----
20	-46.2	-45.8	-45.4	-43.9	-43.5	-43.4	-44.5	-45.9	-42.6	-----
15	-50.5	-50.2	-50.0	-48.6	-48.3	-48.1	-49.2	-50.3	-47.9	-----
10	-54.9	-54.7	-54.5	-53.3	-53.1	-52.8	-53.8	-54.8	-53.2	-----
5	-59.3	-59.2	-59.0	-57.9	-57.9	-57.5	-58.4	-59.2	-58.6	-----
0	-63.7	-63.6	-63.5	-62.6	-62.7	-62.3	-63.1	-63.7	-63.9	-----
-5	-68.1	-68.1	-68.0	-67.3	-67.5	-67.0	-67.7	-68.1	-69.2	-----
-6	-69.0	-69.0	-68.9	-68.2	-68.5	-67.9	-68.6	-69.0	-70.2	-----

TABLE 2. UNOCCUPIED PERIOD

90	15.4	16.7	17.6	21.4	23.9	22.8	20.3	16.3	31.7	-----
85	11.0	12.2	13.1	16.7	19.1	18.1	15.7	11.8	26.4	-----
80	6.6	7.8	8.6	12.1	14.2	13.4	11.1	7.4	21.1	-----
75	2.2	3.3	4.1	7.4	9.4	8.6	6.4	2.9	15.8	-----
70	-2.2	-1.2	-0.4	2.7	4.6	3.9	1.8	-1.5	10.5	-----
65	-6.6	-5.6	-4.9	-1.9	-0.2	-0.8	-2.8	-5.9	5.1	-----
60	-11.0	-10.1	-9.4	-6.6	-5.0	-5.5	-7.5	-10.4	-0.2	-----
55	-15.4	-14.5	-13.9	-11.3	-9.8	-10.3	-12.1	-14.8	-5.5	-----
50	-19.8	-19.0	-18.4	-15.9	-14.6	-15.0	-16.7	-19.3	-10.8	-----
45	-24.2	-23.5	-22.9	-20.6	-19.4	-19.7	-21.4	-23.7	-16.1	-----
40	-28.6	-27.9	-27.4	-25.3	-24.2	-24.4	-26.0	-28.1	-21.4	-----
35	-33.0	-32.4	-31.9	-29.9	-29.0	-29.2	-30.6	-32.6	-26.7	-----
30	-37.4	-36.9	-36.4	-34.6	-33.8	-33.9	-35.3	-37.0	-32.0	-----
25	-41.8	-41.3	-40.9	-39.3	-38.7	-38.6	-39.9	-41.5	-37.3	-----
20	-46.2	-45.8	-45.4	-43.9	-43.5	-43.4	-44.5	-45.9	-42.6	-----
15	-50.5	-50.2	-50.0	-48.6	-48.3	-48.1	-49.2	-50.3	-47.9	-----
10	-54.9	-54.7	-54.5	-53.3	-53.1	-52.8	-53.8	-54.8	-53.2	-----
5	-59.3	-59.2	-59.0	-57.9	-57.9	-57.5	-58.4	-59.2	-58.6	-----
0	-63.7	-63.6	-63.5	-62.6	-62.7	-62.3	-63.1	-63.7	-63.9	-----
-5	-68.1	-68.1	-68.0	-67.3	-67.5	-67.0	-67.7	-68.1	-69.2	-----
-6	-69.0	-69.0	-68.9	-68.2	-68.5	-67.9	-68.6	-69.0	-70.2	-----
-6	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-74.0	-----

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
SYSTEM COMPARISON PERFORMANCE SIMULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
OPERATIONAL PERFORMANCE SIMULATION

DESIGN BASIS SYSTEM
DX AC UNITS WITH FREE COOLING COILS AND HI EFFICIENCY 4-STEP COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON2/4F DESIGN SYS Page 1
Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex) Date : 11-25-86
Site : AURORA, IL FERMI, User Defined 60117862.0
Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 144000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 90 % ; Input power = 0.2 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON2/4F DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site : AURORA,IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

Page 2
 Date : 11-25-86
 60117862.0

C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 240.0 tons

KW/Ton @ 85 F entering water = 0.58 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <N>

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 65 %

D. PUMPING SYSTEMS

System	PERIMETER		dP, ft wg	dT, F	dP, ft wg
	dT, F				
Chilled water	0.00	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 600.0 kw; Unoccupied = 600.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON2/4F DESIGN SYS
Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
Site : AURORA, IL FERMI, User Defined
Date : 11-25-86

Period : All
Zone : Block
Serial Number :
60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	23326	466529 kwh/yr	5411737	1592264
Electric (Unocc)	38989	779778 kwh/yr	9045420	2661381
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	62315		14457157	4253645

NON-HVAC ENERGY

Electric (Occ)	98513	1970267 kwh/yr	22855101	6724522
Electric (Unocc)	176484	3529671 kwh/yr	40944185	12046768
Non-HVAC Total	274997		63799286	18771290
Grand Total	337312		78256443	23024934
Total/Sq.Ft.	11.33		2629.58	773.69

HVAC Summary:

HVAC Total Cost = 2.09 \$/Sq.Ft./yr
= 18.47 % of Total Cost
Total HVAC Electrical Energy = 41.88 kwh/Sq.Ft./yr
= 18.47 % of Total Electrical Energy
Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON2/4F DESIGN SYS Page 1
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex) Date : 11-25-86
 Site : AURORA,IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$34,204)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 144000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <Y>

Reclaim device: Efficiency = 90 % ; Input power = 0.2 kw

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON2/4F DESIGN SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

 C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$19,632)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 240.0 tons

KW/Ton @ 85 F entering water = 0.58 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <N>

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 65 %

 D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$8,479)

System	PERIMETER		dP, ft wg	dP, ft wg
	dT, F	dT, F		
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

 E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$274,997)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 600.0 kw; Unoccupied = 600.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

 F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$337,312)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON2/4F DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Perimeter Cooling Plant					No Interior Zone Exists
Bin	Bin	Coil Load	Input	Cost	
Temp	Hours	MBH	KW	\$/yr	
(F)	hr/yr				
-----OCCUPIED PERIOD-----					
90	25.8	2869.8	128.9	166.3	
85	59.4	2805.5	119.4	354.7	
80	145.3	2742.6	110.7	804.0	
75	237.7	2681.1	102.6	1219.4	
70	270.6	2620.8	95.2	1287.6	
65	264.5	2554.1	87.9	1162.2	
60	255.0	2500.5	77.4	986.9	
55	244.7	2447.9	62.5	764.1	
50	232.1	2399.3	43.9	509.8	
45	229.5	2351.9	30.1	344.9	
40	237.6	2304.5	19.3	229.5	
35	238.5	2257.1	10.9	130.1	
30	218.2	2209.7	4.0	43.2	
25	174.5	2162.3	3.3	28.7	
20	122.4	2114.9	3.3	20.1	
15	78.1	2067.5	3.3	12.9	
10	46.1	2020.2	3.3	7.6	
5	25.1	1972.8	3.3	4.1	
0	12.7	1925.4	3.3	2.1	
-5	6.2	1878.0	3.3	1.0	
-6	4.6	1868.5	3.3	0.8	
Total Costs				\$8080.1	
-----UNOCCUPIED PERIOD-----					
90	14.6	2851.1	127.4	93.0	
85	36.3	2787.3	118.1	214.3	
80	99.3	2725.0	109.5	543.5	
75	215.3	2664.1	101.5	1092.7	
70	357.6	2604.3	94.2	1683.6	
65	463.3	2538.1	87.0	2014.5	
60	500.4	2485.0	76.5	1913.9	
55	482.0	2433.4	61.7	1486.6	
50	447.6	2386.4	43.4	971.0	
45	422.7	2339.3	29.6	626.2	
40	413.7	2292.2	19.0	392.7	
35	417.0	2245.2	10.6	221.6	
30	417.4	2198.1	3.7	76.9	
25	395.2	2151.0	3.3	65.0	
20	336.9	2104.0	3.3	55.4	
15	252.8	2056.9	3.3	41.6	
10	165.7	2009.8	3.3	27.3	
5	96.3	1962.8	3.3	15.8	
0	50.9	1915.7	3.3	8.4	
-5	25.3	1868.7	3.3	4.2	
-6	21.1	1859.2	3.3	3.5	
Total Costs				\$11551.8	

COOLING PLANT COSTS

Job Name : CCF SUBCON2/4F DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant	No Interior Zone Exists
Temp	Hours	Coil Load	Input
(F)	hr/yr	MBH	KW
-----OCCUPIED PERIOD-----			
90	25.8	2869.8	128.9
85	59.4	2805.5	119.4
80	145.3	2742.6	110.7
75	237.7	2681.1	102.6
70	270.6	2620.8	95.2
65	264.5	2554.1	87.9
60	255.0	2500.5	77.4
55	244.7	2447.9	62.5
50	232.1	2399.3	43.9
45	229.5	2351.9	30.1
40	237.6	2304.5	19.3
35	238.5	2257.1	10.9
30	218.2	2209.7	4.0
25	174.5	2162.3	3.3
20	122.4	2114.9	3.3
15	78.1	2067.5	3.3
10	46.1	2020.2	3.3
5	25.1	1972.8	3.3
0	12.7	1925.4	3.3
-5	6.2	1878.0	3.3
-6	4.6	1868.5	3.3
Total Costs			\$8080.1
-----UNOCCUPIED PERIOD-----			
90	14.6	2851.1	127.4
85	36.3	2787.3	118.1
80	99.3	2725.0	109.5
75	215.3	2664.1	101.5
70	357.6	2604.3	94.2
65	463.3	2538.1	87.0
60	500.4	2485.0	76.5
55	482.0	2433.4	61.7
50	447.6	2386.4	43.4
45	422.7	2339.3	29.6
40	413.7	2292.2	19.0
35	417.0	2245.2	10.6
30	417.4	2198.1	3.7
25	395.2	2151.0	3.3
20	336.9	2104.0	3.3
15	252.8	2056.9	3.3
10	165.7	2009.8	3.3
5	96.3	1962.8	3.3
0	50.9	1915.7	3.3
-5	25.3	1868.7	3.3
-6	21.1	1859.2	3.3
Total Costs			\$11551.8

FAN AND PUMP COSTS

Job Name : CCF SUBCON2/4F DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	78.1	100.7		19.5 25.2
85	59.4	78.1	231.9		19.5 58.0
80	145.3	78.1	567.3		19.5 141.9
75	237.7	78.1	928.1		19.5 232.1
70	270.6	78.1	1056.6		19.5 264.2
65	264.5	78.1	1032.8		19.3 255.6
60	255.0	78.1	995.7		19.3 246.4
55	244.7	78.1	955.5		19.3 236.4
50	232.1	78.1	906.3		19.3 224.3
45	229.5	78.1	896.1		19.3 221.8
40	237.6	78.1	927.7		19.3 229.6
35	238.5	78.1	931.2		19.3 230.5
30	218.2	78.1	852.0		19.3 210.8
25	174.5	78.1	681.4		19.3 168.6
20	122.4	78.1	477.9		19.3 118.3
15	78.1	78.1	304.9		19.3 75.5
10	46.1	78.1	180.0		19.3 44.5
5	25.1	78.1	98.0		19.3 24.3
0	12.7	78.1	49.6		19.3 12.3
-5	6.2	78.1	24.2		19.3 6.0
-6	4.6	78.1	18.0		19.3 4.4
Total Costs			\$12215.9		\$3030.5
UNOCCUPIED PERIOD					
90	14.6	78.1	57.0		19.5 14.3
85	36.3	78.1	141.7		19.5 35.4
80	99.3	78.1	387.7		19.5 96.9
75	215.3	78.1	840.7		19.5 210.2
70	357.6	78.1	1396.3		19.5 349.1
65	463.3	78.1	1809.0		19.3 447.7
60	500.4	78.1	1953.9		19.3 483.5
55	482.0	78.1	1882.0		19.3 465.7
50	447.6	78.1	1747.7		19.3 432.5
45	422.7	78.1	1650.5		19.3 408.4
40	413.7	78.1	1615.3		19.3 399.8
35	417.0	78.1	1628.2		19.3 402.9
30	417.4	78.1	1629.8		19.3 403.3
25	395.2	78.1	1543.1		19.3 381.9
20	336.9	78.1	1315.5		19.3 325.5
15	252.8	78.1	987.1		19.3 244.3
10	165.7	78.1	647.0		19.3 160.1
5	96.3	78.1	376.0		19.3 93.1
0	50.9	78.1	198.7		19.3 49.2
-5	25.3	78.1	98.8		19.3 24.4
-6	21.1	78.1	82.4		19.3 20.4
Total Costs			\$21988.3		\$5448.7

COOLING COIL LOADS

Job : CCF SUBCON2/4F DESIGN SYS
Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-25-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON2/4F DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON2/4F DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

FAN OPERATING COSTS

Job : CCF SUBCON2/4F DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 1
DX AC UNITS WITH HI EFFICIENCY COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4F STDAC SYS Page 1
Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex) Date : 11-25-86
Site : AURORA, IL FERMI, User Defined 60117862.0
Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 144000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4F STDAC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site : AURORA,IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

Page 2
 Date : 11-25-86
 60117862.0

C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 240.0 tons
 KW/Ton @ 85 F entering water = 0.76 kw/ton
 Is hydronic cooling used ? <N>
 Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <Y>
 Are compressors cycled ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw
 Misc. kw : Occupied = 600.0 kw; Unoccupied = 600.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 2/4F STDAC SYS
Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
Site : AURORA,IL FERMI, User Defined
Date : 11-25-86

Period : All
Zone : Block
Serial Number :
60117862.0

HVAC ENERGY	Annual	Energy or Fuel		
Component	Cost	Units	DOE RUF	DOE RIF
	(\$/yr)	Consumed	(1000 BTU)	(1000 BTU)
Electric (Occ)	37451	749012 kwh/yr	8688544	2556379
Electric (Unocc)	66144	1322874 kwh/yr	15345337	4514969
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	103594		24033881	7071348

NON-HVAC ENERGY

Electric (Occ)	98513	1970267 kwh/yr	22855101	6724522
Electric (Unocc)	176484	3529671 kwh/yr	40944185	12046768
Non-HVAC Total	274997		63799286	18771290
Grand Total	378591		87833167	25842638
Total/Sq.Ft.	12.72		2951.38	868.37

HVAC Summary:

HVAC Total Cost = 3.48 \$/Sq.Ft./yr
= 27.36 % of Total Cost
Total HVAC Electrical Energy = 69.62 kwh/Sq.Ft./yr
= 27.36 % of Total Electrical Energy
Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4F STDAC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site : AURORA,IL FERMI, User Defined
 Scope of Analysis : Cooling and Heating Systems

Page 1

Date : 11-25-86

60117862.0

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$34,204)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 2.50 in. wg.

A return fan is not used.

Design supply air= 144000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4F STDAC SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$60,554)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 240.0 tons

KW/Ton @ 85 F entering water = 0.76 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$8,837)

System	PERIMETER			
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$274,997)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 600.0 kw; Unoccupied = 600.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$378,591)

>1. Period			>2. OTHER FUELS		Unit Cost
ELECTRICAL ENERGY USE	Occupied (\$/kwh)	Unoccupied (\$/kwh)			
Compressor	0.050	0.050	Natural Gas		n/a \$/therm
Resistance	0.050	0.050	Fuel Oil		n/a \$/U.S.gal
Inductive	0.050	0.050	Propane		n/a \$/lb
			Remote Heating		n/a \$/MBTU
			Remote Cooling		n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 2/4F STDAC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Perimeter Cooling Plant					No Interior Zone Exists
Bin	Bin	Coil Load	Input	Cost	
Temp	Hours	MBH	KW	\$/yr	
(F)	hr/yr				
-----OCCUPIED PERIOD-----					
90	25.8	2920.7	171.6	221.4	
85	59.4	2844.7	165.5	491.6	
80	145.3	2770.1	161.3	1171.7	
75	237.7	2696.9	157.1	1867.2	
70	270.6	2624.9	153.0	2070.2	
65	264.5	2554.1	149.0	1970.1	
60	255.0	2500.5	145.9	1860.5	
55	244.7	2447.9	142.9	1748.6	
50	232.1	2399.3	140.2	1626.4	
45	229.5	2351.9	137.5	1577.2	
40	237.6	2304.5	134.7	1600.8	
35	238.5	2257.1	132.0	1574.7	
30	218.2	2209.7	129.3	1411.2	
25	174.5	2162.3	126.6	1105.0	
20	122.4	2114.9	123.9	758.6	
15	78.1	2067.5	121.2	473.5	
10	46.1	2020.2	118.5	273.3	
5	25.1	1972.8	115.8	145.4	
0	12.7	1925.4	113.1	71.8	
-5	6.2	1878.0	110.4	34.2	
-6	4.6	1868.5	109.9	25.3	
Total Costs				\$22078.8	
-----UNOCCUPIED PERIOD-----					
90	14.6	2902.0	170.4	124.4	
85	36.3	2826.6	164.5	298.6	
80	99.3	2752.6	160.3	795.8	
75	215.3	2679.9	156.1	1680.9	
70	357.6	2608.5	152.1	2719.0	
65	463.3	2538.1	148.1	3429.8	
60	500.4	2485.0	145.0	3628.8	
55	482.0	2433.4	142.1	3424.5	
50	447.6	2386.4	139.4	3120.1	
45	422.7	2339.3	136.7	2889.8	
40	413.7	2292.2	134.1	2772.8	
35	417.0	2245.2	131.4	2739.0	
30	417.4	2198.1	128.7	2685.7	
25	395.2	2151.0	126.0	2489.9	
20	336.9	2104.0	123.3	2077.4	
15	252.8	2056.9	120.6	1524.9	
10	165.7	2009.8	118.0	977.3	
5	96.3	1962.8	115.3	555.1	
0	50.9	1915.7	112.6	286.6	
-5	25.3	1868.7	109.9	139.0	
-6	21.1	1859.2	109.4	115.4	
Total Costs				\$38474.8	

PERIMETER HEATING PLANT COSTS

Job Name : CCF SUBCON 2/4F STDAC SYS

Date : 11-25-86

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Coil	Primary	Plant	No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost
(F)	hr/yr	MBH	MBH	KW	\$/yr
-----OCCUPIED PERIOD-----					
90	25.8	0.0	0.0	0.0	0.0
85	59.4	0.0	0.0	0.0	0.0
80	145.3	0.0	0.0	0.0	0.0
75	237.7	0.0	0.0	0.0	0.0
70	270.6	0.0	0.0	0.0	0.0
65	264.5	0.0	0.0	0.0	0.0
60	255.0	0.0	0.0	0.0	0.0
55	244.7	0.0	0.0	0.0	0.0
50	232.1	0.0	0.0	0.0	0.0
45	229.5	0.0	0.0	0.0	0.0
40	237.6	0.0	0.0	0.0	0.0
35	238.5	0.0	0.0	0.0	0.0
30	218.2	0.0	0.0	0.0	0.0
25	174.5	0.0	0.0	0.0	0.0
20	122.4	0.0	0.0	0.0	0.0
15	78.1	0.0	0.0	0.0	0.0
10	46.1	0.0	0.0	0.0	0.0
5	25.1	0.0	0.0	0.0	0.0
0	12.7	0.0	0.0	0.0	0.0
-5	6.2	0.0	0.0	0.0	0.0
-6	4.6	0.0	0.0	0.0	0.0
Total Costs					\$0.0
-----UNOCCUPIED PERIOD-----					
90	14.6	0.0	0.0	0.0	0.0
85	36.3	0.0	0.0	0.0	0.0
80	99.3	0.0	0.0	0.0	0.0
75	215.3	0.0	0.0	0.0	0.0
70	357.6	0.0	0.0	0.0	0.0
65	463.3	0.0	0.0	0.0	0.0
60	500.4	0.0	0.0	0.0	0.0
55	482.0	0.0	0.0	0.0	0.0
50	447.6	0.0	0.0	0.0	0.0
45	422.7	0.0	0.0	0.0	0.0
40	413.7	0.0	0.0	0.0	0.0
35	417.0	0.0	0.0	0.0	0.0
30	417.4	0.0	0.0	0.0	0.0
25	395.2	0.0	0.0	0.0	0.0
20	336.9	0.0	0.0	0.0	0.0
15	252.8	0.0	0.0	0.0	0.0
10	165.7	0.0	0.0	0.0	0.0
5	96.3	0.0	0.0	0.0	0.0
0	50.9	0.0	0.0	0.0	0.0
-5	25.3	0.0	0.0	0.0	0.0
-6	21.1	0.0	0.0	0.0	0.0
Total Costs					\$0.0

FAN AND PUMP COSTS

Job Name : CCF SUBCON 2/4F STDAC SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	78.1	100.7		20.2 26.0
85	59.4	78.1	231.9		20.2 59.9
80	145.3	78.1	567.3		20.2 146.6
75	237.7	78.1	928.1		20.2 239.8
70	270.6	78.1	1056.6		20.2 273.0
65	264.5	78.1	1032.8		20.2 266.8
60	255.0	78.1	995.7		20.2 257.2
55	244.7	78.1	955.5		20.2 246.8
50	232.1	78.1	906.3		20.2 234.1
45	229.5	78.1	896.1		20.2 231.5
40	237.6	78.1	927.7		20.2 239.7
35	238.5	78.1	931.2		20.2 240.6
30	218.2	78.1	852.0		20.2 220.1
25	174.5	78.1	681.4		20.2 176.0
20	122.4	78.1	477.9		20.2 123.5
15	78.1	78.1	304.9		20.2 78.8
10	46.1	78.1	180.0		20.2 46.5
5	25.1	78.1	98.0		20.2 25.3
0	12.7	78.1	49.6		20.2 12.8
-5	6.2	78.1	24.2		20.2 6.3
-6	4.6	78.1	18.0		20.2 4.6
Total Costs			\$12215.9		\$3156.0
UNOCCUPIED PERIOD					
90	14.6	78.1	57.0		20.2 14.7
85	36.3	78.1	141.7		20.2 36.6
80	99.3	78.1	387.7		20.2 100.2
75	215.3	78.1	840.7		20.2 217.2
70	357.6	78.1	1396.3		20.2 360.7
65	463.3	78.1	1809.0		20.2 467.4
60	500.4	78.1	1953.9		20.2 504.8
55	482.0	78.1	1882.0		20.2 486.2
50	447.6	78.1	1747.7		20.2 451.5
45	422.7	78.1	1650.5		20.2 426.4
40	413.7	78.1	1615.3		20.2 417.3
35	417.0	78.1	1628.2		20.2 420.6
30	417.4	78.1	1629.8		20.2 421.0
25	395.2	78.1	1543.1		20.2 398.7
20	336.9	78.1	1315.5		20.2 339.8
15	252.8	78.1	987.1		20.2 255.0
10	165.7	78.1	647.0		20.2 167.1
5	96.3	78.1	376.0		20.2 97.1
0	50.9	78.1	198.7		20.2 51.3
-5	25.3	78.1	98.8		20.2 25.5
-6	21.1	78.1	82.4		20.2 21.3
Total Costs			\$21988.3		\$5680.6

COOLING COIL LOADS

Job : CCF SUBCON 2/4F STDAC SYS
 Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-25-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 2/4F STDAC SYS

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 2/4F STDAC SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

FAN OPERATING COSTS

Job : CCF SUBCON 2/4F STDAC SYS

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 2
TYPICAL FY1975 DESIGN
DX AC UNITS WITH STANDARD COMPRESSORS AND COILS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4F 1975S SYS Page 1
Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex) Date : 11-25-86
Site : AURORA, IL FERMI, User Defined 60117862.0
Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 3.00 in. wg.

A return fan is not used.

Design supply air= 144000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 2/4F 1975S SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 240.0 tons

KW/Ton @ 85 F entering water = 0.95 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 600.0 kw; Unoccupied = 600.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 2/4F 1975S SYS	Period : All
Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)	Zone : Block
Site : AURORA, IL FERMI, User Defined	Serial Number :
Date : 11-25-86	60117862.0

HVAC ENERGY	Annual	Energy or Fuel		
Component	Cost	Units	DDE RUF	DOE RIF
	(\$/yr)	Consumed	(1000 BTU)	(1000 BTU)
Electric (Occ)	46044	920882 kwh/yr	10682234	3142971
Electric (Unocc)	81290	1625804 kwh/yr	18859329	5548870
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	127334		29541563	8691841

NON-HVAC ENERGY

Electric (Occ)	98513	1970267 kwh/yr	22855101	6724522
Electric (Unocc)	176484	3529671 kwh/yr	40944185	12046768
Non-HVAC Total	274997		63799286	18771290
Grand Total	402331		93340849	27463131
Total/Sq.Ft.	13.52		3136.45	922.82

HVAC Summary:

HVAC Total Cost	=	4.28 \$/Sq.Ft./yr
	=	31.65 % of Total Cost
Total HVAC Electrical Energy	=	85.57 kwh/Sq.Ft./yr
	=	31.65 % of Total Electrical Energy
Non-Electrical HVAC Energy	=	-0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4F 1975S SYS

Page 1

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$41,045)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 3.00 in. wg.

A return fan is not used.

Design supply air= 144000 cfm @ 52 F; Vent. air= 2360 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <N>

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 2/4F 1975S SYS

Page 2

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Date : 11-25-86

Site : AURORA, IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling and Heating Systems

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$77,060)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 240.0 tons

KW/Ton @ 85 F entering water = 0.95 kw/ton

Is hydronic cooling used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$9,229)

System	PERIMETER			
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	117.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$274,997)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 29.8 kw; Unoccupied = 26.8 kw

Misc. kw : Occupied = 600.0 kw; Unoccupied = 600.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$402,331)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 2/4F 1975S SYS
 Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-25-86
 Serial Number:
 60117862.0

Perimeter Cooling Plant					No Interior Zone Exists
Bin	Bin	Coil Load	Input	Cost	
Temp (F)	Hours hr/yr	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----					
90	25.8	2975.1	218.0	281.3	
85	59.4	2899.1	210.1	623.9	
80	145.3	2824.6	204.8	1487.7	
75	237.7	2751.4	199.6	2371.8	
70	270.6	2679.4	194.4	2630.7	
65	264.5	2608.6	189.4	2504.7	
60	255.0	2555.0	185.6	2366.1	
55	244.7	2502.5	181.8	2224.7	
50	232.1	2452.6	178.3	2068.9	
45	229.5	2405.2	174.9	2007.0	
40	237.6	2357.8	171.5	2037.7	
35	238.5	2310.4	168.2	2005.2	
30	218.2	2263.0	164.8	1797.7	
25	174.5	2215.6	161.4	1408.2	
20	122.4	2168.2	158.0	967.1	
15	78.1	2120.8	154.6	603.9	
10	46.1	2073.5	151.3	348.7	
5	25.1	2026.1	147.9	185.6	
0	12.7	1978.7	144.5	91.8	
-5	6.2	1931.3	141.1	43.8	
-6	4.6	1921.8	140.5	32.3	
Total Costs				\$28088.9	
-----UNOCCUPIED PERIOD-----					
90	14.6	2956.5	216.5	158.1	
85	36.3	2881.1	208.8	379.0	
80	99.3	2807.1	203.5	1010.5	
75	215.3	2734.4	198.4	2135.3	
70	357.6	2663.0	193.3	3455.6	
65	463.3	2592.6	188.3	4360.9	
60	500.4	2539.5	184.5	4615.5	
55	482.0	2486.7	180.7	4355.1	
50	447.6	2439.7	177.4	3969.3	
45	422.7	2392.6	174.0	3677.6	
40	413.7	2345.5	170.7	3530.0	
35	417.0	2298.5	167.3	3488.2	
30	417.4	2251.4	163.9	3421.6	
25	395.2	2204.3	160.6	3173.4	
20	336.9	2157.3	157.2	2648.8	
15	252.8	2110.2	153.9	1945.2	
10	165.7	2063.2	150.5	1247.2	
5	96.3	2016.1	147.2	708.7	
0	50.9	1969.0	143.8	366.1	
-5	25.3	1922.0	140.5	177.7	
-6	21.1	1912.5	139.8	147.5	
Total Costs				\$48971.2	

PERIMETER HEATING PLANT COSTS

Job Name : CCF SUBCON 2/4F 1975S SYS

Date : 11-25-86

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Coil	Primary Plant			No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost	
(F)	hr/yr	MBH	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----						
90	25.8	0.0	0.0	0.0	0.0	
85	59.4	0.0	0.0	0.0	0.0	
80	145.3	0.0	0.0	0.0	0.0	
75	237.7	0.0	0.0	0.0	0.0	
70	270.6	0.0	0.0	0.0	0.0	
65	264.5	0.0	0.0	0.0	0.0	
60	255.0	0.0	0.0	0.0	0.0	
55	244.7	0.0	0.0	0.0	0.0	
50	232.1	0.0	0.0	0.0	0.0	
45	229.5	0.0	0.0	0.0	0.0	
40	237.6	0.0	0.0	0.0	0.0	
35	238.5	0.0	0.0	0.0	0.0	
30	218.2	0.0	0.0	0.0	0.0	
25	174.5	0.0	0.0	0.0	0.0	
20	122.4	0.0	0.0	0.0	0.0	
15	78.1	0.0	0.0	0.0	0.0	
10	46.1	0.0	0.0	0.0	0.0	
5	25.1	0.0	0.0	0.0	0.0	
0	12.7	0.0	0.0	0.0	0.0	
-5	6.2	0.0	0.0	0.0	0.0	
-6	4.6	0.0	0.0	0.0	0.0	
Total Costs					\$0.0	
-----UNOCCUPIED PERIOD-----						
90	14.6	0.0	0.0	0.0	0.0	
85	36.3	0.0	0.0	0.0	0.0	
80	99.3	0.0	0.0	0.0	0.0	
75	215.3	0.0	0.0	0.0	0.0	
70	357.6	0.0	0.0	0.0	0.0	
65	463.3	0.0	0.0	0.0	0.0	
60	500.4	0.0	0.0	0.0	0.0	
55	482.0	0.0	0.0	0.0	0.0	
50	447.6	0.0	0.0	0.0	0.0	
45	422.7	0.0	0.0	0.0	0.0	
40	413.7	0.0	0.0	0.0	0.0	
35	417.0	0.0	0.0	0.0	0.0	
30	417.4	0.0	0.0	0.0	0.0	
25	395.2	0.0	0.0	0.0	0.0	
20	336.9	0.0	0.0	0.0	0.0	
15	252.8	0.0	0.0	0.0	0.0	
10	165.7	0.0	0.0	0.0	0.0	
5	96.3	0.0	0.0	0.0	0.0	
0	50.9	0.0	0.0	0.0	0.0	
-5	25.3	0.0	0.0	0.0	0.0	
-6	21.1	0.0	0.0	0.0	0.0	
Total Costs					\$0.0	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 2/4F 1975S SYS

Date : 11-25-86

Building Name : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Serial Number:

Site Name : AURORA, IL FERMI, User Defined

60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
-----OCCUPIED PERIOD-----					
90	25.8	93.7	120.9		21.1 27.2
85	59.4	93.7	278.3		21.1 62.6
80	145.3	93.7	680.8		21.1 153.1
75	237.7	93.7	1113.7		21.1 250.4
70	270.6	93.7	1267.9		21.1 285.1
65	264.5	93.7	1239.3		21.1 278.7
60	255.0	93.7	1194.8		21.1 268.7
55	244.7	93.7	1146.5		21.1 257.8
50	232.1	93.7	1087.5		21.1 244.5
45	229.5	93.7	1075.3		21.1 241.8
40	237.6	93.7	1113.3		21.1 250.3
35	238.5	93.7	1117.5		21.1 251.3
30	218.2	93.7	1022.4		21.1 229.9
25	174.5	93.7	817.6		21.1 183.8
20	122.4	93.7	573.5		21.1 129.0
15	78.1	93.7	365.9		21.1 82.3
10	46.1	93.7	216.0		21.1 48.6
5	25.1	93.7	117.6		21.1 26.4
0	12.7	93.7	59.5		21.1 13.4
-5	6.2	93.7	29.1		21.1 6.5
-6	4.6	93.7	21.6		21.1 4.8
Total Costs			\$14659.1		\$3296.2
-----UNOCCUPIED PERIOD-----					
90	14.6	93.7	68.4		21.1 15.4
85	36.3	93.7	170.1		21.1 38.2
80	99.3	93.7	465.3		21.1 104.6
75	215.3	93.7	1008.8		21.1 226.8
70	357.6	93.7	1675.5		21.1 376.8
65	463.3	93.7	2170.8		21.1 488.1
60	500.4	93.7	2344.6		21.1 527.2
55	482.0	93.7	2258.4		21.1 507.8
50	447.6	93.7	2097.2		21.1 471.6
45	422.7	93.7	1980.6		21.1 445.3
40	413.7	93.7	1938.4		21.1 435.9
35	417.0	93.7	1953.9		21.1 439.3
30	417.4	93.7	1955.7		21.1 439.8
25	395.2	93.7	1851.7		21.1 416.4
20	336.9	93.7	1578.5		21.1 354.9
15	252.8	93.7	1184.5		21.1 266.3
10	165.7	93.7	776.4		21.1 174.6
5	96.3	93.7	451.2		21.1 101.5
0	50.9	93.7	238.5		21.1 53.6
-5	25.3	93.7	118.5		21.1 26.7
-6	21.1	93.7	98.9		21.1 22.2
Total Costs			\$26386.0		\$5933.0

COOLING COIL LOADS

Job : CCF SUBCON 2/4F 1975S SYS
Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-25-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 2/4F 1975S SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 2/4F 1975S SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

FAN OPERATING COSTS

Job : CCF SUBCON 2/4F 1975\$ SYS

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
SYSTEMS LIFE CYCLE COST ANALYSIS
AND PAYBACK CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
LIFE CYCLE COST ANALYSIS
FOR

DESIGN BASIS SYSTEM
DX AC UNITS WITH FREE COOLING AND FOUR STEP HI-EFF. COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F. KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 2/4F DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 598000

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

***** NON-FINANCED CASH DEBITS/CREDITS *****

YEAR AMOUNT
 1986 598000.00

***** FINANCE INSTRUMENTS *****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

***** FUEL COSTS *****

1986 EST. OF FUEL 1 = \$ 62315.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

***** MAINTENANCE COST *****

1986 EST. OF MAINT. = \$ 2000.00

***** DISCOUNT/INTEREST/ESCALATION RATES *****

YEAR	%	FINANCE %		ESCALATION %			
		DISC.	LOAN1	LOAN2	FUEL1	FUEL2	FUEL3
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

***** UNIFIED PRESENT WORTH LIFE CYCLE COST *****

PROJECT NAME : CCF SUBCON 2/4F DESIGN SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : 598000

YEAR		1986	1987	1988	1989	1990
CASH	\$	598000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	62893.86	63418.47	63947.45
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	598000.00	0.00	64934.86	65480.25	66030.26
CUM.	\$	598000.00	598000.00	662934.88	728415.12	794445.38

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	64480.84	65018.68	65561.01	66107.86	66659.27
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	66584.88	67144.18	67708.17	68276.91	68850.44
CUM.	\$	861030.25	928174.44	995882.62	1064159.50	1133010.00

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	67215.28	67775.93	68341.26	68911.30	69486.09
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	69428.79	70012.01	70600.13	71193.20	71791.25
CUM.	\$	1202438.75	1272450.75	1343050.88	1414244.12	1486035.38

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	70065.69	70650.11	71239.41	71833.62	72432.79
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$	72394.34	73002.51	73615.78	74234.23	74857.87
CUM.	\$	1558429.75	1631432.25	1705048.00	1779282.25	1854140.12

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	73036.96	73646.16	74260.45	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$	75486.76	76120.95	76760.47	0.00	0.00
CUM.	\$	1929626.88	2005747.88	2082508.38	2082508.38	2082508.38

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
LIFE CYCLE COST ANALYSIS
FOR

ALTERNATE SYSTEM NUMBER 1
DX AC UNITS WITH HI-EFFICIENCY COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 2/4F STDAC SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 564000

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 564000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 103594.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 2/4F STDAC SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : 564000

YEAR		1986	1987	1988	1989	1990
CASH	\$	564000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	104556.31	105428.43	106307.82
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	564000.00	0.00	106597.31	107490.23	108390.63
CUM.	\$	564000.00	564000.00	670597.31	778087.56	886478.19

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	107194.56	108088.67	108990.26	109899.35	110816.03
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	109298.60	110214.17	111137.42	112068.41	113007.20
CUM.	\$	995776.81	1105991.00	1217128.38	1329196.75	1442204.00

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	111740.36	112672.40	113612.20	114559.86	115515.41
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	113953.87	114908.47	115871.08	116841.76	117820.58
CUM.	\$	1556157.88	1671066.38	1786937.50	1903779.25	2021599.88

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	116478.95	117450.50	118430.16	119418.00	120414.07
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$	118807.60	119802.91	120806.55	121818.61	122839.15
CUM.	\$	2140407.50	2260210.50	2381017.00	2502835.50	2625674.80

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	121418.46	122431.23	123452.44	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$	123868.27	124906.00	125952.44	0.00	0.00
CUM.	\$	2749543.00	2874449.00	3000401.50	3000401.50	3000401.50

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 2
FY1975 DX AC UNITS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 2/4F 1975B SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 535000

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 535000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 127334.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
	DISC.	LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 2/4F 1975S SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : 535000

YEAR		1986	1987	1988	1989	1990
CASH	\$	535000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	128516.85	129588.82	130669.73
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	535000.00	0.00	130557.84	131650.61	132752.55
CUM.	\$	535000.00	535000.00	665557.88	797208.50	929961.06

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	131759.67	132858.69	133966.88	135084.31	136211.05
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	133863.72	134984.19	136114.05	137253.36	138402.22
CUM.	\$	1063824.75	1198809.00	1334923.00	1472176.38	1610578.62

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	137347.19	138492.81	139648.00	140812.81	141987.33
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	139560.69	140728.88	141906.88	143094.70	144292.50
CUM.	\$	1750139.25	1890868.12	2032775.00	2175869.80	2320162.20

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	143171.67	144365.88	145570.03	146784.25	148008.58
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR'S	\$	145500.33	146718.28	147946.41	149184.86	150433.66
CUM.	\$	2465662.50	2612380.80	2760327.20	2909512.00	3059945.80

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	149243.13	150487.98	151743.20	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR'S	\$	151692.94	152962.75	154243.22	0.00	0.00
CUM.	\$	3211638.80	3364601.50	3518844.80	3518844.80	3518844.80

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
LIFE CYCLE COST ANALYSIS
UNIFIED PRESENT WORTH COMPARISONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC9.DAT
 PROJECT : CCF SUBCON 2/4F DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 598000

FILE NO. : LCC10.DAT
 PROJECT : CCF SUBCON 2/4F STDAC SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 564000

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	598000.00	564000.00	34000.00	34000.00
1987	0.00	0.00	0.00	34000.00
1988	64934.86	106597.30	-41662.44	-7662.44
1989	65480.25	107490.20	-42009.95	-49672.39
1990	66030.26	108390.60	-42360.34	-92032.74
1991	66584.88	109298.60	-42713.72	-134746.47
1992	67144.18	110214.20	-43070.02	-177816.50
1993	67708.17	111137.40	-43429.23	-221245.73
1994	68276.91	112068.40	-43791.49	-265037.22
1995	68850.44	113007.20	-44156.77	-309194.00
1996	69428.79	113953.90	-44525.11	-353719.12
1997	70012.01	114908.50	-44896.49	-398615.62
1998	70600.13	115871.10	-45270.97	-443886.59
1999	71193.20	116841.80	-45648.59	-489535.19
2000	71791.25	117820.60	-46029.35	-535564.56
2001	72394.34	118807.60	-46413.26	-581977.88
2002	73002.51	119802.90	-46800.39	-628778.25
2003	73615.78	120806.50	-47190.72	-675969.00
2004	74234.23	121818.60	-47584.38	-723553.38
2005	74857.87	122839.10	-47981.23	-771534.62
2006	75486.76	123868.30	-48381.54	-819916.19
2007	76120.95	124906.00	-48785.05	-868701.25
2008	76760.47	125952.40	-49191.93	-917893.12

*** APPARENT BREAK-EVEN YEAR = 1988 ***

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC9.DAT
PROJECT : CCF SUBCON 2/4F DESIGN SYS
ANALYST : S.F.KRSTULOVICH
COMMENTS : 598000

FILE NO. : LCC11.DAT
PROJECT : CCF SUBCON 2/4F 1975S SYS
ANALYST : S.F.KRSTULOVICH
COMMENTS : 535000

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	598000.00	535000.00	63000.00	63000.00
1987	0.00	0.00	0.00	63000.00
1988	64934.86	130557.80	-65622.94	-2622.94
1989	65480.25	131650.59	-66170.34	-68793.28
1990	66030.26	132752.50	-66722.24	-135515.53
1991	66584.88	133863.70	-67278.82	-202794.38
1992	67144.18	134984.20	-67840.02	-270634.38
1993	67708.17	136114.00	-68405.83	-339040.19
1994	68276.91	137253.41	-68976.50	-408016.69
1995	68850.44	138402.20	-69551.77	-477568.44
1996	69428.79	139560.70	-70131.91	-547700.31
1997	70012.01	140728.91	-70716.90	-618417.25
1998	70600.13	141906.91	-71306.77	-689724.00
1999	71193.20	143094.70	-71901.50	-761625.50
2000	71791.25	144292.50	-72501.25	-834126.75
2001	72394.34	145500.30	-73105.95	-907232.75
2002	73002.51	146718.30	-73715.79	-980948.50
2003	73615.78	147946.41	-74330.63	-1055279.12
2004	74234.23	149184.91	-74950.68	-1130229.75
2005	74857.87	150433.70	-75575.84	-1205805.62
2006	75486.76	151692.91	-76206.15	-1282011.75
2007	76120.95	152962.80	-76841.84	-1358853.50
2008	76760.47	154243.20	-77482.73	-1436336.25

*** APPARENT BREAK-EVEN YEAR = 1988 ***

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
SIMPLE PAYBACK CALCULATIONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

CCF SUBCONSTRUCT 2/4F
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	STD AC SYS
INITIAL TOTAL COST	\$ 598,000	\$ 564,000
ANNUAL OPERATING COST	\$ 62,315	\$ 103,594
ANNUAL MAINTENANCE COST	\$ 4,000	\$ 4,000
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

YEAR	DESIGN SYS EXPENSES		STD AC SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 598,000	\$ 598,000	\$ 564,000	\$ 564,000

1	\$ 66,315	\$ 664,315	\$ 107,594	\$ 671,594
2	\$ 66,315	\$ 730,630	\$ 107,594	\$ 779,188
3	\$ 66,315	\$ 796,945	\$ 107,594	\$ 886,782
4	\$ 66,315	\$ 863,260	\$ 107,594	\$ 994,376
5	\$ 66,315	\$ 929,575	\$ 107,594	\$1,101,970
6	\$ 66,315	\$ 995,890	\$ 107,594	\$1,209,564
7	\$ 66,315	\$1,062,205	\$ 107,594	\$1,317,158
8	\$ 66,315	\$1,128,520	\$ 107,594	\$1,424,752
9	\$ 66,315	\$1,194,835	\$ 107,594	\$1,532,346
10	\$ 66,315	\$1,261,150	\$ 107,594	\$1,639,940
11	\$ 66,315	\$1,327,465	\$ 107,594	\$1,747,534
12	\$ 66,315	\$1,393,780	\$ 107,594	\$1,855,128
13	\$ 66,315	\$1,460,095	\$ 107,594	\$1,962,722
14	\$ 66,315	\$1,526,410	\$ 107,594	\$2,070,316
15	\$ 66,315	\$1,592,725	\$ 107,594	\$2,177,910
16	\$ 66,315	\$1,659,040	\$ 107,594	\$2,285,504
17	\$ 66,315	\$1,725,355	\$ 107,594	\$2,393,098
18	\$ 66,315	\$1,791,670	\$ 107,594	\$2,500,692
19	\$ 66,315	\$1,857,985	\$ 107,594	\$2,608,286
20	\$ 66,315	\$1,924,300	\$ 107,594	\$2,715,880
SALVAGE (\$	0)	\$1,924,300	(\$ 0)	\$2,715,880

PAYBACK FOR DESIGN SYS OCCURS AFTER 0.8 YEARS (\$ 652,621)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$1,924,300
TOTAL COST OF STD AC SYS FOR 20 YEARS IS \$2,715,880

CCF SUBCONSTRUCT 2/4F
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	1975S SYS
INITIAL TOTAL COST	\$ 598,000	\$ 535,000
ANNUAL OPERATING COST	\$ 62,315	\$ 127,334
ANNUAL MAINTENANCE COST	\$ 4,000	\$ 4,000
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

YEAR	DESIGN SYS EXPENSES		1975S SYS EXPENSES		
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE	
INITIAL	\$ 598,000	\$ 598,000	\$ 535,000	\$ 535,000	

1	\$ 66,315	\$ 664,315	\$ 131,334	\$ 666,334	
2	\$ 66,315	\$ 730,630	\$ 131,334	\$ 797,668	
3	\$ 66,315	\$ 796,945	\$ 131,334	\$ 929,002	
4	\$ 66,315	\$ 863,260	\$ 131,334	\$1,060,336	
5	\$ 66,315	\$ 929,575	\$ 131,334	\$1,191,670	
6	\$ 66,315	\$ 995,890	\$ 131,334	\$1,323,004	
7	\$ 66,315	\$1,062,205	\$ 131,334	\$1,454,338	
8	\$ 66,315	\$1,128,520	\$ 131,334	\$1,585,672	
9	\$ 66,315	\$1,194,835	\$ 131,334	\$1,717,006	
10	\$ 66,315	\$1,261,150	\$ 131,334	\$1,848,340	
11	\$ 66,315	\$1,327,465	\$ 131,334	\$1,979,674	
12	\$ 66,315	\$1,393,780	\$ 131,334	\$2,111,008	
13	\$ 66,315	\$1,460,095	\$ 131,334	\$2,242,342	
14	\$ 66,315	\$1,526,410	\$ 131,334	\$2,373,676	
15	\$ 66,315	\$1,592,725	\$ 131,334	\$2,505,010	
16	\$ 66,315	\$1,659,040	\$ 131,334	\$2,636,344	
17	\$ 66,315	\$1,725,355	\$ 131,334	\$2,767,678	
18	\$ 66,315	\$1,791,670	\$ 131,334	\$2,899,012	
19	\$ 66,315	\$1,857,985	\$ 131,334	\$3,030,346	
20	\$ 66,315	\$1,924,300	\$ 131,334	\$3,161,680	
SALVAGE (\$	0)	\$1,924,300	(\$	0)	\$3,161,680

PAYBACK FOR DESIGN SYS OCCURS AFTER 1.0 YEARS (\$ 662,256)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$1,924,300

TOTAL COST OF 1975S SYS FOR 20 YEARS IS \$3,161,680

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 2/4 FUTURE
DX AC UNITS OPERATIONAL DATA

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

TYPICAL OPERATING EFFICIENCIES FOR COMPUTER ROOM AIR CONDITIONERS
(DX SYSTEMS MANDATORY TO ATTAIN 42F DEWPOINT FOR 68F DB AT 45% RH)

TYPICAL STATE-OF-THE-ART UNITS WITH COMPRESSOR UNLOADERS AND A-COIL
COMPRESSOR PERFORMANCE PROFILE

4 STEPS FULL LOADED:	0.76KW/TON	100% CAPACITY
FIRST STEP UNLOADED:	0.67KW/TON	88% CAPACITY
SECOND STEP UNLOADED:	0.54KW/TON	76% CAPACITY
THIRD STEP UNLOADED:	0.57KW/TON	38% CAPACITY

FAN PERFORMANCE PROFILE

STATIC PRESSURE DROP WITH A-COIL CONFIGURATION: 2.50 INCHES WC

TYPICAL STATE-OF-THE-ART UNITS W/ STANDARD HI EFFICIENCY COMPRESSORS AND A-COIL
COMPRESSOR PERFORMANCE PROFILE

COMPRESSORS LOADED: 0.76KW/TON 100% capacity

FAN PERFORMANCE PROFILE

STATIC PRESSURE DROP WITH A-COIL CONFIGURATION: 2.50 INCHES WC

TYPICAL 1975 STYLE UNITS WITH STANDARD COMPRESSORS AND SLAB-COIL
COMPRESSOR PERFORMANCE PROFILE

COMPRESSORS LOADED: 0.95KW/TON 100% CAPACITY

FAN PERFORMANCE PROFILE

STATIC PRESSURE DROP WITH SLAB-COIL CONFIGURATION: 3.00 INCHES WC

COOLING PLANT INPUT POWER

Job : CCF SUBCON2/4F DESIGN SYS

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-25-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON2/4F DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 2/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-25-86

$$4000 \times .57 = 2280$$

$$11400 \times .54 = 6156$$

$$3700 \times .67 = 2479$$

$$900 \times .76 = 684$$

$$TOTAL = 11599 \div 20000 = \underline{\underline{.58 \text{ KW / TON AVG.}}}$$

TM-1436
Appendices VII & VIII

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 3/4
SYSTEMS ANALYSIS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 3/4
BUILDING SECTOR PHYSICAL PARAMETERS AND DESCRIPTION

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 3/4 Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 90 F; Heating = 65 F; Setback = 0 F
 Warm-up factor = 0 %; Room design relative humidity = 50 %
 Floor Areas: Perimeter = 8,250 Sqft; Interior = 0 Sqft
 No cooling during unoccupied period. (Pulldown cycle not considered)

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	780	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	1,630	0.060	690	0.550
Southeast Wall	3,260	0.060	1,380	0.550
South Wall	3,260	0.060	1,380	0.550
Southwest Wall	3,260	0.060	1,380	0.550
West Wall	0	0.060	0	0.550
Northwest Wall	0	0.060	660	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium
 BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed
 Shade Factors : Glass = 0.650 ; Skylights = 0.000
 Internal shades are used. ; A ceiling plenum is not used.

3. LIGHTS:

Perimeter : 2.000 Watts/Sqft = 16,500 Watts Total
 Interior : 0.000 Watts/Sqft = 0 Watts Total
 Diversity Factors : Occupied = 100 %; Unoccupied = 100 %
 Perimeter Lights : Ballast , exposed
 Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = 3.273 Watts/Sqft = 27,000 Watts Total
 Unoccupied = 3.273 Watts/Sqft = 27,000 Watts Total
 Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total
 Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 8,250 sqft/person = 1 people total
 Activity Level: 2. Office or retail
 Sensible = 245.0 BTU/hr/person; Latent = 205.0 BTU/hr/person
 Diversity Factors : Occupied = 100 %; Unoccupied = 0 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr
 Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 0 Sqft; Interior = 0 Sqft
 Wall U-Factor = 0.000 BTU/(hr-sqft-F)
 Adjacent region is not heated
 Adjacent region is not cooled

VII-1

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 413 cfm; Unoccupied = 165 cfm

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 3/4
BUILDING LOAD CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

LOAD PROFILE SUMMARY

Building Name : CCF SUBCONSTRUCT 3/4 (Complex)

Date : 11-26-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD (Load does not include vent. load, fan heat)

Bin	Bin	<-----Perimeter Zone----->			<-----Interior Zone----->				
Temp	Hours	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum	Zone
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(tons)	(F)
93	0.0	35.09	-0.01	0.00	90	0.00	0.00	0.00	---
90	25.8	27.92	-0.49	0.00	90	0.00	0.00	0.00	---
85	59.4	25.32	-0.65	0.00	90	0.00	0.00	0.00	---
80	145.3	22.72	-0.79	0.00	90	0.00	0.00	0.00	---
75	237.7	20.13	-0.91	0.00	90	0.00	0.00	0.00	---
70	270.6	17.53	-1.01	0.00	90	0.00	0.00	0.00	---
65	264.5	14.93	-1.10	0.00	90	0.00	0.00	0.00	---
60	255.0	12.34	-1.17	0.00	90	0.00	0.00	0.00	---
55	244.7	9.74	-1.23	0.00	90	0.00	0.00	0.00	---
50	232.1	7.14	-1.28	0.00	90	0.00	0.00	0.00	---
45	229.5	4.54	-1.50	0.00	90	0.00	0.00	0.00	---
40	237.6	1.95	-1.68	0.00	90	0.00	0.00	0.00	---
35	238.5	0.00	0.00	0.00	---	0.00	0.00	0.00	---
30	218.2	0.00	0.00	0.00	---	0.00	0.00	0.00	---
25	174.5	0.00	0.00	0.00	---	0.00	0.00	0.00	---
20	122.4	0.00	0.00	0.00	---	0.00	0.00	0.00	---
15	78.1	-1.48	-0.79	0.00	65	0.00	0.00	0.00	---
10	46.1	-4.08	-0.85	0.00	65	0.00	0.00	0.00	---
5	25.1	-6.68	-0.90	0.00	65	0.00	0.00	0.00	---
0	12.7	-9.27	-0.94	0.00	65	0.00	0.00	0.00	---
-5	6.2	-11.87	-0.97	0.00	65	0.00	0.00	0.00	---
-6	4.6	-12.39	-0.98	0.00	65	0.00	0.00	0.00	---

TABLE 2. UNOCCUPIED PERIOD (Load does not include vent. load, fan heat)

90	14.6	0.00	0.00	0.00	---	0.00	0.00	0.00	---
85	36.3	0.00	0.00	0.00	---	0.00	0.00	0.00	---
80	99.3	0.00	0.00	0.00	---	0.00	0.00	0.00	---
75	215.3	0.00	0.00	0.00	---	0.00	0.00	0.00	---
70	357.6	0.00	0.00	0.00	---	0.00	0.00	0.00	---
65	463.3	0.00	0.00	0.00	---	0.00	0.00	0.00	---
60	500.4	0.00	0.00	0.00	---	0.00	0.00	0.00	---
55	482.0	0.00	0.00	0.00	---	0.00	0.00	0.00	---
50	447.6	0.00	0.00	0.00	---	0.00	0.00	0.00	---
45	422.7	0.00	0.00	0.00	---	0.00	0.00	0.00	---
40	413.7	0.00	0.00	0.00	---	0.00	0.00	0.00	---
35	417.0	0.00	0.00	0.00	---	0.00	0.00	0.00	---
30	417.4	0.00	0.00	0.00	---	0.00	0.00	0.00	---
25	395.2	0.00	0.00	0.00	---	0.00	0.00	0.00	---
20	336.9	0.00	0.00	0.00	---	0.00	0.00	0.00	---
15	252.8	-0.37	-0.32	0.00	65	0.00	0.00	0.00	---
10	165.7	-2.85	-0.35	0.00	65	0.00	0.00	0.00	---
5	96.3	-5.34	-0.37	0.00	65	0.00	0.00	0.00	---
0	50.9	-7.82	-0.38	0.00	65	0.00	0.00	0.00	---
-5	25.3	-10.30	-0.40	0.00	65	0.00	0.00	0.00	---
-6	21.1	-10.80	-0.40	0.00	65	0.00	0.00	0.00	---
-6	0.0	-25.53	-0.40	0.00	65	0.00	0.00	0.00	---

SOLAR GAIN SUMMARY

Building Name : CCF SUBCONSTRUCT 3/4 (Complex)

Date : 11-26-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. SOLAR GAINS BY EXPOSURE

Bin Temp (F)	Solar Gains by Exposure (BTU/(hr-sqft))								Perim Horiz	Inter Horiz
	North	NE	East	SE	South	SW	West	NW		
93	10.9	17.9	25.9	27.1	37.4	74.5	75.2	37.6	0.0	0.0
90	7.7	12.6	18.3	19.2	26.5	52.8	53.3	26.6	0.0	0.0
85	7.3	12.0	17.4	18.3	25.3	50.2	50.6	25.3	0.0	0.0
80	6.9	11.3	16.5	17.4	24.0	47.6	47.9	23.9	0.0	0.0
75	6.5	10.7	15.6	16.5	22.8	45.0	45.2	22.5	0.0	0.0
70	6.1	10.0	14.7	15.5	21.5	42.4	42.5	21.1	0.0	0.0
65	5.7	9.4	13.8	14.6	20.3	39.8	39.8	19.7	0.0	0.0
60	5.4	8.7	12.8	13.7	19.0	37.2	37.1	18.4	0.0	0.0
55	5.0	8.1	11.9	12.8	17.8	34.6	34.5	17.0	0.0	0.0
50	4.6	7.4	11.0	11.9	16.5	32.0	31.8	15.6	0.0	0.0
45	4.2	6.8	10.1	11.0	15.3	29.4	29.1	14.2	0.0	0.0
40	3.8	6.1	9.2	10.0	14.1	26.7	26.4	12.9	0.0	0.0
35	3.4	5.5	8.3	9.1	12.8	24.1	23.7	11.5	0.0	0.0
30	3.0	4.8	7.3	8.2	11.6	21.5	21.0	10.1	0.0	0.0
25	2.6	4.1	6.4	7.3	10.3	18.9	18.4	8.7	0.0	0.0
20	2.2	3.5	5.5	6.4	9.1	16.3	15.7	7.3	0.0	0.0
15	1.8	2.8	4.6	5.4	7.8	13.7	13.0	6.0	0.0	0.0
10	1.4	2.2	3.7	4.5	6.6	11.1	10.3	4.6	0.0	0.0
5	1.0	1.5	2.8	3.6	5.3	8.5	7.6	3.2	0.0	0.0
0	0.6	0.9	1.8	2.7	4.1	5.9	4.9	1.8	0.0	0.0
-5	0.2	0.2	0.9	1.8	2.8	3.3	2.2	0.5	0.0	0.0
-6	0.1	0.1	0.7	1.6	2.6	2.8	1.7	0.2	0.0	0.0
-6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ETD SUMMARY

Building Name : CCF SUBCONSTRUCT 3/4 (Complex)

Date : 11-26-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD

Bin Temp (F)	Equivalent Temperature Differences (F)								Perim Roof	Inter Roof
	North	NE	East	SE	By Exposure		West	NW		
					South	SW				
93	-4.0	-2.1	-0.8	4.5	8.0	6.5	3.0	-2.7	18.4	-----
90	-6.6	-5.3	-4.4	-0.6	1.9	0.8	-1.7	-5.7	9.7	-----
85	-11.0	-9.8	-8.9	-5.3	-2.9	-3.9	-6.3	-10.2	4.4	-----
80	-15.4	-14.2	-13.4	-9.9	-7.8	-8.6	-10.9	-14.6	-0.9	-----
75	-19.8	-18.7	-17.9	-14.6	-12.6	-13.4	-15.6	-19.1	-6.2	-----
70	-24.2	-23.2	-22.4	-19.3	-17.4	-18.1	-20.2	-23.5	-11.5	-----
65	-28.6	-27.6	-26.9	-23.9	-22.2	-22.8	-24.8	-27.9	-16.9	-----
60	-33.0	-32.1	-31.4	-28.6	-27.0	-27.5	-29.5	-32.4	-22.2	-----
55	-37.4	-36.5	-35.9	-33.3	-31.8	-32.3	-34.1	-36.8	-27.5	-----
50	-41.8	-41.0	-40.4	-37.9	-36.6	-37.0	-38.7	-41.3	-32.8	-----
45	-46.2	-45.5	-44.9	-42.6	-41.4	-41.7	-43.4	-45.7	-38.1	-----
40	-50.6	-49.9	-49.4	-47.3	-46.2	-46.4	-48.0	-50.1	-43.4	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
30	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
25	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
15	-47.5	-47.2	-47.0	-45.6	-45.3	-45.1	-46.2	-47.3	-44.9	-----
10	-51.9	-51.7	-51.5	-50.3	-50.1	-49.8	-50.8	-51.8	-50.2	-----
5	-56.3	-56.2	-56.0	-54.9	-54.9	-54.5	-55.4	-56.2	-55.6	-----
0	-60.7	-60.6	-60.5	-59.6	-59.7	-59.3	-60.1	-60.7	-60.9	-----
-5	-65.1	-65.1	-65.0	-64.3	-64.5	-64.0	-64.7	-65.1	-66.2	-----
-6	-66.0	-66.0	-65.9	-65.2	-65.5	-64.9	-65.6	-66.0	-67.2	-----

TABLE 2. UNOCCUPIED PERIOD

90	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
85	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
80	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
75	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
70	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
65	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
60	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
55	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
50	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
45	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
40	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
30	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
25	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
20	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
15	-47.5	-47.2	-47.0	-45.6	-45.3	-45.1	-46.2	-47.3	-44.9	-----	-----
10	-51.9	-51.7	-51.5	-50.3	-50.1	-49.8	-50.8	-51.8	-50.2	-----	-----
5	-56.3	-56.2	-56.0	-54.9	-54.9	-54.5	-55.4	-56.2	-55.6	-----	-----
0	-60.7	-60.6	-60.5	-59.6	-59.7	-59.3	-60.1	-60.7	-60.9	-----	-----
-5	-65.1	-65.1	-65.0	-64.3	-64.5	-64.0	-64.7	-65.1	-66.2	-----	-----
-6	-66.0	-66.0	-65.9	-65.2	-65.5	-64.9	-65.6	-66.0	-67.2	-----	-----
-6	-71.0	-71.0	-71.0	-71.0	-71.0	-71.0	-71.0	-71.0	-71.0	-----	-----

SUBJECT

SUBCON 3/4 - Misc. Equip. Heat Loads

NAME

S.F. KRSTULOVICH

DATE

11.12.86

REVISION DATE

MINIMUM EQUIP. WASTE HEAT LOADS:

1. 100 TON CHILLER $(100 \text{ TN} \times .85 \text{ kW/TN} \times 0.175 \text{ EFF.}) = 15 \text{ kW}$
2. RW PUMP $(30 \text{ HP} \times .20 \text{ EFF} \times .746) = 4.5 \text{ kW}$
3. CW PUMP $(30 \text{ HP} \times .20 \text{ EFF} \times .746) = 4.5 \text{ kW}$
4. CHW PUMP $(20 \text{ HP} \times .20 \text{ EFF} \times .746) = 3.0 \text{ kW}$

TOTAL = 27 kW

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 3/4
SYSTEM COMPARISON PERFORMANCE SIMULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 3/4
OPERATIONAL PERFORMANCE SIMULATION

DESIGN BASIS SYSTEM
ELECTRIC UNIT HEATERS AND UTILITIES

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 3/4 DESIGN SYS Page 1
Building Name : CCF SUBCONSTRUCT 3/4 (Complex) Date : 11-26-86
Site : AURORA,IL FERMI, User Defined 60117862.0
Scope of Analysis : Heating Systems Only

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Forward curved

Supply fan total static pressure = 0.10 in. wg.

A return fan is not used.

Design supply air= 8000 cfm @ 42 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 3/4 DESIGN SYS Page 2
 Building Name : CCF SUBCONSTRUCT 3/4 (Complex) Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Heating Systems Only

C. COOLING PLANTS

Cooling system does not exist

D. PUMPING SYSTEMS

System	PERIMETER		dP, ft wg	dP, ft wg
	dT, F	dT, F		
Chilled water	10.00	60.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	0.00	60.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 16.5 kw; Unoccupied = 16.5 kw
 Misc. kw : Occupied = 27.0 kw; Unoccupied = 27.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	n/a \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 3/4 DESIGN SYS

Period : All

Building Name : CCF SUBCONSTRUCT 3/4 (Complex)

Zone : Block

Site : AURORA,IL FERMI, User Defined

Serial Number:

Date : 11-26-86

60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	127	2531 kwh/yr	29357	8638
Electric (Unocc)	346	6913 kwh/yr	80190	23594
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	472		109547	32231

NON-HVAC ENERGY

Electric (Occ)	6805	136094 kwh/yr	1578692	464489
Electric (Unocc)	12248	244966 kwh/yr	2841604	836069
Non-HVAC Total	19053		4420296	1300558
Grand Total	19525		4529843	1332789
Total/Sq.Ft.	2.37		549.07	161.55

HVAC Summary:

HVAC Total Cost	=	0.06 \$/Sq.Ft./yr
Total HVAC Electrical Energy	=	2.42 % of Total Cost
Non-Electrical HVAC Energy	=	1.14 kwh/Sq.Ft./yr
	=	2.42 % of Total Electrical Energy
	=	0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 3/4 DESIGN SYS

Page 1

Building Name : CCF SUBCONSTRUCT 3/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Heating Systems Only

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$7)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Forward curved

Supply fan total static pressure = 0.10 in. wg.

A return fan is not used.

Design supply air= 8000 cfm @ 42 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <Y>

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$465)

> 1 . PERIMETER PLANT : ELECTRICAL RESISTANCE

Is hydronic heating used ? <N>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 3/4 DESIGN SYS

Page 2

Building Name : CCF SUBCONSTRUCT 3/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Heating Systems Only

 C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$0)

Cooling system does not exist

 D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$0)

System	PERIMETER		dT, F	dP, ft wg	dT, F	dP, ft wg
	dT, F	dP, ft wg				
Chilled water	10.00	60.00	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00	0.00	0.00
Condenser water	0.00	60.00	0.00	0.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00	0.00	0.00

 E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$19,053)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 16.5 kw; Unoccupied = 16.5 kw

Misc. kw : Occupied = 27.0 kw; Unoccupied = 27.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

 F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$19,525)

>1. Period			>2. OTHER FUELS		Unit Cost
ELECTRICAL ENERGY USE	Occupied (\$/kwh)	Unoccupied (\$/kwh)			
Compressor	0.050	0.050	Natural Gas		n/a \$/therm
Resistance	0.050	0.050	Fuel Oil		n/a \$/U.S.gal
Inductive	0.050	0.050	Propane		n/a \$/lb
			Remote Heating		n/a \$/MBTU
			Remote Cooling		n/a \$/MBTU

PERIMETER HEATING PLANT COSTS

Job Name : CCF SUBCON 3/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 3/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Coil	Primary Plant			No Auxiliary Plant Used
Temp	Hours	Load	Output	Input	Cost	
(F)	hr/yr	MBH	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----						
90	25.8	0.0	0.0	0.0	0.0	
85	59.4	0.0	0.0	0.0	0.0	
80	145.3	0.0	0.0	0.0	0.0	
75	237.7	0.0	0.0	0.0	0.0	
70	270.6	0.0	0.0	0.0	0.0	
65	264.5	0.0	0.0	0.0	0.0	
60	255.0	0.0	0.0	0.0	0.0	
55	244.7	0.0	0.0	0.0	0.0	
50	232.1	0.0	0.0	0.0	0.0	
45	229.5	0.0	0.0	0.0	0.0	
40	237.6	0.0	0.0	0.0	0.0	
35	238.5	0.0	0.0	0.0	0.0	
30	218.2	0.0	0.0	0.0	0.0	
25	174.5	0.0	0.0	0.0	0.0	
20	122.4	0.0	0.0	0.0	0.0	
15	78.1	17.2	17.2	5.0	19.7	
10	46.1	48.4	48.4	14.2	32.7	
5	25.1	79.5	79.5	23.3	29.2	
0	12.7	110.7	110.7	32.4	20.6	
-5	6.2	141.9	141.9	41.6	12.9	
-6	4.6	148.1	148.1	43.4	10.0	
Total Costs					\$125.0	
-----UNOCCUPIED PERIOD-----						
90	14.6	0.0	0.0	0.0	0.0	
85	36.3	0.0	0.0	0.0	0.0	
80	99.3	0.0	0.0	0.0	0.0	
75	215.3	0.0	0.0	0.0	0.0	
70	357.6	0.0	0.0	0.0	0.0	
65	463.3	0.0	0.0	0.0	0.0	
60	500.4	0.0	0.0	0.0	0.0	
55	482.0	0.0	0.0	0.0	0.0	
50	447.6	0.0	0.0	0.0	0.0	
45	422.7	0.0	0.0	0.0	0.0	
40	413.7	0.0	0.0	0.0	0.0	
35	417.0	0.0	0.0	0.0	0.0	
30	417.4	0.0	0.0	0.0	0.0	
25	395.2	0.0	0.0	0.0	0.0	
20	336.9	0.0	0.0	0.0	0.0	
15	252.8	3.8	3.8	1.1	14.2	
10	165.7	33.6	33.6	9.9	81.6	
5	96.3	63.4	63.4	18.6	89.5	
0	50.9	93.2	93.2	27.3	69.5	
-5	25.3	123.0	123.0	36.1	45.6	
-6	21.1	129.0	129.0	37.8	39.9	
Total Costs					\$340.3	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 3/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 3/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	0.0	0.0		0.0
85	59.4	0.0	0.0		0.0
80	145.3	0.0	0.0		0.0
75	237.7	0.0	0.0		0.0
70	270.6	0.0	0.0		0.0
65	264.5	0.0	0.0		0.0
60	255.0	0.0	0.0		0.0
55	244.7	0.0	0.0		0.0
50	232.1	0.0	0.0		0.0
45	229.5	0.0	0.0		0.0
40	237.6	0.0	0.0		0.0
35	238.5	0.0	0.0		0.0
30	218.2	0.0	0.0		0.0
25	174.5	0.0	0.0		0.0
20	122.4	0.0	0.0		0.0
15	78.1	0.2	0.7		0.0
10	46.1	0.2	0.4		0.0
5	25.1	0.2	0.2		0.0
0	12.7	0.2	0.1		0.0
-5	6.2	0.2	0.1		0.0
-6	4.6	0.2	0.0		0.0
Total Costs			\$1.5		\$0.0
UNOCCUPIED PERIOD					
90	14.6	0.0	0.0		0.0
85	36.3	0.0	0.0		0.0
80	99.3	0.0	0.0		0.0
75	215.3	0.0	0.0		0.0
70	357.6	0.0	0.0		0.0
65	463.3	0.0	0.0		0.0
60	500.4	0.0	0.0		0.0
55	482.0	0.0	0.0		0.0
50	447.6	0.0	0.0		0.0
45	422.7	0.0	0.0		0.0
40	413.7	0.0	0.0		0.0
35	417.0	0.0	0.0		0.0
30	417.4	0.0	0.0		0.0
25	395.2	0.0	0.0		0.0
20	336.9	0.0	0.0		0.0
15	252.8	0.2	2.2		0.0
10	165.7	0.2	1.4		0.0
5	96.3	0.2	0.8		0.0
0	50.9	0.2	0.4		0.0
-5	25.3	0.2	0.2		0.0
-6	21.1	0.2	0.2		0.0
Total Costs			\$5.3		\$0.0

PRIMARY HEATING PLANT LOADS

Job : CCF SUBCON 3/4 DESIGN SYS

Building : CCF SUBCONSTRUCT 3/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

PRIMARY HEATING PLANT INPUT POWER

Job : CCF SUBCON 3/4 DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 3/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-26-86

PRIMARY HEATING PLANT OPERATING COSTS

Job : CCF SUBCON 3/4 DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 3/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-26-86

FAN OPERATING COSTS

Job : CCF SUBCON 3/4 DESIGN SYS
 Building : CCF SUBCONSTRUCT 3/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-26-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 3/4
SYSTEMS LIFE CYCLE COST ANALYSIS
AND
PAYBACK CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 3/4
LIFE CYCLE COST ANALYSIS
FOR
DESIGN BASIS SYSTEM
ELECTRIC UNIT HEATERS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 3/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$128300 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 128300.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 472.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 1000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 3/4 DESIGN SYS

ANALYST NAME : S.F.KRSTULOVICH

COMMENTS : \$128300 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	128300.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	476.38	480.36	484.36
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	1020.49	1030.90	1041.41
YEAR'S	\$	128300.00	0.00	1496.88	1511.25	1525.77
CUM.	\$	128300.00	128300.00	129796.88	131308.13	132833.89

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	488.41	492.48	496.59	500.73	504.91
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1052.02	1062.75	1073.58	1084.53	1095.58
YEAR'S	\$	1540.43	1555.23	1570.17	1585.26	1600.49
CUM.	\$	134374.31	135929.55	137499.72	139084.97	140685.45

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	509.12	513.36	517.65	521.96	526.32
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1106.75	1118.04	1129.43	1140.95	1152.58
YEAR'S	\$	1615.87	1631.40	1647.08	1662.91	1678.90
CUM.	\$	142301.33	143932.73	145579.81	147242.72	148921.61

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	530.71	535.13	539.60	544.10	548.64
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1164.33	1176.20	1188.19	1200.30	1212.54
YEAR'S	\$	1695.04	1711.33	1727.79	1744.40	1761.18
CUM.	\$	150616.64	152327.97	154055.75	155800.16	157561.33

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	553.21	557.83	562.48	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1224.90	1237.39	1250.00	0.00	0.00
YEAR'S	\$	1778.11	1795.22	1812.48	0.00	0.00
CUM.	\$	159339.44	161134.66	162947.14	162947.14	162947.14

FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE		QUANTITIES BY JG		PRICES BY JG		CHECKED BY		PROJECT NO. 10-5-3		DATE 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 20/27	
SECTION		CES		DESCRIPTION OF WORK ITEMS		QUANTITY		WN		DISTRIBUTION OF ITEMIZED COST		(1)		(2)		(3)	
ITEM NO.										UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
8.5				AIR HANDLING UNITS		1		EA			3000		25000				
				GEN'L. VENTILATION UNITS		1		EA			2500		25000				
				FAN, AXIAL, SUPPLY, 8000 CFM		1		EA			8000		25000				
				FAN, " EXHAUST, 4000 CFM		1		EA			4000		25000				
				HR. RECOVERY WATER		2		EA			1500		25000				
				FACE HTG. COIL		2		EA			2500		25000				
				HUMIDIFIER		2		EA			2500		25000				
				FILTER SET (REEFLE)		2		EA			200		2000				
				EXCH. BRISBAND, ATLAS 750 UNIT		2		EA			5000		25000				
				COMPUTER KN. VENT. UNITS		1		EA			5000		25000				
				FANS AXIAL, S.E. 4000 CFM		1		EA			1000		25000				
				HR. RECOVERY WATER		2		EA			2500		25000				
				FACE HTG. COILS		2		EA			2500		25000				
				HUMIDIFIER 100 LB.		2		EA			2500		25000				
				WALL PANS (8")		3		EA			2500		25000				
				TOILET EXH. FAN, AXIAL, 4000 CFM		1		EA			2500		25000				
				WALL EXH. FANS, 11000 CFM		2		EA			600		2400				
				WALL LOUVERS, 42x42		3		EA			2400		2400				
				UNIT HEATERS 25 KW		2		EA			4000		4000				
				UNIT HEATERS 5 KW		10		EA			44000		44000				
8.6				HEAT PUMP UNITS		6		EA			1200		7200				
				1 1/2 TON		9		EA			1400		12600				
				2 TON		21		EA			1500		31500				
				3 TON		24		EA			1800		43200				
				5 TON		13		EA			3500		45500				

VII-21

FERMILAB COST ESTIMATE			PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE			PROJECT NO. 10-5-3		DATE 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 21/27	
SECTION	CES	QUANTITIES BY JG	PRICES BY JG	CHECKED BY	WIN	DISTRIBUTION OF ITEMIZED COST							
						(1)		(2)		(3)			
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT			UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT		
8.7	TOILET EXH. DUCTWORK 12x12x200'	1200	LB			3.50	4200		UNLINED				
	GRILLES 12x12	14	EA			25	300						
	FIRE DAMPERS 12x12	4	EA			25	100						
	CARP. ROOF DUCTWORK 16x16x400'	3600	LB			3.50	11900		INTERN. LINED				
	LICHAUT UNIT DUCT ELBOWS	12	EA			500	6000						
	Flex Duct 12" d	70	L.F.			500	400						
	Duct Insul. 1"	2200	S.F.			1.75	3900						
	FIRE DAMPERS	7	EA			25	100						
	GRILLES	12	EA			25	300						
	GENI. VENT. DUCTS, 16x16x250'	2200	LB			3.50	7700						
	" 8x12x600'	3300	LB			3.50	11600		1300				
	" 96x8x250'	3000	LB			3.50	10500		2000				
	INSULATED Duct 1"	4300	S.F.			1.75	7500						
	Flex. Duct 6" d	400	L.F.			400	1600						
	DAMPERS 6" d	78	EA			15	1200						
	VOLUME DAMPERS, 16x16x1200	60	EA			150	600						
	FIRE DAMPERS, 16x16x1200	8	EA			200	1600						
	HANT PUMP DUCTWORK	13	EA						7300				
	RETURN PLUMB 24x24	400	EA			100	4000						
	OUTLET DUCTS 16x16x850'	8300	LB			3.50	29050		29100	600			
	Flex Duct 12" d	1800	L.F.			500	9000						
	Duct Insul. 1"	5000	S.F.			1.75	8750		8800				
	GRILLES	200	EA			25	5000		7500				
	FIRE DAMPERS	21	EA			25	525		500	125400			
	FIRE SMOKE DAMPERS	14	EA			500	7000						

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FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2		PROJECT NO. DATE 10-5-3 10 SEPT, 86		REVISION DATE 16 SEPT, 86		PAGE 22/27	
SECTION	CES	QUANTITIES BY JG	PRICES BY JG	CHECKED BY WN	DISTRIBUTION OF ITEMIZED COST				
					(1)		(2)		(3)
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
8.8	NEW PIPING	100							
	8" SCHED. 10 VICTORIC	30	L.F.	38	1900	38	3800		
	6" d "	200	L.F.	28	5000	28			
	2" d "	60	L.F.	10	1000	10			
	VALVES, 8" BUTT. FLY	10	EA	40	4500	40			
	" 6" "	10	EA	350	3500	350			
	" 2 1/2" "	8	EA	250	2000	250			
	" 2" BALL	10	EA	40	400	40			
	" 8 PRESS. ROD.	1	EA		2500				
	ACCESSORIES	100			5000				
	INSULATION 8" PIPE	1000	L.F.	800	400	800	800		
	" 6" "	200	L.F.	600	1200	600			
	CHW PIPING, SCHED. 10 VICT. 4" d	100	L.F.	17	1700	17			
	VALVES, 4" d BUTT.	16	EA	250	4000	250			
	ACCESSORIES & DISC. VALVES	100			3000				
	PIPE INSUL. 4" d	100	L.F.	500	500	500			
	CW PIPING, SCHED. VICT. 6" d	300	L.F.	28	8400	28			
	" " 4" d	300	L.F.	17	5100	17			
	" " 3" d	100	L.F.	14	1400	14			
	" " 1 1/2" d	350	L.F.	800	2800	800			
	VALVES, 6" BUTT.	10	EA	350	3500	350			
	1 1/2" BALL	24	EA	35	800	35			
	ACCESSORIES & DISC. VALVES	100			3000				
	PIPE INSUL. 4" d	700	L.F.	500	3500	500			
	" 1 1/2" d	350	L.F.	300	1100	300			

VII-23

(66,610)

(6,6,400)

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
SYSTEMS ANALYSIS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4

BUILDING SECTOR PHYSICAL PARAMETERS AND DESCRIPTION

12 NOVEMBER, 1986

ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 4/4 Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 85 F; Heating = 85 F; Setback = 0 F
 Warm-up factor = 0 %; Room design relative humidity = 50 %
 Floor Areas: Perimeter = 1 Sqft; Interior = 0 Sqft
 Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	0	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	0	0.060	0	0.550
Southeast Wall	0	0.060	0	0.550
South Wall	0	0.060	0	0.550
Southwest Wall	0	0.060	0	0.550
West Wall	0	0.060	0	0.550
Northwest Wall	0	0.060	0	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium
 BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed
 Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are not used. ; A ceiling plenum is not used.

3. LIGHTS:

Perimeter : 0.000 Watts/Sqft = 0 Watts Total
 Interior : 0.000 Watts/Sqft = 0 Watts Total
 Diversity Factors : Occupied = 0 %; Unoccupied = 0 %
 Perimeter Lights : Ballast , recessed
 Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = %350000.000 Watts/Sqft = 350,000 Watts Total
 Unoccupied = %350000.000 Watts/Sqft = 350,000 Watts Total
 Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total
 Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 0 sqft/person = 0 people total
 Activity Level: 6. User defined activity level
 Sensible = 0.0 BTU/hr/person; Latent = 0.0 BTU/hr/person
 Diversity Factors : Occupied = 0 %; Unoccupied = 0 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr
 Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 0 Sqft; Interior = 0 Sqft
 Wall U-Factor = 0.000 BTU/(hr-sqft-F)
 Adjacent region is not heated
 Adjacent region is not cooled

VIII-1

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 0 cfm; Unoccupied = 0 cfm

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
BUILDING LOAD CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

LOAD PROFILE SUMMARY

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Date : 11-26-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD (Load does not include vent. load, fan heat)

Bin	Bin	<-----Perimeter Zone----->			<-----Interior Zone----->				
Temp	Hours	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum	Zone
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(tons)	(F)
93	0.0	99.55	0.00	0.00	85	0.00	0.00	0.00	--
90	25.8	99.55	0.00	0.00	85	0.00	0.00	0.00	--
85	59.4	99.55	0.00	0.00	85	0.00	0.00	0.00	--
80	145.3	99.55	0.00	0.00	85	0.00	0.00	0.00	--
75	237.7	99.55	0.00	0.00	85	0.00	0.00	0.00	--
70	270.6	99.55	0.00	0.00	85	0.00	0.00	0.00	--
65	264.5	99.55	0.00	0.00	85	0.00	0.00	0.00	--
60	255.0	99.55	0.00	0.00	85	0.00	0.00	0.00	--
55	244.7	99.55	0.00	0.00	85	0.00	0.00	0.00	--
50	232.1	99.55	0.00	0.00	85	0.00	0.00	0.00	--
45	229.5	99.55	0.00	0.00	85	0.00	0.00	0.00	--
40	237.6	99.55	0.00	0.00	85	0.00	0.00	0.00	--
35	238.5	99.55	0.00	0.00	85	0.00	0.00	0.00	--
30	218.2	99.55	0.00	0.00	85	0.00	0.00	0.00	--
25	174.5	99.55	0.00	0.00	85	0.00	0.00	0.00	--
20	122.4	99.55	0.00	0.00	85	0.00	0.00	0.00	--
15	78.1	99.55	0.00	0.00	85	0.00	0.00	0.00	--
10	46.1	99.55	0.00	0.00	85	0.00	0.00	0.00	--
5	25.1	99.55	0.00	0.00	85	0.00	0.00	0.00	--
0	12.7	99.55	0.00	0.00	85	0.00	0.00	0.00	--
-5	6.2	99.55	0.00	0.00	85	0.00	0.00	0.00	--
-6	4.6	99.55	0.00	0.00	85	0.00	0.00	0.00	--

TABLE 2. UNOCCUPIED PERIOD (Load does not include vent. load, fan heat)

90	14.6	99.55	0.00	0.00	85	0.00	0.00	0.00	--
85	36.3	99.55	0.00	0.00	85	0.00	0.00	0.00	--
80	99.3	99.55	0.00	0.00	85	0.00	0.00	0.00	--
75	215.3	99.55	0.00	0.00	85	0.00	0.00	0.00	--
70	357.6	99.55	0.00	0.00	85	0.00	0.00	0.00	--
65	463.3	99.55	0.00	0.00	85	0.00	0.00	0.00	--
60	500.4	99.55	0.00	0.00	85	0.00	0.00	0.00	--
55	482.0	99.55	0.00	0.00	85	0.00	0.00	0.00	--
50	447.6	99.55	0.00	0.00	85	0.00	0.00	0.00	--
45	422.7	99.55	0.00	0.00	85	0.00	0.00	0.00	--
40	413.7	99.55	0.00	0.00	85	0.00	0.00	0.00	--
35	417.0	99.55	0.00	0.00	85	0.00	0.00	0.00	--
30	417.4	99.55	0.00	0.00	85	0.00	0.00	0.00	--
25	395.2	99.55	0.00	0.00	85	0.00	0.00	0.00	--
20	336.9	99.55	0.00	0.00	85	0.00	0.00	0.00	--
15	252.8	99.55	0.00	0.00	85	0.00	0.00	0.00	--
10	165.7	99.55	0.00	0.00	85	0.00	0.00	0.00	--
5	96.3	99.55	0.00	0.00	85	0.00	0.00	0.00	--
0	50.9	99.55	0.00	0.00	85	0.00	0.00	0.00	--
-5	25.3	99.55	0.00	0.00	85	0.00	0.00	0.00	--
-6	21.1	99.55	0.00	0.00	85	0.00	0.00	0.00	--
-6	0.0	0.00	0.00	0.00	85	0.00	0.00	0.00	--

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 4/4
SYSTEM COMPARISON PERFORMANCE SIMULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
OPERATIONAL PERFORMANCE SIMULATION

DESIGN BASIS SYSTEM
RECIPROCATING CHILLERS WITH 8-STEP UNLOADERS AND ICW FREE COOLING HX

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4 DESIGN SYS Page 1
Building Name : CCF SUBCONSTRUCT 4/4 (Complex) Date : 11-26-86
Site : AURORA,IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 36198 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4 DESIGN SYS Page 2
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex) Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling Systems Only

 C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 100.0 tons
 KW/Ton @ 85 F entering water = 0.85 kw/ton
 Is hydronic cooling used ? <Y>
 Is chilled water reset used ? <N>
 Is hot gas bypass used ? <N>
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <Y> ; Economizer efficiency = 60 %

 D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

 E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw
 Misc. kw : Occupied = 350.0 kw; Unoccupied = 350.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

 F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	0.000 \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 4/4 DESIGN SYS
Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
Site : AURORA,IL FERMI, User Defined
Date : 11-26-86

Period : All
Zone : Block
Serial Number:
60117862.0

HVAC ENERGY	Annual Cost (\$/yr)	Energy or Fuel Units Consumed	DOE RUF (1000 BTU)	DOE RIF (1000 BTU)
Component				
Electric (Occ)	5267	105344 kwh/yr	1221996	359541
Electric (Unocc)	8220	164391 kwh/yr	1906934	561066
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	13487		3128930	920607
NON-HVAC ENERGY				
Electric (Occ)	54751	1095010 kwh/yr	12702118	3737270
Electric (Unocc)	98550	1970990 kwh/yr	22863485	6726989
Non-HVAC Total	153300		35565603	10464259
Grand Total	166787		38694532	11384865
Total/Sq.Ft.	%166786.77		%38694532.24	%11384865.37

HVAC Summary:

HVAC Total Cost = %13486.77 \$/Sq.Ft./yr
= 8.09 % of Total Cost
Total HVAC Electrical Energy = %269735.30 kwh/Sq.Ft./yr
= 8.09 % of Total Electrical Energy
Non-Electrical HVAC Energy = -0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4 DESIGN SYS

Page 1

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$34)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 36198 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4 DESIGN SYS

Page 2

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$10,347)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 100.0 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is hot gas bypass used ? <N>

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 60 %

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$3,105)

System	PERIMETER		dT, F	dP, ft wg	dP, ft wg
	dT, F	dP, ft wg			
Chilled water	10.00	120.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$153,300)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw

Misc. kw : Occupied = 350.0 kw; Unoccupied = 350.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$166,787)

>1. ELECTRICAL ENERGY USE			>2. OTHER FUELS		Unit Cost
Period	Occupied	Unoccupied			
(\$/kwh)	(\$/kwh)	(\$/kwh)	Natural Gas		n/a \$/therm
			Fuel Oil		n/a \$/U.S.gal
Compressor	0.050	0.050	Propane		n/a \$/lb
Resistance	0.050	0.050	Remote Heating	0.000	\$/MBTU
Inductive	0.050	0.050	Remote Cooling		n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 4/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant			No Interior Zone Exists
Temp	Hours	Coil Load	Input	Cost	
(F)	hr/yr	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----					
90	25.8	1194.8	66.4	85.7	
85	59.4	1194.8	59.3	176.1	
80	145.3	1194.8	52.9	384.2	
75	237.7	1194.8	47.1	560.3	
70	270.6	1194.8	42.0	568.6	
65	264.5	1194.8	37.5	495.5	
60	255.0	1194.8	33.4	426.3	
55	244.7	1194.8	29.7	363.1	
50	232.1	1194.8	24.2	280.7	
45	229.5	1194.8	19.6	225.4	
40	237.6	1194.8	15.9	188.3	
35	238.5	1194.8	12.7	151.3	
30	218.2	1194.8	10.0	109.4	
25	174.5	1194.8	7.8	67.9	
20	122.4	1194.8	5.9	36.0	
15	78.1	1194.8	4.3	16.6	
10	46.1	1194.8	2.9	6.6	
5	25.1	1194.8	1.7	2.1	
0	12.7	1194.8	1.5	0.9	
-5	6.2	1194.8	1.5	0.5	
-6	4.6	1194.8	1.5	0.3	
Total Costs				\$4145.8	
-----UNOCCUPIED PERIOD-----					
90	14.6	1194.8	66.4	48.5	
85	36.3	1194.8	59.3	107.6	
80	99.3	1194.8	52.9	262.6	
75	215.3	1194.8	47.1	507.5	
70	357.6	1194.8	42.0	751.3	
65	463.3	1194.8	37.5	868.0	
60	500.4	1194.8	33.4	836.5	
55	482.0	1194.8	29.7	715.2	
50	447.6	1194.8	24.2	541.4	
45	422.7	1194.8	19.6	415.1	
40	413.7	1194.8	15.9	327.9	
35	417.0	1194.8	12.7	264.5	
30	417.4	1194.8	10.0	209.2	
25	395.2	1194.8	7.8	153.7	
20	336.9	1194.8	5.9	99.0	
15	252.8	1194.8	4.3	53.8	
10	165.7	1194.8	2.9	23.8	
5	96.3	1194.8	1.7	8.2	
0	50.9	1194.8	1.5	3.7	
-5	25.3	1194.8	1.5	1.9	
-6	21.1	1194.8	1.5	1.5	
Total Costs				\$6201.1	

FAN AND PUMP COSTS

Job Name : CCF SUBCON 4/4 DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	0.1	0.1		7.1
85	59.4	0.1	0.2		7.1
80	145.3	0.1	0.6		7.1
75	237.7	0.1	0.9		7.1
70	270.6	0.1	1.1		7.1
65	264.5	0.1	1.0		7.1
60	255.0	0.1	1.0		7.1
55	244.7	0.1	1.0		7.1
50	232.1	0.1	0.9		7.1
45	229.5	0.1	0.9		7.1
40	237.6	0.1	0.9		7.1
35	238.5	0.1	0.9		7.1
30	218.2	0.1	0.9		7.1
25	174.5	0.1	0.7		7.1
20	122.4	0.1	0.5		7.1
15	78.1	0.1	0.3		7.1
10	46.1	0.1	0.2		7.1
5	25.1	0.1	0.1		7.1
0	12.7	0.1	0.0		7.1
-5	6.2	0.1	0.0		7.1
-6	4.6	0.1	0.0		7.1
Total Costs			\$12.3		\$1109.1
UNOCCUPIED PERIOD					
90	14.6	0.1	0.1		7.1
85	36.3	0.1	0.1		7.1
80	99.3	0.1	0.4		7.1
75	215.3	0.1	0.8		7.1
70	357.6	0.1	1.4		7.1
65	463.3	0.1	1.8		7.1
60	500.4	0.1	2.0		7.1
55	482.0	0.1	1.9		7.1
50	447.6	0.1	1.8		7.1
45	422.7	0.1	1.7		7.1
40	413.7	0.1	1.6		7.1
35	417.0	0.1	1.6		7.1
30	417.4	0.1	1.6		7.1
25	395.2	0.1	1.6		7.1
20	336.9	0.1	1.3		7.1
15	252.8	0.1	1.0		7.1
10	165.7	0.1	0.7		7.1
5	96.3	0.1	0.4		7.1
0	50.9	0.1	0.2		7.1
-5	25.3	0.1	0.1		7.1
-6	21.1	0.1	0.1		7.1
Total Costs			\$22.1		\$1996.4

COOLING COIL LOADS

Job : CCF SUBCON 4/4 DESIGN SYS
Building : CCF SUBCONSTRUCT 4/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-26-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 4/4 DESIGN SYS

Building : CCF SUBCONSTRUCT 4/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 4/4 DESIGN SYS
 Building : CCF SUBCONSTRUCT 4/4 (Complex)
 Site : AURORA, IL FERMI, User Defined

Zone : Block
 Period : All
 Date : 11-26-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 1
RECIPROCATING CHILLERS WITH 8-STEP UNLOADERS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4 STD CW SYS Page 1
Building Name : CCF SUBCONSTRUCT 4/4 (Complex) Date : 11-26-86
Site : AURORA, IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 36198 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4 STD CW SYS
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
 Site : AURORA,IL FERMI, User Defined
 Scope of Analysis : Cooling Systems Only

Page 2

Date : 11-26-86

60117862.0

C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 100.0 tons
 KW/Ton @ 85 F entering water = 0.85 kw/ton
 Is hydronic cooling used ? <Y>
 Is chilled water reset used ? <N>
 Is hot gas bypass used ? <N>
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw
 Misc. kw : Occupied = 350.0 kw; Unoccupied = 350.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. Period			>2. OTHER FUELS		Unit Cost
ELECTRICAL ENERGY USE	Occupied (\$/kwh)	Unoccupied (\$/kwh)			
Compressor	0.050	0.050	Natural Gas	n/a	\$/therm
Resistance	0.050	0.050	Fuel Oil	n/a	\$/U.S.gal
Inductive	0.050	0.050	Propane	n/a	\$/lb
			Remote Heating	0.000	\$/MBTU
			Remote Cooling	n/a	\$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 4/4 STD CW SYS
Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
Site : AURORA,IL FERMI, User Defined
Date : 11-26-86

Period : All
Zone : Block
Serial Number:
60117862.0

HVAC ENERGY	Annual Cost	Energy or Fuel Units Consumed	DOE RUF (1000 BTU)	DOE RIF (1000 BTU)
Component	(\$/yr)			
Electric (Occ)	9918	198356 kwh/yr	2300935	676990
Electric (Unocc)	16929	338584 kwh/yr	3927569	1155586
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	26847		6228504	1832576
NON-HVAC ENERGY				
Electric (Occ)	54751	1095010 kwh/yr	12702118	3737270
Electric (Unocc)	98550	1970990 kwh/yr	22863485	6726989
Non-HVAC Total	153300		35565603	10464259
Grand Total	180147		41794106	12296835
Total/Sq.Ft.	%180147.01		%41794106.15	%12296834.83

HVAC Summary:

HVAC Total Cost = %26847.00 \$/Sq.Ft./yr
= 14.90 % of Total Cost
Total HVAC Electrical Energy = %536939.94 kwh/Sq.Ft./yr
= 14.90 % of Total Electrical Energy
Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4 STD CW SYS Page 1
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex) Date : 11-26-86
 Site : AURORA, IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$34)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 36198 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4 STD CW SYS

Page 2

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$23,707)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 100.0 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is hot gas bypass used ? <N>

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$3,105)

System	PERIMETER		dT, F	dP, ft wg	dT, F	dP, ft wg
	dT, F	dP, ft wg				
Chilled water	10.00	120.00	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$153,300)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw

Misc. kw : Occupied = 350.0 kw; Unoccupied = 350.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$180,147)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	0.000 \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 4/4 STD CW SYS
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number :
 60117862.0

Bin	Bin	Perimeter Cooling Plant	No Interior Zone Exists
Temp	Hours	Coil Load	Input
(F)	hr/yr	MBH	KW
			Cost
			\$/yr

OCCUPIED PERIOD

90	25.8	1194.8	78.0	100.6
85	59.4	1194.8	75.2	223.3
80	145.3	1194.8	72.4	526.1
75	237.7	1194.8	69.8	829.3
70	270.6	1194.8	67.3	909.9
65	264.5	1194.8	64.8	857.6
60	255.0	1194.8	62.6	797.6
55	244.7	1194.8	60.3	738.0
50	232.1	1194.8	56.7	657.6
45	229.5	1194.8	53.3	611.2
40	237.6	1194.8	50.1	594.9
35	238.5	1194.8	47.1	561.7
30	218.2	1194.8	44.3	483.2
25	174.5	1194.8	41.7	363.6
20	122.4	1194.8	39.2	240.0
15	78.1	1194.8	36.9	144.1
10	46.1	1194.8	34.7	80.1
5	25.1	1194.8	32.7	41.1
0	12.7	1194.8	31.0	19.7
-5	6.2	1194.8	31.0	9.6
-6	4.6	1194.8	31.0	7.1

Total Costs \$8796.4

UNOCCUPIED PERIOD

90	14.6	1194.8	78.0	56.9
85	36.3	1194.8	75.2	136.4
80	99.3	1194.8	72.4	359.6
75	215.3	1194.8	69.8	751.2
70	357.6	1194.8	67.3	1202.5
65	463.3	1194.8	64.8	1502.1
60	500.4	1194.8	62.6	1565.2
55	482.0	1194.8	60.3	1453.7
50	447.6	1194.8	56.7	1268.2
45	422.7	1194.8	53.3	1125.7
40	413.7	1194.8	50.1	1035.9
35	417.0	1194.8	47.1	982.1
30	417.4	1194.8	44.3	924.3
25	395.2	1194.8	41.7	823.4
20	336.9	1194.8	39.2	660.6
15	252.8	1194.8	36.9	466.6
10	165.7	1194.8	34.7	287.9
5	96.3	1194.8	32.7	157.5
0	50.9	1194.8	31.0	78.9
-5	25.3	1194.8	31.0	39.2
-6	21.1	1194.8	31.0	32.7

Total Costs \$14910.7

FAN AND PUMP COSTS

Job Name : CCF SUBCON 4/4 STD CW SYS
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	0.1	0.1		7.1
85	59.4	0.1	0.2		7.1
80	145.3	0.1	0.6		7.1
75	237.7	0.1	0.9		7.1
70	270.6	0.1	1.1		7.1
65	264.5	0.1	1.0		7.1
60	255.0	0.1	1.0		7.1
55	244.7	0.1	1.0		7.1
50	232.1	0.1	0.9		7.1
45	229.5	0.1	0.9		7.1
40	237.6	0.1	0.9		7.1
35	238.5	0.1	0.9		7.1
30	218.2	0.1	0.9		7.1
25	174.5	0.1	0.7		7.1
20	122.4	0.1	0.5		7.1
15	78.1	0.1	0.3		7.1
10	46.1	0.1	0.2		7.1
5	25.1	0.1	0.1		7.1
0	12.7	0.1	0.0		7.1
-5	6.2	0.1	0.0		7.1
-6	4.6	0.1	0.0		7.1
Total Costs			\$12.3		\$1109.1
UNOCCUPIED PERIOD					
90	14.6	0.1	0.1		7.1
85	36.3	0.1	0.1		7.1
80	99.3	0.1	0.4		7.1
75	215.3	0.1	0.8		7.1
70	357.6	0.1	1.4		7.1
65	463.3	0.1	1.8		7.1
60	500.4	0.1	2.0		7.1
55	482.0	0.1	1.9		7.1
50	447.6	0.1	1.8		7.1
45	422.7	0.1	1.7		7.1
40	413.7	0.1	1.6		7.1
35	417.0	0.1	1.6		7.1
30	417.4	0.1	1.6		7.1
25	395.2	0.1	1.6		7.1
20	336.9	0.1	1.3		7.1
15	252.8	0.1	1.0		7.1
10	165.7	0.1	0.7		7.1
5	96.3	0.1	0.4		7.1
0	50.9	0.1	0.2		7.1
-5	25.3	0.1	0.1		7.1
-6	21.1	0.1	0.1		7.1
Total Costs			\$22.1		\$1996.4

COOLING COIL LOADS

Job : CCF SUBCON 4/4 STD CW SYS
Building : CCF SUBCONSTRUCT 4/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-26-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 4/4 STD CW SYS

Building : CCF SUBCONSTRUCT 4/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 4/4 STD CW SYS

Zone : Block

Building : CCF SUBCONSTRUCT 4/4 (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-26-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 2
TYPICAL FY1975 DESIGN
RECIPROCATING CHILLERS WITH STANDARD EFFICIENCY COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4 1975W SYS Page 1
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex) Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 36198 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4 1975W SYS

Page 2

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 100.0 tons

KW/Ton @ 85 F entering water = 0.95 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg	dP, ft wg
	dT, F	dP, ft wg			
Chilled water	10.00	120.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw

Misc. kw : Occupied = 350.0 kw; Unoccupied = 350.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

Period	Occupied	Unoccupied	Unit Cost
	(\$/kwh)	(\$/kwh)	(\$/therm)
ELECTRICAL ENERGY USE			
Compressor	0.050	0.050	n/a \$/therm
Resistance	0.050	0.050	n/a \$/U.S.gal
Inductive	0.050	0.050	n/a \$/lb
2. OTHER FUELS			
Natural Gas			0.000 \$/MBTU
Fuel Oil			n/a \$/MBTU
Propane			
Remote Heating			
Remote Cooling			

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 4/4 1975W SYS

Period : All

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Zone : Block

Site : AURORA,IL FERMI, User Defined

Serial Number:

Date : 11-26-86

60117862.0

HVAC ENERGY	Annual Cost (\$/yr)	Energy or Fuel Units Consumed	DOE RUF (1000 BTU)	DOE RIF (1000 BTU)
Component				
Electric (Occ)	14669	293378 kwh/yr	3403183	1001299
Electric (Unocc)	26403	528050 kwh/yr	6125384	1802236
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	41071		9528566	2803534
NON-HVAC ENERGY				
Electric (Occ)	54751	1095010 kwh/yr	12702118	3737270
Electric (Unocc)	98550	1970990 kwh/yr	22863485	6726989
Non-HVAC Total	153300		35565603	10464259
Grand Total	194371		45094169	13267793
Total/Sq.Ft.	%194371.41		%45094169.06	%13267793.00

HVAC Summary:

HVAC Total Cost = %41071.41 \$/Sq.Ft./yr
 = 21.13 % of Total Cost
 Total HVAC Electrical Energy = %821428.11 kwh/Sq.Ft./yr
 = 21.13 % of Total Electrical Energy
 Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
 1 therm nat gas = 100000 BTU RUF and RIF
 1 U.S. gal oil = 138700 BTU RUF and RIF
 1 Imp. gal oil = 168000 BTU RUF and RIF
 1 lb propane = 21680 BTU RUF and RIF
 RUF = Resource utilization factor (Source value)
 RIF = Resource impact factor (Point of use value)
 MBH = 1000 BTU/hr
 MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4 1975W SYS

Page 1

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$34)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 36198 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4 1975W SYS

Page 2

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

 C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$37,932)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 100.0 tons

KW/Ton @ 85 F entering water = 0.95 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

 D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$3,105)

System	PERIMETER			
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

 E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$153,300)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw

Misc. kw : Occupied = 350.0 kw; Unoccupied = 350.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

 F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$194,371)

>1. Period			>2. OTHER FUELS		Unit Cost
ELECTRICAL ENERGY USE	Occupied (\$/kwh)	Unoccupied (\$/kwh)			
Compressor	0.050	0.050	Natural Gas		n/a \$/therm
Resistance	0.050	0.050	Fuel Oil		n/a \$/U.S.gal
Inductive	0.050	0.050	Propane		n/a \$/lb
			Remote Heating	0.000	\$/MBTU
			Remote Cooling		n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 4/4 1975W SYS
 Building Name : CCF SUBCONSTRUCT 4/4 (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant	No Interior Zone Exists
Temp	Hours	Coil Load	Input
(F)	hr/yr	MBH	KW
			Cost
			\$/yr

OCCUPIED PERIOD

90	25.8	1194.8	87.3	112.6
85	59.4	1194.8	86.6	257.2
80	145.3	1194.8	86.6	629.1
75	237.7	1194.8	86.6	1029.2
70	270.6	1194.8	86.6	1171.7
65	264.5	1194.8	86.6	1145.3
60	255.0	1194.8	86.6	1104.1
55	244.7	1194.8	86.6	1059.5
50	232.1	1194.8	86.6	1005.0
45	229.5	1194.8	86.6	993.7
40	237.6	1194.8	86.6	1028.8
35	238.5	1194.8	86.6	1032.7
30	218.2	1194.8	86.6	944.8
25	174.5	1194.8	86.6	755.6
20	122.4	1194.8	86.6	530.0
15	78.1	1194.8	86.6	338.2
10	46.1	1194.8	86.6	199.6
5	25.1	1194.8	86.6	108.7
0	12.7	1194.8	86.6	55.0
-5	6.2	1194.8	86.6	26.8
-6	4.6	1194.8	86.6	19.9

Total Costs \$13547.5

UNOCCUPIED PERIOD

90	14.6	1194.8	87.3	63.7
85	36.3	1194.8	86.6	157.2
80	99.3	1194.8	86.6	430.0
75	215.3	1194.8	86.6	932.2
70	357.6	1194.8	86.6	1548.4
65	463.3	1194.8	86.6	2006.1
60	500.4	1194.8	86.6	2166.7
55	482.0	1194.8	86.6	2087.0
50	447.6	1194.8	86.6	1938.1
45	422.7	1194.8	86.6	1830.3
40	413.7	1194.8	86.6	1791.3
35	417.0	1194.8	86.6	1805.6
30	417.4	1194.8	86.6	1807.3
25	395.2	1194.8	86.6	1711.2
20	336.9	1194.8	86.6	1458.8
15	252.8	1194.8	86.6	1094.6
10	165.7	1194.8	86.6	717.5
5	96.3	1194.8	86.6	417.0
0	50.9	1194.8	86.6	220.4
-5	25.3	1194.8	86.6	109.5
-6	21.1	1194.8	86.6	91.4

Total Costs \$24384.0

FAN AND PUMP COSTS

Job Name : CCF SUBCON 4/4 1975W SYS

Date : 11-26-86

Building Name : CCF SUBCONSTRUCT 4/4 (Complex)

Serial Number:

Site Name : AURORA,IL FERMI, User Defined

60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	0.1	0.1		7.1
85	59.4	0.1	0.2		7.1
80	145.3	0.1	0.6		7.1
75	237.7	0.1	0.9		7.1
70	270.6	0.1	1.1		7.1
65	264.5	0.1	1.0		7.1
60	255.0	0.1	1.0		7.1
55	244.7	0.1	1.0		7.1
50	232.1	0.1	0.9		7.1
45	229.5	0.1	0.9		7.1
40	237.6	0.1	0.9		7.1
35	238.5	0.1	0.9		7.1
30	218.2	0.1	0.9		7.1
25	174.5	0.1	0.7		7.1
20	122.4	0.1	0.5		7.1
15	78.1	0.1	0.3		7.1
10	46.1	0.1	0.2		7.1
5	25.1	0.1	0.1		7.1
0	12.7	0.1	0.0		7.1
-5	6.2	0.1	0.0		7.1
-6	4.6	0.1	0.0		7.1
Total Costs			\$12.3		\$1109.1
UNOCCUPIED PERIOD					
90	14.6	0.1	0.1		7.1
85	36.3	0.1	0.1		7.1
80	99.3	0.1	0.4		7.1
75	215.3	0.1	0.8		7.1
70	357.6	0.1	1.4		7.1
65	463.3	0.1	1.8		7.1
60	500.4	0.1	2.0		7.1
55	482.0	0.1	1.9		7.1
50	447.6	0.1	1.8		7.1
45	422.7	0.1	1.7		7.1
40	413.7	0.1	1.6		7.1
35	417.0	0.1	1.6		7.1
30	417.4	0.1	1.6		7.1
25	395.2	0.1	1.6		7.1
20	336.9	0.1	1.3		7.1
15	252.6	0.1	1.0		7.1
10	165.7	0.1	0.7		7.1
5	96.3	0.1	0.4		7.1
0	50.9	0.1	0.2		7.1
-5	25.3	0.1	0.1		7.1
-6	21.1	0.1	0.1		7.1
Total Costs			\$22.1		\$1996.4

COOLING COIL LOADS

Job : CCF SUBCON 4/4 1975W SYS
Building : CCF SUBCONSTRUCT 4/4 (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-26-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 4/4 1975W SYS

Building : CCF SUBCONSTRUCT 4/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 4/4 1975W SYS

Building : CCF SUBCONSTRUCT 4/4 (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
SYSTEMS LIFE CYCLE COST ANALYSIS
AND
PAYBACK CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
LIFE CYCLE COST ANALYSIS
FOR
DESIGN BASIS SYSTEM
RECIPROCATING CHILLERS WITH FREE COOLING AND 8 STEP COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 4/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$113200 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 113200.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 13487.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 1500.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 4/4 DESIGN SYS

ANALYST NAME : S.F.KRSTULOVICH

COMMENTS : \$113200 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	113200.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	13612.29	13725.83	13840.31
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	1530.74	1546.35	1562.11
YEAR'S	\$	113200.00	0.00	15143.03	15272.17	15402.42
CUM.	\$	113200.00	113200.00	128343.02	143615.19	159017.61

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	13955.76	14072.16	14189.54	14307.90	14427.24
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1578.03	1594.12	1610.37	1626.79	1643.38
YEAR'S	\$	15533.79	15666.29	15799.92	15934.69	16070.62
CUM.	\$	174551.41	190217.69	206017.61	221952.30	238022.91

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	14547.58	14668.92	14791.28	14914.65	15039.06
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1660.13	1677.05	1694.15	1711.42	1728.87
YEAR'S	\$	16207.71	16345.98	16485.43	16626.07	16767.93
CUM.	\$	254230.61	270576.59	287062.03	303688.09	320456.03

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	15164.50	15290.99	15418.53	15547.14	15676.82
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1746.49	1764.30	1782.29	1800.45	1818.81
YEAR'S	\$	16910.99	17055.29	17200.82	17347.59	17495.63
CUM.	\$	337367.03	354422.31	371623.12	388970.72	406466.34

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	15807.58	15939.43	16072.38	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1837.35	1856.08	1875.00	0.00	0.00
YEAR'S	\$	17644.93	17795.52	17947.39	0.00	0.00
CUM.	\$	424111.28	441906.81	459854.19	459854.19	459854.19

FERMILAB COST ESTIMATE SECTION		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE		PROJECT NO. & DATE 10-5-3 10 SEPT. 86		REVISION DATE 16 SEPT. 86		PAGE 19/27	
QUANTITIES BY JG		PRICES BY JG		CHECKED BY JG		VIN		DISTRIBUTION OF ITEMIZED COST	
CES		JG		JG		JG		(1) (2) (3)	
DESCRIPTION OF WORK ITEMS		QUANTITY		UNIT		AMOUNT		UNIT	
ITEM NO.									
P.2.12									
Chillers 100TON REFR.		2		CH		62,000			
INSTAL CHILLERS		2		CH		12,000			
HT. EXCHANGER, CIRC. PUMP & R. 300GPM		1		CH		6,000			
AUX. CIRC. BOILER, 20 KW		1		EA		8,100			
CHILCO WATER PUMPS, 300GPM, 70'		2		CH		4,000			
HT. RECLAMING WTR. PUMPS		2		CH		50,000		700	
EXPAUSION TANKS, 50GPM.		2		CH		600			
AUXILIARY STEEL SUPPORTS		LOT				59,000		186,900	
B.4 COMPUTER RM. A/C UNIT									
PACKAGE, SELF CONT. 10TON		12		EA		14,700		176,400	
INSTAL SELF CONT. UNITS		12		CH		1,100		13,200	
CEILING A/C UNITS, SELF CONT. 2TON		22		CH		42,000		92,400	
WATER DETECTORS		24		CH		150		3,600	
								241,000	

FERMILAB COST ESTIMATE		PROJECT TITLE CENTRAL COMPUTING FACILITY - TITLE 2 PHASE 2 - SUPERSTRUCTURE		PROJECT NO. DATE 10-5-3 10 SEPT, 86		REVISION DATE 16 SEPT. 86		PAGE 22/27	
SECTION	CES	QUANTITIES BY JG	PRICES BY JG	CHECKED BY WN	DISTRIBUTION OF ITEMIZED COST				
ITEM NO.	DESCRIPTION OF WORK ITEMS	QUANTITY	UNIT	(1)		(2)		(3)	
				UNIT	AMOUNT	UNIT	AMOUNT	UNIT	AMOUNT
8.8	COOLING/HOTTING WATER PIPING								
	NEW PIPING	100							
	8" SCHED. 10 VICTOLIC	50	L.F.	28	1900	3800			
	6" d " "	200	L.F.	28	5600				
	2" d " "	60	L.F.	10	600				
	VALVES, 8" BUTT. FLY	10	DA	40	4500				
	" 6" "	10	DA	30	3500				
	" 2 1/2" "	8	DA	20	2000				
	" 2" BALL	10	DA	40	400				
	" 8 PCESS. FGD.	1	DA		2500				
	ACCESSORIES	LOT			5000				
	INSULATION 8" PIPE	100	L.F.	800	400	800			
	" 6" "	200	L.F.	600	1200				
	COLD PIPING, SCHED 10 VICT. 4" d	100	L.F.	17	1700				
	VALVES, 4" d BUTT.	16	DA	20	4000				
	ACCESSORIES & DISC. VALVES	LOT			3000				
	PIPE INSUL. 4" d	100	L.F.	500	500				
	COLD PIPING, SCHED VICT. 6" d	300	L.F.	28	8400				
	" " 4" d	300	L.F.	17	5100				
	" " 3" d	100	L.F.	14	1400				
	" " 1 1/2" d	350	L.F.	800	2800				
	VALVES, 6" BUTT.	10	DA	30	3500				
	1 1/2" BALL	24	DA	35	800				
	ACCESSORIES & DISC. VALVES	LOT			3000				
	PIPE INSUL. 4" d	700	L.F.	500	3500				
	" 1 1/2" d	350	L.F.	300	1100				

VIII-37

(66,400)

(6,6,4,2,2)

FERMILAB COST ESTIMATE		PROJECT TITLE		CENTRAL COMPUTING FACILITY - TITLE 2		PHASE 2 - SUPERSTRUCTURE		QUANTITIES BY		PRICES BY		CHECKED BY		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		JG		J	
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FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 4/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 1
RECIPROCATING CHILLERS WITH 8 STEP COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 4/4 STD CW SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$101000 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 101000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 26847.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 1000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 4/4 STD CW SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$101000 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	101000.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	27096.39	27322.40	27550.30
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	1020.49	1030.90	1041.41
YEAR'S	\$	101000.00	0.00	28116.88	28353.30	28591.71
CUM.	\$	101000.00	101000.00	129116.88	157470.19	186061.91

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	27780.10	28011.82	28245.47	28481.07	28718.63
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1052.02	1062.75	1073.58	1084.53	1095.58
YEAR'S	\$	28832.13	29074.57	29319.05	29565.59	29814.21
CUM.	\$	214894.03	243968.59	273287.66	302853.25	332667.47

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	28958.17	29199.71	29443.27	29688.86	29936.50
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1106.75	1118.04	1129.43	1140.95	1152.58
YEAR'S	\$	30064.93	30317.75	30572.71	30829.81	31089.08
CUM.	\$	362732.41	393050.16	423622.88	454452.69	485541.75

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	30186.20	30437.99	30691.87	30947.88	31206.01
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1164.33	1176.20	1188.19	1200.30	1212.54
YEAR'S	\$	31350.53	31614.19	31880.06	32148.18	32418.55
CUM.	\$	516892.28	548506.50	580386.56	612534.75	644953.31

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	31466.30	31728.77	31993.42	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1224.90	1237.39	1250.00	0.00	0.00
YEAR'S	\$	32691.21	32966.16	33243.42	0.00	0.00
CUM.	\$	677644.50	710610.62	743854.06	743854.06	743854.06

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 2
FY1975 RECIPROCATING CHILLERS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 4/4 1975W SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$93000 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 93000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 41071.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 1000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 4/4 1975W SYS

ANALYST NAME : S.F.KRSTULOVICH

COMMENTS : \$93000 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	93000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	41452.52	41798.28	42146.93
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	1020.49	1030.90	1041.41
YEAR'S	\$	93000.00	0.00	42473.02	42829.18	43188.33
CUM.	\$	93000.00	93000.00	135473.02	178302.19	221490.52

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	42498.48	42852.96	43210.40	43570.82	43934.25
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1052.02	1062.75	1073.58	1084.53	1095.58
YEAR'S	\$	43550.50	43915.71	44283.98	44655.35	45029.83
CUM.	\$	265041.00	308956.72	353240.69	397896.03	442925.88

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	44300.71	44670.23	45042.82	45418.53	45797.37
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1106.75	1118.04	1129.43	1140.95	1152.58
YEAR'S	\$	45407.47	45788.26	46172.26	46559.48	46949.95
CUM.	\$	488333.34	534121.62	580293.88	626853.38	673803.31

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	46179.38	46564.56	46952.96	47344.60	47739.50
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1164.33	1176.20	1188.19	1200.30	1212.54
YEAR'S	\$	47343.70	47740.76	48141.15	48544.90	48952.04
CUM.	\$	721147.00	768887.75	817028.88	865573.75	914525.81

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	48137.70	48539.22	48944.09	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1224.90	1237.39	1250.00	0.00	0.00
YEAR'S	\$	49362.60	49776.61	50194.09	0.00	0.00
CUM.	\$	963888.44	1013665.06	1063859.12	1063859.12	1063859.12

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
UNIFIED PRESENT WORTH COMPARISONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC13.DAT
 PROJECT : CCF SUBCON 4/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$113200 PER UNIT COSTS

FILE NO. : LCC14.DAT
 PROJECT : CCF SUBCON 4/4 STD CW SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$101000 PER UNIT COSTS

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	113200.00	101000.00	12200.00	12200.00
1987	0.00	0.00	0.00	12200.00
1988	15143.03	28116.88	-12973.85	-773.85
1989	15272.17	28353.30	-13081.13	-13854.98
1990	15402.42	28591.71	-13189.29	-27044.28
1991	15533.79	28832.13	-13298.34	-40342.62
1992	15666.29	29074.57	-13408.28	-53750.90
1993	15799.92	29319.05	-13519.13	-67270.03
1994	15934.69	29565.59	-13630.90	-80900.94
1995	16070.62	29814.21	-13743.59	-94644.53
1996	16207.71	30064.93	-13857.22	-108501.75
1997	16345.98	30317.75	-13971.77	-122473.52
1998	16485.43	30572.71	-14087.28	-136560.78
1999	16626.07	30829.81	-14203.74	-150764.53
2000	16767.93	31089.08	-14321.15	-165085.69
2001	16910.99	31350.53	-14439.54	-179525.23
2002	17055.29	31614.19	-14558.90	-194084.13
2003	17200.82	31880.06	-14679.24	-208763.38
2004	17347.59	32148.18	-14800.59	-223563.97
2005	17495.63	32418.55	-14922.92	-238486.89
2006	17644.93	32691.21	-15046.28	-253533.16
2007	17795.52	32966.16	-15170.64	-268703.78
2008	17947.39	33243.42	-15296.03	-283999.81

*** APPARENT BREAK-EVEN YEAR = 1988 ***

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC13.DAT
 PROJECT : CCF SUBCON 4/4 DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$113200 PER UNIT COSTS

FILE NO. : LCC15.DAT
 PROJECT : CCF SUBCON 4/4 1975W SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$93000 PER UNIT COSTS

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	113200.00	93000.00	20200.00	20200.00
1987	0.00	0.00	0.00	20200.00
1988	15143.03	42473.02	-27329.99	-7129.99
1989	15272.17	42829.18	-27557.01	-34687.00
1990	15402.42	43188.33	-27785.91	-62472.91
1991	15533.79	43550.50	-28016.71	-90489.62
1992	15666.29	43915.71	-28249.42	-118739.04
1993	15799.92	44283.98	-28484.06	-147223.09
1994	15934.69	44655.35	-28720.66	-175943.75
1995	16070.62	45029.83	-28959.21	-204902.95
1996	16207.71	45407.47	-29199.76	-234102.72
1997	16345.98	45788.26	-29442.28	-263545.00
1998	16485.43	46172.26	-29686.83	-293231.81
1999	16626.07	46559.48	-29933.41	-323165.22
2000	16767.93	46949.95	-30182.02	-353347.22
2001	16910.99	47343.70	-30432.71	-383779.91
2002	17055.29	47740.76	-30685.47	-414465.38
2003	17200.82	48141.15	-30940.33	-445405.72
2004	17347.59	48544.90	-31197.31	-476603.03
2005	17495.63	48952.04	-31456.41	-508059.44
2006	17644.93	49362.60	-31717.67	-539777.12
2007	17795.52	49776.61	-31981.09	-571758.25
2008	17947.39	50194.09	-32246.70	-604004.94

*** APPARENT BREAK-EVEN YEAR = 1988 ***

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4
SIMPLE PAYBACK CALCULATIONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

CDF SUBCONSTRUCT 4/4
SIMPLE PAYBACK

INPUT VALUES			DESIGN SYS		STD CW SYS	
INITIAL TOTAL COST			\$	113,200	\$	101,000
ANNUAL OPERATING COST			\$	13,487	\$	26,847
ANNUAL MAINTENANCE COST			\$	1,500	\$	1,000
SALVAGE VALUE AT YEAR 20			\$	0	\$	0

YEAR	DESIGN SYS EXPENSES		STD CW SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 113,200	\$ 113,200	\$ 101,000	\$ 101,000

1	\$ 14,987	\$ 128,187	\$ 27,847	\$ 128,847
2	\$ 14,987	\$ 143,174	\$ 27,847	\$ 156,694
3	\$ 14,987	\$ 158,161	\$ 27,847	\$ 184,541
4	\$ 14,987	\$ 173,148	\$ 27,847	\$ 212,388
5	\$ 14,987	\$ 188,135	\$ 27,847	\$ 240,235
6	\$ 14,987	\$ 203,122	\$ 27,847	\$ 268,082
7	\$ 14,987	\$ 218,109	\$ 27,847	\$ 295,929
8	\$ 14,987	\$ 233,096	\$ 27,847	\$ 323,776
9	\$ 14,987	\$ 248,083	\$ 27,847	\$ 351,623
10	\$ 14,987	\$ 263,070	\$ 27,847	\$ 379,470
11	\$ 14,987	\$ 278,057	\$ 27,847	\$ 407,317
12	\$ 14,987	\$ 293,044	\$ 27,847	\$ 435,164
13	\$ 14,987	\$ 308,031	\$ 27,847	\$ 463,011
14	\$ 14,987	\$ 323,018	\$ 27,847	\$ 490,858
15	\$ 14,987	\$ 338,005	\$ 27,847	\$ 518,705
16	\$ 14,987	\$ 352,992	\$ 27,847	\$ 546,552
17	\$ 14,987	\$ 367,979	\$ 27,847	\$ 574,399
18	\$ 14,987	\$ 382,966	\$ 27,847	\$ 602,246
19	\$ 14,987	\$ 397,953	\$ 27,847	\$ 630,093
20	\$ 14,987	\$ 412,940	\$ 27,847	\$ 657,940
SALVAGE	(\$ 0)	\$ 412,940	(\$ 0)	\$ 657,940

PAYBACK FOR DESIGN SYS OCCURS AFTER 0.9 YEARS (\$ 127,418)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 412,940

TOTAL COST OF STD CW SYS FOR 20 YEARS IS \$ 657,940

CCF SUBCONSTRUCT 4/4
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	1975W SYS
INITIAL TOTAL COST	\$ 113,200	\$ 93,000
ANNUAL OPERATING COST	\$ 13,487	\$ 41,071
ANNUAL MAINTENANCE COST	\$ 1,500	\$ 1,000
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

YEAR	DESIGN SYS EXPENSES		1975W SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 113,200	\$ 113,200	\$ 93,000	\$ 93,000

1	\$ 14,987	\$ 128,187	\$ 42,071	\$ 135,071
2	\$ 14,987	\$ 143,174	\$ 42,071	\$ 177,142
3	\$ 14,987	\$ 158,161	\$ 42,071	\$ 219,213
4	\$ 14,987	\$ 173,148	\$ 42,071	\$ 261,284
5	\$ 14,987	\$ 188,135	\$ 42,071	\$ 303,355
6	\$ 14,987	\$ 203,122	\$ 42,071	\$ 345,426
7	\$ 14,987	\$ 218,109	\$ 42,071	\$ 387,497
8	\$ 14,987	\$ 233,096	\$ 42,071	\$ 429,568
9	\$ 14,987	\$ 248,083	\$ 42,071	\$ 471,639
10	\$ 14,987	\$ 263,070	\$ 42,071	\$ 513,710
11	\$ 14,987	\$ 278,057	\$ 42,071	\$ 555,781
12	\$ 14,987	\$ 293,044	\$ 42,071	\$ 597,852
13	\$ 14,987	\$ 308,031	\$ 42,071	\$ 639,923
14	\$ 14,987	\$ 323,018	\$ 42,071	\$ 681,994
15	\$ 14,987	\$ 338,005	\$ 42,071	\$ 724,065
16	\$ 14,987	\$ 352,992	\$ 42,071	\$ 766,136
17	\$ 14,987	\$ 367,979	\$ 42,071	\$ 808,207
18	\$ 14,987	\$ 382,966	\$ 42,071	\$ 850,278
19	\$ 14,987	\$ 397,953	\$ 42,071	\$ 892,349
20	\$ 14,987	\$ 412,940	\$ 42,071	\$ 934,420
SALVAGE (\$	0)	\$ 412,940	(\$ 0)	\$ 934,420

PAYBACK FOR DESIGN SYS OCCURS AFTER 0.7 YEARS (\$ 124,378)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 412,940

TOTAL COST OF 1975W SYS FOR 20 YEARS IS \$ 934,420

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
SYSTEMS ANALYSIS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 4/4 FUTURE
BUILDING SECTOR PHYSICAL PARAMETERS AND DESCRIPTION

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

COMPLEX BUILDING INPUT SUMMARY

Building Name : CCF SUBCONSTRUCT 4/4 FUT Date : 11-26-86

Site : AURORA,IL FERMI, User Defined 60117862.0

1. ROOM CONDITIONS AND FLOOR AREAS

Thermostat settings : Cooling = 85 F; Heating = 85 F; Setback = 0 F

Warm-up factor = 0 %; Room design relative humidity = 50 %

Floor Areas: Perimeter = 1 Sqft; Interior = 0 Sqft

Cooling provided during unoccupied period.

2. WALLS, ROOF, GLASS, SKYLIGHTS:

Exposure	Area (Sqft)	U-Factor BTU/(hr-sqft-F)	Glass Area (Sqft)	Glass U-Factor BTU/(hr-sqft-F)
North Wall	0	0.060	0	0.550
Northeast Wall	0	0.060	0	0.550
East Wall	0	0.060	0	0.550
Southeast Wall	0	0.060	0	0.550
South Wall	0	0.060	0	0.550
Southwest Wall	0	0.060	0	0.550
West Wall	0	0.060	0	0.550
Northwest Wall	0	0.060	0	0.550
Perimeter Roof	0	0.050	0	0.001
Interior Roof	0	0.050	0	0.001

WALLS: Color = Light; Wt. = Medium; ROOF: Color = Medium; Wt. = Medium

BUILDING WT. = Medium; VERTICAL GLASS : Double Glazed

Shade Factors : Glass = 0.650 ; Skylights = 0.000

Internal shades are not used. ; A ceiling plenum is not used.

3. LIGHTS:

Perimeter : 0.000 Watts/Sqft = 0 Watts Total

Interior : 0.000 Watts/Sqft = 0 Watts Total

Diversity Factors : Occupied = 0 %; Unoccupied = 0 %

Perimeter Lights : Ballast , recessed

Interior Lights : Ballast , recessed

4. MISCELLANEOUS ELECTRICAL LOADS:

Perimeter : Occupied = %630000.000 Watts/Sqft = 630,000 Watts Total

Unoccupied = %630000.000 Watts/Sqft = 630,000 Watts Total

Interior : Occupied = 0.000 Watts/Sqft = 0 Watts Total

Unoccupied = 0.000 Watts/Sqft = 0 Watts Total

5. PEOPLE LOADS

Total Occupancy = 0 sqft/person = 0 people total

Activity Level: 6. User defined activity level

Sensible = 0.0 BTU/hr/person; Latent = 0.0 BTU/hr/person

Diversity Factors : Occupied = 0 %; Unoccupied = 0 %

6. MISCELLANEOUS INTERNAL LOADS:

Sensible : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

Latent : Occupied = 0 BTU/hr; Unoccupied = 0 BTU/hr

7. WALLS ADJACENT TO NON-CONDITIONED REGIONS:

Wall Areas : Perimeter = 0 Sqft; Interior = 0 Sqft

Wall U-Factor = 0.000 BTU/(hr-sqft-F)

Adjacent region is not heated

Adjacent region is not cooled

IX-1

8. INFILTRATION DATA:

Air Flow Rates: Occupied = 0 cfm; Unoccupied = 0 cfm

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
BUILDING LOAD CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

LOAD PROFILE SUMMARY

Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Date : 11-26-86

Site Name : AURORA,IL FERMI, User Defined

60117862.0

TABLE 1. OCCUPIED PERIOD (Load does not include vent. load, fan heat)

Bin	Bin	<-----Perimeter Zone----->			<-----Interior Zone----->				
Temp	Hours	Sensible	Latent	Plenum	Zone	Sensible	Latent	Plenum	Zone
(F)	(hr/yr)	(tons)	(tons)	(tons)	(F)	(tons)	(tons)	(tons)	(F)
93	0.0	179.18	0.00	0.00	85	0.00	0.00	0.00	---
90	25.8	179.18	0.00	0.00	85	0.00	0.00	0.00	---
85	59.4	179.18	0.00	0.00	85	0.00	0.00	0.00	---
80	145.3	179.18	0.00	0.00	85	0.00	0.00	0.00	---
75	237.7	179.18	0.00	0.00	85	0.00	0.00	0.00	---
70	270.6	179.18	0.00	0.00	85	0.00	0.00	0.00	---
65	264.5	179.18	0.00	0.00	85	0.00	0.00	0.00	---
60	255.0	179.18	0.00	0.00	85	0.00	0.00	0.00	---
55	244.7	179.18	0.00	0.00	85	0.00	0.00	0.00	---
50	232.1	179.18	0.00	0.00	85	0.00	0.00	0.00	---
45	229.5	179.18	0.00	0.00	85	0.00	0.00	0.00	---
40	237.6	179.18	0.00	0.00	85	0.00	0.00	0.00	---
35	238.5	179.18	0.00	0.00	85	0.00	0.00	0.00	---
30	218.2	179.18	0.00	0.00	85	0.00	0.00	0.00	---
25	174.5	179.18	0.00	0.00	85	0.00	0.00	0.00	---
20	122.4	179.18	0.00	0.00	85	0.00	0.00	0.00	---
15	78.1	179.18	0.00	0.00	85	0.00	0.00	0.00	---
10	46.1	179.18	0.00	0.00	85	0.00	0.00	0.00	---
5	25.1	179.18	0.00	0.00	85	0.00	0.00	0.00	---
0	12.7	179.18	0.00	0.00	85	0.00	0.00	0.00	---
-5	6.2	179.18	0.00	0.00	85	0.00	0.00	0.00	---
-6	4.6	179.18	0.00	0.00	85	0.00	0.00	0.00	---

TABLE 2. UNOCCUPIED PERIOD (Load does not include vent. load, fan heat)

90	14.6	179.18	0.00	0.00	85	0.00	0.00	0.00	---
85	36.3	179.18	0.00	0.00	85	0.00	0.00	0.00	---
80	99.3	179.18	0.00	0.00	85	0.00	0.00	0.00	---
75	215.3	179.18	0.00	0.00	85	0.00	0.00	0.00	---
70	357.6	179.18	0.00	0.00	85	0.00	0.00	0.00	---
65	463.3	179.18	0.00	0.00	85	0.00	0.00	0.00	---
60	500.4	179.18	0.00	0.00	85	0.00	0.00	0.00	---
55	482.0	179.18	0.00	0.00	85	0.00	0.00	0.00	---
50	447.6	179.18	0.00	0.00	85	0.00	0.00	0.00	---
45	422.7	179.18	0.00	0.00	85	0.00	0.00	0.00	---
40	413.7	179.18	0.00	0.00	85	0.00	0.00	0.00	---
35	417.0	179.18	0.00	0.00	85	0.00	0.00	0.00	---
30	417.4	179.18	0.00	0.00	85	0.00	0.00	0.00	---
25	395.2	179.18	0.00	0.00	85	0.00	0.00	0.00	---
20	336.9	179.18	0.00	0.00	85	0.00	0.00	0.00	---
15	252.8	179.18	0.00	0.00	85	0.00	0.00	0.00	---
10	165.7	179.18	0.00	0.00	85	0.00	0.00	0.00	---
5	96.3	179.18	0.00	0.00	85	0.00	0.00	0.00	---
0	50.9	179.18	0.00	0.00	85	0.00	0.00	0.00	---
-5	25.3	179.18	0.00	0.00	85	0.00	0.00	0.00	---
-6	21.1	179.18	0.00	0.00	85	0.00	0.00	0.00	---
-6	0.0	0.00	0.00	0.00	85	0.00	0.00	0.00	---

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 4/4 FUTURE
SYSTEM COMPARISON PERFORMANCE SIMULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
OPERATIONAL PERFORMANCE SIMULATION

DESIGN BASIS SYSTEM
RECIPROCATING CHILLERS WITH 8-STEP UNLOADERS AND ICW FREE COOLING HX

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON4/4F DESIGN SYS Page 1
Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
Site : AURORA,IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 65157 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON4/4F DESIGN SYS Page 2
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling Systems Only

 C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 200.0 tons
 KW/Ton @ 85 F entering water = 0.85 kw/ton
 Is hydronic cooling used ? <Y>
 Is chilled water reset used ? <N>
 Is hot gas bypass used ? <N>
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <Y> ; Economizer efficiency = 65 %

D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw
 Misc. kw : Occupied = 630.0 kw; Unoccupied = 630.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	0.000 \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON4/4F DESIGN SYS Period : All
Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Zone : Block
Site : AURORA,IL FERMI, User Defined Serial Number:
Date : 11-26-86 60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	8647	172949 kwh/yr	2006209	590275
Electric (Unocc)	13464	269289 kwh/yr	3123753	919084
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	22112		5129962	1509359

NON-HVAC ENERGY

Electric (Occ)	98551	1971018 kwh/yr	22863810	6727085
Electric (Unocc)	177389	3547782 kwh/yr	41154270	12108579
Non-HVAC Total	275940		64018079	18835664
Grand Total	298052		69148041	20345023
Total/Sq.Ft.	%298051.90		%69148041.19	%20345022.78

HVAC Summary:

HVAC Total Cost = %22111.90 \$/Sq.Ft./yr
= 7.42 % of Total Cost
Total HVAC Electrical Energy = %442238.09 kwh/Sq.Ft./yr
= 7.42 % of Total Electrical Energy
Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON4/4F DESIGN SYS Page 1
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
 Site : AURORA, IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$62)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 65157 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON4/4F DESIGN SYS

Page 2

Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$15,839)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 200.0 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is hot gas bypass used ? <N>

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <Y> ; Economizer efficiency = 65 %

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$6,211)

System	PERIMETER			
	dT, F	dP, ft wg	dT, F	dP, ft wg
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$275,940)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw

Misc. kw : Occupied = 630.0 kw; Unoccupied = 630.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$298,052)

>1. ELECTRICAL ENERGY USE			>2. OTHER FUELS		Unit Cost
Period	Occupied (\$/kwh)	Unoccupied (\$/kwh)			
Compressor	0.050	0.050	Natural Gas		n/a \$/therm
Resistance	0.050	0.050	Fuel Oil		n/a \$/U.S.gal
Inductive	0.050	0.050	Propane		n/a \$/lb
			Remote Heating	0.000	\$/MBTU
			Remote Cooling		n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON4/4F DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant			No Interior Zone Exists
Temp	Hours	Coil Load	Input	Cost	
(F)	hr/yr	MBH	KW	\$/yr	
-----OCCUPIED PERIOD-----					
90	25.8	2150.7	108.0	139.3	
85	59.4	2150.7	96.1	285.3	
80	145.3	2150.7	85.3	619.9	
75	237.7	2150.7	75.7	899.5	
70	270.6	2150.7	67.1	907.7	
65	264.5	2150.7	59.4	786.1	
60	255.0	2150.7	52.7	671.3	
55	244.7	2150.7	46.3	566.9	
50	232.1	2150.7	37.1	430.2	
45	229.5	2150.7	29.4	337.0	
40	237.6	2150.7	22.9	272.5	
35	238.5	2150.7	17.5	209.1	
30	218.2	2150.7	13.0	141.5	
25	174.5	2150.7	9.1	79.5	
20	122.4	2150.7	5.8	35.6	
15	78.1	2150.7	3.0	11.8	
10	46.1	2150.7	2.9	6.7	
5	25.1	2150.7	2.9	3.7	
0	12.7	2150.7	2.9	1.9	
-5	6.2	2150.7	2.9	0.9	
-6	4.6	2150.7	2.9	0.7	
Total Costs				\$6407.1	
-----UNOCCUPIED PERIOD-----					
90	14.6	2150.7	108.0	78.8	
85	36.3	2150.7	96.1	174.4	
80	99.3	2150.7	85.3	423.6	
75	215.3	2150.7	75.7	814.8	
70	357.6	2150.7	67.1	1199.5	
65	463.3	2150.7	59.4	1377.0	
60	500.4	2150.7	52.7	1317.4	
55	482.0	2150.7	46.3	1116.6	
50	447.6	2150.7	37.1	829.7	
45	422.7	2150.7	29.4	620.8	
40	413.7	2150.7	22.9	474.4	
35	417.0	2150.7	17.5	365.6	
30	417.4	2150.7	13.0	270.8	
25	395.2	2150.7	9.1	180.0	
20	336.9	2150.7	5.8	98.0	
15	252.8	2150.7	3.0	38.0	
10	165.7	2150.7	2.9	24.2	
5	96.3	2150.7	2.9	14.1	
0	50.9	2150.7	2.9	7.4	
-5	25.3	2150.7	2.9	3.7	
-6	21.1	2150.7	2.9	3.1	
Total Costs				\$9431.9	

FAN AND PUMP COSTS

Job Name : CCF SUBCON4/4F DESIGN SYS
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	kW	\$/yr		kW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	0.1	0.2		14.2 18.3
85	59.4	0.1	0.4		14.2 42.1
80	145.3	0.1	1.0		14.2 103.0
75	237.7	0.1	1.7		14.2 168.5
70	270.6	0.1	1.9		14.2 191.9
65	264.5	0.1	1.9		14.2 187.5
60	255.0	0.1	1.8		14.2 180.8
55	244.7	0.1	1.7		14.2 173.5
50	232.1	0.1	1.6		14.2 164.6
45	229.5	0.1	1.6		14.2 162.7
40	237.6	0.1	1.7		14.2 168.5
35	238.5	0.1	1.7		14.2 169.1
30	218.2	0.1	1.5		14.2 154.7
25	174.5	0.1	1.2		14.2 123.7
20	122.4	0.1	0.9		14.2 86.8
15	78.1	0.1	0.6		14.2 55.4
10	46.1	0.1	0.3		14.2 32.7
5	25.1	0.1	0.2		14.2 17.8
0	12.7	0.1	0.1		14.2 9.0
-5	6.2	0.1	0.0		14.2 4.4
-6	4.6	0.1	0.0		14.2 3.3
Total Costs			\$22.1		\$2218.2
UNOCCUPIED PERIOD					
90	14.6	0.1	0.1		14.2 10.4
85	36.3	0.1	0.3		14.2 25.7
80	99.3	0.1	0.7		14.2 70.4
75	215.3	0.1	1.5		14.2 152.7
70	357.6	0.1	2.5		14.2 253.5
65	463.3	0.1	3.3		14.2 328.5
60	500.4	0.1	3.5		14.2 354.8
55	482.0	0.1	3.4		14.2 341.7
50	447.6	0.1	3.2		14.2 317.4
45	422.7	0.1	3.0		14.2 299.7
40	413.7	0.1	2.9		14.2 293.3
35	417.0	0.1	2.9		14.2 295.7
30	417.4	0.1	2.9		14.2 295.9
25	395.2	0.1	2.8		14.2 280.2
20	336.9	0.1	2.4		14.2 238.9
15	252.8	0.1	1.8		14.2 179.2
10	165.7	0.1	1.2		14.2 117.5
5	96.3	0.1	0.7		14.2 68.3
0	50.9	0.1	0.4		14.2 36.1
-5	25.3	0.1	0.2		14.2 17.9
-6	21.1	0.1	0.1		14.2 15.0
Total Costs			\$39.8		\$3992.7

COOLING COIL LOADS

Job : CCF SUBCON4/4F DESIGN SYS
Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-26-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON4/4F DESIGN SYS

Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON4/4F DESIGN SYS

Zone : Block

Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Period : All

Site : AURORA, IL FERMI, User Defined

Date : 11-26-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 1
RECIPROCATING CHILLERS WITH 8-STEP UNLOADERS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4F STDCW SYS Page 1
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117842.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 65157 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS

>1. PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4F STDCW SYS Page 2
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
 Site : AURORA, IL FERM1, User Defined 60117662.0
 Scope of Analysis : Cooling Systems Only

C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 200.0 tons
 KW/Ton @ 85 F entering water = 0.85 kw/ton
 Is hydronic cooling used ? <Y>
 Is chilled water reset used ? <N>
 Is hot gas bypass used ? <N>
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw
 Misc. kw : Occupied = 630.0 kw; Unoccupied = 630.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS

Period	Occupied	Unoccupied	Period	Occupied	Unoccupied	Unit Cost
0.050	0.050	0.050	0.050	0.050	0.050	n/a \$/therm
0.050	0.050	0.050	0.050	0.050	0.050	n/a \$/U.S.gal
0.050	0.050	0.050	0.050	0.050	0.050	n/a \$/lb
0.050	0.050	0.050	0.050	0.050	0.050	0.000 \$/MBTU
0.050	0.050	0.050	0.050	0.050	0.050	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 4/4F STDCW SYS

Period : All

Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Zone : Block

Site : AURORA,IL FERMI, User Defined

Serial Number:

Date : 11-26-86

60117862.0

HVAC ENERGY	Annual Cost (\$/yr)	Energy or Fuel Units Consumed	DGE RUF (1000 BTU)	DGE RIF (1000 BTU)
Electric (Occ)	16807	336150 kwh/yr	3899335	1147279
Electric (Unocc)	28681	573621 kwh/yr	6653999	1957767
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	45489		10553334	3105046

NON-HVAC ENERGY

Electric (Occ)	98551	1971018 kwh/yr	22863810	6727085
Electric (Unocc)	177389	3547782 kwh/yr	41154270	12108579
Non-HVAC Total	275940		64018079	18835664
Grand Total	321429		74571413	21940710
Total/Sq.Ft.	%321428.50		%74571413.38	%21940709.78

HVAC Summary:

HVAC Total Cost	=	%45488.51 \$/Sq.Ft./yr
	=	14.15 % of Total Cost
Total HVAC Electrical Energy	=	%909770.16 kwh/Sq.Ft./yr
	=	14.15 % of Total Electrical Energy
Non-Electrical HVAC Energy	=	-0.00 % of Total Energy

Key:

1 kwh	=	11600 BTU RUF; 3412 BTU RIF
1 therm nat gas	=	100000 BTU RUF and RIF
1 U.S. gal oil	=	138700 BTU RUF and RIF
1 Imp. gal oil	=	168000 BTU RUF and RIF
1 lb propane	=	21680 BTU RUF and RIF
RUF	=	Resource utilization factor (Source value)
RIF	=	Resource impact factor (Point of use value)
MBH	=	1000 BTU/hr
MBTU	=	Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4F STDCW SYS Page 1
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$62)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 65157 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4F STDCW SYS

Page 2

Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$39,216)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 200.0 tons

KW/Ton @ 85 F entering water = 0.85 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is hot gas bypass used ? <N>

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$6,211)

System	PERIMETER		dT, F	dP, ft wg	dT, F	dP, ft wg
	dT, F	dP, ft wg				
Chilled water	10.00	120.00	0.00	0.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00	0.00	0.00
Ground water	0.00	0.00	0.00	0.00	0.00	0.00

E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$275,940)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw

Misc. kw : Occupied = 630.0 kw; Unoccupied = 630.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$321,428)

>1. ELECTRICAL ENERGY USE	Period		>2. OTHER FUELS	Unit Cost
	Occupied (\$/kwh)	Unoccupied (\$/kwh)		
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	0.000 \$/MBTU
			Remote Cooling	n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 4/4F STDCW SYS
 Building Name : CCF SUBCONSTRUCT 4/4 FLUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant	No Interior Zone Exists
Temp	Hours	Coil Load	Input
(F)	hr/yr	MBH	KW
Cost			
			\$/yr
-----OCCUPIED PERIOD-----			
90	25.8	2150.7	130.2
85	59.4	2150.7	125.4
80	145.3	2150.7	120.7
75	237.7	2150.7	116.2
70	270.6	2150.7	112.0
65	264.5	2150.7	107.9
60	255.0	2150.7	104.0
55	244.7	2150.7	100.2
50	232.1	2150.7	93.9
45	229.5	2150.7	88.1
40	237.6	2150.7	82.6
35	238.5	2150.7	77.5
30	218.2	2150.7	72.7
25	174.5	2150.7	68.2
20	122.4	2150.7	63.9
15	78.1	2150.7	59.9
10	46.1	2150.7	56.1
5	25.1	2150.7	52.6
0	12.7	2150.7	52.6
-5	6.2	2150.7	52.6
-6	4.6	2150.7	52.6
Total Costs			\$14567.2
-----UNOCCUPIED PERIOD-----			
90	14.6	2150.7	130.2
85	36.3	2150.7	125.4
80	99.3	2150.7	120.7
75	215.3	2150.7	116.2
70	357.6	2150.7	112.0
65	463.3	2150.7	107.9
60	500.4	2150.7	104.0
55	482.0	2150.7	100.2
50	447.6	2150.7	93.9
45	422.7	2150.7	88.1
40	413.7	2150.7	82.6
35	417.0	2150.7	77.5
30	417.4	2150.7	72.7
25	395.2	2150.7	68.2
20	336.9	2150.7	63.9
15	252.8	2150.7	59.9
10	165.7	2150.7	56.1
5	96.3	2150.7	52.6
0	50.9	2150.7	52.6
-5	25.3	2150.7	52.6
-6	21.1	2150.7	52.6
Total Costs			\$24648.5

FAN AND PUMP COSTS

Job Name : CCF SUBCON 4/4F STDCW SYS
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	0.1	0.2		14.2 18.3
85	59.4	0.1	0.4		14.2 42.1
80	145.3	0.1	1.0		14.2 103.0
75	237.7	0.1	1.7		14.2 168.5
70	270.6	0.1	1.9		14.2 191.9
65	264.5	0.1	1.9		14.2 187.5
60	255.0	0.1	1.8		14.2 180.8
55	244.7	0.1	1.7		14.2 173.5
50	232.1	0.1	1.6		14.2 164.6
45	229.5	0.1	1.6		14.2 162.7
40	237.6	0.1	1.7		14.2 168.5
35	238.5	0.1	1.7		14.2 169.1
30	218.2	0.1	1.5		14.2 154.7
25	174.5	0.1	1.2		14.2 123.7
20	122.4	0.1	0.9		14.2 86.8
15	78.1	0.1	0.6		14.2 55.4
10	46.1	0.1	0.3		14.2 32.7
5	25.1	0.1	0.2		14.2 17.8
0	12.7	0.1	0.1		14.2 9.0
-5	6.2	0.1	0.0		14.2 4.4
-6	4.6	0.1	0.0		14.2 3.3
Total Costs			\$22.1		\$2218.2
UNOCCUPIED PERIOD					
90	14.6	0.1	0.1		14.2 10.4
85	36.3	0.1	0.3		14.2 25.7
80	99.3	0.1	0.7		14.2 70.4
75	215.3	0.1	1.5		14.2 152.7
70	357.6	0.1	2.5		14.2 253.5
65	463.3	0.1	3.3		14.2 328.5
60	500.4	0.1	3.5		14.2 354.8
55	482.0	0.1	3.4		14.2 341.7
50	447.6	0.1	3.2		14.2 317.4
45	422.7	0.1	3.0		14.2 299.7
40	413.7	0.1	2.9		14.2 293.3
35	417.0	0.1	2.9		14.2 295.7
30	417.4	0.1	2.9		14.2 295.9
25	395.2	0.1	2.8		14.2 280.2
20	336.9	0.1	2.4		14.2 238.9
15	252.8	0.1	1.8		14.2 179.2
10	165.7	0.1	1.2		14.2 117.5
5	96.3	0.1	0.7		14.2 68.3
0	50.9	0.1	0.4		14.2 36.1
-5	25.3	0.1	0.2		14.2 17.9
-6	21.1	0.1	0.1		14.2 15.0
Total Costs			\$39.8		\$3992.7

COOLING COIL LOADS

Job : CCF SUBCON 4/4F STDCW SYS
Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-26-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 4/4F STDCW SYS

Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 4/4F STDCW SYS

Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
OPERATIONAL PERFORMANCE SIMULATION

ALTERNATE COMPARISON SYSTEM NUMBER 2
TYPICAL FY1975 DESIGN
RECIPROCATING CHILLERS WITH STANDARD EFFICIENCY COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4F 1975 SYS Page 1
Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
Site : AURORA, IL FERMI, User Defined 60117862.0
Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 65157 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS

> 1 . PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

SYSTEM INPUT SUMMARY

Job Name : CCF SUBCON 4/4F 1975 SYS Page 2
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex) Date : 11-26-86
 Site : AURORA,IL FERMI, User Defined 60117862.0
 Scope of Analysis : Cooling Systems Only

***** C. COOLING PLANTS

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED
 Capacity @ 85 F entering water = 200.0 tons
 KW/Ton @ 85 F entering water = 0.95 kw/ton
 Is hydronic cooling used ? <Y>
 Is chilled water reset used ? <N>
 Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %
 Is condenser performance altitude adjusted ? <Y>
 Is there one compressor per condenser circuit ? <Y>
 Are compressors cycled ? <N>
 Heat sink type : Open cooling tower
 Minimum entering water temperature = 35 F
 Is a hydronic economizer used ? <N>

***** D. PUMPING SYSTEMS

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

***** E. NON-HVAC SYSTEMS

>1. NON-HVAC ELECTRICAL ENERGY USE
 Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw
 Misc. kw : Occupied = 630.0 kw; Unoccupied = 630.0 kw
 Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw
 >2. DHW SYSTEM (Not utilized in this system)

***** F. FUEL COSTS

>1. Period			>2. OTHER FUELS : Unit Cost	
ELECTRICAL : Occupied	Unoccupied			
ENERGY USE : (\$/kwh)	(\$/kwh)			
Compressor	0.050	0.050	Natural Gas	n/a \$/therm
Resistance	0.050	0.050	Fuel Oil	n/a \$/U.S.gal
Inductive	0.050	0.050	Propane	n/a \$/lb
			Remote Heating	0.000 \$/MBTU
			Remote Cooling	n/a \$/MBTU

TOTAL BUILDING ENERGY SUMMARY

Job Name : CCF SUBCON 4/4F 1975 SYS
Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)
Site : AURORA,IL FERMI, User Defined
Date : 11-26-86

Period : All
Zone : Block
Serial Number:
60117862.0

HVAC ENERGY	Annual	Energy or Fuel	DOE RUF	DOE RIF
Component	Cost	Units	(1000 BTU)	(1000 BTU)
	(\$/yr)	Consumed		
Electric (Occ)	26671	533419 kwh/yr	6187665	1820560
Electric (Unocc)	48007	960141 kwh/yr	11137639	3276962
Natural Gas	0	0 therms/yr	0	0
Fuel Oil	0	0 U.S. gal/yr	0	0
Propane	0	0 lb/yr	0	0
Remote Heating	0	0 MBTU/yr	0	0
Remote Cooling	0	0 MBTU/yr	0	0
HVAC Total	74678		17325304	5097523

NON-HVAC ENERGY

Electric (Occ)	98551	1971018 kwh/yr	22863810	6727085
Electric (Unocc)	177389	3547782 kwh/yr	41154270	12108579
Non-HVAC Total	275940		64018079	18835664
Grand Total	350618		81343383	23933187
Total/Sq.Ft.	%350618.02		%81343382.92	%23933186.68

HVAC Summary:

HVAC Total Cost = %74678.03 \$/Sq.Ft./yr
= 21.30 % of Total Cost
Total HVAC Electrical Energy = %1493560.62 kwh/Sq.Ft./yr
= 21.30 % of Total Electrical Energy
Non-Electrical HVAC Energy = 0.00 % of Total Energy

Key:

1 kwh = 11600 BTU RUF; 3412 BTU RIF
1 therm nat gas = 100000 BTU RUF and RIF
1 U.S. gal oil = 138700 BTU RUF and RIF
1 Imp. gal oil = 168000 BTU RUF and RIF
1 lb propane = 21680 BTU RUF and RIF
RUF = Resource utilization factor (Source value)
RIF = Resource impact factor (Point of use value)
MBH = 1000 BTU/hr
MBTU = Million BTU

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4F 1975 SYS

Page 1

Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

A. AIR HANDLING SYSTEMS (ANNUAL FAN OPERATING COST = \$62)

>1. PERIMETER TERMINAL TYPE : CONSTANT VOLUME

Supply fan type : Backward inclined or airfoil

Supply fan total static pressure = 0.01 in. wg.

A return fan is not used.

Design supply air= 65157 cfm @ 55 F; Vent. air= 0 cfm

Are cooling terminals used for heating ? <N>

Zone heating unit type : Baseboard units

An economizer is not used.

Is a ventilation reclaim device used ? <N>

Are ventilation air dampers closed for unoccupied periods ? <Y>

Damper leak rate = 0.00 % of supply air flow rate

B. HEATING PLANTS (ANNUAL HEATING PLANT OPERATING COST = \$0)

>1. PERIMETER PLANT : REMOTE SOURCE HEATING

Is hydronic heating used ? <Y>

ANNUAL OPERATING COSTS

Job Name : CCF SUBCON 4/4F 1975 SYS

Page 2

Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Date : 11-26-86

Site : AURORA,IL FERMI, User Defined

60117862.0

Scope of Analysis : Cooling Systems Only

 C. COOLING PLANTS (ANNUAL COOLING PLANT OPERATING COST = \$68,405)

>1. PERIMETER PLANT : RECIPROCATING WATER COOLED

Capacity @ 85 F entering water = 200.0 tons

KW/Ton @ 85 F entering water = 0.95 kw/ton

Is hydronic cooling used ? <Y>

Is chilled water reset used ? <N>

Is hot gas bypass used ? <Y> ; Minimum percent unloading = 30 %

Is condenser performance altitude adjusted ? <Y>

Is there one compressor per condenser circuit ? <Y>

Are compressors cycled ? <N>

Heat sink type : Open cooling tower

Minimum entering water temperature = 35 F

Is a hydronic economizer used ? <N>

 D. PUMPING SYSTEMS (ANNUAL PUMP OPERATING COST = \$6,211)

System	PERIMETER		dT, F	dP, ft wg
	dT, F	dP, ft wg		
Chilled water	10.00	120.00	0.00	0.00
Hot water	0.00	0.00	0.00	0.00
Condenser water	10.00	0.01	0.00	0.00
Ground water	0.00	0.00	0.00	0.00

 E. NON-HVAC SYSTEMS (ANNUAL NON-HVAC OPERATING COST = \$275,940)

>1. NON-HVAC ELECTRICAL ENERGY USE

Lighting kw: Occupied = 0.0 kw; Unoccupied = 0.0 kw

Misc. kw : Occupied = 630.0 kw; Unoccupied = 630.0 kw

Other kw : Occupied = 0.0 kw; Unoccupied = 0.0 kw

>2. DHW SYSTEM (Not utilized in this system)

 F. FUEL COSTS (GRAND TOTAL ANNUAL OPERATING COST = \$350,618)

>1. Period			>2. OTHER FUELS		Unit Cost
ELECTRICAL	Occupied	Unoccupied			
ENERGY USE	(\$/kwh)	(\$/kwh)			
Compressor	0.050	0.050	Natural Gas		n/a \$/therm
Resistance	0.050	0.050	Fuel Oil		n/a \$/U.S.gal
Inductive	0.050	0.050	Propane		n/a \$/lb
			Remote Heating	0.000	\$/MBTU
			Remote Cooling		n/a \$/MBTU

COOLING PLANT COSTS

Job Name : CCF SUBCON 4/4F 1975 SYS
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter Cooling Plant	No Interior Zone Exists
Temp	Hours	Coil Load	Input
(F)	hr/yr	MBH	KW
			Cost
			\$/yr

OCCUPIED PERIOD

90	25.8	2150.7	156.2	201.5
85	59.4	2150.7	156.2	463.8
80	145.3	2150.7	156.2	1134.6
75	237.7	2150.7	156.2	1856.2
70	270.6	2150.7	156.2	2113.1
65	264.5	2150.7	156.2	2065.4
60	255.0	2150.7	156.2	1991.2
55	244.7	2150.7	156.2	1910.8
50	232.1	2150.7	156.2	1812.4
45	229.5	2150.7	156.2	1792.1
40	237.6	2150.7	156.2	1855.4
35	238.5	2150.7	156.2	1862.4
30	218.2	2150.7	156.2	1703.9
25	174.5	2150.7	156.2	1362.6
20	122.4	2150.7	156.2	955.8
15	78.1	2150.7	156.2	609.9
10	46.1	2150.7	156.2	360.0
5	25.1	2150.7	156.2	196.0
0	12.7	2150.7	156.2	99.2
-5	6.2	2150.7	156.2	48.4
-6	4.6	2150.7	156.2	35.9

Total Costs \$24430.6

UNOCCUPIED PERIOD

90	14.6	2150.7	156.2	114.0
85	36.3	2150.7	156.2	283.5
80	99.3	2150.7	156.2	775.4
75	215.3	2150.7	156.2	1681.2
70	357.6	2150.7	156.2	2792.4
65	463.3	2150.7	156.2	3617.8
60	500.4	2150.7	156.2	3907.5
55	482.0	2150.7	156.2	3763.8
50	447.6	2150.7	156.2	3495.2
45	422.7	2150.7	156.2	3300.8
40	413.7	2150.7	156.2	3230.5
35	417.0	2150.7	156.2	3256.3
30	417.4	2150.7	156.2	3259.4
25	395.2	2150.7	156.2	3086.0
20	336.9	2150.7	156.2	2630.8
15	252.8	2150.7	156.2	1974.1
10	165.7	2150.7	156.2	1293.9
5	96.3	2150.7	156.2	752.0
0	50.9	2150.7	156.2	397.5
-5	25.3	2150.7	156.2	197.6
-6	21.1	2150.7	156.2	164.8

Total Costs \$43974.5

FAN AND PUMP COSTS

Job Name : CCF SUBCON 4/4F 1975 SYS
 Building Name : CCF SUBCONSTRUCT 4/4 FUT (Complex)
 Site Name : AURORA,IL FERMI, User Defined

Date : 11-26-86
 Serial Number:
 60117862.0

Bin	Bin	Perimeter	Fans	No Interior Zone	All Pumps
Temp	Hours	Input	Cost		Input
(F)	hr/yr	KW	\$/yr		KW
					Cost
					\$/yr
OCCUPIED PERIOD					
90	25.8	0.1	0.2		14.2 18.3
85	59.4	0.1	0.4		14.2 42.1
80	145.3	0.1	1.0		14.2 103.0
75	237.7	0.1	1.7		14.2 168.5
70	270.6	0.1	1.9		14.2 191.9
65	264.5	0.1	1.9		14.2 187.5
60	255.0	0.1	1.8		14.2 180.8
55	244.7	0.1	1.7		14.2 173.5
50	232.1	0.1	1.6		14.2 164.6
45	229.5	0.1	1.6		14.2 162.7
40	237.6	0.1	1.7		14.2 168.5
35	238.5	0.1	1.7		14.2 169.1
30	218.2	0.1	1.5		14.2 154.7
25	174.5	0.1	1.2		14.2 123.7
20	122.4	0.1	0.9		14.2 86.8
15	78.1	0.1	0.6		14.2 55.4
10	46.1	0.1	0.3		14.2 32.7
5	25.1	0.1	0.2		14.2 17.8
0	12.7	0.1	0.1		14.2 9.0
-5	6.2	0.1	0.0		14.2 4.4
-6	4.6	0.1	0.0		14.2 3.3
Total Costs			\$22.1		\$2218.2
UNOCCUPIED PERIOD					
90	14.6	0.1	0.1		14.2 10.4
85	36.3	0.1	0.3		14.2 25.7
80	99.3	0.1	0.7		14.2 70.4
75	215.3	0.1	1.5		14.2 152.7
70	357.6	0.1	2.5		14.2 253.5
65	463.3	0.1	3.3		14.2 328.5
60	500.4	0.1	3.5		14.2 354.8
55	482.0	0.1	3.4		14.2 341.7
50	447.6	0.1	3.2		14.2 317.4
45	422.7	0.1	3.0		14.2 299.7
40	413.7	0.1	2.9		14.2 293.3
35	417.0	0.1	2.9		14.2 295.7
30	417.4	0.1	2.9		14.2 295.9
25	395.2	0.1	2.8		14.2 280.2
20	336.9	0.1	2.4		14.2 238.9
15	252.8	0.1	1.8		14.2 179.2
10	165.7	0.1	1.2		14.2 117.5
5	96.3	0.1	0.7		14.2 68.3
0	50.9	0.1	0.4		14.2 36.1
-5	25.3	0.1	0.2		14.2 17.9
-6	21.1	0.1	0.1		14.2 15.0
Total Costs			\$39.8		\$3992.8

COOLING COIL LOADS

Job : CCF SUBCON 4/4F 1975 SYS
Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)
Site : AURORA, IL FERMI, User Defined

Zone : Block
Period : All
Date : 11-26-86

COOLING PLANT INPUT POWER

Job : CCF SUBCON 4/4F 1975 SYS

Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

COOLING PLANT OPERATING COSTS

Job : CCF SUBCON 4/4F 1975 SYS

Building : CCF SUBCONSTRUCT 4/4 FUT (Complex)

Site : AURORA, IL FERMI, User Defined

Zone : Block

Period : All

Date : 11-26-86

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
SYSTEMS LIFE CYCLE COST ANALYSIS
AND
PAYBACK CALCULATIONS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
LIFE CYCLE COST ANALYSIS
FOR

DESIGN BASIS SYSTEM
RECIPROCATING CHILLERS WITH FREE COOLING AND 8 STEP COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON4/4F DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$168000 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 168000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 22112.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 2000.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON4/4F DESIGN SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$168000 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	168000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	22317.40	22503.56	22691.26
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	2040.99	2061.79	2082.81
YEAR'S	\$	168000.00	0.00	24358.39	24565.35	24774.07
CUM.	\$	168000.00	168000.00	192358.39	216923.73	241697.81

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	22880.53	23071.38	23263.82	23457.87	23653.53
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2104.05	2125.50	2147.16	2169.05	2191.17
YEAR'S	\$	24984.57	25196.88	25410.99	25626.92	25844.70
CUM.	\$	266682.38	291879.25	317290.25	342917.19	368761.88

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	23850.83	24049.77	24250.37	24452.64	24656.61
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2213.51	2236.07	2258.87	2281.90	2305.16
YEAR'S	\$	26064.33	26285.84	26509.24	26734.54	26961.76
CUM.	\$	394826.22	421112.06	447621.31	474355.84	501317.59

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	24862.27	25069.65	25278.76	25489.61	25702.22
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2328.66	2352.40	2376.38	2400.61	2425.08
YEAR 'S	\$	27190.93	27422.05	27655.14	27890.21	28127.30
CUM.	\$	528508.50	555930.56	583585.69	611475.88	639603.19

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	25916.60	26132.78	26350.75	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	2449.80	2474.78	2500.01	0.00	0.00
YEAR 'S	\$	28366.40	28607.55	28850.76	0.00	0.00
CUM.	\$	667969.56	696577.12	725427.88	725427.88	725427.88

FERMILAB CENTRAL COMPUTING FACILITY
SUBCONSTRUCTION 4/4 FUTURE
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 1
RECIPROCATING CHILLERS WITH 8 STEP COMPRESSORS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 4/4F STDCW SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 152000

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 152000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 45489.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 1500.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 4/4F STDOW SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : 152000

YEAR		1986	1987	1988	1989	1990
CASH	\$	152000.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	45911.56	46294.51	46680.66
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	1530.74	1546.35	1562.11
YEAR'S	\$	152000.00	0.00	47442.30	47840.86	48242.77
CUM.	\$	152000.00	152000.00	199442.30	247283.16	295525.94

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	47070.03	47462.65	47858.54	48257.73	48660.25
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1578.03	1594.12	1610.37	1626.79	1643.38
YEAR'S	\$	48648.06	49056.77	49468.91	49884.52	50303.63
CUM.	\$	344174.00	393230.75	442699.66	492584.19	542887.81

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	49066.13	49475.40	49888.08	50304.20	50723.79
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1660.13	1677.05	1694.15	1711.42	1728.87
YEAR'S	\$	50726.26	51152.45	51582.23	52015.61	52452.66
CUM.	\$	593614.06	644766.50	696348.75	748364.38	800817.00

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	51146.88	51573.50	52003.68	52437.45	52874.83
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1746.49	1764.30	1782.29	1800.45	1818.81
YEAR'S	\$	52893.38	53337.80	53785.97	54237.90	54693.65
CUM.	\$	853710.38	907048.19	960834.12	1015072.00	1069765.62

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	53315.86	53760.58	54209.00	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1837.35	1856.08	1875.00	0.00	0.00
YEAR'S	\$	55153.22	55616.66	56084.00	0.00	0.00
CUM.	\$	1124918.88	1180535.50	1236619.50	1236619.50	1236619.50

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
LIFE CYCLE COST ANALYSIS
FOR
ALTERNATE SYSTEM NUMBER 2
FY1975 RECIPROCATING CHILLERS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

PROJECT NAME : CCF SUBCON 4/4F 1975W SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$140000 PER UNIT COSTS

ESTIMATE YEAR : 1986
 COMMISSION YEAR : 1988
 LAST STUDY YEAR : 2008

**** NON-FINANCED CASH DEBITS/CREDITS ****

YEAR AMOUNT
 1986 140000.00

**** FINANCE INSTRUMENTS ****

NOTE 1 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

NOTE 2 PRINCIPAL (1986 EST.) = \$ 0.00
 (0 EST.) = \$ 0.00
 INSTRUMENT = NONE

**** FUEL COSTS ****

1986 EST. OF FUEL 1 = \$ 74678.00 (ELEC.)
 2 = \$ 0.00
 3 = \$ 0.00

**** MAINTENANCE COST ****

1986 EST. OF MAINT. = \$ 1500.00

**** DISCOUNT/INTEREST/ESCALATION RATES ****

YEAR	%	FINANCE %		ESCALATION %			
		LOAN1	LOAN2	FUEL1	FUEL2	FUEL3	MAIN.
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1987	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1988	7.90	0.00	0.00	8.40	0.00	0.00	9.00
1989	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1990	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1991	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1992	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1993	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1994	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1995	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1996	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1997	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1998	7.90	0.00	0.00	8.80	0.00	0.00	9.00
1999	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2000	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2001	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2002	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2003	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2004	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2005	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2006	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2007	7.90	0.00	0.00	8.80	0.00	0.00	9.00
2008	7.90	0.00	0.00	8.80	0.00	0.00	9.00

**** UNIFIED PRESENT WORTH LIFE CYCLE COST ****

PROJECT NAME : CCF SUBCON 4/4F 1975W SYS
 ANALYST NAME : S.F.KRSTULOVICH
 COMMENTS : \$140000 PER UNIT COSTS

YEAR		1986	1987	1988	1989	1990
CASH	\$	140000.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	0.00	0.00	75371.71	76000.39	76634.32
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	0.00	0.00	1530.74	1546.35	1562.11
YEAR'S	\$	140000.00	0.00	76902.45	77546.73	78196.43
CUM.	\$	140000.00	140000.00	216902.44	294449.19	372645.62

YEAR		1991	1992	1993	1994	1995
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	77273.54	77918.09	78568.02	79223.36	79884.17
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1578.03	1594.12	1610.37	1626.79	1643.38
YEAR'S	\$	79851.57	79512.20	80178.39	80850.15	81527.55
CUM.	\$	451497.19	531009.38	611187.75	692037.88	773565.44

YEAR		1996	1997	1998	1999	2000
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT. 1	\$	0.00	0.00	0.00	0.00	0.00
MORT. 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	80550.48	81222.36	81899.85	82582.98	83271.81
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1660.13	1677.05	1694.15	1711.42	1728.87
YEAR'S	\$	82210.62	82899.41	83594.00	84294.41	85000.69
CUM.	\$	855776.06	938675.50	1022269.50	1106563.88	1191564.50

YEAR		2001	2002	2003	2004	2005
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	83966.40	84666.77	85372.98	86085.09	86803.13
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1746.49	1764.30	1782.29	1800.45	1818.81
YEAR'S	\$	85712.89	86431.07	87155.26	87885.54	88621.94
CUM.	\$	1277277.38	1363708.50	1450863.75	1538749.25	1627371.25

YEAR		2006	2007	2008	2009	2010
CASH	\$	0.00	0.00	0.00	0.00	0.00
MORT.1	\$	0.00	0.00	0.00	0.00	0.00
MORT.2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 1	\$	87527.16	88257.23	88993.39	0.00	0.00
FUEL 2	\$	0.00	0.00	0.00	0.00	0.00
FUEL 3	\$	0.00	0.00	0.00	0.00	0.00
MAINT.	\$	1837.35	1856.08	1875.00	0.00	0.00
YEAR'S	\$	89364.51	90113.31	90868.40	0.00	0.00
CUM.	\$	1716735.75	1806849.00	1897717.38	1897717.38	1897717.38

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
LIFE CYCLE COST ANALYSIS
UNIFIED PRESENT WORTH COMPARISONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC16.DAT
 PROJECT : CCF SUBCON4/4F DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$168000 PER UNIT COSTS

FILE NO. : LCC17.DAT
 PROJECT : CCF SUBCON 4/4F STDCW SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : 152000

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	168000.00	152000.00	16000.00	16000.00
1987	0.00	0.00	0.00	16000.00
1988	24358.39	47442.30	-23083.91	-7083.91
1989	24565.35	47840.86	-23275.51	-30359.42
1990	24774.07	48242.77	-23468.70	-53828.12
1991	24984.57	48648.06	-23663.49	-77491.60
1992	25196.88	49056.77	-23859.89	-101351.49
1993	25410.99	49468.91	-24057.92	-125409.41
1994	25626.92	49884.52	-24257.60	-149667.02
1995	25844.70	50303.63	-24458.93	-174125.94
1996	26064.33	50726.26	-24661.93	-198787.88
1997	26285.84	51152.45	-24866.61	-223654.48
1998	26509.24	51582.23	-25072.99	-248727.48
1999	26734.54	52015.61	-25281.07	-274008.56
2000	26961.76	52452.66	-25490.90	-299499.47
2001	27190.93	52893.38	-25702.45	-325201.91
2002	27422.05	53337.80	-25915.75	-351117.66
2003	27655.14	53785.97	-26130.83	-377248.50
2004	27890.21	54237.90	-26347.69	-403596.19
2005	28127.30	54693.65	-26566.35	-430162.53
2006	28366.40	55153.22	-26786.82	-456949.34
2007	28607.55	55616.66	-27009.11	-483958.44
2008	28850.76	56084.00	-27233.24	-511191.69

*** APPARENT BREAK-EVEN YEAR = 1988 ***

**** UPW LIFE CYCLE COST COMPARISON ****

FILE NO. : LCC16.DAT
 PROJECT : CCF SUBCON4/4F DESIGN SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$168000 PER UNIT COSTS

FILE NO. : LCC18.DAT
 PROJECT : CCF SUBCON 4/4F 1975W SYS
 ANALYST : S.F.KRSTULOVICH
 COMMENTS : \$140000 PER UNIT COSTS

YEAR	(A) FILE 1 \$	(B) FILE 2 \$	(A-B) YR'S \$	(A-B) CUM. \$
1986	168000.00	140000.00	28000.00	28000.00
1987	0.00	0.00	0.00	28000.00
1988	24358.39	76902.45	-52544.06	-24544.06
1989	24565.35	77546.73	-52981.38	-77525.44
1990	24774.07	78196.43	-53422.36	-130947.81
1991	24984.57	78851.57	-53867.00	-184814.81
1992	25196.88	79512.20	-54315.32	-239130.13
1993	25410.99	80178.39	-54767.40	-293897.50
1994	25626.92	80850.15	-55223.23	-349120.75
1995	25844.70	81527.55	-55682.85	-404803.62
1996	26064.33	82210.62	-56146.29	-460949.91
1997	26285.84	82899.41	-56613.57	-517563.47
1998	26509.24	83594.00	-57084.76	-574648.25
1999	26734.54	84294.41	-57559.87	-632208.06
2000	26961.76	85000.69	-58038.93	-690247.00
2001	27190.93	85712.89	-58521.96	-748768.94
2002	27422.05	86431.07	-59009.02	-807777.94
2003	27655.14	87155.26	-59500.12	-867278.06
2004	27890.21	87885.54	-59995.33	-927273.44
2005	28127.30	88621.94	-60494.64	-987768.06
2006	28366.40	89364.51	-60998.11	-1048766.25
2007	28607.55	90113.31	-61505.76	-1110272.00
2008	28850.76	90868.40	-62017.64	-1172289.62

*** APPARENT BREAK-EVEN YEAR = 1988 ***

FERMILAB CENTRAL COMPUTING FACILITY

SUBCONSTRUCTION 4/4 FUTURE
SIMPLE PAYBACK CALCULATIONS
FOR
ALL SYSTEMS

12 NOVEMBER, 1986
ANALYST: S.F.KRSTULOVICH

FERMILAB CONSTRUCTION ENGINEERING SERVICES

CCF SUBCONSTRUCT 4/4F
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	STD CW SYS
INITIAL TOTAL COST	\$ 168,000	\$ 152,000
ANNUAL OPERATING COST	\$ 22,112	\$ 45,489
ANNUAL MAINTENANCE COST	\$ 2,000	\$ 1,500
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

YEAR	DESIGN SYS EXPENSES		STD CW SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 168,000	\$ 168,000	\$ 152,000	\$ 152,000

1	\$ 24,112	\$ 192,112	\$ 46,989	\$ 198,989
2	\$ 24,112	\$ 216,224	\$ 46,989	\$ 245,978
3	\$ 24,112	\$ 240,336	\$ 46,989	\$ 292,967
4	\$ 24,112	\$ 264,448	\$ 46,989	\$ 339,956
5	\$ 24,112	\$ 288,560	\$ 46,989	\$ 386,945
6	\$ 24,112	\$ 312,672	\$ 46,989	\$ 433,934
7	\$ 24,112	\$ 336,784	\$ 46,989	\$ 480,923
8	\$ 24,112	\$ 360,896	\$ 46,989	\$ 527,912
9	\$ 24,112	\$ 385,008	\$ 46,989	\$ 574,901
10	\$ 24,112	\$ 409,120	\$ 46,989	\$ 621,890
11	\$ 24,112	\$ 433,232	\$ 46,989	\$ 668,879
12	\$ 24,112	\$ 457,344	\$ 46,989	\$ 715,868
13	\$ 24,112	\$ 481,456	\$ 46,989	\$ 762,857
14	\$ 24,112	\$ 505,568	\$ 46,989	\$ 809,846
15	\$ 24,112	\$ 529,680	\$ 46,989	\$ 856,835
16	\$ 24,112	\$ 553,792	\$ 46,989	\$ 903,824
17	\$ 24,112	\$ 577,904	\$ 46,989	\$ 950,813
18	\$ 24,112	\$ 602,016	\$ 46,989	\$ 997,802
19	\$ 24,112	\$ 626,128	\$ 46,989	\$1,044,791
20	\$ 24,112	\$ 650,240	\$ 46,989	\$1,091,780
SALVAGE (\$	0)	\$ 650,240	(\$ 0)	\$1,091,780

PAYBACK FOR DESIGN SYS OCCURS AFTER 0.7 YEARS (\$ 184,864)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 650,240

TOTAL COST OF STD CW SYS FOR 20 YEARS IS \$1,091,780

CCF SUBCONSTRUCT 4/4F
SIMPLE PAYBACK

INPUT VALUES	DESIGN SYS	1975W SYS
INITIAL TOTAL COST	\$ 168,000	\$ 140,000
ANNUAL OPERATING COST	\$ 22,112	\$ 74,678
ANNUAL MAINTENANCE COST	\$ 2,000	\$ 1,500
SALVAGE VALUE AT YEAR 20	\$ 0	\$ 0

YEAR	DESIGN SYS EXPENSES		1975W SYS EXPENSES	
	ANNUAL	CUMULATIVE	ANNUAL	CUMULATIVE
INITIAL	\$ 168,000	\$ 168,000	\$ 140,000	\$ 140,000

1	\$ 24,112	\$ 192,112	\$ 76,178	\$ 216,178
2	\$ 24,112	\$ 216,224	\$ 76,178	\$ 292,356
3	\$ 24,112	\$ 240,336	\$ 76,178	\$ 368,534
4	\$ 24,112	\$ 264,448	\$ 76,178	\$ 444,712
5	\$ 24,112	\$ 288,560	\$ 76,178	\$ 520,890
6	\$ 24,112	\$ 312,672	\$ 76,178	\$ 597,068
7	\$ 24,112	\$ 336,784	\$ 76,178	\$ 673,246
8	\$ 24,112	\$ 360,896	\$ 76,178	\$ 749,424
9	\$ 24,112	\$ 385,008	\$ 76,178	\$ 825,602
10	\$ 24,112	\$ 409,120	\$ 76,178	\$ 901,780
11	\$ 24,112	\$ 433,232	\$ 76,178	\$ 977,958
12	\$ 24,112	\$ 457,344	\$ 76,178	\$1,054,136
13	\$ 24,112	\$ 481,456	\$ 76,178	\$1,130,314
14	\$ 24,112	\$ 505,568	\$ 76,178	\$1,206,492
15	\$ 24,112	\$ 529,680	\$ 76,178	\$1,282,670
16	\$ 24,112	\$ 553,792	\$ 76,178	\$1,358,848
17	\$ 24,112	\$ 577,904	\$ 76,178	\$1,435,026
18	\$ 24,112	\$ 602,016	\$ 76,178	\$1,511,204
19	\$ 24,112	\$ 626,128	\$ 76,178	\$1,587,382
20	\$ 24,112	\$ 650,240	\$ 76,178	\$1,663,560
SALVAGE (\$	0)	\$ 650,240	(\$ 0)	\$1,663,560

PAYBACK FOR DESIGN SYS OCCURS AFTER 0.5 YEARS (\$ 180,967)

TOTAL COST OF DESIGN SYS FOR 20 YEARS IS \$ 650,240

TOTAL COST OF 1975W SYS FOR 20 YEARS IS \$1,663,560

TM-1436
Appendices X - XII

MANUFACTURER EVALUATION
OF
COMPUTER ROOM DX AC EQUIPMENT

Liebert Corporation
Environmental Systems
Energy Analysis

5/16/86

For
FERMI LABS
STEVE KRSTULOVICH

15 TON UNIT

Prepared by
ZONATHERM PRODUCTS
MICHAEL BORDENET

Liebert Corporation
1050 Dearborn Drive, Columbus, Ohio 43229
Environmental Energy Analysis
For FERMILAB

5/16/86
Page: 1

Pre-report summary

The energy cost of 1 FH 1926 (60 Hz) units for one year is \$ 14375

Design Criteria

Region Chicago, Illinois	Model Unit.....FH 1926 (60 Hz)
Room Drybulb..... 72 F	Air Flow per Unit..... 8400 CFM
Room Relative Humidity..... 50 %	No. of Compressors per Unit.. 2
Main Fan Motor..... 3.00 HP	Glycol Pump Motor..... 2.00 HP
Number of Units..... 1	Drycooler Fan Motor..... 2.25 HP
Design Ambient..... 95 F	

Performance and Operation Breakdown

Temperature Range (F)	min-35	35-39	40-44	45-49	50-54	55-59	60-64
Mean Coincident WB (F)	30.0	34.0	38.0	43.0	47.0	52.0	57.0
Total Room Load (KBTUH)	164.2	164.2	164.2	164.2	164.2	164.2	164.2
Sens Room Load (KBTUH)	156.4	156.4	156.4	156.4	156.4	156.4	156.4
Total Cool/Unit (KBTUH)	188.7	188.7	188.7	188.7	188.7	188.7	188.7
Sens Cool/Unit (KBTUH)	167.2	167.2	167.2	167.2	167.2	167.2	167.2
Evaporator Temp (F)	43.4	43.4	43.4	43.4	43.4	43.4	43.4
Condensing Temp (F)	105.0	105.0	105.0	105.0	105.0	105.0	105.0
Humidifier Cap (lb/hr)	17.4	17.4	17.4	17.4	17.4	17.4	17.4

Breakdown of Energy Use

Fan Motor	Max (KW)	2.2	2.2	2.2	2.2	2.2	2.2
	x %Oper	100.0	100.0	100.0	100.0	100.0	100.0
	= Actual (KW/H)	2.2	2.2	2.2	2.2	2.2	2.2
Compressor 1	Max (KW)	6.2	6.2	6.2	6.2	6.2	6.2
	x %Oper	100.0	100.0	100.0	100.0	100.0	100.0
	= Actual (KW/H)	6.2	6.2	6.2	6.2	6.2	6.2
Compressor 2	Max (KW)	6.2	6.2	6.2	6.2	6.2	6.2
	x %Oper	83.8	83.8	83.8	83.8	83.8	83.8
	= Actual (KW/H)	5.2	5.2	5.2	5.2	5.2	5.2
Humidifier	Max (KW)	6.4	6.4	6.4	6.4	6.4	6.4
	x %Oper	59.6	59.6	59.6	59.6	59.6	59.6
	= Actual (KW/H)	3.8	3.8	3.8	3.8	3.8	3.8
Reheat	Max (KW)	25.0	25.0	25.0	25.0	25.0	25.0
	x %Oper	0.0	0.0	0.0	0.0	0.0	0.0
	= Actual (KW/H)	0.0	0.0	0.0	0.0	0.0	0.0
Glycol Pump & Drycooler	Max (KW)	3.2	3.2	3.2	3.2	3.2	3.2
	x %Oper	100.0	100.0	100.0	100.0	100.0	100.0
	= Actual (KW/H)	3.2	3.2	3.2	3.2	3.2	3.2
Total KW/Hour.....		20.5	20.5	20.5	20.5	20.5	20.5
x Hours/Year.....		2521	725	572	565	581	700
x Cost/KWHR.....		\$0.080	\$0.080	\$0.080	\$0.080	\$0.080	\$0.080
	=====						
= Cost/Unit.....		\$ 4141	\$ 1191	\$ 940	\$ 928	\$ 954	\$ 1150

These ratios reflect the opinion of Liebert Corporation engineers based on available published catalog information.

Liebert Corporation
1050 Dearborn Drive, Columbus, Ohio 43229
Environmental Energy Analysis
For **FERMI LAB**

5/16/86
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Performance and Operation Breakdown (cont.)

Temperature Range (F)	65-69	70-74	75-79	80-84	85-89	90-max
Mean Coincident WB (F)	61.0	64.0	67.0	70.0	72.0	74.0
Total Cool Load (KBTUH)	164.2	164.2	164.2	164.2	164.2	164.2
Sens Cool Load (KBTUH)	156.4	156.4	156.4	156.4	156.4	156.4
Total Cool/Unit (KBTUH)	188.7	183.5	178.4	173.1	167.8	162.2
Sens Cool/Unit (KBTUH)	167.2	165.1	163.0	160.8	158.6	156.4
Evaporator Temp (F)	43.4	43.9	44.3	44.8	45.3	45.8
Condensing Temp (F)	105.0	110.0	115.0	120.0	125.0	130.0
Humidifier Cap (lb/hr)	17.4	17.4	17.4	17.4	17.4	17.4

Breakdown of Energy Use (cont.)

Fan Motor	Max (KW)	2.2	2.2	2.2	2.2	2.2
	x %Oper	100.0	100.0	100.0	100.0	100.0
	= Actual (KW/H)	2.2	2.2	2.2	2.2	2.2
Compressor 1	Max (KW)	6.2	6.5	6.8	7.1	7.7
	x %Oper	100.0	100.0	100.0	100.0	100.0
	= Actual (KW/H)	6.2	6.5	6.8	7.1	7.7
Compressor 2	Max (KW)	6.2	6.5	6.8	7.1	7.7
	x %Oper	83.8	86.8	89.9	93.1	96.5
	= Actual (KW/H)	5.2	5.6	6.1	6.6	7.2
Humidifier	Max (KW)	6.4	6.4	6.4	6.4	6.4
	x %Oper	59.6	48.1	35.4	21.3	5.8
	= Actual (KW/H)	3.8	3.1	2.3	1.4	0.4
Reheat	Max (KW)	25.0	25.0	25.0	25.0	25.0
	x %Oper	0.0	0.0	0.0	0.0	0.0
	= Actual (KW/H)	0.0	0.0	0.0	0.0	0.0
Glycol Pump & Drycooler	Max (KW)	3.2	3.2	3.2	3.2	3.2
	x %Oper	100.0	100.0	100.0	100.0	100.0
	= Actual (KW/H)	3.2	3.2	3.2	3.2	3.2
Total KW/Hour		20.5	20.6	20.6	20.5	20.4
x Hours/Year		759	681	487	324	165
x Cost/KWHR		\$0.080	\$0.080	\$0.080	\$0.080	\$0.080
= Cost/Unit		\$ 1247	\$ 1122	\$ 802	\$ 532	\$ 269
						\$ 107

Cost Summary

Unit energy cost per year	\$ 14375
Energy cost for 1 FH 1926 unit(s) per year	\$ 14375
Ten year projected energy cost	\$ 189475
Present value of ten year energy cost	\$ 122370

Note: This projection is based on 6% annual inflation and a 10% interest rate.

These ratios reflect the opinion of Liebert Corporation engineers based on available published catalog information.

Liebert Corporation
Environmental Systems

Energy Analysis

5/16/86

For
FERMI LABS
STEVE KRSTULOVICH

15 TON ECONOCOIL, UNLOADERS

Prepared by
ZONATHERM PRODUCTS
MICHAEL BORDENET

Liebert Corporation

1050 Dearborn Drive, Columbus, Ohio 43229

5/16/86

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Stepped Operation Environmental Energy Analysis
For **FERMI LABS**

Pre-report summary

The energy cost of 1 FE 192GU (60 Hz) units for one year is \$ **9398**

Design Criteria

Region Chicago, Illinois

Room Drybulb..... 72 F
 Room Relative Humidity..... 50 %
 Main Fan Motor..... 5.00 HP
 Number of Units..... 1
 Design Ambient..... 95 F

Model Unit..... FE 192GU (60 Hz)
 Air Flow per Unit..... 8400 CFM
 No. of Stages per Unit..... 4
 Glycol Pump Motor..... 3.00 HP
 Drycooler Fan Motor..... 2.25 HP

Performance and Operation Breakdown

Temperature Range (F)	min-35	35-39	40-44	45-49	50-54	55-59	60-64
Mean Coincident WB (F)	30.0	34.0	38.0	43.0	47.0	52.0	57.0
Humidifier Cap (lb/hr)	17.4	17.4	17.4	17.4	17.4	17.4	17.4
Total Room Load (KBTUH)	164.2	164.2	164.2	164.2	164.2	164.2	164.2
Sens Room Load (KBTUH)	156.4	156.4	156.4	156.4	156.4	156.4	156.4
Step 1 Totl Cap (KBTUH)	54.0	54.0	55.5	56.6	57.4	60.5	63.1
Sens Cap (KBTUH)	48.3	49.5	51.4	53.0	54.1	60.5	63.1
Step 2 Totl Cap (KBTUH)	107.9	108.1	110.9	113.2	114.8	121.1	126.2
Sens Cap (KBTUH)	97.6	99.0	102.8	106.1	108.3	121.1	126.2
Step 3 Totl Cap (KBTUH)	137.4	137.7	140.9	143.7	146.2	150.6	155.3
Sens Cap (KBTUH)	120.7	121.7	125.6	129.1	132.2	140.2	145.1
Step 4 Totl Cap (KBTUH)	167.0	167.4	170.9	174.2	177.7	180.0	184.5
Sens Cap (KBTUH)	143.8	144.4	148.4	152.0	156.2	159.2	164.0
% Load Free-Cooled	94.4	86.5	70.8	55.1	39.3	23.6	7.9
Econo-o-Coil Cap (KBTUH)	147.6	135.3	110.7	86.1	61.5	36.9	12.3

Breakdown of Energy Use

Fan Motor	Max (KW)	3.7	3.7	3.7	3.7	3.7	3.7	3.7
	x %Oper	100.0	100.0	100.0	100.0	100.0	100.0	100.0
= Actual (KW/H)		3.7	3.7	3.7	3.7	3.7	3.7	3.7
Step 1	Max (KW)	2.4	2.4	2.3	2.3	2.2	2.2	2.2
	x %Oper	18.0	42.6	88.9	67.5	24.7	2.6	0.0
= Actual (KW/H)		0.4	1.0	2.0	1.6	0.5	0.1	0.0
Step 2	Max (KW)	4.8	4.8	4.6	4.6	4.4	4.4	4.4
	x %Oper	0.0	0.0	0.0	32.5	75.3	97.4	5.3
= Actual (KW/H)		0.0	0.0	0.0	1.5	3.3	4.3	0.2
Step 3	Max (KW)	8.4	8.4	8.3	8.4	8.2	8.3	8.2
	x %Oper	0.0	0.0	0.0	0.0	0.0	0.0	94.7
= Actual (KW/H)		0.0	0.0	0.0	0.0	0.0	0.0	7.8
Step 4	Max (KW)	12.0	12.0	12.0	12.2	12.0	12.2	12.0
	x %Oper	0.0	0.0	0.0	0.0	0.0	0.0	0.0
= Actual (KW/H)		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Humidifier	Max (KW)	6.4	6.4	6.4	6.4	6.4	6.4	6.4
	x %Oper	0.0	0.0	0.0	0.0	0.0	0.0	11.1
= Actual (KW/H)		0.0	0.0	0.0	0.0	0.0	0.0	0.7
Reheat	Max (KW)	25.0	25.0	25.0	25.0	25.0	25.0	25.0
	x %Oper	0.0	0.0	0.0	0.0	0.0	0.0	0.0
= Actual (KW/H)		0.0	0.0	0.0	0.0	0.0	0.0	0.0
Glycol Pump	Max (KW)	3.9	3.9	3.9	3.9	3.9	3.9	3.9
& Drycooler	x %Oper	100.0	100.0	100.0	100.0	100.0	100.0	100.0
= Actual (KW/H)		3.9	3.9	3.9	3.9	3.9	3.9	3.9
Total KW/Hour.....		8.1	8.7	9.7	10.7	11.5	12.0	16.4
x Hours/Year.....		2521	725	572	565	381	604	700
x Cost/KWHR.....		\$0.080	\$0.080	\$0.080	\$0.080	\$0.080	\$0.080	\$0.080
= Cost/Unit.....		\$ 1629	\$ 503	\$ 443	\$ 483	\$ 535	\$ 579	\$ 916

These ratios reflect the opinion of Liebert Corporation engineers based on available published catalog information.

Liebert Corporation

1050 Dearborn Drive, Columbus, Ohio 43229

5/16/86
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Stepped Operation Environmental Energy Analysis
For **FERMI LABS**

Performance and Operation Breakdown (cont.)

Temperature Range (F)	65-69	70-74	75-79	80-84	85-89	90-max
Mean Coincident WB (F)	61.0	64.0	67.0	70.0	72.0	74.0
Humidifier Cap (lb/hr)	17.4	17.4	17.4	17.4	17.4	17.4
Total Cool Load (KBTUH)	164.2	164.2	164.2	164.2	164.2	164.2
Sens Cool Load (KBTUH)	156.4	156.4	156.4	156.4	156.4	156.4
Step 1 Totl Cap (KBTUH)	61.9	60.5	59.1	57.7	56.4	55.0
Sens Cap (KBTUH)	61.9	60.5	59.1	57.7	56.4	55.0
Step 2 Totl Cap (KBTUH)	123.7	121.0	118.3	115.5	112.8	110.0
Sens Cap (KBTUH)	123.7	121.0	118.3	115.5	112.8	110.0
Step 3 Totl Cap (KBTUH)	154.6	151.0	147.3	143.6	139.9	134.9
Sens Cap (KBTUH)	144.8	142.5	140.2	137.9	135.6	132.7
Step 4 Totl Cap (KBTUH)	185.5	181.0	176.4	171.7	167.0	159.9
Sens Cap (KBTUH)	165.9	164.0	162.2	160.3	158.3	155.4
% Load Free-Cooled	0%	0%	0%	0%	0%	0%
Econ-o-Coil Cap (KBTUH)	0.0	0.0	0.0	0.0	0.0	0.0
<u>Breakdown of Energy Use (cont.)</u>						
Fan Motor Max (KW)	3.7	3.7	3.7	3.7	3.7	3.7
x %Oper	100.0	100.0	100.0	100.0	100.0	100.0
= Actual (KW/H)	3.7	3.7	3.7	3.7	3.7	3.7
Step 1 Max (KW)	2.6	2.8	3.1	3.3	3.6	3.8
x %Oper	0.0	0.0	0.0	0.0	0.0	0.0
= Actual (KW/H)	0.0	0.0	0.0	0.0	0.0	0.0
Step 2 Max (KW)	5.2	5.6	6.2	6.6	7.2	7.6
x %Oper	0.0	0.0	0.0	0.0	0.0	0.0
= Actual (KW/H)	0.0	0.0	0.0	0.0	0.0	0.0
Step 3 Max (KW)	8.7	9.3	10.0	10.5	11.2	11.7
x %Oper	45.0	35.3	26.4	17.4	8.4	0.0
= Actual (KW/H)	3.9	3.3	2.6	1.8	0.9	0.0
Step 4 Max (KW)	12.2	13.0	13.6	14.4	15.0	15.6
x %Oper	55.0	64.7	73.6	82.6	91.6	100.0
= Actual (KW/H)	6.7	8.4	10.0	11.9	13.7	15.6
Humidifier Max (KW)	6.4	6.4	6.4	6.4	6.4	6.4
x %Oper	43.2	36.2	26.4	15.2	3.0	0.0
= Actual (KW/H)	2.8	2.3	1.7	1.0	0.2	0.0
Reheat Max (KW)	25.0	25.0	25.0	25.0	25.0	25.0
x %Oper	0.0	0.0	0.0	0.0	0.0	0.0
= Actual (KW/H)	0.0	0.0	0.0	0.0	0.0	0.0
Glycol Pump & Drycooler Max (KW)	3.9	3.9	3.9	3.9	3.9	3.9
x %Oper	100.0	100.0	100.0	100.0	100.0	100.0
= Actual (KW/H)	3.9	3.9	3.9	3.9	3.9	3.9
Total KW/Hour.....	21.0	21.7	22.0	22.3	22.5	23.2
x Hours/Year.....	759	681	487	324	165	64
x Cost/KWHR.....	\$0.080	\$0.080	\$0.080	\$0.080	\$0.080	\$0.080
= Cost/Unit.....	\$ 1277	\$ 1180	\$ 857	\$ 579	\$ 297	\$ 119

Cost Summary

Unit energy cost per year..... \$ 9398
 Energy cost for 1 FE 192GU units per year..... \$ 9398
 Ten year projected energy cost..... \$ 123872
 Present value of ten year energy cost..... \$ 80001

Note: This projection is based on 6% annual inflation and a 10% interest rate.

These ratios reflect the opinion of Liebert Corporation engineers based on available published catalog information.

DOE 6430.1
CHAPTER XIII
ENERGY CONSERVATION GUIDELINES

CHAPTER XIII

ENERGY CONSERVATION AND USE OF RENEWABLE ENERGY SOURCES

1. COVERAGE.

- a. These criteria are particularly oriented to the Department's new buildings and building additions, their operating systems and energy using equipment. They shall be applied in the planning and design of such facilities with the objective of minimizing consumption of nonrenewable energy on a life cycle cost effective basis. Companion use shall be made of energy conservation-related design criteria in Chapters IV, V, and VI of this Order. For purposes of this chapter the term building shall be interpreted as new building and building additions, unless otherwise stated.
- b. The objective of minimizing consumption of nonrenewable energy on a life cycle cost effective basis also shall be applied in the planning and design of building and building systems alteration projects and other energy-using facilities (such as new central utilities plants, utility distribution systems, and exterior lighting systems).
- c. It is also necessary that buildings or other structures acquired by the Department, or by contractors or subcontractors for the Department, are energy efficient. These include preengineered metal buildings, in-plant fabricated modular/relocatable buildings, trailer units, and other buildings that may be acquired. The building envelope thermal transmittance values criteria in paragraph 6b and other applicable energy conservation criteria for mechanical-electrical systems identified in paragraph 6c shall be considered minimum criteria to be applied. These transmittance values criteria shall be reflected, to the maximum extent feasible, in specifications that are developed and applied in such facility acquisitions.
- d. This chapter contains a substantial amount of information that is deemed necessary to assure full recognition within the Department, and by contractors and subcontractors, of the Federal law, Executive order, and Federal regulation requirements as related to energy conservation and use of renewable energy sources in the Department's facilities.

2. FEDERAL LAW, EXECUTIVE ORDERS, REGULATIONS, AND DEPARTMENTAL DIRECTIVES.

- a. Title V of Public Law 95-619, "National Energy Conservation Policy Act," of 11-9-78, which states in part:
 - (1) "It is the policy of the United States that the Federal Government has the opportunity and responsibility, with the participation of industry to further develop, demonstrate, and promote the use of

energy conservation, solar heating and cooling, and other renewable energy sources in Federal buildings." (section 542, part 3 Title V.)

- (2) "All new Federal buildings shall be life cycle cost effective...."
"In the design of new Federal buildings, cost evaluations shall be made on the basis of life cycle cost rather than initial cost."
(section 545(b), part 3 Title V.)
 - (3) "The term 'Federal Building' means any building, structure, or facility which is constructed, renovated, or leased, or purchased in whole or in part for use by the United States, and which includes a heating system, a cooling system, or both." (section 544, part 3 Title V.)
- b. Executive Order (E.O.) 12003, "Relating to Energy Policy and Conservation," of 7-20-77, amending E.O. 11912, "Delegations of Authorities Relating to Energy Policy and Conservation," of 4-13-76, which established the 45 percent energy-use reduction goal for new Federal buildings.
- c. Subpart C, "Guidelines for Buildings Plans," of 10 CFR part 436, which requires in Section 436.51, "Design Program for New Federal Buildings":
- (1) That each Federal agency shall provide in its buildings plan for the metering of building energy use in new Federal buildings; analysis of at least two alternative building designs, at least one of which includes a renewable energy system; and selection of a building design which minimizes total life cycle costs as measured in accordance with subpart A of 10 CFR part 436.
 - (2) That the design goal for a new Federal building shall be set by building category at the rate of building energy consumption equivalent to a reduction of 45 percent in average energy use per gross square foot of floor area in FY 1985, from the average building energy use per gross square foot of floor area of a representative Federal building of that category in FY 1975.
- d. Subpart A, "Methodologies and Procedures for Life Cycle Cost Analyses," of 10 CFR part 436, which establishes a methodology for estimating and comparing the life cycle costs of Federal buildings and for determining life cycle cost-effectiveness. The methodology evaluates the economic consequences of investments in alternative building systems (energy conservation measures including renewable energy systems for existing buildings, and energy-saving building systems including renewable energy systems for new buildings).
- e. DOE 4330.3, FUELS AND ENERGY USE POLICY, of 10-22-80, states in part, that "It is the policy of the Department to --- maximize the use of

noncritical fuels, such as coal and solar, and minimize the use of the critical fuels, petroleum and natural gas, by discontinuation of the use of natural gas and petroleum in new facilities; --- (by) the increased use of residual (waste) energy; (by) emphasis on the use of new and advanced energy technologies; ----. See DOE 4330.3 for all requirements related to fuels and energy use, including controls on the use of electric resistance space heating in new facilities.

- f. DOE 4330.2A, IN-HOUSE ENERGY MANAGEMENT PROGRAM, of 2-16-82, states that "It is the policy of DOE to promote efficient and economical use of energy in all DOE-owned or -leased facilities, including buildings and energy conversion and distribution systems, and DOE-owned or -operated vehicles and equipment implementing an In-House Energy Management Program for DOE," with an objective of "assuring energy efficient design of new facilities."

3. TIMING OF EVALUATIONS AND SELECTIONS OF ENERGY CONSERVATION FEATURES AND ENERGY SUPPLY SOURCES.

- a. Integral elements of the facility planning and design process are evaluations and selections of energy conservation features and energy supply sources. To assure that the necessary energy conservation features are included in the overall project requirements, and associated cost are included in the official cost estimate prior to project authorization, evaluations and selections of features on the basis of life cycle cost effectiveness need to be made during:
- (1) The conceptual design phase, for line item construction projects proposed for full project authorization in annual budget requests after performance of conceptual design. Where all such energy conservation and energy supply features cannot be identified during the conceptual design phase, suitable allowances will need to be included in the project authorization funding requests to assure the achievement of an energy-efficient facility in the follow-on design phases.
 - (2) The conceptual design phase, or in preliminary (Title I) or detailed (Title II) design prior to full project authorization for line item construction projects that are to initially receive partial authorization (e.g., for architect-engineer work only, prior to full project authorization).
 - (3) The planning phase (e.g., conceptual design or other project planning), or in preliminary or detailed design prior to full project authorization, for contingency-type projects.
 - (4) The planning phase, or in preliminary or detailed design prior to full project authorization, for general plant projects.

- b. Evaluations of energy conservation and supply alternatives will usually be required through the preliminary design and into the final design phase. These evaluations usually include new or updated life cycle cost analyses, and often result in different systems being selected than originally conceptualized. Therefore, careful planning is required during the conceptual phase to ensure that the conceptual cost estimates provide contingencies to cover the changes in selected systems that are likely to occur during the design process.
- c. Fuels and energy selections shall be in conformance with DOE 4330.3, FUELS AND ENERGY USE POLICY, of 10-22-80.

4. LIFE CYCLE COST ANALYSES.

- a. Life cycle costing involves a systematic comparison of investment decisions using a discount factor to calculate the present worth of future benefits and costs. Prescribed "Methodology and Procedures for Life Cycle Cost Analyses," promulgated by the Assistant Secretary for Conservation and Renewable Energy, as a final rule in the Federal Register of 1-23-80 (subpart A to 10 CFR part 436), as amended, shall be utilized.
- b. The latest edition of the "Life Cycle Costing Manual for Federal Energy Management Programs," NBS Handbook 135, shall be used, as supplemented with additional DOE-specific requirements developed and promulgated by the In-House Energy Management Branch, Office of Project and Facilities Management, Directorate of Administration, at DOE Headquarters. Single copies of the Handbook may be obtained from the Department's Technical Information Center, P.O. Box 62, Oak Ridge, TN, 37830.

5. USE OF COMPUTER OR OTHER ENERGY ANALYSIS TECHNIQUES.

- a. For most of the Department's buildings, a suitable type of computer analysis (dynamic or static) technique or other automated analysis technique (such as the use of programmable calculators), or combinations thereof, shall be used to evaluate energy conservation alternatives. Such computer techniques shall also be used to develop energy-efficient building design concepts and determine the design energy consumption (i.e., estimate of building energy use). The term, "building energy use," means energy use that is principally for heating, ventilation, cooling, domestic hot water, and lighting. Exception to the use of these techniques may be taken for small buildings such as small utility-type buildings, or other buildings with relatively low projected building energy use, where manual analysis methods may be adequate. In general, such exceptions could be taken when building energy use is not expected to exceed 500 million Btu per year (apply conversion values for electricity of 3,412 Btu/kilowatt hour and 1,000 Btu/pound for steam).
- b. Analysis techniques in general declining order of sophistication and analysis capabilities, and detail of input data required, are briefly described below:

- (1) Dynamic computer analysis techniques, such as DOE 2 (and DOE 2.1) or BLAST, using mainframe CPU (central processing units)/time-sharing computer systems. These techniques provide capability for hour-to-hour load and energy consumption analysis over a full-year study period (see paragraph c, below, for additional information).
 - (2) Static computer analysis techniques, using mainframe CPU/time-sharing computer systems. These techniques utilize load estimate inputs for peak load periods and generally provide capability for 3-hour interval energy consumption analysis over a full-year study period.
 - (3) Other static analysis techniques include:
 - (a) Use of smaller, "minicomputer," systems (present generation not capable of handling the more detailed programs).
 - (b) Use of simpler, "microcomputer," systems (lower range machine capability than minicomputers, but much faster and more capable than programmable calculators).
 - (c) Use of programmable calculators in table-top systems including a printer and magnetic card reader, with commercially available programs from calculator manufacturers, or others.
 - (d) Use of manual analysis methods (generally requiring only a 4-function calculator).
- c. It is not within the scope of these criteria to dictate the specific automated analysis technique to be used, as this will need to be determined on a case-by-case basis for each building. However, since dynamic computer analysis techniques, such as DOE-2, currently provide the greatest flexibility and analysis capability, it is recommended that such dynamic techniques be used for the larger, more energy-consuming, buildings. Departmental elements having first-line responsibilities for the design of facilities should assure that capability for use of dynamic techniques, such as DOE 2, is available within their DOE or operating contractor organizations and application of these techniques is made, where feasible. All buildings and building additions of greater than 30,000 gross square feet in size shall be considered for dynamic analysis applications. The magnitude of projected building energy use, type of building occupancy, and opportunities for reducing energy use from non-renewable energy sources on a life cycle cost-effective basis, normally determine if these techniques should be used. There are, generally, four basic program phases in dynamic computer analysis and the related design process in developing energy-efficient building concepts.
- (1) Determine the building design heating and cooling loads based upon multiple architectural, mechanical, and electrical systems combinations.

- (2) Based on weather data, determine the annual thermal loads for phase (1), above.
- (3) Simulate the operation of various mechanical-electrical environmental systems to the thermal load analysis in phase (2), above, to determine hourly, monthly, and annual energy consumption.
- (4) Perform life cycle cost analysis for the systems evaluated in phases (1) and (3), above. (See paragraph 4b, above.)

- d. Effective application of dynamic analysis techniques, and the more sophisticated static analysis techniques, may often require the type of design detail and other informational input that is developed in the preliminary (Title I) design phase, and sometimes continuing into the detailed (Title II) design phase. Where this is the case, other automated analysis techniques, requiring commensurately less informational input, should be used in the project planning phase for the larger building projects with the objective of identifying the principal energy conservation features. At a minimum, the use of programmable calculator techniques is recommended during the project planning phase for all but the very small building projects, where manual analysis techniques may be adequate. The use of mini- or micro-computer analysis techniques is recommended for other building projects, and these may also be adequate for use during final design for some of the less-complex, less energy-using buildings. However, where the capability exists to use the more sophisticated techniques, such as DOE 2, they should be used wherever feasible. For the larger building projects, where such capability has not yet been developed or is not available from architect-engineer firms in the area, the lesser sophisticated computer analysis techniques should at least be used to assure as energy-efficient designs as practicable.
- e. The inside temperatures to be used for building energy consumption analyses shall conform to Federal Property Management Regulations (FPMR), 41 CFR, Chapter 101, Subchapter D, Section 101-20.116 Inside Operating Temperature Requirements, except where the use of other less stringent inside operating temperatures is justified.

6. ENERGY CONSERVATION FEATURES FOR BUILDINGS.

a. Evaluation and Selection of Energy Conservation Features.

- (1) Energy conservation shall be given its full share of attention in the planning and design, or acquisition, of DOE buildings. While the basic programmatic or operating requirements must be the principal "driving force" in the development of the building concept and its design, the Federally-mandated requirements to maximize energy conservation on a life cycle cost-effective basis, and with regard to the 45 percent energy-use reduction goal must also be satisfied. Incorporation of energy conservation features on the basis of their life cycle cost-effectiveness will result in some additional

first-costs for building projects. For a typical building project, present indications are that the additional construction costs (first costs) can be on the order of 3-5 percent, or more, depending upon the types and numbers of energy conservation features that are determined to be cost-effective and included in the project. When renewable energy systems, such as active solar systems, are determined to be cost-effective, and included in the project, there will be additional construction costs. From experience, to date, there are indications that these additional construction costs could be on the order of 5-10 percent, or more, for typical building applications.

- (2) The additional first-costs for building projects or additional acquisition costs for other buildings such as pre-engineered metal buildings or in-plant fabricated modular buildings, from an energy-use efficiency standpoint, need to be included in the total project cost estimate. Cost allowances also need to be included in the cost estimate for the performance of energy analysis and life-cycle costing evaluations and for contingencies, the same as for other project elements.
- (3) Insulating characteristics of the building envelope are of paramount importance with relation to energy conservation for building heating and cooling, and are an integral and dependent element of the architectural and structural building design concept. Therefore, development of basic insulation characteristics shall be considered a prerequisite to follow on evaluation of other energy conservation alternatives on the basis of their life cycle cost-effectiveness. The basic criteria to be applied in architectural and structural planning and design are contained in paragraph b, below and in paragraph 11(1), Chapter IV of this Order.
- (4) Evaluation of other energy conservation features (i.e., energy-related building components and systems) shall be based on application of life cycle costing methodologies. Care should be taken to assure that the combination selected will best meet the minimum life cycle cost objective to maximize the net dollar benefits, comparing total energy conservation costs with total energy cost savings. Meeting the objectives is not, usually, only a matter of selecting energy conservation features that are determined individually to be life cycle cost-effective, because of the interdependence that may exist among the different features.
- (5) The 45 percent building energy-use reduction goal, as described in paragraph 9 below, shall be applied in planning and designing each building project, in the planning and acquisition of each new pre-engineered metal building and in-plant fabricated modular building, and in the planning and acquisition of other semi-permanent or temporary facilities to the extent that technical specifications can be applied in their acquisition.

- (2) Special attention shall be given to providing energy-efficient central air conditioning units for trailer units or other small buildings or facilities, where cooling is required. The seasonal energy efficiency ratios to be used in specifying equipment below 65,000 Btu/hour in capacity should not be less than 8 Btu/Watt-hour. By definition, "seasonal energy efficiency ratio" (SEER) means the total cooling of a central air conditioner in Btu during its normal annual usage period for cooling, divided by the total electrical energy input in watt-hours during the same period.
 - (3) Utilization of waste heat and waste heat recovery systems shall be evaluated for building projects, central utilities plants, and for other significant heat-producing process equipment and facility projects. Wherever technically feasible and life cycle cost-effective, heat recovery systems shall be incorporated.
 - (4) Utilization of cooling energy storage shall be evaluated for building projects, as appropriate. Chilled water storage based on a daily or weekly cycle can significantly reduce initial plant equipment, maintenance, and energy costs (particularly electrical demand charges). Wherever technically feasible and life cycle cost-effective, such energy storage systems should also be evaluated as an emergency supplemental water supply source for fire suppression.
7. ENERGY CONSERVATION FEATURES FOR OTHER PROJECTS. Energy conservation features that are life cycle cost effective shall be included in other facility projects, such as renovations of building, area, and site utility systems and central utilities plants.
8. USE OF RENEWABLE ENERGY SYSTEMS. Subsection (c) of Section 436.51, "Design Program for New Federal Buildings," 10 CFR part 436, "Federal Energy Management and Planning Programs," requires that "Each Federal agency shall plan to install one or more active or passive solar or other renewable energy systems to provide energy for building energy use unless the Federal agency states in its annual report that such a system would not minimize total life cycle costs...." Subsection (a)(3) requires that each Federal agency shall provide, in its Buildings Plan, "For analysis of at least two alternative building designs under Subpart A of this part at least one of which includes a renewable energy system...." Consistent with these regulations, the criteria for the Department's new buildings, building additions, and alterations are as follows:
 - a. Active Solar Systems. The application of active solar systems shall be evaluated for building projects. These are solar heating and/or cooling systems in which thermal storage devices other than the building mass are used and where thermal energy is transferred in a completely regulated way by pumps or fans. Active solar systems shall be provided wherever they are determined to be technically feasible, life cycle cost effective, and where the total project cost will not exceed applicable statutory limits.

features. Passive solar applications are also interrelated with or interdependent on such design parameters and requirements as building size, climatic conditions, building functions, levels of internally-generated thermal loads (mechanical-electrical systems, equipment, occupancy, and so forth) and space environmental requirements for occupants and functions.

- (4) A source of guidance in the evaluation and design for passive solar applications is the two-volume DOE "Passive Solar Design Handbook": Volume One, "Passive Solar Design Concepts" of 3-80, DOE/CS-0127/1 and Volume Two, "Passive Solar Design Analysis" of 1-80, DOE/CS-0127/2. Single copies, or a set, may be obtained by request to the Department's Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

- c. Other Renewable Systems. The opportunity for application of other renewable energy sources in facility projects (photovoltaics or other renewable energy applications) should be evaluated on a case-by-case basis. Evaluations and selections should be based on the application of life cycle costing methodologies.

9. ENERGY-USE REDUCTION GOALS FOR NEW DOE BUILDINGS.

a. Application of the 45 Percent Reduction Goal.

- (1) Executive Order (E.O.) 12003 and Federal Regulations, 10 CFR part 436 established two energy use reduction goals for owned and leased new Federal buildings. Both goal's "average energy use" is computed on the basis of annual use per gross square foot of floor area.
 - (a) The individual new building design goal of a 45 percent reduction in average building energy use over the average energy use of a representative Federal building of the same category completed prior to FY 1975.
 - (b) The overall Department "end goal" of 45 percent reduction in average energy use for all new buildings in FY 1985 over the average energy use for all buildings of the Department in FY 1975.
- (2) For application purposes, a building shall be considered new if either of the following apply:
 - (a) Construction was not complete prior to November 9, 1978, and design could be feasibly modified after November 14, 1979; or
 - (b) Design started after November 9, 1979.
- (3) For application purposes, a leased building is included if construction had not started prior to July 20, 1977.

In determining if the design can be feasibly modified, such factors as schedule effects and cost limitations shall be considered.

- (4) It is important to keep in mind that the Department's "end goal" is a 45 percent reduction in average energy use per gross square foot for the total of all its new buildings in FY 1985, from the average energy use per gross square foot of existing buildings in FY 1975. To achieve the "end goal" the average energy use reduction of all new buildings must be equal to 45 percent. This can only be met if all new buildings equal or exceed the individual building goal, or new buildings exceeding the 45 percent goal offset those that do not meet the individual buildings goal.
- (5) All new DOE buildings will not have the same opportunities for reducing building energy use. It may not be possible for some buildings to achieve the 45 percent reduction goal, such as warehouse/storage facilities with minimal heating and lighting requirements and no cooling requirements. If DOE is to fully achieve the reduction goal for all of its new buildings, special attention needs to be given to meeting the goal for the energy-using buildings having large potentials for energy-use reduction, and to exceed the goal for these facilities, wherever feasible.
- (6) Subsection (a)(3) of section 436.51, 10 CFR part 436, requires each Federal agency to provide in its Buildings Plan "For analysis of at least two alternative building designs using Life Cycle Cost Analysis, at least one of which includes a renewable energy system. Both alternative designs must be consistent with budget limitations and basic requirements for heating, ventilation, cooling, lighting, domestic hot water, and functional purposes."
 - (a) This requirement shall not be construed as requiring two completely different overall building design concepts for all new DOE buildings. The Final Rule on this subject, as published in the Federal Register of 11-14-79, contains the following clarifying information and guidance.

"The purpose of requiring analysis of more than one design is to promote a minimum level of exploration of design alternatives. Section 436.51 should be interpreted broadly. There should at least be a comparison to two or more component designs within a common approach. For more complex designs, DOE encourages, but will not mandate, a comparison of two completely different overall designs which could also have component design variances. Each agency should analyze reasonable alternatives since each agency has the ultimate responsibility in achieving the most 'cost-effective' design consistent with the energy reduction goal of 45 percent."

- (b) Therefore, in applying this requirement the fundamental objective will be to evaluate alternative building systems and other energy-related features (components) and make selections from the standpoint of life cycle cost-effectiveness. The term, "building system," as defined in 10 CFR part 436, "means any part of the structure of a Federal building significantly affecting building energy use, or any energy using system contributing to building energy use."

- 1 Where a single overall building design concept, will not be expected to achieve the 45 percent reduction goal, an alternate concept may need to be evaluated. However, engineering judgment is needed here. For example, small buildings, or other buildings with low projected energy consumption and having limited opportunity for significant improvement in energy-use, the additional cost for making alternate design studies may often exceed the benefits to be achieved. For larger energy-using buildings or building additions having greater opportunities for significant improvements in energy efficiency, evaluation of alternate overall building design concepts may need to be made.
- 2 For the larger or more complex building projects, alternate overall building design concepts may often be evaluated for reasons other than for energy conservation specifically, such as to develop the best concept for satisfying programmatic or operating needs, which is the fundamental requirement in the planning and design or acquisition, of any building. In the evaluation of such alternate concepts, energy conservation shall be given its share of attention. Where energy conservation can be the discriminating factor between programmatic or operating needs options, it shall be applied in the option selection.

- b. Estimating Energy Use of a Representative Building in FY 1975. For application of the 45 percent reduction goal to a new building, a reasonably accurate estimate of the building energy use for a representative building of the same category (and in the same general climatic region) in FY 1975, is needed. In many cases, accurate data will not be available, and a "best-judgment" approach will need to be taken. However, where computer or other automated analysis techniques are being used for energy analysis of the new building, during planning or design, a "simulation" of energy use for this building, as if it had been constructed in early-to-mid 1970's, may be a feasible method. This and other possible approaches are described below:

- (1) By means of an energy audit of an existing building of that category on the particular site, or in the general area, that was completed in the FY 1970 - FY 1975 time period.
- (2) From metered energy use of such existing buildings, either onsite or in the general area, when available.

- (3) By a simulated energy-use analysis of the new building that is under planning or design, by applying the design and construction standards and criteria that were in use, by the Department or architect-engineer firms in the general locality during the FY 1970 - FY 1975 time period. (The then-applicable building envelope insulation standards; building design temperature criteria; interior illumination levels; building fenestration criteria; types of heating, ventilating, and air conditioning systems used; building operation features, such as HVAC controls, lighting controls). In making comparisons of the estimated building energy use of a new building with respect to the 45 percent reduction goal, exclude any estimate of energy to be supplied from a renewable energy source.

10. ESTIMATES OF ADDITIONAL CONSTRUCTION COSTS FOR NEW DOE BUILDINGS.

- a. Federal Regulations in 10 CFR part 436, require that estimates be made and documented of the additional construction cost attributable to incorporation of energy conservation systems into new building designs, in order to achieve the 45 percent goal. The regulations in 10 CFR part 436 further require estimates of the related energy cost savings over the projected useful facility life. The term 'alternative building system' means a primarily energy-saving building system, including a renewable energy system, for consideration as part of the design for a new Federal building.
- b. The above regulation provisions can be met by properly structuring the life cycle cost analysis required and described in this chapter.
- c. Estimates of additional construction costs and energy cost savings for new DOE buildings are to be included in the Energy Conservation Report for the project. See paragraph 14, below.

11. BUILDING ENERGY PERFORMANCE STANDARDS.

- a. The Department of Energy has responsibilities for the development and promulgation of "energy performance standards" for new commercial and residential buildings. Proposed Rulemaking (subpart A of 10 CFR part 435) was published in the Federal Register of 11-28-79. Section 306 of the "Energy Conservation Standards for New Buildings Act of 1976," requires that Federal agencies assure that new Federal buildings meet or exceed the applicable performance standards when they are promulgated for use. This requirement is also stated in section 436.52(b), subpart C of 10 CFR part 436.
- b. When promulgated, applicable building performance standards for Federal buildings shall not be construed as limiting further reduction in energy use of the Department's new buildings where such further reduction can be achieved on the basis of life cycle cost analysis. The "energy performance standards" do not relate to the 45 percent building energy reduction

goal for new Federal buildings. When the energy performance standards are promulgated for use, the lesser energy-use value, between the applicable energy performance standard and the energy use value necessary to achieve the 45 percent reduction goal, shall be applied in the planning and design, or acquisition, of new DOE buildings.

12. ENERGY MANAGEMENT SYSTEMS AND DEVICES.

- a. Energy management systems and devices are characterized by their ability to control energy consuming systems or equipment. Examples of simple devices are manual valves and electrical switches. An example of a simple automatic energy management device is a single set-point thermostat. Moving to higher levels of complexity, technology, and methodology, a typical example would be a computer-based energy monitoring and control system (EMCS).
- b. The application of energy management systems and devices will often directly interface with the architectural, mechanical and electrical design requirements for a building. They also interface with telecommunications system design requirements where telecommunication circuits are used both within the building and from building-to-building on the site. Close coordination needs to be maintained among all affected design disciplines, during the planning and design of energy management systems.
- c. Energy monitoring and control systems (EMCS) usually consist of a central computing system with peripheral equipment, data transmission media, field interface devices, multiplex panels, necessary interfacing controls, and sensors. Each field interface device will generally contain a micro-computer that performs certain local control functions in a stand-alone mode of operation.
 - (1) Criteria and methodology for the design of an EMCS should be obtained from U.S. Army Corps of Engineers Technical Manual, TM 5-815-2, "Energy Monitoring and Control Systems."
 - (2) Guidance for preparation of design and procurement documents should be obtained from the following U.S. Army Corps of Engineers Guide Specifications.
 - (a) CEGS-13947, "Large Energy Monitoring and Control Systems."
 - (b) CEGS-13948, "Medium Energy Monitoring and Control Systems."
 - (c) CEGS-13949, "Small Energy Monitoring and Control Systems."
 - (d) CEGS-13950, "Micro Energy Monitoring and Control Systems."

- (3) A methodology for estimating the economics and energy conservation performance of an EMCS may be obtained by adapting the guidance in Navy Civil Engineering Laboratory document, "EMCS Economic Analysis Guideline," PO No. 78 MR 423, to be consistent with the "Life Cycle Cost Analysis," of this Chapter XIII.

13. ENERGY METERING.

a. The intent of these metering criteria is to:

- (1) assure that all significant utilization of energy in all of the Department's new owned and leased buildings and facilities is metered in accordance with 10 CFR part 436;
- (2) provide submetering for process and production energy usage within the Department's new buildings and facilities;
- (3) provide a means for validation of the Department's progress toward goals for effective energy efficient design in new buildings (see paragraph 2c(2));
- (4) assure that the Department's new buildings and facilities are provided with sufficient metering to facilitate compliance with the energy usage reporting requirements of 10 CFR 436 and DOE 4330.2A.
- (5) measure the effectiveness of corrective and energy conserving actions taken during the operation of a building; and
- (6) identify capabilities for emergency energy use reduction during periods of shortages and curtailments.

b. Permanent metering shall be provided for each type of energy supplied to and consumed by the Department's owned and leased new buildings and facilities with the following exemptions:

- (1) Permanent metering of the energy supplies to small buildings and facilities, and other buildings and facilities having relatively low total energy usage is not required. This exemption may generally be appropriate for a new temporary office facility, new perimeter guard station buildings, small storage and utility buildings, and other facilities where the individual total energy usage is not expected to exceed 500 million Btu per year. (Apply conversion values of 3,412 Btu/kilowatt hour for electricity and 1,000 Btu/pound for steam.)
- (2) Normally, permanent metering is not required for a type of energy supply that is estimated to supply 10 percent, or less, of the total energy input to the building.
- (3) Metering of energy supplied from a renewable energy source or from waste heat and waste heat recovery generally will not be required. However, where energy metering is feasible and if the information

gained is to be used to evaluate the effectiveness of the renewable energy systems or controls, permanent metering or features for ease of temporary metering should be provided.

- c. Permanent submetering shall be provided for each type of process and production energy consumed in the Department's owned and leased new buildings and facilities except where the cost of providing the submetering becomes excessive compared to the management benefits gained. When permanent submetering is not provided, a discussion of the rationale for the exclusion shall be included in the Energy Conservation Report documentation. (See paragraph 14a(4).)
- (1) Process energy means energy for production and research processes and does not include building energy. Building energy means energy used principally for heating, ventilating, cooling, domestic hot water and lighting.
 - (2) Generally, where the total process use is only about 10 percent or less of the total energy input to the building that total energy input may be considered as "building energy use." Conversely, where the total process energy use is about 90 percent or more of the total energy input to the building that total energy input may be considered as "process energy use."
- d. In order to comply with the provisions of 10 CFR part 436 and DOE 4330.2A, the Department reports energy consumption in its buildings and facilities, establishes consumption goals, and develops 10-year Plans for "buildings energy" and "metered process energy" consumption. The metering features incorporated into the design will predetermine the manner in which energy consumption will be reported for new buildings or facilities as follows:
- (1) If a facility has submetering to separate building energy and process energy usage within the facility, then;
 - (a) the building energy and the process energy will be separately reported as "building energy" consumption and "metered process energy" consumption in the Energy Conservation Report documentation and the Quarterly Energy Conservation Performance Report required by DOE 4330.2A.
 - (b) the development of the estimated total annual energy consumption that will be included in the Energy Conservation Report documentation (see paragraph 14) must be separated into building energy and metered process energy corresponding to the meters and submeters incorporated in the facility. The separation by energy use category is necessary for the reporting and subsequent validation of the Department's progress toward goals for energy efficient design in new buildings.

- (2) If a building or facility is not provided with submetering for process or production energy usage, then:
 - (a) those buildings or facilities with predominant building energy usage will have the entire energy usage reported as building energy in the Energy Conservation Report documentation and the Quarterly Energy Conservation Performance Report (QECPR) required by DOE 4330.2A;
 - (b) those buildings or facilities with predominant process energy usage will have the entire energy usage reported as metered process energy in the Energy Conservation Report and the QECPR; and
 - (c) The decision not to provide submetering and the subsequent determination to report the entire energy usage of a building or facility as all building or all metered processes energy must be made by the appropriate DOE Energy Coordinator and an explanation of the decision and determination must be included in the Energy Conservation Report documentation.
- e. Energy metering requirements need to be established prior to establishing the official project cost estimate for authorization to assure that the capital costs are properly included in the total project cost estimate.
- f. In the selection of metering devices, proper consideration shall be given to compatibility for use with an existing or projected energy monitoring and control system (EMCS).

14. DOCUMENTATION.

- a. Energy Conservation Report. An energy conservation report (summary evaluation) shall be developed for each new building, building addition, appropriate building alteration, and other energy-using projects. The initial report, covering such data and information as can be developed during the project planning phase, shall be included as a part of the appropriate project planning documents (conceptual design reports or other project planning documents). These initial analyses shall be updated at the end of preliminary (Title I) design and included as a part of the appropriate design documents (updated conceptual design reports, Title I design reports, or other Title I design documentation). They shall be further updated as a part of Title II design documentation, when final selections of energy conservation features or renewable energy sources are not made until the Title II design phase.
- (1) Analyses for building or building addition projects shall include:
 - (a) Identification of methods used for building energy consumption analyses. This analysis includes loads and building systems analysis (computer dynamic analysis, other computer analysis, use of programmable calculator, or manual calculations).

- (b) Methodology of life cycle costing analysis for the evaluation and comparison of energy conservation alternatives and use of renewable energy sources (computer dynamic analysis, other computer analysis, use of programmable calculator, or manual calculations).
- (c) Description of the major energy conservation features selected, such as building envelope U values (or R values), type of fenestration and percent of gross wall area, type of air handling system, reheat systems, automatic system control features, central supervisory and control features, lighting levels and controls, and so forth.
- (d) Results, including backup data (or identify source for obtaining data on an as-requested basis) of life cycle cost analyses of active or passive solar system applications or other renewable energy source applications, as appropriate.
- (e) Discussion of evaluations made of nonrenewable energy supply alternatives, and basis for selection(s). Discussion shall include determination of conformance with the Department's fuels and energy use policy (DOE 4330.3).
- (f) Estimates of total energy input to the building (see paragraph (3) below, for energy conversion values). Estimates shall be subdivided as follows:
 - 1 For buildings incorporating submetering, separately identify building energy and metered process energy and the number of square feet associated with each type of energy usage. Include:
 - a Btu/year by types of energy.
 - b Total Btu/year.
 - c Btu/gross square foot/year.
 - 2 For buildings without submetering, identify the energy usage type as either entirely building energy or entirely metered process energy and the number of square feet associated with the type of energy usage. Identification of energy usage types (building or metered process) and associated number of square feet must correspond to the actual metering and submetering features incorporated. Include:
 - a Btu/year by types of energy.
 - b Total Btu/year.
 - c Btu/gross square foot/year.

- (g) Provide the following information with regard to the 45 percent energy-use reduction goal (see paragraphs 9 and 10, above):
- 1 Estimated baseline building energy use of a representative building of the appropriate category in FY 1975. Provide information corresponding to paragraph 14a(1)(f), above.
 - 2 Estimated percentage of energy-use reduction (if less than the 45 percent goal, provide brief explanation).
 - 3 Method used to estimate the baseline energy use of a representative building of the appropriate category in FY 1975 (see paragraph 9b, above).
 - 4 Estimated additional construction costs to achieve the 45 percent goal, or to achieve the estimated percent reduction if either higher or lower than this goal (do not adjust these estimated costs to a 45 percent energy use reduction level).
 - 5 Estimated energy cost savings over the projected life of the building (with respect to the additional investment costs in 4, above). Include the first year energy unit cost, the first year energy cost savings, and the present worth factor for each energy source included in the computation. The projected life of the building used in the computation shall also be included.
- (h) Provide a comparison of estimated building energy use with applicable building energy performance standard for Federal buildings (see paragraph 11, above). This information is not required until such time as these standards are promulgated for required use.
- (2) Reports for other energy-using facility projects (other than buildings/additions) shall include:
- (a) Discussion of life cycle cost analyses made of energy conservation features and selections made, analyses of renewable energy source applications, evaluations made of nonrenewable energy supply alternatives and basis for selection(s), and conformance with the Department's fuels and energy use policy (DOE 4330.3).
 - (b) Estimates of energy use, and energy savings achieved, in Btu per year, by types of energy and total. See paragraph (3), below, for energy conversion values.

- (3) Energy conversion values, from 10 CFR part 436, are listed below:

<u>Electricity</u>	<u>11,600 and 3,412 Btu/kilowatt hour</u>
Fuel Oil (distillate)	5,825,400 Btu/barrel
Residual Fuel	6,287,000 Btu/barrel
Natural Gas	1,030,000 Btu/1000 cubic feet
Liquified Petroleum Gas (LPG) including propane and butane	4,011,000 Btu/barrel
Coal	24,500,000 Btu/short ton
Steam (purchased)	1,390 and 1,000 Btu/pound
Energy sources not listed	Conversion factors from a standard engineering reference manual or other reliable reference.

The higher values for electricity and steam are only to be used in reporting energy use and energy savings. As stated in 10 CFR part 436, subpart 436.45, "---in calculating energy costs for life cycle costing purposes, only the conversion values of 3,412 Btu per kilowatt hour of electricity and 1000 Btu per pound of steam (purchased steam) shall be used."

- (4) Energy metering provisions shall be discussed in the energy conservation report including types of permanent metering for energy inputs to the building, types of submetering for process energy use, compatibility with existing or projected energy monitoring and control systems (EMCS), and an estimate of the total costs for metering and submetering provisions. Include a narrative of the actions taken and the decisions and determinations made to assure compliance with the energy metering criteria in paragraphs 13c and 13d(2)(c). If metering provisions are not being made, provide brief explanation.
- b. Distribution of Project Planning and Design Documents. In addition to other recipients of project planning and design documents (conceptual design reports, Title I design reports, Title II updates of information previously reported or not previously available, or other design documentation), DOE field organizations are requested to provide one copy of each document to the In-House Energy Management Branch, Office of Project and Facilities Management, at DOE Headquarters. The energy conservation reports and other directly-related information in these documents, is needed by the In-House Energy Management Branch for fulfillment of its energy management program responsibilities, including the reporting requirements under the provisions of 10 CFR part 436, "Federal Energy Management and Planning Programs."

FERMILAB ENERGY ANALYSIS
SOFTWARE DOCUMENTATION

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WEATHER CALCULATIONS

CARRIER SYSTEMS
E20-II

INTRODUCTION

1.1 TEMPERATURE AND HUMIDITY CALCULATIONS

The purposes of the weather calculations are to compute:

1. Bin dry bulb temperatures and corresponding average humidity conditions which are used in the estimation of bin hours, peak solar gains, building loads, and system performance levels.
2. Occupied and unoccupied bin hour profiles which are used with energy cost and system component input power data to determine component operating cost/year for each bin.
3. Peak solar gain values for use in the calculation of solar gain loads and equivalent temperature differences.

These three categories of computations are discussed in the following sections.

The purpose of this section is to discuss the calculation of outdoor dry bulb temperatures, wet bulb temperatures, specific humidity ratios and the design dewpoint temperature.

a. Dry Bulb Temperatures

Bin dry bulb temperatures are defined for the temperature range between the 1% summer and 99% winter design dry bulbs for a given site. Each dry bulb corresponds to one of a number of temperature bins.

A bin is a 5 F sub-division of the dry bulb range for which building load and system performance conditions are analyzed. The bin temperature 70 F, for instance, corresponds to the bin containing dry bulb temperatures T_a such that $70 = <T_a < 75$. A maximum of 24 average bins are permitted in the profile for any one site. This represents a range of 120 F between summer and winter design conditions and is sufficient for most sites. When it is not, bins adjacent to the winter design condition are omitted. Average bins contain temperatures at which average building load and system performance characteristics are studied. Two design bins are also included: one each at the 1% summer and 99% winter design conditions. These special "bins" each have a temperature range of exactly 1 F.

b. Wet Bulb Temperatures

A set of wet bulb temperatures corresponding to average humidity conditions at each bin dry bulb temperature is defined in order to facilitate the calculation of the bin specific humidity ratio, W_a .

The following assumptions are used in computing average bin wet bulbs:

- i. Outdoor air is saturated at and below 50 F. Examination of actual bin weather data shows this to be a sound assumption.
- ii. At the summer design condition, the average wet bulb temperature may be approximated as follows:

$$T_{dwb} = T_{swb} - .1 (T_{swb} - 50)$$
 where:
 T_{dwb} = Average wet bulb temperature at 1% summer design condition, F
 T_{swb} = 1% Summer design wet bulb temperature, F
- iii. The average wet bulb temperature varies linearly with bin dry bulb temperature between T_{dwb} and 50 F.

As a result of the approximating assumptions, wet bulb temperatures are computed as follows:

$$T_{wb} = T_{swb} \text{ for summer design bin}$$

$$T_{wb} = (T_{dwb} - 50) / (T_{sdb} - 50) * (T_{db} - 50) + 50 \text{ if } T_{db} > 50 \text{ F}$$

$$T_{wb} = T_{db} \text{ if } T_{db} \leq 50 \text{ F}$$

where:

T_{wb} = Wet bulb temperature corresponding to T_{db} , F.
 T_{sdb} = 1% summer design dry bulb, F
 T_{swb} = 1% summer design wet bulb, F
 T_{db} = Bin dry bulb temperature, F

c. Specific Humidity Ratio

The bin specific humidity ratio is computed for use in a variety of subsequent calculations such as that of the latent infiltration and ventilation loads. The calculation described below utilizes psychrometric principles:

$$W_a = [(1093 - .556T_{wb})W_s - .24(T_{db} - T_{wb})] / (1093 + .444T_{db} - T_{wb})$$

where:

W_a = Specific humidity ratio, lb/lb
 T_{db} = Bin dry bulb temperature, F.
 T_{wb} = Bin wet bulb temperature, F.
 W_s = Specific humidity ratio at T_{wb} for saturation condition, lb/lb.
 $\quad = .62198P_s / (14.696 - P_s)$
 P_s = Atmospheric pressure at T_{wb} for saturation condition, psia.
 $\quad = 4.993 \times 10^8 \exp(-11040 / (T_{wb} + 460))$ if $T_{wb} < 32$
 $\quad = 2.4074 \times 10^7 \exp(-9548 / (T_{wb} + 460))$ if $T_{wb} \geq 32$

d. Design Dewpoint Temperature

The design dewpoint temperature is used in correcting Carrier peak solar heat gain values and in the calculation of the bin hour profiles. It is calculated using psychrometric relations as follows:

$$T_{dp} = -11040 / \ln(P_s / 4.993 \times 10^8) - 460 \text{ if } P_s < .089788$$

$$T_{dp} = -9548 / \ln(P_s / 2.4074 \times 10^7) - 460 \text{ if } P_s \geq .089788$$

where:

T_{dp} = Dewpoint temperature computed at 1% summer design condition, F.
 P_s = Atmospheric pressure at T_{swb} for saturation condition, psia. See equations in 1.1c.
 T_{swb} = 1% summer design wet bulb temperature, F.
 $\ln$ = Natural logarithm function.

1.2 BIN HOUR PROFILE CALCULATIONS

The purpose of these calculations is to determine the number of hours per year during which the outdoor air temperature is within each bin. Separate profiles are computed for occupied and unoccupied periods. Bin hour profiles are intended to represent the distribution of hourly temperatures during the year for average weather conditions.

In the first step of the calculation procedure, bin hour profiles for the three daily observation periods are determined. Next, occupied and unoccupied period profiles are computed using this data and the building occupancy schedule. Each calculation step is discussed in a separate sub-section below.

a. Observation Period Bin Hour Profiles

Bin weather data are listed in the United States Air Force Weather Manual [1] both as total hours/year/bin and as hours/year/bin for the following three daily observation periods:

Observation Period (As listed in ref [1])	Period Begins	Period Ends
01—08	1:00 am	8:59 am
09—16	9:00 am	4:59 pm
17—24	5:00 pm	12:59 am

Occupied and unoccupied period bin hour profiles are computed by assigning hours from each of the observation periods to the occupied and unoccupied profiles according to the building occupancy schedule. This procedure is described in (b) below. First, however, bin hour profiles for the three observation periods must be determined.

Bin hour profiles for the three observation profiles are computed using a modified version of the Erbs Method [5]. The Erbs Method is a statistical calculation procedure which provides accurate bin hour profiles for sites in North America. The method was developed from a study of hourly weather data for a number of sites in North America. Certain simplifying assumptions were introduced into the method so that it could be used in the OPCOST program. A summary of the modified Erbs Method appears below.

The modified Erbs Method utilizes the following three input values:

T_{sdb} = 1% summer design dry bulb temperature, F.
 T_{wdb} = 99% winter design dry bulb temperature, F.
 DR = Daily temperature range, F.

Bin hour profiles are computed using the following five stage procedure:

- > 1. Estimate mean monthly temperatures for each month with a correlation involving T_{sdb} , T_{wdb} and DR .
- > 2. Compute the mean monthly temperature for each observation period using the equation:

$$T_{mp} = T_{mm} + C [.4632(\sin(t_2^* - 3.805) - \sin(t_1^* - 3.805)) + .0492(\sin(2t_2^* - .36) - \sin(2t_1^* - .36))]$$

where:

T_{mp} = Mean monthly temperature for observation period, C.

T_{mm} = Mean monthly temperature, C.

C = $12A / (p(t_2 - t_1))$

A = Amplitude of daily ambient temperature variation, C.
 Assumed to be equal to the daily range, DR .

p = π , 3.141593.

t_2^* = $2p(t_2 - 1)/24$

t_1^* = $2p(t_1 - 1)/24$

t_1 = Starting time for observation period, 1 for 1am, 9 for 9am, 17 for 5 pm.

t_2 = Ending time for observation period, 9 for 9am, 17 for 5pm, 25 for 1am.

The preceding equation is derived by integrating the Fourier series approximation of the hourly temperature variation for a typical day in the month,

$$T_a = T_{mm} + A [0.4632\sin(t_2^* - 3.805) + 0.0984\sin((2t_1^* - .36))]$$

where:

T_a = Hourly ambient temperature, C.

between the starting and ending times for the observation period, and dividing by the length of the observation period.

- > 3. Determine the mean annual temperature for each observation period from the mean monthly temperatures. Compute the standard deviation for the mean monthly temperatures from the mean annual temperature for each observation period.
- > 4. Compute the standard deviation for the distribution of ambient temperatures about the mean monthly temperature for each month and observation period. Standard deviations are computed in this case using the following correlation:

$$D_{pm} = 1.45 - .0209T_{pm} + .0664D_{pa}$$

where:

D_{pm} = Standard deviation for ambient temperatures about the mean monthly temperature for an observation period.

T_{pm} = Mean monthly temperature for the observation period, C.

D_{pa} = Standard deviation for mean monthly temperatures about the mean annual temperature for each observation period.

- > 5. Compute the monthly bin hour profiles for each observation period. Temperatures are assumed to have a normal distribution about the mean monthly temperature. Bin hours are computed as follows:

$$H_b = 24N(Q(h_2) - Q(h_1))$$

where:

H_b = Bin hours in one bin, hrs/yr/bin.

$Q(h)$ = Ambient temperature cumulative distribution function.

$$= 1/(1 + \exp(-3.396h))$$

h = Non-dimensional temperature scale parameter.

$$= (T - T_{pm}) / (D_{pm} \sqrt{N})$$

T = Ambient temperature, C.

h_2 = h value computed for the temperature at the upper limit of a temperature bin.

h_1 = h value computed for the temperature at the lower limit of a temperature bin.

N = Number of days in month.

Bin hour profiles are computed for each observation period, month by month in this way. Monthly profiles are then summed to obtain the annual profile. Annual observation profiles are summed to obtain the total bin hour profile.

More information concerning this method may be found in reference [5] or is available upon request.

b. Occupied / Unoccupied Bin Hour Profiles

Having determined bin hour profiles for each of the observation periods, the next task is to assign hours to the occupied and unoccupied period profiles according to the building occupancy schedule. In order to carry out this task, the average fractions of each observation period which occur during the occupied and unoccupied period are calculated. These fractions depend directly upon the user-specified building occupancy schedule. Occupied bin hours are then computed as follows:

$$H_0 = R_1 H_1 + R_2 H_2 + R_3 H_3$$

where:

H_0 = Occupied period bin hours for a sample bin, hr/yr.

R_1 = Average fraction of hours in first observation period which occur during occupied period.

H_1 = Bin hours in sample bin occurring during first observation period.

R_2 = Average fraction of hours in second observation period which occur during occupied period.

H_2 = Bin hours in sample bin occurring during second observation period.

R_3 = Average fraction of hours in third observation period which occur during occupied period.

H_3 = Bin hours in sample bin occurring during third observation period.

A similar equation is utilized to compute the unoccupied period bin hours.

The following example illustrates this final step in the procedure:

Day	Schedule:		Occupied Period			Unoccupied Period		
	Occupied Begins:	Period Ends:	1am - 9am	9am - 5pm	5pm - 1am	1am - 9am	9am - 5pm	5pm - 1am
Sun	— Off —		0	0	0	8	8	8
Mon	6am	12am	3	8	7	5	0	1
Tue	6am	12am	3	8	7	5	0	1
Wed	6am	12am	3	8	7	5	0	1
Thu	6am	12am	3	8	7	5	0	1
Fri	6am	12am	3	8	7	5	0	1
Sat	— Off —		0	0	0	8	8	8
Total Hrs/Wk - >			15	40	35	41	16	21

The average fractions of hours in each observation period which occur during the occupied and unoccupied period are then computed:

Period	1am to 9am	9am to 5pm	5pm to 1am
Occupied	$15/56 = 0.27$	$40/56 = 0.71$	$35/56 = 0.63$
Unoccupied	$41/56 = 0.73$	$16/56 = 0.29$	$21/56 = 0.37$

For a sample bin, suppose that:

Total hours = 600 hr/yr
 1am - 9am hours = 100 hr/yr
 9am - 5pm hours = 300 hr/yr
 5pm - 1am hours = 200 hr/yr

Then, for this example:

Occupied hrs = $(100)(.27) + (300)(.71) + (200)(.63) = 366$ hr/yr

Unoccupied hrs = $(100)(.73) + (300)(.29) + (200)(.37) = 234$ hr/yr

A final adjustment is made to the occupied and unoccupied profiles when a summer shutdown period is specified. Certain types of buildings such as schools and factories are closed and not air conditioned for extended periods each year. By specifying the number of days the building is shut down and that the building is not cooled during the unoccupied period, the effect of summer shutdown on annual operating cost can be estimated. The estimation procedure is discussed below.

The first step in the procedure is to compute the occupied hours affected by the shutdown period:

$$H_{sd} = H_{occ} \cdot D_{sd}$$

where:

H_{sd} = Total number of occupied hours affected by the shutdown period, hr/yr.

H_{occ} = Average occupied hours per day, computed using the building occupancy schedule.

D_{sd} = Number of shutdown days, days/yr.

Starting with the highest temperature bin and proceeding downward, hours are transferred from the occupied to the unoccupied profiles until a total of H_{sd} hours have been transferred. The rationale for this transfer is that bin hours in the highest temperature bins occur predominantly during the months of June, July and August, the time frame during which the shutdown period is assumed to occur. Building shutdown during months other than June, July and August cannot be accurately modeled with this procedure. As a result, the maximum shutdown period allowed is the length of time between June 1 and August 31: 92 days.

1.3 PEAK SOLAR GAIN CALCULATIONS

Peak solar heat gain (PSHG) values must be defined so that solar gain loads and equivalent temperature differences may be computed as described in sections 2.3a and 2.3b. The program user may elect to use PSHG data directly from Table 6 of the Carrier Design Manual [2]. These data are pre-stored in the program. If the user desires to utilize data from an alternate source, PSHG data may be manually entered. Only PSHG values for the months of January and July need be entered for the reasons described in section 2.2. The alternate methods of defining PSHG data are described below.

a. Use of Pre-Stored Carrier PSHG Values

For a given site latitude, PSHG values are computed using a straight-line interpolation method with data from Table 6 of the Carrier Design Manual [2]. Table 6 data are summarized in Table 1.1.

TABLE 1.1 CARRIER PEAK SOLAR HEAT GAINS

Lat. Deg N	Month	Exposure					
		N	NE/NW	E/W	SE/SW	S	Horiz
0	Jan	10	52	152	153	67	233
	Jul	48	153	152	52	14	233
10	Jan	9	37	143	161	106	210
	Jul	30	148	158	66	14	247
20	Jan	8	26	128	164	141	180
	Jul	19	138	163	85	14	251
30	Jan	7	16	116	162	159	145
	Jul	16	131	164	100	30	246
40	Jan	5	12	100	156	166	103
	Jul	15	127	164	125	69	233
50	Jan	4	9	64	127	153	53
	Jul	14	117	163	143	106	211
60	Jan	2	4	29	81	104	15
	Jul	17	108	162	156	142	183

The PSHG values computed using Table 1.1 are automatically corrected for altitude and design dewpoint as follows:

Altitude correction : +0.7% for every 1000 ft above sea level
 -0.7% for every 1000 ft below sea level

Dewpoint correction : -7% for every 10 degrees above 67 F
 : +7% for every 10 degrees below 67 F

In addition, the sash correction factor of 1.17 is used since the majority of commercial buildings today have sashless or steel sash windows.

b. Manually Entered PSHG Values

When the program user wishes to utilize PSHG values from an alternate source such as the ASHRAE Fundamentals Manual or wishes to use Carrier PSHG values without a sash correction, PSHG values must be manually entered. All entered values must be fully corrected for site altitude and dewpoint conditions.

COMPLEX BUILDING THERMAL LOAD CALCULATIONS

2.0 INTRODUCTION

Design loads and average load profiles are computed for a complex building using Carrier E20 load calculation methods and certain load averaging assumptions. These loads are computed using detailed information concerning the building construction and the nature of load generating components. Building thermal loads are subsequently utilized in the simulation of the behavior of the air handling systems.

A complex building may be comprised of one or two zones. A zone is defined as a region of the building with a single thermostatic control. Two zone types exist: the perimeter zone which may have exterior wall, roof and glass exposures, and the interior zone which may only have an exterior roof exposure. Zones, in turn, are made up of a number of elements such as walls, roofs, glass, people, and lights, which influence the thermal load a zone experiences.

Sensible, latent and plenum thermal loads are computed for each zone. It should be noted that a zone thermal load does not include ventilation air or fan heat gain components. These load components are system-related and can be properly computed only during simulation of the air handling system operation. It should also be noted that zone latent thermal loads, comprised of latent heat gain from people, infiltration air and miscellaneous internal sources, may exist even at low ambient temperature conditions. When cold, dry ventilation air at these conditions is introduced into the zone during the air handling system operation, these latent thermal loads are in most cases eliminated. Because of these considerations, the user should not attempt to manually estimate system coil loads by adding the sensible and latent thermal load components.

Zone thermal loads are computed for cooling and heating design conditions and for average occupied and unoccupied conditions bin by bin. Table 2.1 shows a breakdown of the three types of thermal loads for each zone. Development of the load calculation is discussed in the following sections.

TABLE 2.1 ZONE THERMAL LOAD COMPONENTS

Load Component	Perimeter Zone			Interior Zone		
	S	L	P	S	L	P
Solar Gain: Windows	x					
Skylights	x			x		
Transmission: Walls	x					
Roof	x		x	x		x
Windows	x					
Skylights	x			x		
Transmission thru walls						
Adj. Non-Cond Region	x			x		
Lighting Heat Gain	x		x	x		x
Misc Electric Heat Gain	x			x		
People Heat Gain	x	x		x	x	
Misc Internal Heat Gain	x	x		x	x	
Infiltration	x	x				

- Notes:
- S = Sensible thermal load
L = Latent thermal load
P = Plenum thermal load
 - A fixed portion of the roof transmission load and a fixed portion of the lighting heat gain comprise the plenum load when a plenum exists and when lights are recessed. See sections 2.3b and 2.3e for more information.

2.1 DESIGN LOAD CALCULATIONS

The purpose of design load calculations is to determine extreme cooling and heating thermal load conditions in each zone. Design loads are used for equipment sizing and the computation of design air flow rates and supply air temperatures.

The Carrier E20 load calculation method, described in reference [2], is used to compute design loads. Major assumptions used in the calculations are summarized in Table 2.2 below. As shown, the design cooling load is assumed to occur at 3pm in July, when the summer design temperature typically occurs. Maximum lighting and occupancy levels are also assumed for the cooling design calculation. The design heating load includes only transmission and infiltration components. Calculation of individual load components is described in section 2.3.

TABLE 2.2 DESIGN LOAD CALCULATION ASSUMPTIONS

Load Component	Assumptions For:	
	Cooling Design	Heating Design
Solar Gains	Peak solar gains, 3pm July, no cloud cover	Not considered.
Wall, Roof Transmission	ETD values based on peak solar, July, 3pm	Use actual temperature differences instead of ETDs
Glass Transmission	Normal procedure	Normal procedure
Transmission Thru Walls Adj to Non-Cond Region	Normal procedure	Normal procedure
Lighting Heat Gain	Maximum wattage used	Not considered.
Miscellaneous Electric Heat Gain	Occupied load value	Not considered.
People Heat Gain	Maximum occupancy	Not considered.
Miscellaneous Internal Heat Gain	Occupied load values	Not considered.
Infiltration	Normal procedure	Normal procedure

2.2 TYPICAL LOAD CALCULATION METHOD

In addition to computing design zone thermal loads, typical loads corresponding to each bin must be computed. These load data are utilized in the simulation of average air handling system performance bin by bin. Loads are computed using principles from both the Carrier E20 Load Calculation Method [2] and the ASHRAE TC 4.7 Simplified Energy Analysis Method [3]. The development of the OPCOST load calculation method is discussed below. A discussion of individual load component calculations is found in section 2.3.

a. Basic Principles

As stated, the goal of this load calculation is to compute a thermal load which corresponds to average load condition existing when the outdoor air temperature is in a certain temperature bin. These loads will henceforth be referred to as "bin loads". Program users often have the misconception that a bin load is computed for a specific month and time of day. Bin loads are actually the average of many loads occurring for a variety of months and times of day when the ambient dry bulb is in a certain temperature bin.

The bin thermal load can be mathematically stated as follows:

$$\text{Load} = \frac{(\text{Sum of loads occurring when OA temperature is in bin})}{(\text{Number of hours OA temperature is in bin})}$$

Further, the bin load is the sum of the average component loads. For example, the average sensible thermal load can be written as:

$$\begin{aligned} \text{Bin Sensible Load} = & \text{Bin solar gain} \\ & + \text{Bin wall transmission} \\ & + \text{Bin lighting heat gain} \\ & + \dots \text{etc.} \dots \end{aligned}$$

Finally, each component load can be computed as:

$$\text{Bin Component Load} = \frac{(\text{Sum of bin loads for one component})}{(\text{Number of hours in bin})}$$

To precisely compute bin loads, an hourly simulation would be run for the 8760 hours in the year and a listing of hourly temperatures and component loads would be printed. Loads would then be segregated by bin and period, and averaged. Because this program is not an hourly simulation, certain approximating assumptions must be made in estimating bin component loads. In defining these assumptions the precise analysis methodology above is kept in mind to make realistic assumptions.

b. Load Dependency

When computing average bin loads, we seek to define load components as a function of bin temperature. The assumptions necessary to accomplish this depend upon what other variables each load component is a function of. For example, wall transmission is a function of wall area, U-value and indoor-outdoor equivalent temperature difference (ETD). For a particular zone, wall area and U-value are constants, while the ETD varies with solar flux, indoor and outdoor temperature and time of day. Broadly, we can say that wall transmission is solar and temperature dependent. By similar analysis, each load component can be categorized by dependency as follows:

1. Period dependent loads
 - People sensible and latent heat gain
 - Lighting heat gain
 - Miscellaneous electric heat gain
 - Miscellaneous internal sensible and latent heat gain.
2. Temperature dependent loads
 - Glass transmission
 - Sensible infiltration
 - Transmission for wall adjacent to non-conditioned region
3. Humidity dependent load
 - Latent infiltration
4. Solar dependent loads
 - Solar gains
5. Solar and temperature dependent loads
 - Exterior wall transmission
 - Roof transmission

Assumptions necessary for the estimation of each type of load component is discussed in a following sub-section.

c. Period Dependent Loads

Period dependent loads are independent of outdoor air temperature and are assumed constant during the occupied and the unoccupied period. By defining the average number of people occupying a zone, the average lighting wattage, the average miscellaneous electrical wattage and average miscellaneous internal heat gains for each period, loads in this category can be accurately estimated.

d. Temperature Dependent Loads

Temperature dependent loads are solely dependent upon the indoor-outdoor air temperature difference. The indoor air temperature is determined by a separate calculation described in section 2.4. Thus, for our purposes, these loads are solely dependent upon the outdoor air dry bulb temperature and no averaging assumptions are necessary.

e. Humidity Dependent Load

This load is dependent upon the difference between indoor and outdoor specific humidity ratios. Indoor specific humidity is a function of indoor design relative humidity and dry bulb values, and with the stated assumptions from 2.3i is independently computed. Outdoor air specific humidity is a function of the outdoor dry bulb temperature, as described in 1.1c. Thus, this average load component is an indirect function of outdoor air temperature and no additional assumptions are necessary.

f. Solar Dependent / Solar and Temperature Dependent Loads

These two load categories are discussed together because of the common solar dependency. Estimation of loads which are both solar and temperature dependent involve the calculation of an equivalent temperature difference (ETD). Each ETD is comprised of a solar- and a temperature-related component. The temperature-related component is a direct function of outdoor air temperature as discussed in (d) above. Estimation of the solar component is discussed below.

Solar dependent loads are the most challenging to estimate, because the relationship between time-delayed solar gains and outdoor air temperature is difficult to ascertain. As an example, consider the estimation of the average solar gain through a south facing window for the 70 F bin. The precise calculation of the average solar gain would utilize the equation:

$$\text{Avg solar gain} = \frac{(\text{Sum of south glass solar gains, 70 F bin})}{(\text{Number of hours, 70 F bin})}$$

For a sample site such as Chicago, 70 F bin temperatures could occur in any month from April to October and for any hour of the day. The distribution of hours in each bin by month and time of day depends upon a number of site- and climate-related factors such as latitude, elevation, proximity to bodies of water and to mountains, and prevailing wind patterns. As a result, the distribution is extremely difficult to compute without actual hourly weather data. Thus, unless some way can be found to correlate bin temperatures with a month and time of day, average solar gains cannot be satisfactorily estimated.

Fortunately, there exist two temperatures at which reasonable correlations with month and time can be made: the 1% summer and 99% winter design temperatures. Analysis of actual bin weather data has shown that in an average year, there are 30 hours at or above the 1% summer design temperature and 22 hours at or below the 99% winter design temperature [4]. For North American sites, it is reasonable to assume that hours at and above the summer design condition occur in June, July and August, with the preponderance of hours at or near July 3pm.

Likewise, hours at and below the winter design condition can be assumed to occur during December, January and February, with the preponderance of hours at or near January 3am. The choice of 3am is not critical since there is no instantaneous solar flux, and storage load factors and ETDs vary slightly from hour to hour here.

Having identified months and hours corresponding to two temperatures, solar gains and the solar portions of ETDs can be computed for each exposure at each condition. Carrier E20 methodology is used here, modified only by the use of the percentage of available sunshine factors to attenuate peak solar gains. Solar gains and the solar portion of ETDs are approximated as linear functions of outdoor air dry bulb temperature between the design points. The use of linear functions is judged to provide the best unbiased approximation of solar dependent load components possible under the terms of this simplified energy analysis.

It is very important that the reader understand exactly what the solar gain values in each bin represent. Bin solar gains are the average solar gains occurring when the outdoor air temperature is within the limits of each bin. Thus, for bins near the summer design temperature, the bin solar gains represent average values for daylight hours since this is when most high temperature bin hours occur. For bins near the winter design temperature, the bin solar gains represent average values for night hours since this is when most low temperature bin hours occur. Finally, for intermediate bins, the solar gains represent daily averages since bin hours at these temperatures tend to be more evenly split between daylight and night hours.

Because bin solar gains are average values, the same solar gains are used for both occupied and unoccupied periods. At first glance, this may seem to be an improper use of the solar gains. However, it is the best application of the solar gain data for reasons discussed in the following paragraph.

2.3 LOAD COMPONENT CALCULATIONS

First, it is important to consider when bin hours occur. In high temperature bins, hours occur mainly during daylight hours. If the occupied period occurs during daylight hours, the use of the average solar gain in high temperature bins for unoccupied period load calculations may be a poor approximation. However, because there would be very few unoccupied hours in this bin, and many more occupied hours, the impact of this approximation on annual system energy totals and costs becomes negligible. The same is true of low temperature bins where the solar gain tends to be an average for night hours. Use of these solar gains for occupied period load calculations may also be a poor approximation, but has little effect on annual system costs because so few occupied period bin hours would exist. Finally, for intermediate bins the solar gains represent daily averages and are good approximations for both occupied and unoccupied period load calculations. Using the same type of logic, and a slightly more detailed analysis, we would find the same to be true regardless of the building schedule.

Finally, the reader should consider the overall value of the solar gain approximation. The approximation may only be flawed for the unoccupied period in high temperature bins, and occupied periods in low temperature bins. The numbers bin hours for the occupied period in high temperature bins and for the unoccupied period in low temperature bins are small enough that the impact of the poor approximation on annual system energy use and costs is made trivial. Thus, the application of solar gains using this method provides a good engineering estimate of building and system behavior.

The purpose of this section is to provide documentation of the calculation of the various thermal load components. Where applicable, differences between design and average bin load calculations will be noted.

a. Solar Gains

Basic solar gain equation:

$$Q_{sg} = PSHG \cdot F_s \cdot SLF \cdot SF \cdot A_g$$

where:

Q_{sg} = Solar gain for one exposure, Btu/hr.

$PSHG$ = Corrected peak solar heat gain for desired month and exposure, Btu/hr. Calculation of $PSHG$ is discussed in 1.3.

F_s = Fraction of available sunshine for desired month.

SLF = Storage load factor for one exposure. Value is dependent upon building weight, operating schedule, use of internal shading and time of day as shown in Tables 2.3 and 2.4.

SF = Internal shade factor which defines the fraction of solar energy transmitted through the glass panes and internal shade covering. Values used are:

0.56 for light colored shades

0.65 for medium colored shades

0.75 for dark colored shades

1.00 for no internal shades

or other value defined by the program user.

A_g = Glass area for the exposure, sqft.

For cooling design solar gains, use:

i. $PSHG$ values for July

ii. SLF values for 3pm

iii. $F_s = 1.00$ (i.e. assume clear sky)

For the heating design condition, solar gains are not considered.

For bin solar gains, the following equation is used:

$$Q_{sga} = (Q_{sgs} - Q_{sgw}) \cdot (T_a - T_{sdb}) / (T_{sdb} - T_{wdb}) + Q_{sgs}$$

where:

Q_{sga} = Solar gain for one glass exposure corresponding to typical conditions at T_a , BTU/hr.

Q_{sgs} = Solar gain for one glass exposure corresponding to typical conditions at T_{sdb} , BTU/hr.

The following values are used in the calculation of Q_{sgs} :

- i. PSHG for July
- ii. SLF for 3pm
- iii. F_s for summer condition

Q_{sgw} = Solar gain for one glass exposure corresponding to typical conditions occurring at T_{wdb} , BTU/hr. The following values are used in the calculation of Q_{sgw} :

- i. PSHG for January
- ii. SLF for 3am
- iii. F_s for winter conditions

T_a = Outdoor air bin dry bulb temperature, F.

T_{sdb} = 1% summer design dry bulb temperature, F.

T_{wdb} = 99% winter design dry bulb temperature, F.

Finally, the operating schedule used in choosing storage load factor values is determined as follows. Carrier SLF values are defined for the following 3 operating schedules:

24 hour : First hour = 6am, last hour = 5am

16 hour : First hour = 6am, last hour = 9pm

12 hour : First hour = 6am, last hour = 5pm

Because the program user is free to define any building operating schedule he desires, a procedure must be used to decide which storage load factors to utilize for any given user-entered schedule:

12 hour SLFs used if a. Cooling not provided during unoccupied period.

b. 5am = $< h_1 = < 8$ am

c. 5pm = $< h_2 = < 9$ pm

16 hour SLFs used if a. Cooling not provided during unoccupied period.

b. 5am = $< h_1 = < 8$ am

c. 9pm $< h_2 = < 12$ am

24 hour SLFs are used in all other cases.

h_1 = Average weekly starting time for building occupancy.

h_2 = Average weekly ending time for building occupancy.

b. Wall and Roof Transmission Loads

Basic wall and roof transmission load equation:

$$Q_w = U_w \cdot A_w \cdot \text{ETD}$$

where:

Q_w = Transmission load for wall or roof exposure, BTU/hr.

U_w = Wall or roof exposure U-factor, BTU/(hr-sqft-F).

A_w = Wall or roof exposure area, sqft.

ETD = Equivalent temperature difference for wall or roof exposure, F.

Basic equivalent temperature difference equation:

$$\text{ETD} = K_w(R_s F_s / R_m)(t_{em} - t_{es}) + t_{es} + X_d$$

where:

K_w = Wall or roof color correction factor:

1.00 for dark wall or roof surface

0.78 for medium wall or roof surface

0.55 for light wall or roof surface

R_s = Peak solar heat gain for wall or roof exposure, BTU/(hr-sqft). Computed as described in 1.3.

R_m = Peak solar heat gain for wall or roof exposure at 40° N latitude, month of July, at sea level with design dewpoint of 67° F and clear sky conditions, BTU/(hr-sqft).

F_s = Fraction of available sunshine.

t_{em} = Equivalent temperature difference for sunlit wall or roof exposure and a specific time of day, F. This value is taken from either Table 19 or 20 of the Carrier Design Manual [2] and is uncorrected for design conditions. Values are summarized in Table 2.5.

t_{es} = Equivalent temperature difference for shaded wall or roof exposure and a specific time of day, F. This value is taken from either Table 19 or 20 of the Carrier Design Manual [2] and is uncorrected for design conditions. Values are summarized in Table 2.5.

X_d = Design temperature correction factor, F

$$= T_{ad} - T_i - .5 * DR - 5$$

(This equation is derived from data in Table 20A of reference [2])

T_{ad} = Design dry bulb temperature for desired month at 3pm, F.

T_i = Indoor design dry bulb temperature, F.

DR = Daily temperature range, F.

Cooling design ETDs are computed using the following values:

- R_s values for July
- t_{es} and t_{em} values for 3pm
- $F_s = 1.00$
- T_i = Indoor cooling dry bulb temperature.

At the heating design condition actual indoor-outdoor temperature differences are utilized instead of ETDs. The indoor design temperature used is the occupied heating temperature.

TABLE 2.3 Carrier Storage Load Factors, With Internal Shade

3 PM Values										3 AM		
	24 hr			16 hr			12 hr			24 hr		
Ex	L	M	H	L	M	H	L	M	H	L	M	H
N	.98	.87	.84	.98	.87	.84	1.0	.98	.96	.01	.10	.12
NE	.13	.16	.17	.13	.16	.17	.13	.19	.21	0	.03	.04
E	.14	.18	.18	.14	.18	.18	.14	.21	.23	0	.03	.05
SE	.20	.24	.24	.20	.24	.24	.20	.28	.30	0	.04	.06
S	.50	.59	.59	.50	.59	.59	.50	.65	.67	0	.06	.08
SW	.86	.70	.66	.86	.70	.66	.87	.77	.74	.01	.07	.08
W	.65	.54	.52	.65	.54	.52	.67	.61	.61	.02	.07	.09
NW	.39	.34	.33	.39	.34	.33	.41	.40	.41	.02	.06	.08
H	.50	.59	.59	.50	.59	.59	.50	.65	.67	0	.06	.08

*From Tables 7, 9 and 11 of Carrier Design Manual [2]

TABLE 2.4 Carrier Storage Load Factors, Without Internal Shade

3 PM Values										3 AM		
	24 hr			16 hr			12 hr			24 hr		
Ex	L	M	H	L	M	H	L	M	H	L	M	H
N	.97	.76	.69	.95	.80	.75	1.0	.95	.92	.02	.18	.23
NE	.16	.21	.22	.16	.21	.22	.16	.26	.29	0	.05	.07
E	.18	.25	.26	.18	.25	.26	.18	.31	.34	0	.06	.08
SE	.32	.36	.35	.32	.36	.35	.32	.44	.45	0	.08	.10
S	.75	.57	.51	.75	.57	.51	.76	.68	.65	.01	.11	.14
SW	.78	.50	.43	.78	.50	.47	.80	.62	.57	.02	.12	.14
W	.49	.30	.27	.49	.30	.27	.52	.43	.42	.03	.13	.15
NW	.27	.19	.17	.27	.19	.17	.30	.30	.30	.03	.11	.13
H	.75	.57	.51	.75	.57	.51	.76	.68	.65	.01	.11	.14

*From Tables 8, 10 and 11 of Carrier Design Manual [2].

TABLE 2.5 Carrier Equivalent Temperature Differences

Exposure	3 PM			3 AM		
	L	M	H	L	M	H
North (or Shade)	12	8	1	-1	0	2
Northeast (Sunlit)	13	11	16	-3	1	8
East (Sunlit)	13	13	19	-2	1	12
Southeast (Sunlit)	19	21	15	-1	3	10
South (Sunlit)	28	25	7	0	1	9
Southwest (Sunlit)	34	24	7	0	4	8
West (Sunlit)	32	19	10	0	3	16
Northwest (Sunlit)	19	10	6	-1	1	11
Horizontal (Sunlit)	36	33	31	6	11	16
Horizontal (Shaded)	13	10	6	-4	-3	0

*From Tables 19 and 20 of Carrier Design Manual [2].

Key for Tables 2.3-2.5:

Building Wts (for SLFs): L = 30; M = 100; H = 150 lb/sqft floor area

Wall Weights (for ETDs): L = 20; M = 60; H = 140 lb/sqft wall area

Roof Weights (for ETDs): L = 20; M = 40; H = 60 lb/sqft roof area

For bin wall or roof transmission loads, the following equation is used:

$$Q_{wa} = U_w \cdot A_w \cdot ETD_a$$

where:

Q_{wa} = Wall or roof exposure transmission load corresponding to typical conditions at T_a , BTU/hr.

ETD_a = Wall or roof exposure ETD corresponding to typical conditions at T_a , F.

T_a = Outdoor air bin dry bulb, F

The computation of ETD_a is developed below:

$$ETD_a =$$

$$= K_w(R_s F_s / R_m)(t_{em} - t_{es}) + t_{es} + X_d$$

$$= K_w(R_s F_s / R_m)(t_{em} - t_{es}) + t_{es} + T_{ad} - T_i - .5 \cdot DR - 5$$

$$= [K_w(R_s F_s / R_m)(t_{em} - t_{es}) + t_{es} + T_{ad} - .5 \cdot DR - 5] - T_i$$

$$= T_{ae} - T_i$$

where:

T_i = Indoor dry bulb temperature, determined as described in section 2.4, F.

T_{ae} = Outdoor air equivalent temperature, F. This temperature is computed considering both the outdoor air dry bulb and the effect of the transmission of solar energy through the wall or roof exposure.

Outdoor air equivalent temperature equation:

$$T_{ae} = (T_{aes} - T_{aew})(T_a - T_{sdb}) / (T_{sdb} - T_{wdb}) + T_{aes}$$

where:

T_{aes} = Outdoor air equivalent temperature computed for typical conditions at T_{sdb} , F. Values used to compute T_{aes} :

i. R_s for July

ii. t_{es} and t_{em} for 3pm (see Table 2.5)

iii. F_s for summer conditions

iv. $T_{ad} = T_{sdb}$

T_{aew} = Outdoor air equivalent temperature computed for typical conditions at T_{wdb} , F. Values used to compute T_{aew} :

i. R_s for January

ii. t_{es} and t_{em} for 3am (see Table 2.5)

iii. F_s for winter conditions

iv. T_{ad} = estimated maximum temperature on winter design day.
= $T_{wdb} + DR$

T_a = Outdoor air bin dry bulb, F
 T_{sdb} = 1% summer design dry bulb temperature, F.
 T_{wdb} = 99% winter design dry bulb temperature, F.

Finally, if a plenum is used, it is assumed that 70% of the roof transmission heat is transferred to air in the plenum; 30% of the load reaches the zone.

c. Glass and Skylight Transmission Load

Glass and skylight transmission load equation:

$$Q_g = U_g \cdot A_g \cdot (T_a - T_i)$$

where:

Q_g = Transmission load for glass or skylight exposure, BTU/hr.
 U_g = Glass or skylight exposure U-factor, BTU/(hr-sqft-F).
 A_g = Glass or skylight exposure area, sqft.
 T_a = Outdoor air bin dry bulb, F.
 T_i = Indoor air dry bulb, F.

d. Transmission Through Walls Adjacent to Non-Conditioned Region

This load element allows the user to model transmission through walls adjacent to a region not conditioned by the HVAC system. With this element, the user can model adjacent regions such as an unconditioned warehouse.

Transmission load equation:

$$Q_{wu} = U_{wu} \cdot A_{wu} \cdot (T_u - T_i)$$

where:

Q_{wu} = Transmission loss through wall adjacent to non-conditioned region, BTU/hr.
 U_{wu} = Wall U-factor, BTU/(hr-sqft-F).
 A_{wu} = Wall area, sqft.
 T_i = Indoor air dry bulb, F.
 T_u = Air dry bulb temperature in non-conditioned region, F. T_u modeled in four ways:
 i. Adjacent region is only heated:
 $T_u = T_{uh}$ if $T_a \leq T_{uh}$
 $T_u = T_a$ if $T_a > T_{uh}$
 ii. Adjacent region is only cooled:
 $T_u = T_{uc}$ if $T_a \geq T_{uc}$
 $T_u = T_a$ if $T_a < T_{uc}$
 iii. Adjacent region is cooled and heated:
 $T_u = T_{uc}$ if $T_a \geq T_{uc}$
 $T_u = T_a$ if $T_{uh} < T_a < T_{uc}$
 $T_u = T_{uh}$ if $T_a \leq T_{uh}$
 iv. Adjacent region is neither cooled nor heated:
 $T_u = T_a$

T_{uc} = Adjacent region indoor dry bulb for cooling, F.
 T_{uh} = Adjacent region indoor dry bulb for heating, F.
 T_a = Outdoor air bin dry bulb, F.

e. Lighting Heat Gain

Heat gain from lights is assumed to be instantaneous. No lighting storage load factors are used in estimating lighting heat gain.

Lighting heat gain equation:

$$Q_l = E_l \cdot H_f \cdot D_l \cdot A_f \cdot 3.413$$

where:

Q_l = Total lighting heat gain, BTU/hr
 E_l = (Lighting watts)/(sqft zone floor area).
 H_f = Heating factor for lighting ballast:
 1.25 if ballast is used in lights.
 1.00 otherwise.

D_l = Lighting diversity factor: the typical fraction of total lighting watts in use for the occupied or unoccupied period.

Design cooling load : $D_l = 1.00$
 Typical occupied period : $D_l = \text{User defined.}$
 Typical unoccupied period : $D_l = \text{User defined.}$
 Design heating load : $D_l = 0.00$

A_f = Zone floor area, sqft.

3.413 = (Btu/hr)/Watt

If a plenum is used, the lighting heat gain may be split between the plenum and the zone as follows:

$Q_{lp} = R_l \cdot Q_l$ = Portion of lighting load to plenum

$Q_{lz} = (1 - R_l) \cdot Q_l$ = Portion of lighting load to zone

where:

R_l = Fraction of lighting load to plenum.
 = 0.30 if a plenum exists and lights are recessed.
 = 0.00 otherwise.

f. Miscellaneous Electrical Heat Gain

The purpose of this load element is to model heat generation in the zone by electrical machinery and appliances. Separate miscellaneous electrical wattages are defined by the user for the occupied and unoccupied periods.

Heat gain equation:

$$Q_e = E_m \cdot A_f \cdot 3.413$$

where:

Q_e = Miscellaneous electrical heat gain, BTU/hr.
 E_m = (Miscellaneous electrical watts)/(sqft floor area).
 A_f = Zone floor area, sqft.
 3.413 = (BTU/hr)/Watt

g. People Sensible and Latent Heat Gain

Heat gain equations:

$$Q_{ps} = P_s D_p A_f / P_a \quad Q_{pl} = P_l D_p A_f / P_a$$

where:

Q_{ps} = People sensible heat gain, BTU/hr.
 Q_{pl} = People latent heat gain, BTU/hr.
 P_s = (BTU/hr sensible heat gain)/person
 P_l = (BTU/hr latent heat gain)/person
 P_a = (sqft floor area)/person
 D_p = People diversity factor: the typical fraction of the maximum occupancy level for either the occupied or unoccupied period.
 i. Design cooling load : $D_p = 1.00$
 ii. Typical occupied load : $D_p = \text{user defined.}$
 iii. Typical unoccupied load : $D_p = \text{user defined.}$
 iv. Design heating load : $D_p = 0.00$

A_f = Zone floor area, sqft.

P_s and P_l may be user defined or may be chosen from one of the five pre-stored activity levels in Table 2.6.

TABLE 2.6 People Sensible and Latent Heat Gain Factors

Activity Level	Sensible Heat Gain (BTU/hr)/person	Latent Heat Gain (BTU/hr)/person
1. Seated at rest	230	120
2. Office or retail	245	205
3. Light work	280	270
4. Medium work	295	455
5. Heavy work	525	925

h. Miscellaneous Sensible and Latent Heat Gains

Miscellaneous heat gain equations:

$$Q_{msz} = Q_{ms} A_{fz} / (A_{fp} + A_{fi})$$

$$Q_{mlz} = Q_{ml} A_{fz} / (A_{fp} + A_{fi})$$

where:

Q_{msz} = Miscellaneous sensible heat gain for zone z, BTU/hr.

Q_{mlz} = Miscellaneous latent heat gain for zone z, BTU/hr.

Q_{ms} = Total miscellaneous sensible heat gain for occupied or unoccupied period, BTU/hr.

Q_{ml} = Total miscellaneous latent heat gain for occupied or unoccupied period, BTU/hr.

A_{fz} = Zone floor area, sqft.

A_{fp} = Perimeter zone floor area, sqft.

A_{fi} = Interior zone floor area, sqft.

i. Infiltration Sensible and Latent Loads

Infiltration is assumed to occur only in the perimeter zone. Separate infiltration air flow rates are entered by the program user for the occupied and unoccupied periods.

Infiltration load equations:

$$Q_{is} = 1.1 \cdot V_i \cdot (T_a - T_i)$$

$$Q_{il} = 4840 \cdot V_i \cdot (W_a - W_i)$$

where:

Q_{is} = Sensible infiltration load, BTU/hr.

Q_{il} = Latent infiltration load, BTU/hr.

V_i = Infiltration air flow rate, cfm.

T_a = Outdoor air bin dry bulb, F.

T_i = Indoor air dry bulb, F.

W_a = Outdoor air bin specific humidity ratio, lb/lb.

Computed as described in 1.2c.

W_i = Indoor design air specific humidity ratio, lb/lb.

This value is computed assuming the indoor relative humidity is fixed at the user-specified value. The computation is only an approximation since OPCOST does not simulate humidity control and thus, the zone relative humidity may actually float on either side of the design value. W_i is computed using the specific humidity ratio equations described in Chapter 1 of the Documentation Guide.

R_h = Indoor design relative humidity, decimal.

j. Warm-Up Cycle Loads

When the thermostat is set back during unoccupied heating periods, a warm-up cycle will occur at the end of these periods as the equipment warms the building from the unoccupied to occupied thermostat settings. The size of the warm-up load depends upon a number of factors including the magnitude of the setback. To account for warm-up cycles, unoccupied heating loads are increased by a user-specified percentage. In this way, the effect of the warm-up load is modeled by spreading the load evenly over the unoccupied period. The program user must estimate the warm-up percentage by taking into consideration the size of the setback, the length of the unoccupied period, and the thermal mass of the building.

k. Pulldown Cycle Loads

When cooling is not provided during the unoccupied period, a pulldown cycle will occur at the beginning of each occupied cooling period as the equipment cools the building to the thermostat setting. It is assumed that equipment is turned on one hour before an occupied period begins to pull the building temperature down. This is typically the case. To account for pulldown cycles, occupied period cooling loads are increased by a fixed percentage. In this way, the effect of the pulldown load is modeled by spreading the load evenly over the occupied period. The pulldown factor is computed as follows:

$$F_{pd} = (H_0 + H_0/h_0)/H_0 = 1 + 1/h_0$$

2.4 ZONE DRY BULB TEMPERATURE CALCULATION

where:

F_{pd} = Pulldown factor. Occupied period cooling loads are multiplied by this factor to account for the pulldown load.

H_o = Number of hours in an occupied temperature bin, hr/yr.

h_o = Length of occupied period, hr/period.

The purpose of this section is to describe the simple procedure used to determine the representative indoor dry bulb temperature for each bin load condition. The procedure utilizes the following thermostat data provided by the user:

T_c = Indoor cooling thermostat setting, F.

T_h = Indoor occupied heating thermostat setting, F.

T_{sb} = Unoccupied heating setback degrees, F.

It is assumed the air conditioning system maintains zone air at the thermostat setting temperature under all load conditions, except in the dead band region where the temperature floats between the cooling and heating settings. Determination of design and average bin zone temperatures, as well as dead band modelling are discussed in the following sub-sections.

a. Cooling Design Bin

At the cooling design condition, the zone air is assumed to be maintained at the cooling thermostat setting, T_c .

b. Heating Design Bin

At the heating design condition, the zone air temperature is assumed to be maintained at the occupied heating thermostat setting, T_h . The purpose of the heating design load calculation is to estimate the extreme heating load condition. Use of T_h will yield a worst case load while use of the unoccupied thermostat setting may not.

c. Typical Bins

A simple trial and error procedure is used to determine the representative zone air temperature for each bin.

For the first trial, loads are computed using the cooling thermostat setting, T_c , as the indoor air temperature. If the resulting sensible thermal load is a cooling load, the indoor air temperature assumed is correct. If the load computed is a heating load, we proceed to the second trial.

For the second trial, loads are computed using the heating thermostat setting as the indoor air temperature. For the occupied period, this setting is T_h ; for the unoccupied period, it is $(T_h - T_{sb})$. If the resulting load is a heating load, the correct indoor air temperature value was assumed. If the computed load is a cooling load, then the thermostat must be in the dead band region.

d. Dead Band Condition

When dead band conditions occur, the indoor dry bulb temperature floats between the cooling and heating settings so that transmission loads are balanced by internal gains and the zone sensible thermal load is zero.

a. Derivation of Basic Fan Power Equation

First, we define:

$$P_f = .746 \cdot \text{BHP} / .9$$

where:

P_f = Fan input power, kw.

BHP = Fan brake horsepower, hp.

.746 = kw/hp conversion factor.

.9 = Assumed value of fan motor efficiency.

Next, we can define:

$$\text{BHP} = 0.000157 V_f T_s / n_f$$

where:

V_f = Fan air flow rate, cfm.

T_s = Total static pressure across fan, inches of water, gage.

n_f = Fan drive and mechanical efficiency.

.000157 = Conversion factor:

= (62.3 lbm/ft³ water)(ft/12 in)(hp-min/33000 ft-lb)

Combining these equations, we obtain:

$$P_f = (.746)(.000157)V_f T_s / (.9n_f) \quad (\text{Eqn 4.1})$$

Finally, we can also define:

$$Q_f = 3.413 \cdot P_f$$

where:

Q_f = Fan heat gain, BTU/hr.

3.413 = MBH/kw

Varied and unvaried versions of equation 4.1 are used for the five categories of fans as described below.

b. Central Single Speed Constant Volume Fan Model

Equation:

$$P_f = (.746)(.000157)V_f T_s / (.9n_f)$$

where values used for n_f are defined in Table 4.1.

c. Central 2-Speed Constant Volume Fan Model

Equation:

$$P_f = (.746)(.000157)V_f T_s R_f^3 / (.9n_f)$$

where:

R_f = (Low speed rpm)/(High speed rpm), if low speed setting used.

= 1.00 if high speed setting used.

n_f values are shown in Table 4.1.

d. Central Single Speed Variable Volume Fan Model

Equation:

$$P_f = (.746)(.000157)V_f T_s M_{fe} / (.9n_f)$$

where:

M_{fe} = Fan energy multiplier for part load fan operation

= $A + B \cdot R + C \cdot R^2$, such that $M_{fe} > E$

R = (Part load fan air flow rate)/(Design fan air flow rate), cfm/cfm.

A, B, C, E and n_f values are defined in Table 4.1.

e. Central 2-Speed Variable Volume Fan Model

Equation:

$$P_f = (.746)(.000157)V_f T_s M_{fe} R_f^3 / (.9 n_f)$$

where:

 M_{fe} = Fan energy multiplier. See (e) above. R_f = Part load fan air flow ratio. See (d) above.A, B, C, E, and n_f values are defined in Table 4.1**f. Terminal Single Speed Constant Volume Fan**

Equation:

$$P_f = (.746)(.000157)V_f T_s / (.9 n_f)$$

where:

 n_f is a user entered average fan efficiency.

TABLE 4.1 Central Fan Data

Fan Type	n_f	A	B	C	E
1. FC	.600	.375	.625	.000	.40
2. FC with dampers	.560	.300	.300	.400	.45
3. FC with variable freq. drive	.490	.073	.246	.681	.10
4. FC with variable speed drive	.530	.158	-.565	1.407	.10
5. FC with 2-speed motor	.600	.375	.625	.000	0.0
6. BI/AF	.600	.092	2.325	-1.417	.45
7. BI/AF with inlet vanes	.550	.448	-.173	.725	.37
8. BI/AF w/ var. freq. drive	.470	.073	.246	.681	.10
9. BI/AF w/ var. speed drive	.475	.158	-.565	1.407	.10
10. Controlled pitch axial	.600	.158	-.565	1.407	.10

Key: FC = Forward curved

BI/AF = Backward inclined or air foil.

4.16 OUTDOOR AIR ECONOMIZERS

Outdoor air economizers control the outdoor ventilation damper position. By modulating the flow of outdoor air to the system, the proper mixture of outdoor and return air can be achieved to minimize or eliminate the cooling coil load. Four basic economizer control strategies are offered in the OPCOST program, and are discussed below. In the discussion, "economizer cooling" refers to the use of outdoor air to reduce the coil load. Mechanical cooling refers to the use of a refrigeration plant to provide cooling.

a. Integrated Enthalpy Control

This type of control involves the comparison of outdoor and return air enthalpies and dry bulb temperatures to determine outdoor air damper position. Mechanical and economizer cooling may occur simultaneously. The control strategy is shown in Figure 4.23, and is subsequently discussed.

FIGURE 4.23
Integrated Enthalpy
Economizer Operation

Operating Mode

Discussion

A	$h_r < h_a$. Ventilation dampers are held at minimum flow position. Use of additional outdoor air will not reduce the cooling coil load.
B	$h_r > h_a$ and $T_a > T_s$. Ventilation dampers are full open. Supply air is 100% outdoor air. The cooling coil load is reduced, but mechanical cooling is still required.
C	$h_r > h_a$ and $T_a = < T_s$. The ventilation damper position is varied between maximum and minimum flow positions. Outdoor and return air streams are mixed so that no mechanical cooling is needed.
D	Ventilation dampers are held at the minimum flow position. Use of the minimum quantity of outdoor air eliminates the need for mechanical cooling, but may create the need for heating of the supply air stream.

Key:

h_r = Return air enthalpy, BTU/lbm.

h_a = Outdoor air enthalpy, BTU/lbm.

T_s = Cooling coil outlet dry bulb temperature, F.

T_a = Outdoor air dry bulb temperature, F.

b. Non-Integrated Enthalpy Control

This type of control involves the comparison of outdoor and cooling coil outlet air enthalpy with the C-Scale threshold of the Honeywell enthalpy sensor. The C-Scale threshold closely tracks the coil outlet dry bulb temperature. Therefore, a sufficient approximation of this control strategy is to use outdoor and cooling coil outlet air dry bulb temperatures to control ventilation damper position. See the description of Non-Integrated Dry Bulb Control for more information.

c. Integrated Dry Bulb Control

Integrated dry bulb control involves a comparison of the outdoor and return air dry bulb temperatures to determine the ventilation air damper position. With the integrated control strategy, mechanical and economizer cooling may occur simultaneously. The control scheme is illustrated in Figure 4.24, and is discussed below.

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FIGURE 4.24
Integrated Dry Bulb
Economizer Operation

Operating Mode	Discussion
A	$T_a > T_r$. Ventilation dampers are held at the minimum flow position. An increase in ventilation air flow will not reduce the coil load.
B	$T_s < T_a = < T_r$. Ventilation dampers are opened to the maximum flow position. The use of 100% ventilation air reduces the cooling coil load, but some amount of mechanical cooling is still required.
C	$T_a = < T_s$. Ventilation damper position varies between maximum and minimum flow positions. Proper amounts of outdoor and return air are mixed to result in a supply air stream with temperature T_s . No mechanical cooling is therefore required.
D	Ventilation dampers are held at the minimum flow position. When the minimum quantity of ventilation air is used, no mechanical cooling is required, but heating of the supply air stream may be required.

Key:

T_a = Outdoor air dry bulb temperature, F.

T_r = Return air dry bulb temperature, F.

T_s = Required cooling coil outlet dry bulb temperature, F.

d. Non-Integrated Dry Bulb Control

Non-integrated dry bulb control involves a comparison of outdoor and cooling coil outlet air dry bulb temperatures to determine the ventilation air damper position. With non-integrated control, mechanical and economizer cooling do not occur simultaneously. The control scheme is illustrated in Figure 4.25 and is discussed below.

FIGURE 4.25
Non-Integrated Dry Bulb
Economizer Operation

Operating Mode	Discussion
A	$T_a > T_s$. Ventilation dampers are held at the minimum flow position.
B	$T_a = < T_s$. Ventilation dampers modulate between maximum and minimum flow positions so that outdoor air and return air streams mix to create a supply air stream with temperature T_s . At this condition, no mechanical cooling is required.
C	Ventilation dampers are held at the minimum flow position. Use of the minimum quantity of outdoor air eliminates the need for mechanical cooling, but may create the need for heating of the supply air stream.

Key:

T_a = Outdoor air dry bulb temperature, F.

T_s = Required cooling coil outlet dry bulb temperature, F.

4.17 VENTILATION AIR RECLAIM

A ventilation reclaim device is used to transfer heat between exhaust and ventilation air in order to reduce central coil loads. To reduce cooling coil loads, heat is transferred from hot outdoor ventilation air to cooler exhaust air to reduce the coil inlet temperature. To reduce heating coil loads, heat is transferred from hot exhaust air to cooler ventilation air to increase the coil inlet temperature. The heat transfer mechanism may be a pump around system, a heat wheel, a heat pipe or some similar device. The system is illustrated schematically in Figure 4.26. The two modes of system operation are discussed below.

FIGURE 4.26
Ventilation Air Reclaim

a. Cooling Mode

For cooling reclaim, the temperatures T_a , T_r , and T_m , shown in Figure 4.26, are sensed by thermostats located in the appropriate air ducts. When $T_a > T_r$, it is possible to transfer heat from hot outdoor air to cooler exhaust air, and the reclaim device is turned on. As heat is transferred, the outdoor air is cooled, and the mixed air temperature, T_m is lowered. This in turn reduces the cooling coil load. The amount of heat transferred is estimated using the following equation:

$$Q_{VR} = 1.1 V_V e_C (T_a - T_r)$$

where:

Q_{VR} = Cooling ventilation reclaim heat transfer, BTU/hr

V_V = Ventilation air flow rate, cfm.

e_C = Reclaim device efficiency. This value is the estimated average fraction of total heat transfer possible using the device

T_a = Outdoor air dry bulb temperature, F.

T_r = Return air dry bulb temperature, F.

Knowing Q_{VR} , T_r , the supply air flow rate and the ventilation air flow rate, the mixed air temperature, T_m can be computed. This temperature is subsequently used in the calculation of the cooling coil load.

b. Heating Mode

For heat reclaim operation, the temperatures T_a , T_r , and T_m are again measured by thermostats in the appropriate air ducts. When the condition $T_a < T_r$ occurs, heat can be transferred from the hot exhaust air stream to the cooler ventilation air stream, and the reclaim device is turned on. Heat is transferred from the exhaust to the ventilation air in order to elevate the mixed air temperature, T_m . The amount of heat transferred between air streams is estimated using the following equation:

$$Q_{VR} = 1.1 V_V e_C (T_r - T_a)$$

where:

Q_{VR} = Heating ventilation reclaim heat transfer, BTU/hr.

The remaining variables were defined in (a) above.

Knowing Q_{VR} , T_r , and the ventilation and supply air flow rates, the mixed air temperature, T_m can easily be determined. This temperature is subsequently used in the calculation of the heating coil load.

4.18 CONTROL OF SUPPLY AIR TEMPERATURE

In the descriptions of air handling system operation (sections 4.1 - 4.14) the control of supply air temperature to maintain a constant temperature or to vary this temperature is often alluded to. The purpose of this section is to briefly describe the various methods of controlling supply air temperature. All the methods involve controlling the heat transfer at a cooling coil. The major methods used are listed in the table below.

Cooling Plant Type	Temperature Controlled By:
1. Direct Expansion	Cycling Cooling Plant As the cooling plant is cycled on and off, the supply air temperature fluctuates. The end result of this control is that the time-averaged supply temperature is at the desired level.
2. Direct Expansion	Unloading Compressors The unloading of compressors reduces the capacity of the plant so that the proper amount of cooling is provided to obtain the desired supply temperature.
3. Liquid Chilling	Varying Chilled Water Temperature By varying the temperature of chilled water entering the cooling coil, the heat transfer at the coil and ultimately, the supply temperature are controlled.
4. Liquid Chilling	Varying Chilled Water Flow Rate to Coil By varying the flow of constant temperature water to the cooling coil, heat transfer at the coil and ultimately, the supply temperature are controlled.
5. Any	Bypassing Air Around Coil By varying the flow of air over the coil, the coil outlet temperature may be controlled.

5.3 WATER COOLED RECIPROCATING COOLING PLANT

- T_{ec} = Effective condenser entering air temperature
 = $T_a + E/1180$
 Use when condenser performance is not adjusted for altitude. See 5.1b for discussion.
 = T_a
 Use otherwise.
 T_a = Outdoor air dry bulb, F.
 N_c = Nominal plant capacity at 95 F outdoor air dry bulb temperature, Tons.
 N_k = Nominal plant KW/Ton at 95 F outdoor air dry bulb temperature.
 T_{lw} = Leaving chilled water temperature, F.
 = T_{dw}
 If chilled water reset control is not utilized.
 = $T_{dw} + 10(1 - R_{pl})$
 and $T_{lw} = < T_{dw} + 10$, and $T_{lw} = < 60$ F
 If chilled water reset control used.
 R_{pl} = Part load ratio.
 = $Q_c / (12 N_c)$
 T_{dw} = Design leaving chilled water temperature, F.
 Q_c = Total cooling coil load, MBH.
 12 = MBH/Ton
 MBH = 1000 BTU/hr

This cooling plant is a vapor compression machine which utilizes one or more reciprocating compressors and a water cooled condenser. The unit may be direct expansion or liquid chilling. It is assumed that the compressor motors are electric.

Energy costs considered for this plant are classified as follows:

- i. Cooling Plant Costs:
 - Compressor energy cost
 - Cooling tower fan energy cost (if applicable)
- ii. Pump Costs:
 - Condenser water pump energy costs
 - Chilled water pump energy costs (if applicable)

The calculation of pump input power is described in section 5.16, while that for the cooling tower fan power is summarized in section 5.15. The compressor input power computation is developed below.

a. Plant Part Load Performance Equation

The part load performance of this cooling plant is determined using the following equation:

$$P_c = R_{kw} N_{kw}$$

where:

P_c = Compressor input power, KW.

R_{kw} = Fraction of nominal compressor KW for plant operating condition.

N_{kw} = Nominal compressor input KW at 85 F condenser entering water temperature.

The fraction R_{kw} is dependent upon the part load ratio, entering water temperature, capacity control mechanism, and the use of suction temperature control. The relationship between R_{kw} and these variables was quantified via a statistical analysis of the part load performance characteristics of a number of water cooled reciprocating units. The calculation of R_{kw} and N_{kw} are summarized below.

$$R_{kw} = (R_{ew} C_{st} C_{cc} Q) / (12 N_c)$$

$$N_{kw} = N_k N_c$$

where:

R_{ew} = Condenser entering water temperature factor.
 = $(0.133 + .01T_{ew}) / (1.645 - .0076T_{ew})$

- C_{st} = Suction temperature control factor. See section 5.1b for discussion.
 = 1.0
 Use if suction temperature is fixed.
 = $.92 + .08Q/(12N_c)$, $C_{st} = < 1$
 Use if suction temperature is scheduled.
 C_{cc} = Capacity control factor. See section 5.1b for discussion.
 = $.4(Q/(12N_c))^2 - .1(Q/(12N_c)) + .7$, $C_{cc} = < 1$
 Use for multiple compressors per condenser circuit arrangement.
 = 1.0
 Use for one compressor per condenser circuit arrangement, with no compressor cycling.
 = $1.15 - .15(Q/(12N_c))$, $C_{cc} > 1$
 Use for one compressor per condenser circuit arrangement, with compressor cycling.
 Q = Cooling plant load, MBH
 = $12 R_u N_c$
 Use when hot gas bypass control is utilized and the last unloading step has been reached. See section 5.1b for discussion.
 = Q_c
 Use for all other cases.
 N_c = Nominal plant capacity at 85 F condenser entering water temperature, Tons.
 N_k = Nominal compressor KW/Ton at 85 F condenser entering water temperature.
 T_{ew} = Condenser entering water temperature, F. See section 5.15 for discussion of computation.
 R_u = Part load fraction at final unloading step.
 Q_c = Cooling coil load, MBH.
 12 = MBH/Ton.
 MBH = 1000 BTU/hr.

5.4 AIR COOLED CENTRIFUGAL CHILLER

This cooling plant is a vapor compression machine which utilizes a centrifugal compressor and an air cooled condenser. The unit is liquid chilling. The compressor motor is assumed to be electric.

Energy costs considered for this plant are classified as follows:

- i. Cooling Plant Costs:
 - Compressor energy cost
 - Condenser fan energy cost
- ii. Pump Costs:
 - Chilled water pump energy cost

This type of cooling plant is currently marketed by only one major air conditioning manufacturer from whom it was not possible to obtain part load performance data. In lieu of such data, the part load performance of this machine is approximated using the model for a water cooled centrifugal chiller with a closed circuit cooling tower. The only departure from the standard water cooled model is that no minimum entering water temperature restriction is imposed. Input power calculations are discussed for the compressor in section 5.5, for the cooling tower fans in section 5.15 and for the chilled water pump in section 5.16.

5.5 WATER COOLED CENTRIFUGAL CHILLER

This cooling plant is a vapor compression chiller which utilizes a centrifugal compressor and a water cooled condenser. The unit is liquid chilling. The compressor motor is assumed to be electric.

Energy costs considered for this plant are classified as follows:

- i. Cooling Plant Costs:
 - Compressor energy cost
 - Cooling tower fan energy cost (if applicable)
- ii. Pump Costs:
 - Condenser water pump energy cost
 - Chilled water pump energy cost

The calculation of pump input power is discussed in section 5.16 while that for the cooling tower fan input power is described in section 5.15. The computation of compressor input power is developed below.

a. Chiller Part Load Performance Equation

The part load performance of this cooling plant is determined using the following equation:

$$P_c = R_{kw} N_{kw}$$

where:

P_c = Compressor input power, KW.

R_{kw} = Fraction of nominal compressor input power at plant operating condition.

N_{kw} = Nominal compressor input power at 85 F condenser entering water temperature, KW.

The fraction R_{kw} is dependent upon the part load ratio, the entering water temperature, suction temperature control and the use of sequenced chillers. The relationship between R_{kw} and these variables was determined from a statistical analysis of the part load performance characteristics of a number of water cooled centrifugal chillers. The calculation of R_{kw} and N_{kw} described below applies to the use of a single chiller. Modification of the calculations for use of sequenced chillers is described in sub-section (b).

$$R_{kw} = C_{st} C_{pl} C_w$$

$$N_{kw} = N_k N_c$$

where:

C_{st} = Suction temperature control factor. See section 5.1b for discussion.

= 1.0

Use if suction temperature is fixed.

= $.92 + .08Q_c/(12N_c)$

Use if suction temperature is scheduled.

C_{pl} = Part load factor.

= $.375R_{pl}^2 + .4R_{pl} + .225$

C_w = Condenser entering water temperature factor.

= $.00015T_{ew}^2 - .013T_{ew} + 1.021$

N_c = Nominal plant capacity at 85 F condenser entering water temperature, Tons.

N_k = Nominal plant KW/Ton at 85 F condenser entering water temperature.

R_{pl} = Part load ratio.

= $Q_c/(12N_c)$

T_{ew} = Condenser entering water temperature, F. See section 5.15 for discussion.

Q_c = Cooling coil load, MBH.

12 = MBH/Ton

MBH = 1000 BTU/hr

b. Part Load Performance Analysis for Sequenced Chillers

In some applications, a number of centrifugal chillers are connected to the chilled water loop to enhance part load performance for the system. It is assumed that each chiller connected to the loop has the same nominal capacity. The performance of each chiller in the system is analyzed assuming the chillers are controlled as described in the following example:

Two 200-ton centrifugal chillers are connected to the chilled water loop. For the sake of simplicity in this example, the condenser entering water temperature and the plant capacities remain constant as the coil load varies. It is assumed that the system is controlled so that the part load fraction experienced by each chiller corresponds to the sample schedule shown below:

5.8 WATER SOURCE HEAT PUMP

It is assumed that the same heating plant which provides heat for the zone or building provides steam for the absorption chiller. Therefore, the generator input, P_{gi} , is added to the heating coil loads to determine the total heating plant load. The heating plant input power is computed using the method described for the chosen plant (see sections 5.9 – 5.12).

This dual cooling and heating system utilizes reversible water cooled reciprocating heat pumps. The heat pumps are connected to a common water loop as shown in Figure 5.2. The system has three distinct operating modes as described below.

i. Cooling Mode

Both zones require cooling. The units operate as direct expansion cooling plants. Heat is rejected through the water loop to a cooling tower or heat sink.

ii. Reclaim Mode

One zone requires cooling, the other, heating. Accordingly, heat pumps in the cooling zone provide cooling and reject heat to the water loop. Units in the heating zone operate using the water loop as a heat source. As a result, heat rejected by the cooling units is reclaimed and used by the heating units.

iii. Heating Mode

Both zones require heating. The heat pumps operate using the water loop as a heat source. An auxiliary heating plant is used to maintain the loop water at a specified minimum temperature.

FIGURE 5.2
Water Source Heat Pump
System Diagram

The energy costs considered for this system are classified as follows:

- i. Cooling Plant Costs:
 - Compressor input energy cost
 - Cooling tower fan energy cost (if applicable)
- ii. Heating Plant Costs:
 - Auxiliary heating plant energy cost
- iii. Pump Costs:
 - Condenser (loop) water pump energy cost

The calculation of pump power is described in section 5.16. Computation of cooling tower fan power is summarized in section 5.15. The analyses of heat pump and auxiliary heating plant performance are developed below. In separate sections, the heat pump part-load performance equations for cooling and heating duty are described, and the modeling of each of the three system operating modes is discussed.

a. Heat Pump Part-Load Performance Equation for Cooling Duty

For cooling duty, the heat pump performance is analyzed using a modified version of the water cooled reciprocating cooling plant model. The derivation of this model is discussed in section 5.3. The model and its modifications are summarized below.

$$P_c = R_{kw} N_{kw}$$

$$R_{kw} = (R_{ew} C_{st} C_{cc} Q) / (12 N_c)$$

$$N_{kw} = N_k N_c$$

where:

P_c = Compressor input power, KW. It is assumed that the compressor motor is electric.

R_{kw} = Fraction of nominal compressor KW for plant operating condition.

N_{kw} = Nominal compressor input KW at 85 F condenser entering water temperature.

R_{ew} = Condenser entering water temperature factor.

$$= (0.133 + .01T_{ew}) / (1.645 - .0076T_{ew})$$

C_{st} = Suction temperature control factor. See section 5.1b for discussion.

$$= 1.0$$

The heat pumps considered are direct expansion units in which the suction temperature is fixed.

C_{cc} = Capacity control factor. See section 5.1b for discussion.

$$= 1.15 - .15(Q / (12N_c)), C_{cc} > 1$$

The heat pumps considered have one compressor per condenser circuit. Compressors are cycled to regulate capacity.

Q = Cooling plant load, MBH. Hot gas bypass control is not used with these heat pumps. As a result no false loading occurs and the plant cooling load is always equal to the coil load.

N_c = Nominal plant capacity at 85 F condenser entering water temperature, Tons.

N_k = Nominal compressor KW/Ton at 85 F condenser entering water temperature.

T_{ew} = Condenser entering water temperature, F. See sub-sections (c), (d) and (e) below for discussion.

12 = MBH/Ton

MBH = 1000 BTU/hr

b. Heat Pump Part Load Performance Equation for Heating Duty

For heating duty, the part load performance of the heat pump is analyzed using a modified version of the ground source heat pump model. The derivation of this model is described in section 5.14. The model and its modifications are summarized below.

$$P_c = R_{kw} N_{kw}$$

$$R_{kw} = Q_p R_{ew} / Q_{cap}$$

where:

P_c = Compressor input power, KW.

N_{kw} = Nominal compressor input power at 70 F evaporator entering water temperature, KW.

R_{kw} = Fraction of nominal compressor input power at plant operating condition.

R_{ew} = Evaporator entering water temperature factor.

$$.00022T_{ew}^2 - .0216T_{ew} + 1.42$$

- Q_p = Plant heating load. In this system, the heat pump must be sized so that under all conditions, the plant capacity is sufficient to meet the heating load. As a result, the plant heating load is equal to the heating coil load.
- Q_{cap} = Plant capacity, MBH.
 $= (.00018T_{ew}^2 - .0124T_{ew} + 1)H_c$
- T_{ew} = Evaporator entering water temperature, F. See sub-sections (c), (d), and (e) for discussion.
- H_c = Nominal plant capacity at 70 F evaporator entering water temperature, MBH.
 MBH = 1000 BTU/hr.

c. System Operation in Cooling Mode

When both zones require cooling, the heat pumps operate as cooling plants, rejecting heat to the water loop. Compressor input power for units in each zone is computed using the equation described in sub-section (a). The condenser entering water temperature is computed using the appropriate heat sink model, described in section 5.15. This temperature is always held below the specified maximum entering water temperature and above the minimum temperature. The auxiliary heater is not used in this mode, and therefore consumes no energy.

d. System Operation in Heat Reclaim Mode

In this mode, heat pumps in the zone requiring cooling operate as cooling plants and reject heat to the water loop. The units in the zone requiring heating operate as heating plants and extract heat from the water loop. In this way heat is reclaimed.

To analyze the performance of the system, a basic heat balance is written for a control volume including the water loop and the heat pumps:

$$(\text{Heat rejected to loop}) - (\text{Heat extracted from loop}) = 0$$

$$(Q_c + Q_{cc}) - (Q_h - Q_{ch}) = 0$$

where:

- Q_c = Cooling zone total coil load, MBH.
 Q_h = Heating zone total coil load, MBH.
 Q_{cc} = Compressor heat for cooling zone heat pumps, MBH.
 $= 3.413 \cdot (\text{Compressor input KW})$
 Q_{ch} = Compressor heat for heating zone heat pumps, MBH.
 $= 3.413 \cdot (\text{Compressor input KW})$

In order to compute compressor input powers, the steady state entering water temperature must first be determined. By substituting the heat pump performance equations from sub-sections (a) and (b) into the heat balance above, an equation is obtained in which zone loads and the entering water temperature are the unknowns. For given zone loads, the steady state entering water temperature can be calculated using this equation. Compressor input power is then computed using the performance equations from sub-sections (a) and (b).

In the event that the computed entering water temperature is below the specified minimum temperature, the auxiliary heater must be used. Compressor power and heat are computed for entering water at the minimum temperature. The load on the auxiliary heater is computed using the heat balance below:

$$Q_{aux} + (Q_c + Q_{cc}) - (Q_h - Q_{ch}) = 0$$

where:

- Q_{aux} = Auxiliary heater load, MBH.

The auxiliary heating plant input power is computed using the model for the chosen plant (see sections 5.9 - 5.12).

e. System Operation in Heating Mode

When both zones require heating, the units provide heat using the water loop as a heat source. The auxiliary heater is used to maintain the entering water at the specified minimum temperature. Compressor power and heat are computed using this entering water temperature value. The auxiliary heating plant load is then computed using the following heat balance for a control volume including the water loop and heat pump units:

5.9 ELECTRICAL RESISTANCE HEATING PLANT

$$Q_{aux} - (\text{Heat removed from loop}) = 0$$

$$Q_{aux} - (Q_h - Q_{ch}) = 0$$

where:

Q_{aux} = Auxiliary heating plant load, MBH.

Q_h = Sum of heating coil loads for interior and perimeter zones, MBH.

Q_{ch} = Sum of compressor heat gains for units in interior and perimeter zones, MBH.

The auxiliary heating plant input power is computed using the model for the chosen heating plant (see sections 5.9 - 5.12).

Heat is provided by direct heating elements or by electrically heated water with this system. It is assumed that the plant or coil element is properly sized to meet all heating loads encountered. Further, 100% conversion efficiency is assumed.

Energy costs considered for this means of heating are classified as follows:

i. Heating Plant Costs:

Coil element or plant input energy cost

ii. Pump Costs:

Hot water pump energy cost (only for hydronic HVAC systems)

Pump input power calculations are described in section 5.16. Total heating element or plant input power is computed using the following equation.

$$P_h = Q_h / 3.413$$

where:

P_h = Heating input power, KW.

Q_h = Total heating load, MBH

3.413 = MBH/KW

MBH = 1000 BTU/hr

5.10 COMBUSTION HEATING PLANTS

With this group of plants, a fuel is burned either to heat air directly or to heat water. The fuel used may be natural gas, fuel oil or propane.

Energy costs considered for these plants are classified as follows:

i. Heating Plant Costs:

Heating plant fuel cost

ii. Pump Costs:

Hot water pump energy cost (only for hydronic HVAC systems)

Pump input power calculations are described in section 5.16. Heating plant input power is computed using the following equation.

$$P_h = Q_h F / \eta_p$$

where:

P_h = Plant input power in therm/hr for natural gas, US or Imperial gallons/hr for fuel oil, or lb/hr for propane.

Q_h = Heating load, MBH.

F = Conversion factor or heating value factor:

= (1 therm natural gas/hr)/(100 MBH)

= (1 US gallon fuel oil/hr)/(138.7 MBH)

= (1 Imperial gallon fuel oil/hr)/(168 MBH)

= (1 lb propane/hr)/(21.68 MBH)

5.11 AIR COOLED CONDENSER

n_p = Plant efficiency.
 = Average seasonal efficiency if value defined by user.
 = $.45 + .669(Q_h/H_c) - .361(Q_h/H_c)^2$
 If user chooses to have computer generate part load plant efficiency. The efficiency is limited to the range $.45 = n_p \leq .758$. This polynomial was derived from data generated for a study of combustion plant part load efficiency by the California Energy Commission.
 H_c = Heating plant rated capacity, MBH.
 MBH = 1000 BTU/hr.

With this system, waste heat is provided to the zone at no cost. Typically, the source of the waste heat is the air cooled condenser of a refrigeration unit. This heating plant option may also be used, however, to model any situation in which free heat is provided.

It is assumed that sufficient heat is available at all times to meet the heating load. No heating plant or pumping costs are incurred with this system.

5.12 REMOTE SOURCE HEATING

With this system, hot water is provided to the building from a remote source. Typically, such a system is used for a college campus or complex of buildings. Hot water is generated at a central source and is provided to the buildings. A pump in the building is then used to distribute the water throughout the building. It is assumed that sufficient heat is available at all times to meet all heating loads.

Energy costs considered for this system are classified as follows:

- i. Heating Plant Costs:
Cost of purchased hot water
- ii. Pump Costs:
Hot water pump energy cost

Hot water pump calculations are described in section 5.16. Assuming no pipe losses, the heat purchased is equal to the zone or building heating load.

5.13 AIR SOURCE HEAT PUMP HEATING PLANT

This heating plant is a vapor compression heat pump which utilizes one or more reciprocating compressors and air as the heat source. The heat pump provides some or all of the required heat as the plant capacity permits. Any additional heat required is provided by an auxiliary heating plant. It is assumed that the compressor motor is electric.

Energy costs considered for this plant are classified as follows:

- i. Heating Plant Costs
Compressor and evaporator fan energy cost
Auxiliary heating plant energy cost
- ii. Pump Costs
Hot water pump energy cost (if used with auxiliary plant)

Hot water pump calculations are described in section 5.16. The input power calculations for the heat pump and auxiliary plant are described below.

a. Heat Pump Input Power

The part load performance of the heat pump is determined using the following equation:

$$P_h = R_{kw} N_{kw}$$

5.15 COOLING TOWERS AND HEAT SINKS

The water cooled cooling plants modeled in the OPCOST program utilize one of three heat sink types listed below:

- i. Open cooling tower
- ii. Closed circuit cooling tower
- iii. Constant temperature heat sink

The purpose of this section of documentation is to describe the models used to compute the condenser entering water temperature for a given set of atmospheric and load conditions, and the cooling tower fan input power (if applicable) for each heat sink. Heat sink models are discussed in sub-sections below.

a. Open Cooling Tower

In an open cooling tower, condenser water is sprayed over baffles or fill in the tower as shown in Figure 5.3. The tower fan draws ambient air through the tower. Condenser water is cooled by contact with the air, and then collected in the sump before being pumped back to the condenser.

A study of the performance of open cooling towers yielded the following correlation for condenser entering water temperature as a function of ambient and part load conditions.

$$T_{ew} = A_0 + A_2 R_{pl} + A_2 R_{pl}^2$$

where:

$$A_0 = 3.065065 + 2.72273h_a - .0217201h_a^2,$$

$$A_0 = <T_a - 3$$

$$A_1 = 61.1089 - .900838A_0 + 2.96571 \times 10^{-3} A_0^2$$

$$A_2 = -22.4969 + .337364A_0 - 9.42044 \times 10^{-4} A_0^2$$

T_a = Outdoor air dry bulb temperature, F.

h_a = Outdoor air enthalpy, BTU/lbm.

$$= .24T_a + W_a(1061 + .444T_a)$$

W_a = Outdoor air specific humidity ratio, lb/lb. W_a is computed using the equations described in section 1.1.

R_{pl} = Cooling tower part load ratio.

Q_c = Plant cooling load, MBH

N_c = Cooling plant rated capacity, Tons

12 = MBH/Ton

MBH = 1000 BTU/hr

The following restrictions are imposed, and adjustments made to the computed value of T_{ew} :

- i. $T_{mw} < T_{ew} < 130$
It is assumed that the cooling tower is controlled so that T_{ew} is always less than or equal to 130 F and greater than or equal to a user-defined minimum entering water temperature, T_{mw} .
- ii. When hot gas bypass control is used with a water cooled reciprocating chiller, it is assumed that the cooling tower is controlled so that $T_{ew} > 80$ F.
- iii. If the tower performance has not been adjusted for altitude, T_{ew} is increased by the quantity (Elevation)/1180 to account for altered tower performance due to the change in air density with elevation. See sub-section 5.1b for discussion.

The preceding equation for T_{ew} is used in an iterative solution method to determine the steady state system operating condition. This method is necessary because of the inter-relation of cooling plant and cooling tower performance. The entering water temperature is affected by the quantity of heat rejected by the cooling plant. In turn, the plant heat rejection is affected by compressor heat gain, which is dependent upon the entering water temperature. A small number of iterative cycles is usually required to determine the steady state value of T_{ew} .

Finally, the cooling tower fan input power is estimated as follows:

$$P_f = F_f Q_{cap}$$

where:

P_f = Cooling tower fan input power, KW.

F_f = Fan power factor. The value of this factor was determined from a study of the performance of open cooling towers.

$$= 1.177 \times 10^{-2} \text{ KW/Ton}$$

Q_{cap} = Nominal heat rejection capacity, Tons. It is assumed that the tower is sized to handle the plant heat rejection at the design condition.
 $= N_c + .2844 \cdot N_k \cdot N_c$
 N_c = Nominal cooling plant capacity at 85 F condenser entering water temperature, Tons.
 N_k = Nominal cooling plant KW/Ton at 85 F condenser entering water temperature.
 $.2844 = [3.413 \text{ MBH/KW}][\text{Ton}/(12 \text{ MBH})]$

FIGURE 5.3
Open Cooling Tower

b. Closed Circuit Cooling Tower

In a closed circuit cooling tower, condenser water flows through coils in the tower as shown in Figure 5.4. Tower water is pumped from the sump and sprayed over the coils while a tower fan draws air through the tower. Spray water is cooled by contact with ambient air. The spray water in turn cools the tower coils causing the transfer of heat from the condenser water to the spray water.

To compute the condenser entering water temperature, a modified version of the open cooling tower model is used:

$$T_{ew} = A_0 + A_1 R_{pl} + A_2 R_{pl}^2 + 5$$

where all equation components are the same as defined in sub-section (a) above.

The cooling tower fan input power is computed using the equation:

$$P_f = F_f Q_{cap}$$

where:

P_f = Cooling tower fan input power, KW.

F_f = Fan power factor. The value of this factor was determined from a study of the performance of closed circuit cooling towers.
 $= 5.884 \times 10^{-3} \text{ KW/Ton.}$

Q_{cap} = Nominal heat rejection capacity, Tons. It is assumed the cooling tower is sized to handle the heat rejection of the cooling plant at the design condition.
 $= N_c + .2844 \cdot N_k \cdot N_c$

N_c = Nominal cooling plant capacity at 85 F entering water temperature, Tons.

N_k = Nominal cooling plant KW/Ton at 85 F entering water temperature.

$.2844 = [3.413 \text{ MBH/KW}][\text{Ton}/(12 \text{ MBH})]$

FIGURE 5.4
Closed Circuit Cooling
Tower

c. Constant Temperature Heat Sink

With this heat sink, constant temperature water is provided to the condenser throughout the year. This model may be used for such heat sinks as cooling ponds and ground water. The condenser entering water temperature is set equal to a user-defined typical entering water temperature. This temperature represents average entering water conditions during the year. No fans are associated with this heat sink.

5.16 PUMP INPUT POWER CALCULATIONS

The energy consumption of pumps associated with heating and cooling systems is considered in computing the system operating cost. The following four pumping systems are examined:

- i. Chilled water pumping system which transports water between the chiller and the cooling coils.
- ii. Hot water pumping system which transports water between the water heater and the heating coils.
- iii. Condenser water pumping system which transports water between the cooling plant condenser and the heat sink.
- iv. Ground water pumping system which transports ground or well water to the evaporator of a ground source heat pump.

The purpose of this section is to describe the calculation of pump input power for these four pumping systems. In separate sub-sections below modeling assumptions are described, and the pump power equation is derived.

a. Assumptions

A simple pump system model is used in which all pumps are assumed to be of the constant speed, constant flow, constant head variety. The use of variable speed pumps, pump cycling, and the operation of pumps in various series and parallel configurations are not considered. Additional assumptions used in the pump model are that:

- i. Pump motors are electric.
- ii. The pump mechanical efficiency is 85%.
- iii. The pump motor efficiency is 90%.
- iv. Piping systems are well insulated so that thermal piping losses may be neglected.
- v. Each pumping system contains one pump.

b. Derivation of Basic Pump Power Equation

Pump input power is computed using the equation:

$$P_p = (V_p D_p) / \eta_p$$

where:

P_p = Pump input power.

V_p = Volumetric flow rate.

D_p = Pump head.

η_p = Pump mechanical and electrical efficiency.

Because each pumping system is used to transfer heat in some way, the total heat transfer may be used to compute the volumetric flow rate. The calculation follows:

$$V_p = Q_p / (\rho_w C_p D_T)$$

where:

Q_p = Total heat transferred in system loop, BTU/hr. This may be a cooling coil load, condenser heat rejection, heating coil load or evaporator heat gain.

ρ_w = Density of water: 62.3 lbm/ft³.

C_p = Heat capacity of water: 1 BTU/(lbm-F).

D_T = System delta-T: the change in water temperature in the system loop, F.

The preceding two equations are combined to obtain pump input power as a function of pump head, D_p , pump system temperature difference, D_T , and pump system heat transfer, Q_p :

$$P_p = (Q_p D_p F) / (\rho_w C_p D_T \eta_p)$$

where:

P_p = Pump input power, KW.

Q_p = System heat transfer, BTU/hr.

= Cooling plant nominal capacity for chilled water system.

= Heating plant rated capacity for hot water system.

= $12000(N_c + .2844 \cdot N_k \cdot N_c)$ for condenser water system. This is the cooling plant heat rejection at the design condition.

= The heat pump nominal capacity at 70 F evaporator entering water temperature for the ground water system.

D_p = Pump head, feet of water, gage.

D_T = Pump system delta-T: the change in water temperature in the system loop, F.

ρ_w = Density of water: 62.3 lbm/ft³.

C_p = Specific heat of water, 1 BTU/(lbm-F).

η_p = Pump mechanical and electrical efficiency: (.85)(.90).

F = Units conversion factor.

= $[(\text{hp} \cdot \text{min}) / (33000 \text{ ft} \cdot \text{lb})] \cdot [(\text{hr} / (60 \text{ min}))] \cdot$
 $[\text{kw} / (1.341 \text{ hp})] \cdot [(62.3 \text{ lbm water}) / \text{ft}^3]$

N_c = Plant nominal capacity at 85 F entering water temperature, tons.

N_k = Plant nominal KW/ton at 85 F entering water temperature.

.2844 = $[3.413 \text{ MBH} / \text{KW}] / [0.12 \text{ MBH}]$

12000 = (BTU/hr)/Ton

5.17 HYDRONIC ECONOMIZERS

A hydronic economizer is an accessory used with a water cooled cooling plant to reduce the mechanical refrigeration load. The economizer consists of a pre-cooling coil and associated controls which will use cooling tower water to pre-cool air before it passes through the main cooling coil. Cooling tower water is only allowed to flow through the pre-cooling coil when the water temperature is less than the coil entering air temperature. A schematic of the economizer is shown in Figure 5.5. The operation of the economizer is integrated so that the economizer and the mechanical refrigeration plant can operate simultaneously.

The amount of cooling occurring at the pre-cooling coil is estimated using the following equation:

$$Q_e = 1.1 V_s e_e (T_{ce} - T_{ew})$$

where:

Q_e = Economizer cooling, BTU/hr.

V_s = Volumetric air flow rate through pre-cooling coil, cfm.

T_{ce} = Dry bulb temperature of air entering pre-cooling coil, F.

T_{ew} = Condenser entering water temperature, F. See section 5.16 for discussion of calculation of T_{ew} .

e_e = Average economizer efficiency. This value is an average fraction of the total possible heat transfer which occurs at the coil. Calculation of this value is discussed below.

a. Calculation of Economizer Efficiency

If a specific economizer is being modeled, the economizer efficiency may be approximated using the product data. For several entering water temperature conditions and, if possible, several entering air conditions, the efficiency should be computed:

$$e_e = TC / (1.1 V_s (T_{ce} - T_{ew}))$$

where:

TC = Total cooling capacity, BTU/h.

The efficiency values computed should then be averaged and this average value should be entered as the economizer efficiency.

If a specific product is not being modeled, some representative efficiency value should be used. A typical value is 70%.

FIGURE 5.5
Hydronic Economizer

AVERAGE ANNUAL OPERATING COST CALCULATIONS

a. Introduction

In this final stage of the analysis, annual operating costs are computed using input power and energy consumption data generated in previous stages. Simple summation calculations are carried out to derive component operating costs from bin by bin power consumption data. These calculations are briefly discussed in the following sections.

b. Summary

Average annual operating costs are compiled from component costs as shown below.

Fan Energy Costs	
Pump Energy Costs	
Cooling Plant Energy Costs	Non-HVAC Electrical Costs
+ Heating Plant Energy Costs	+ DHW Energy Costs
<hr/> Total HVAC Energy Cost	<hr/> Total Non-HVAC Energy Cost
Total HVAC Energy Cost	
+ Total Non-HVAC Energy Cost	
<hr/> Average Annual Operating Cost	

c. HVAC Component Energy Cost Calculation

HVAC component energy costs are computed by summing input power data over all bins, for each zone and period:

$$\begin{aligned}
 \text{Fan Energy Costs} &= \text{Sum of } [P_f \cdot H_b \cdot C_e] \\
 \text{Pump Energy Costs} &= \text{Sum of } [P_p \cdot H_b \cdot C_e] \\
 \text{Cooling Plant Energy Cost} &= \text{Sum of } [P_c \cdot H_b \cdot C_e] \\
 \text{Heating Plant Energy Cost} &= \text{Sum of } [P_h \cdot H_b \cdot C_e]
 \end{aligned}$$

where:

P_f = Fan input power for conditions in one bin, KW.

P_p = Pump input power for conditions in one bin, KW.

P_c = Cooling plant input power for conditions in one bin. Units vary with cooling plant type. See documentation of the cooling plants for an explanation of how plant input power is accounted for.

P_h = Heating plant input power for conditions in one bin. Units vary with plant type.

H_b = Bin hours in one temperature bin, hr/yr.

C_e = Energy cost, \$/fuel unit. A number of fuel costs are defined by the program user. Each cost is applied in the summation calculation with the appropriate plant, fan or pump. Electrical energy costs are sometimes broken into three rate categories: compressive energy-for compressor operation; inductive energy-for fan and pump operation; resistive energy-for electrical resistance heating.

d. Non-HVAC Energy Cost Calculations

Non-HVAC energy costs are computed using the following simple equations:

$$\begin{aligned}
 \text{Non-HVAC Electrical Cost} &= (E_{lo} + E_{mo} + E_{oo})C_{eo} \\
 &\quad + (E_{lu} + E_{mu} + E_{ou})C_{eu}
 \end{aligned}$$

where:

E_{lo}, E_{lu} = Annual energy use for lighting in occupied and unoccupied periods, KWH/yr. See section 6.1a.

E_{mo}, E_{mu} = Annual energy use for miscellaneous electrical appliances and machinery, KWH/yr. See section 6.1b.

E_{oo}, E_{ou} = Annual energy use for other electrical devices and systems, KWH/yr. See section 6.1c.

C_{eo}, C_{eu} = Electrical energy rates, \$/KWH. Rates may vary for occupied and unoccupied time periods, and for type of use. If these multiple costs are used, the resistive costs are utilized in these calculations.

$$\text{DHW Energy Cost} = E_{wo} \cdot C_{eo} + E_{wu} \cdot C_{eu}$$

where:

E_{wo}, E_{wu} = Annual energy use for domestic water heating during the occupied and unoccupied periods, respectively. Units of energy vary with the heating plant used.

C_{eo}, C_{eu} = Fuel or energy cost, \$/fuel unit. Units depend upon the heating plant used. When an electrical resistance heating plant is used, it is possible to define separate electricity costs, C_{eo} for the occupied period, and C_{eu} for the unoccupied period. For all other types of DHW plants, C_{eo} and C_{eu} are equal.

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