Engineering Management
Field Project

Economic Analysis and Optimization of Exterior Insulation Requirements for Ventilated Buildings at Power Generation Facilities with High Internal Heat Gain

By

Douglas E. Hughes

Fall Semester, 2010

An EMGT Field Project report submitted to the Engineering Management Program
and the Faculty of the Graduate School of The University of Kansas
in partial fulfillment of the requirements for the degree of
Master's of Science

Tom H. Bowlin
Tom Bowlin
Committee Chairperson

John Conard
John Conard
Committee Member

Terry Sullivan
Terry Sullivan
Committee Member

Date accepted: 11/9/10

Table of Contents

Appendices

Tables

Figures

1.0 Acknowledgements

I would like to thank committee chairperson Tom Bowlin and committee members John Conard and Terry Sullivan for assisting in reviewing and providing helpful feed back during the development of the field project. Their diverse backgrounds provided for insightful feedback during the project and is very appreciated.

I appreciate the support (financial and otherwise) from Black & Veatch during the engineering management program and would like to thank them for encouraging and providing assistance with attaining the degree.

I would also like to thank the instructors in the University of Kansas Engineering Management program for providing challenging courses and demonstrating a solid understanding of the subject matter. Topics discussed in each course will help as I continue my career and the practical experience gained from each course is appreciated.

2.0 Executive Summary

Industrial buildings require a large amount of heating and ventilation equipment to maintain the indoor environment within acceptable levels for personnel protection and equipment protection. The required heating and ventilation equipment is impacted by the amount of insulation installed in the exterior envelope of the building. This research paper describes a method of determining the optimal level of insulation based on satisfying the client or project goals by minimizing the up front capital expenditures, minimizing energy use or maximizing return on investment.

2.1 Background

The purpose of this project is to evaluate the exterior insulation requirements for buildings with high internal heat gain at power generating facilities. Currently, the majority of the industry provides insulation in conformance with the local energy code or doesn't provide insulation at all. The majority of the energy conservation codes have exemptions for buildings that serve a manufacturing or industrial process; therefore, insulation is not required by code.

Eliminating insulation can result in increased ventilation and heating rates to maintain the desired space temperature conditions. By properly selecting the insulation values for the exterior walls, while taking into consideration the resultant interior surface temperature of the wall (protection of occupants and equipment), and the procurement and installation cost of the required heating and ventilation equipment, it is believed the total installed cost of the building can be dramatically reduced. Total procurement cost for ventilated buildings at power generation facilities can exceed $3,000,000, with installation costs equivalent to or greater than procurement costs. Reduction of the required equipment can have a substantial cost benefit per project.

2.2 Summary of Analysis and Findings

This paper analyzed a typical building that would occur at a power generation facility to determine the optimal mix of exterior insulation and the required mechanical equipment to maintain indoor design conditions. Table 2-1 summarizes the findings of the study.

Table 2-1
Alternate Construction Evaluation

	Base	Alternate 1	Alternate 2	Alternate 3	Alternate 4
Description	ASHRAE 90.1-2004, R-19 Roof, R-12 Walls	ASHRAE 90.1-2007, R-13+R-13 Roof, R-13+R-5.6 Walls	R-30 Roof, R-19 Walls	R-5.6 Walls, R-30 Roof	R-13 Roof, R-13 Walls
Installed Cost	$99,400	$107,000	$97,100	$100,000	$96,000
Annual Energy Use	$21,400	$19,600	$19,000	$24,400	$22,800
Payback, years	N/A	8	0	Neg Return	(5)

The base case is the outdated energy code requirement for insulation. Alternate 1 is the updated energy code requirement for insulation and the remaining alternatives were chosen for evaluation to determine which insulation system provides for the following three items:

- Lowest first cost
- Lowest annual energy consumption
- Payback analysis based on energy savings

As shown in the table, Alternative 4 has the lowest installed cost of all of the options. However, it has a negative rate of return overall when compared to the base case due to the higher annual energy consumption. Alternate 1 is the updated energy code requirement and has an installed cost that is 4% higher than the base case, and 11% higher than the lowest cost option Alternative 4. Alternate 1 has an 8 year payback period. Alternate 3 has a higher capital cost and a negative return due to a higher annual energy cost than the base case.

A typical power generation facility building located in Kansas City, MO would have an installed cost 11% higher than the lowest cost option if the latest edition of the energy code is followed.

The model developed as part of the study also results in engineering labor cost savings due to a standardized approach to the calculation. The reduced labor is equal to $2,776 per building or $33,312 per project (on average, assuming 12 buildings per project), and the total project savings calculated is equal to $167,000 when compared to the latest edition of the energy code.

Thorough evaluation of the design insulation values is required on a project specific basis to determine what the optimal level of insulation is based on the project objectives.

3.0 Introduction

This section of the report provides background information related to the need for this research and the expected outcomes. In addition, a brief discussion will address the overall scope and objectives of this research project.

3.1 Background

This study evaluates the exterior insulation requirements for buildings with high internal heat gain at power generating facilities. Currently the majority of the industry provides insulation in conformance with the local energy code, or doesn't provide insulation at all. The majority of the energy conservation codes have exemptions for buildings that serve a manufacturing or industrial process; therefore, insulation is not required by code.

Eliminating insulation can result in increased ventilation and heating rates to maintain the desired space temperature conditions. By properly selecting the insulation values for the exterior walls, while taking into consideration the resultant interior surface temperature of the wall (protection of occupants and equipment), and the procurement and installation cost of the required heating and ventilation equipment, it is believed the total installed cost of the building can be dramatically reduced. Total procurement cost for ventilated buildings at power generation facilities can exceed $3,000,000, with installation cost equivalent or greater than procurement costs. Reduction of the required equipment can have a substantial cost benefit per project.

3.2 Scope and Objectives

The scope of work for this project includes creating an Excel design template that will perform an optimization routine to determine the proper insulation requirements for the building based on the following design variables and constraints:

- Building envelope components including wall and roof areas, insulation values, building orientation and architectural features
- Design indoor temperatures including summer and winter design temperatures
- Design outdoor ambient conditions including summer and winter extreme design temperature and American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) summer and winter design conditions
- Installation and procurement cost for ventilation fans, heating equipment, intake and exhaust louvers, intake and exhaust dampers, and building insulation

Additionally, the optimization routine will be able to analyze the inputs based on the following economic considerations:

- Minimizing overall first cost
- Achieving a specified pay-back period based on an energy analysis

- Minimize energy consumption based on a user-input fixed price for the building components

The optimization spreadsheet was used to create a design guide for use on future projects. The design guide allows the engineer to select the appropriate parameters based on the following criteria:

- Indoor heat gain per square foot
- Envelope area
- Exterior summer design temperature
- Exterior winter design temperature

The optimization model is validated in Section 6.2 of this report to verify the output from the model against a typical building.

4.0 Literature Review

A brief literature review is included in the following sections. Relevant industry applications are discussed including the limitations of available software. In addition, a review of applicable building code requirements is included to form the basis of the analysis.

4.1 Existing Analysis Software

Several programs are available to compute the energy consumption of air conditioned buildings and are widely used in the industry. Some of the applicable programs are listed below:

<u>Trane Air Conditioning Economics (TRACE)</u>

Trane TRACE is a widely used software package developed by a manufacturer of heating, ventilating and air conditioning equipment to analyze building loads. The below excerpt is from the manufacturer [Trane, 2008]:

> "Trane Air Conditioning Economics, or TRACE™, is a design-and-analysis tool that helps HVAC professionals optimize the design of a building's heating, ventilating, and air-conditioning system based on energy utilization and lifecycle cost. Introduced in 1972, the program was the first of its kind and quickly became a de facto industry standard. A TRACE model can help establish the peak cooling and heating loads during the planning stage of a building project. At the design development

stage, it aids evaluation of energy saving concepts, such as the effects of daylighting, HVAC optimization strategies, and high-performance glazing. Near the end of the construction, when the design is finalized, the TRACE model can help document compliance with ASHRAE Standard 90.1-2004 or validate the building's eligibility for Leadership in Energy and Environmental Design (LEED®) certification."

EnergyPlus

EnergyPlus was developed by the U.S. Department of Energy and is based on the backbone of DOE-2. The main difference between DOE-2 and EnergyPlus is a graphical user interface to simplify the input of information. The below description is from the U.S. Department of Energy:

"EnergyPlus models heating, cooling, lighting, ventilating, and other energy flows as well as water in buildings. While originally based on the most popular features and capabilities of BLAST and DOE-2, EnergyPlus includes many innovative simulation capabilities such as time steps of less than an hour, modular systems and plant integrated with heat balance-based zone simulation, multizone air flow, thermal comfort, water use, natural ventilation, and photovoltaic systems."

DOE-2

"DOE-2 is a widely used and accepted freeware building energy analysis program that can predict the energy use and cost for all types of buildings. DOE-2 uses a description of the building layout, constructions, operating schedules, conditioning systems (lighting, HVAC, etc.) and utility rates provided by the user, along with weather data, to perform an hourly simulation of the building and to estimate utility bills. The “plain” DOE-2 program is a “DOS box” or “batch” program which requires substantial experience to learn to use effectively while offering researchers and experts significant flexibility; eQUEST is a complete interactive Windows implementation of the DOE-2 program with added wizards and graphic displays to aid in the use of DOE-2.”

These programs are capable of computing the energy consumption of various building types and perform a more rigorous analysis than the spreadsheet developed in this project. However, the above programs are mainly geared towards air-conditioned buildings and are have difficulty analyzing ventilated buildings. These programs simply give a total airflow or heating load and are not capable of providing cost analysis or sizing individual components. In contrast, the purpose of this project is to develop a single tool capably of quickly estimating the annual energy use, perform cost analysis and size the required equipment. These programs simply give a total airflow or heating load and are not capable of providing cost analysis or sizing individual components.

4.2 Building Code Review

The applicable building codes vary by region and should be reviewed on a project specific basis. However, for the purpose of this study the building code used will be the *2006 International Building Code* (2006 IBC). The *2006 IBC* references the *2006 International Energy Conservation Code* (2006 IECC) for energy requirements including the applicable building envelope requirements. The following is an excerpt from the *2006 IECC*:

> "501.1 Scope. The requirements contained in this chapter are applicable to commercial buildings, or portions of commercial buildings. These commercial buildings shall meet either the requirements of ASHRAE/IESNA Standard 90.1, Energy Standard for Buildings Except for Low-Rise Residential Buildings, or the requirements contained in this chapter."

Typically buildings will be designed to meet the first option given in the above paragraph, *ASHRAE Standard 90.1*, *Energy Standard for Buildings Except for Low-Rise Residential Buildings*. Section 2.3c of *ASHRAE 90.1-2007* states the following:

> "The provisions of this standard do not apply to buildings or portions thereof that use energy primarily to provide for manufacturing, industrial or commercial purposes."

This section gives an exemption for industrial buildings studied in this paper. Generally insulation is supplied according to the minimum recommended values in the standard; however it is not specifically required. The following figure from *ASHRAE 90.1* is used to determine the insulation requirements.

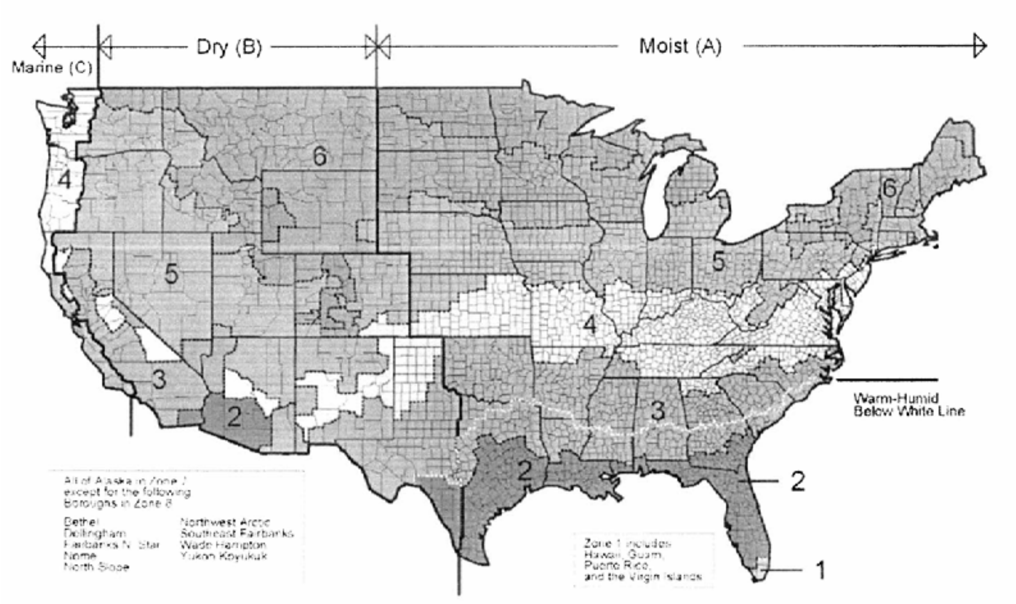


Figure 4-1. ASHRAE 90.1-2007 Climate Zones

This climate zone figure determines the minimum insulation requirements for industrial buildings that comply with the required insulation requirements for typical buildings. Each of the six climate zones shown in the above figure have different requirements for insulation. Appendix A includes a sample for climate zone 4 (including Missouri).

As stated previously the purpose of this report is to determine whether the minimum insulation values listed in *ASHRAE 90.1-2007* should be followed. Section 5 of this report will analyze economic and energy usage based on using or not using these insulation values.

4.3 ASHRAE Handbooks

ASHRAE publishes four design handbooks that are considered the industry norm for design. Each handbook is updated on a four year schedule. The 2009 ASHRAE Fundamentals Handbook details a degree-day method for analyzing the annual heating and cooling loads, and states it is applicable even though computer programs (such as those listed in Section 4.1) are capable of more rigorous computation routines. This is the basis for using the degree-day method of annual energy consumption calculation in the Excel spreadsheet developed as part of this report. The following is an excerpt from Chapter 19 of the *2009 ASHRAE Fundamentals Handbook*:

> "Degree-day methods are the simplest methods for energy analysis and are appropriate if building use and HVAC equipment efficiency are constant. Where efficiency or conditions of use vary with outdoor temperature, consumption can be calculated for different values of the outdoor temperature and multiplied by the corresponding number of hours; this approach is used in various bin methods. When the indoor temperature is allowed to fluctuate or when interior gains vary, simple steady-state models must not be used. Although computers can easily calculate the energy consumption of a building, the concepts of degree-days and balance point temperature remain valuable tools. A climate's severity can be characterized concisely in terms of degree-days. Also, the degree-day

method and its generalizations can provide a simple estimate of annual loads, which can be accurate if the indoor temperature and internal gains are relatively constant and if the heating or cooling systems operate for a complete season."

Section 6 of this report will discuss this method in greater detail.

5.0 Research Procedure

This section of the report summarizes the procedure used to analyze the insulation requirements for industrial buildings with high internal heat gain. The method used to evaluate the insulation requirements and required data is also discussed.

5.1 Identification of Required Design Tool

The objective of this project is to determine the optimal level of exterior envelope insulation to satisfy project or client needs. Typical project budgets do not allow sufficient man-hours to do iterative evaluations of exterior insulation values and the subsequently required heating and ventilation equipment. For this reason a simple to use tool is required that will allow for a minimal amount of input time on the part of the engineer to determine the optimal mix of insulation and heating and ventilation equipment for a particular building.

The design tool needs to have the ability to readily identify the following based on user input for the particular building:

- Minimizing overall first cost
- Achieving a specified pay-back period based on an energy analysis
- Minimize energy consumption based on a user-input fixed price for the building components

An optimization model was developed as part of this project to allow for the above analysis to be completed. The development of the optimization model is discussed in Section 6 of this paper.

5.2 Data Collection

The model requires various information regarding building size and location to allow for calculation of the required equipment, insulation, energy consumption and payback analysis. To allow for a simple comparison a building that was built using standard design practices was used as the model building for the analysis.

Insulation costs were collected from industry standard estimating databases to allow for an accurate cost estimate for the various levels of insulation. Heating and ventilation equipment costs were obtained from vendors based on the calculated equipment requirements.

5.3 Analysis of Model Output

After the model was developed and all required information collected the model was executed for the subject building. The analysis determined the mix of insulation and mechanical equipment that produced the lowest cost, the lowest energy consumption and the highest return on investment.

In addition to material savings, the project should realize engineering man-power savings. The analysis included a determination of the man-hours that could be saved for a typical project due to the use of the optimization model.

6.0 Results

To properly evaluate the insulation requirements for an industrial building with high internal heat gain an optimization tool is required. This resulted in the development of an optimization model that will perform the required analysis. This section of the report discusses the development of the model and includes an analysis of the model output.

6.1 Development of Optimization Model

An optimization model was developed to analyze the required insulation and mechanical equipment for a typical ventilated and heated building. The following sections discuss the operation of the model and functionality.

6.1.1 Introduction

A printout of the Excel model is included in Appendix B. The model consists of twenty-two individual tabs to support the functionality of the model and has visual basic codes to perform some of the calculation routines. The first tab is called “Envelope Information” and is where the majority of the user input occurs. See Figure 6-1 below for a screen-shot of the envelope information tab.

The ‘yellow’ cells in Figure 6-1 are for user input. The physical attributes of the selected building are entered such as the dimensions, doors, insulation values, and quantity of louvers required. The other spreadsheet pages pull information from this tab.

The second tab is the "Design Conditions" tab. The user is required to input the outdoor design conditions, indoor design conditions, interior heat gain and location. Figure 6-2 shows a screenshot of this tab. The 'yellow' cells are the user input cells. The values listed in Figure 6-2 are pulled from the latest edition of ASHRAE Fundamentals climatic design information for the location of the building.

2.0 EXTERIOR ENVELOPE INFORMATION

Exterior Wall and Roof Information

DIRECTION	LENGTH ft	HEIGHT (WIDTH) ft	AREA (HEIGHT) ft²	VOLUME ft3
NORTH	165	22	3630	
SOUTH	165	22	3630	
EAST	60	23.25	1395	
WEST	60	23.25	1395	
ROOF	165	60	9900	
BUILDING	165	60	23.25	230175

Exterior Doors

DIRECTION	HEIGHT ft	WIDTH ft	QUANTITY qty	AREA ft²
NORTH	7	3	2	42
SOUTH	7	3	1	21
EAST				0
WEST	7	3	1	21

Exterior Louvers (Calculated during optimization routine)

DIRECTION	HEIGHT ft	WIDTH ft	QUANTITY qty	AREA ft²
NORTH	4.3	4.3	5	93.9
SOUTH	4.3	4.3	5	93.9
EAST	0.0	0.0	0	0.0
WEST	0.0	0.0	0	0.0

Net Wall, Roof, Door and Louver Area (For use in solar heat gain calculation)

DIRECTION	Area, ft²		
	Wall	Door	Louver
NORTH	3,494	42	94
SOUTH	3,515	21	94
EAST	1,395	0	0
WEST	1,374	21	0
TOTALS	9,778	84	188

Wall, Roof, Door and Louver U-value and type

DIRECTION	U-value Btu/ft²-°F-h	ASHRAE TYPE A-G, 1-13	REFERENCE
NORTH	0.089	G	
SOUTH	0.089	G	
EAST	0.089	G	
WEST	0.089	G	
ROOF	0.065	1	
DOOR	0.7	G	
LOUVER	0.5	G	

Figure 6-1. Envelope Information Screenshot

2.1 DESIGN CONDITIONS

Project Location

City	Kansas City	
State	MO	
WMO #	724460	ASHRAE 2009 Fundamentals
Latitude	39.3	N
Longitude	94.7	W
Elevation	1024	ft
Density	0.07	lb/ft3

Indoor Design Conditions

Indoor design dry-bulb temperature, summer	104	° F	Ref 1
Indoor design dry-bulb temperature, winter	45	° F	Ref 1
Assumed winter infiltration rate	1.5	ACH	Assumed
Calculated infiltration airflow	5,754	CFM	

Outdoor Design Conditions

Annual Heating design temperature, ASHRAE 99.6%	-0.1	° F
Annual Cooling design temperature, ASHRAE 0.4%	96.2	° F
Hottest month dry-bulb temperature range	19	° F
Annual extreme maximum dry-bulb temperature	110.6	° F
Annual extreme minimum dry-bulb temperature	-21.9	° F

Interior Heat Gain

Total equipment heat gain	249938	Btu/hr
Lighting heat gain per sq foot	1.5	W/ft²

Figure 6-2. Screenshot of the Design Conditions Tab

The first calculation tab is the “Heating Calc” tab shown in Figure 6-3. All information on this page is pulled from the previous sheets with the exception of the quantity of unit heaters required. After reviewing the calculated heat load and reviewing the layout of the building, the user must input the quantity of heaters required to provide adequate coverage of the building. The total heat loss from a building is provided by Equation 6-1.

$$q = \left(U_w A_w + U_R A_R + U_L A_L + U_D A_D + mc_p\right) \times \Delta T \qquad \text{Equation 6-1}$$

where:

q = total heat loss, Btu/hr

U_W	=	U-value for walls
A	=	Area, ft²
U_R	=	U-value for roof
U_D	=	U-value for doors
m	=	Mass flow rate of infiltration air, lb/hr
c_p	=	Specific heat of air
ΔT	=	Temperature difference indoor/outdoor

2.5 BASE CASE HEATING LOAD

Design extreme outdoor air temperature	-21.9	° F
Design outdoor air temperature	-0.1	° F
Design indoor air temperature	45	° F
Temperature to protect against freezing	32	° F
Design delta T	53.9	° F
Total wall area	9,778	
Wall U-Value	0.089	
Total roof area	9900	
Roof U-Value	0.065	
Total door area	84	
Door U-Value	0.7	
Total louver area	188	
Louver U-Value	0.5	
Sum of UA	1,666	
Total envelope heat loss	89,822	Btu/hr
Infiltration airflow	5,754	CFM
Infiltration heat loss	312,642	Btu/hr
Total Heat Loss	402,464	Btu/hr
Total Heat Loss	118	kW
Quantity of heaters	16	Qty
Capacity of each heater	7.4	kW

Figure 6-3. Screenshot of the Heating Calc Tab

The "Vent Fan Sizing" tab calculates the required ventilation airflow to maintain indoor design conditions, and a screenshot is shown in Figure 6-4. Seven inputs are required on this page. The minimum required air changes is typically a contract value or industry standard for the type of space being evaluated. The calculated 'Total Airflow' required is the greater of the minimum air change rate or the calculated airflow based on solar and other heat loads. The solar heat load calculation engine is included in Appendix B.

2.2 INTERNAL HEAT GAINS

Total equipment heat gain	249,938	Btu/hr	Ref 2
Lighting heat gain per sq foot	1.5	W/ft²	
Lighting heat gain	50,668	Btu/hr	
Total internal heat load	**300,606**	Btu/hr	

2.3 BASE CASE VENTILATION LOAD

Minimum air changes	5	ACH
Minimum ventilation due to air changes	19,181	CFM
Design outdoor air temperature	96.2	° F
Design indoor air temperature	104	° F
Maximum Solar Load occurs at 1400 hours	46,118	Btu/hr
Total internal heat load	300,606	Btu/hr
Estimated fan heat temperature rise	1	° F
Total airflow required	50,584	CFM
Total required summer ventilation	50,584	CFM
Quantity of fans	5	qty
Airflow per fan	10,117	CFM
Calculated static pressure for fans	0.38	in wg

2.4 STATIC PRESSURE DROP DETERMINATION

Maximum allowable free area velocity	1500	fpm
Minimum allowable free area velocity	1000	fpm
Incremental louver size	2	in
Aspect ratio, H/W	1	dimensionless
Calculated louver height	52	in
Louver width	52	in
Supply fan airflow	10,117	CFM
Louver model	CESCO A6SA	
Louver free area	7.27	ft²
Louver free area velocity	1392	
Damper velocity	539	fpm
Intake louver pressure drop	0.14	
Intake louver birdscreen	0.02	engineer judgement
Intake damper pressure drop	0.01	
Relief louver pressure drop	0.14	
Relief damper pressure drop	0.01	
Relief louver birdscreen	0.02	
Safety factor	15%	
Total pressure drop	0.38	in wg

Figure 6-4. Screenshot of the Vent Fan Sizing Tab

The airflow required to attain a specific airflow is determined by Equation 6-2.

$$Q = \frac{ACH \times 60}{V} \qquad \text{Equation 6-2}$$

where:

Q = Airflow, CFM

ACH = Air change rate

V = Volume

The calculated airflow based on heat dissipation is determined from Equation 6-3.

$$m = \frac{q}{c_p \times \Delta T}$$ Equation 6-3

where:

q = Total heat gain, Btu/hr

c_p = Specific heat of air

ΔT = Temperature difference indoor/outdoor

The resistance to airflow (static pressure drop determination in Figure 6-4) automates the calculation of the fan pressure required. The user sets the minimum and maximum allowable velocity through the louver, incremental louver sizes and the aspect ratio. A drop-down menu allows for selection of the louver model.

To allow for automatic calculation of the pressure drop from the various components an equation is required for the damper. Figure 6-5 is a plot of various pressure and velocity points from hard copies of vendor data. This information was line-fit with a 2nd order polynomial to develop an equation. This equation is used to calculate the pressure drop from the dampers.

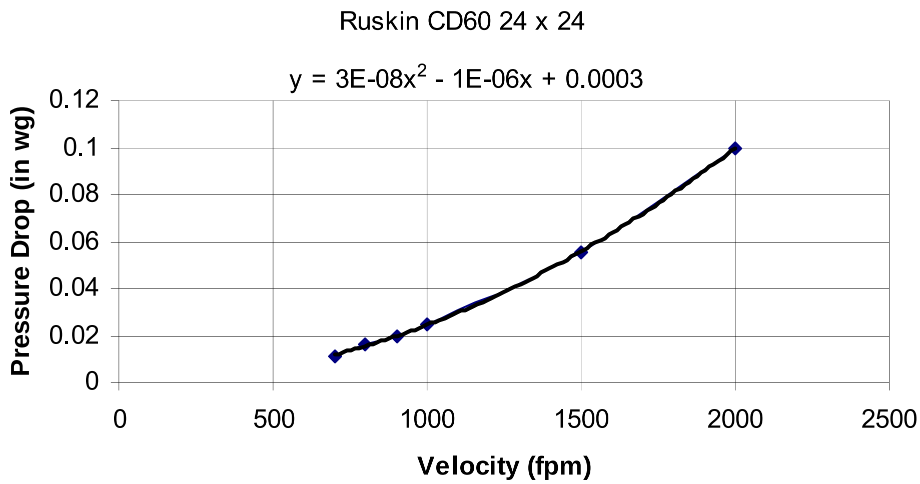


Figure 6-5. Graph of Damper Velocity vs Pressure Drop

The louver calculation was developed in a similar manner to calculate the free area of the louver and the pressure drop through the louver free area. Louvers are more complicated than dampers because the free area must be determined. The free area is the amount of a louver that is not blocked by the framing or louver blades. The catalog data for four louver manufacturers was input into Excel with the free area for each size of louver tabulated. A secondary table was created that calculates the louver free area based on an equation that takes into account the amount of area blocked by framing, and is shown in Table 6-1.

Solver was used to set the “Error Percentage” equal to zero by changing the free area blocked by the side, top, and bottom framing. The error percentage is the difference between the calculated value and the tabulated value.

Table 6-1
Louver Free Area Determination

RS-5605			**Pottorff ECV-645**		
Free area blocked by side framing:	3.52	in	Free area blocked by side framing:	2.42	in
Free area blocked by top/bottom:	4.08	in	Free area blocked by top/bottom:	9.00	in
Free area percentage:	0.68		Free area percentage:	0.67	
Error Percentage:	0.02		Error Percentage:	0.00	
RUSKIN EME6625-805			**CESCO A6S**		
Free area blocked by side framing:	2.42	in	Free area blocked by side framing:	3.00	in
Free area blocked by top/bottom:	9.00	in	Free area blocked by top/bottom:	4.00	in
Free area percentage:	0.55		Free area percentage:	0.44	
Error Percentage:	0.00		Error Percentage:	0.00	

This equation allows for automated calculation of louver pressure drop and simplifies the development of the calculation. Appendix B has a complete printout of the louver calculation routine.

Figure 6-6 is a printout of the visual basic routine that is executed any time a value on the spreadsheet changes related to the louver size. This routine automates the sizing of the louver based on allowable pressure drop, velocity, size constraints and aspect ratio.

```
Sub auto_open()

  ' Run the macro Sheet3.Workbook_Change on opening the file.
            ThisWorkbook.Worksheets("VENT FAN SIZING").OnEntry = "Sheet3.Workbook_Change"
            ThisWorkbook.Worksheets("VENT FAN SIZING (2)").OnEntry = "Sheet8.Workbook_Change"
            ThisWorkbook.Worksheets("ALTERNATE HEAT COOL").OnEntry = "Sheet4.Workbook_Change"

End Sub

Sub Louver1()

' Edit louver height until free area velocity is acceptable
' i is the minimum louver height allowable

i = 12

   Do

   'This cell should reference "Calculated louver height"
   Range("E32").Value = i

   'This cell should reference "Maximum allowable free area velocity"

      i = i + Range("E30").Value

   'Loops until the Louver free area velocity is less than maximum allowable free area velocity

   Loop While Range("E37") > Range("E28")

End Sub

Sub Louver2()

' Edit louver height until free area velocity is acceptable
' i is the minimum louver height allowable

x = 12

   Do

   'This cell should reference "Calculated louver height"
   'Range("E32").Value = x
   Sheets("VENT FAN SIZING (2)").Range("E32").Value = x


   'This cell should reference "Maximum allowable free area velocity"

      x = x + Sheets("VENT FAN SIZING (2)").Range("E30").Value

   'Loops until the Louver free area velocity is less than maximum allowable free area velocity

   Loop While Sheets("VENT FAN SIZING (2)").Range("E37") > Sheets("VENT FAN SIZING (2)").Range("E28")

End Sub
```

Figure 6-6. Visual Basic Routine for Sizing Louver

The remainder of the model deals with calculating the installed cost, minimizing first cost, analyzing payback and minimizing energy use. These will be discussed in more detail in the following sections.

6.1.2 Minimize First Cost

The ‘First Cost Optimization’ tab allows the user to size the insulation and ventilation to minimize the first cost of the installation. This would typically be used for lump sum projects. The spreadsheet allows for four alternatives to be calculated against a base case scenario. Typically the base case will be the minimum code required insulation values. Table 6-2 shows the inputs required for the first cost optimization routine.

Table 6-2
First Cost Optimization

	Description	Base	Alt 1	Alt 2	Alt 3	Alt 4
		ASHRAE 90.1-2004, Single layer R-19 roof and R-13 wall	ASHRAE 90.1-2007, Double layer R-13 roof, Single layer R-13/Continuous R5.6 wall	R-30 roof, R-19 walls	R-5.6 walls with R-30 roof	R-13 roof, R-13 walls
Roof	U-value	0.065	0.055	0.040	0.040	0.089
Roof	Insulation cost/ft²	0.770	1.080	0.890	0.890	0.540
Roof	Installation cost/ft²	0.290	0.420	0.340	0.340	0.210
Wall	U-value	0.089	0.064	0.069	0.179	0.089
Wall	Insulation cost/ft²	0.540	1.060	0.770	0.520	0.540
Wall	Installation cost/ft²	0.210	0.630	0.290	0.420	0.210
	Total First Cost	$99,392	$107,047	$97,083	$99,943	$95,884

The yellow cells represent the inputs required. The insulation cost/ft² value is from *RSMeans Building Construction Cost Data, 2010*. In the base case the insulation values are from the *ASHRAE 90.1-2004* edition and represent the code required minimum insulation. Alternate 1 represents the updated 2007 edition of required insulation. Alternates 2, 3 and 4 are user selected options to compare with the code required values. As shown in the table, the updated 2007 edition costs approximately 8% more than 2004 requirements and is 11% higher than Alternate 4.

The first cost optimization works by calculating the required heating and ventilation equipment required for each case and comparing the total installed cost of each option. After entering information required for Table 6-2 the user clicks on the 'First Cost Optimization" button which activates the visual basic routine shown in Figure 6-7.

```
Sub First_cost()

'this sub will alter the value of C28 from 1 to 4 to
'determine what the minimum cost is for the alternate setups

Sheets("FIRST COST OPTIMIZATION").Range("C28").Value = 1
Louver2
Sheets("FIRST COST OPTIMIZATION").Range("D25").Value = Sheets("ALTERNATE
HEAT COOL").Range("H41").Value
w = Sheets("FIRST COST OPTIMIZATION").Range("D25").Value

Sheets("FIRST COST OPTIMIZATION").Range("C28").Value = 2
Louver2
Sheets("FIRST COST OPTIMIZATION").Range("E25").Value = Sheets("ALTERNATE
HEAT COOL").Range("H41").Value
x = Sheets("FIRST COST OPTIMIZATION").Range("E25").Value

Sheets("FIRST COST OPTIMIZATION").Range("C28").Value = 3
Louver2
Sheets("FIRST COST OPTIMIZATION").Range("F25").Value = Sheets("ALTERNATE
HEAT COOL").Range("H41").Value
y = Sheets("FIRST COST OPTIMIZATION").Range("F25").Value

Sheets("FIRST COST OPTIMIZATION").Range("C28").Value = 4
Louver2
Sheets("FIRST COST OPTIMIZATION").Range("G25").Value = Sheets("ALTERNATE
HEAT COOL").Range("H41").Value
z = Sheets("FIRST COST OPTIMIZATION").Range("G25").Value

b = Sheets("FIRST COST OPTIMIZATION").Range("c27").Value

Sheets("FIRST COST OPTIMIZATION").Range("c28").Value = b
Louver2

End Sub
```

Figure 6-7. Visual Basic Routine for First Cost Optimization

The routine shown in Figure 6-7 runs through the calculations for each set of ventilation parameters and determines the equipment required and the first cost for each. Figure 6-8 shows the calculation output for the base case and the lowest cost alternative option. Each time the insulation values are changed the alternate case fan, louver, and heater values are re-calculated. The lowest first cost option is then entered into the table shown in Figure 5-8. The inputs required by the user are shown in 'yellow' cells. The cost for the base case is determined by the user and manually input. The calculation routine uses these numbers and a linear calculation based on \$/ft², \$/cfm or \$/kW to determine the cost for the alternate system. As shown in the below table, the alternate has a higher ventilation and heating requirement due to the reduced insulation; however, the total installed cost for the building is lower due to the cost savings on the insulation.

BASE CASE INFORMATION (FROM PREVIOUS PAGES)	BASE CASE	Alt 4
Ventilation fan size	52 x 52	50 x 50
Ventilation fan airflow	10,117	10,510
Ventilation fan brake-horsepower	1.80	1.87
Quantity of ventilation fans	5	5
Supply fan installation cost	2600	
Supply fan procurement cost	3400	
Supply fan cost (Each)	6000	6,233
Supply fan cost per CFM	0.59	
Supply fan total cost	30000	31,166
Total quantity of louvers	10	10
Louver installation cost	1200	
Louver procurement cost	1800	
Louver size ft²	18.78	17.4
Louver cost (Each)	$3,000	$2,774
Louver cost per square foot	$160	
Louver total cost	$30,000	$27,737
Heater capacity	7.4	7.6
Quantity of heaters	16	16
Heater installation cost	$400	
Heater procurement cost	$935	
Heater cost (Each)	$1,335	$1,376
Heater cost per kW	$181	
Heater total cost	$21,360	$22,019
Total wall insulation ft²	10050	10,050
Total roof insulation ft²	9900	9,900
Wall insulation U-value	0.089	0.089
Roof insulation U-value	0.065	0.09
Wall insulation cost/ft²	$0.54	$0.54
Roof insulation cost/ft²	$0.77	$0.54
Wall insulation installation cost/ft²	$0.21	$0.21
Roof insulation installation cost/ft²	$0.29	$0.21
Total insulation cost	$18,032	$14,963
Total system cost (Base Case)	$99,392	$95,884

Figure 6-8. First Cost Determination Output

6.1.3 Energy Analysis

The second component of the spreadsheet is the energy analysis portion. This allows the user to calculate the energy consumption for the base case and each alternative. After the previous sections are populated the only input required by the user is the energy rate in $/kW (Note: If demand charges or ratchet rates apply a normalized rate is required) and the weather bin data. The user then clicks the “Run Energy Model” button and the visual basic routing shown in Figure 6-9 is executed to calculate the monthly energy use based on bin data for the location indicating the number of hours at each temperature. Figure 6-10 shows sample output indicating the monthly kW of energy usage and the total energy cost for each alternative.

The entire calculation methodology for energy consumption and calculation results are shown in Appendix B. The program calculates the energy consumption for every occurrence of outdoor air temperature and multiplies it by the number of hourly occurrences of that outdoor air temperature.

```
Sub Energy_calc()

' This routine calculates the energy requirements for each alternate

  Sheets("ENERGY USE").Select

  Range("E9").Select
  ActiveCell.FormulaR1C1 = "=E!R[-6]C[-2]"
  Range("E10").Select
  Sheets("ENERGY USE").Select
  Range("E10").Select
  ActiveCell.FormulaR1C1 = "=E!R[-8]C[-2]"
  Range("E11").Select
  Sheets("E").Select
  Range("C9:O10").Select
  Selection.Copy

  Range("C17").Select
  Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False
  Sheets("ENERGY USE").Select
  Range("E9").Select
  Application.CutCopyMode = False
  ActiveCell.FormulaR1C1 = "=E!R[-6]C[-1]"
  Range("E10").Select
  ActiveCell.FormulaR1C1 = "=E!R[-8]C[-1]"
  Range("E11").Select
  Sheets("E").Select
  Range("C9:N11").Select
  Selection.Copy
  Range("C25").Select
  Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False
  Sheets("ENERGY USE").Select
  Range("E9").Select
  Application.CutCopyMode = False
  ActiveCell.FormulaR1C1 = "=E!R[-6]C"
  Range("E10").Select
  ActiveCell.FormulaR1C1 = "=E!R[-8]C"
  Range("E11").Select
  Sheets("E").Select
  Range("C9:N10").Select
  Selection.Copy


  Range("C33").Select
  Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False
  Sheets("ENERGY USE").Select
  Range("E9").Select
  Application.CutCopyMode = False
  ActiveCell.FormulaR1C1 = "=E!R[-6]C[1]"
  Range("E10").Select
  ActiveCell.FormulaR1C1 = "=E!R[-8]C[1]"
  Range("E11").Select
  Sheets("E").Select
  Range("C9:O10").Select
  Selection.Copy
    Range("C41").Select
  Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False
  Sheets("ENERGY USE").Select
  Range("E9").Select
  Application.CutCopyMode = False
  ActiveCell.FormulaR1C1 = "=E!R[-6]C[2]"
  Range("E10").Select
  ActiveCell.FormulaR1C1 = "=E!R[-8]C[2]"
  Range("E11").Select
  Sheets("E").Select
  Range("C9:N10").Select
  Selection.Copy

  Range("C48").Select
  Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False

  Range("B4").Select
  Application.CutCopyMode = False

End Sub
```

Figure 6-9. Visual Basic Routine for Energy Analysis

Base

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	9	26	130	388	838	1,573	2,155	1,718	923	397	122	23	
Total heater energy	72,180	56,522	39,062	14,781	2,557	51	0	0	1,628	11,717	36,532	62,602	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	$5,053	$3,958	$2,743	$1,062	$238	$114	$151	$120	$179	$848	$2,566	$4,384	$21,415

Alternate 1

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	10	28	138	406	862	1,593	2,172	1,738	946	417	130	25	
Total heater energy	66,430	51,841	35,461	13,297	2,284	45	0	0	1,455	10,519	33,148	57,376	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	$4,651	$3,631	$2,492	$959	$220	$115	$152	$122	$168	$766	$2,329	$4,018	$19,622

Alternate 2

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	10	28	140	412	871	1,601	2,179	1,746	955	425	133	26	
Total heater energy	64,502	50,261	34,225	12,782	2,188	43	0	0	1,394	10,102	31,986	55,609	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	$4,516	$3,520	$2,406	$924	$214	$115	$153	$122	$164	$737	$2,248	$3,894	$19,013

Alternate 3

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	8	23	118	362	804	1,545	2,131	1,690	890	367	110	21	
Total heater energy	81,764	64,289	44,963	17,191	2,998	60	0	0	1,907	13,659	42,075	71,265	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	$5,724	$4,502	$3,156	$1,229	$266	$112	$149	$118	$196	$982	$2,953	$4,990	$24,377

Alternate 4

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	9	24	124	374	819	1,556	2,139	1,701	904	381	116	22	
Total heater energy	76,526	60,075	41,823	15,927	2,769	55	0	0	1,762	12,644	39,128	66,572	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	$5,357	$4,207	$2,936	$1,141	$251	$113	$150	$119	$187	$912	$2,747	$4,662	$22,782

Figure 6-10. Monthly Energy Use Sample Output for Each Alternative

This calculation allows the user to select the insulation requirements that result in the lowest annual energy consumption for the building, regardless of first cost or payback. Figure 6-11 shows a summary of the monthly energy use for each alternative. The next section of this report will discuss payback analysis.

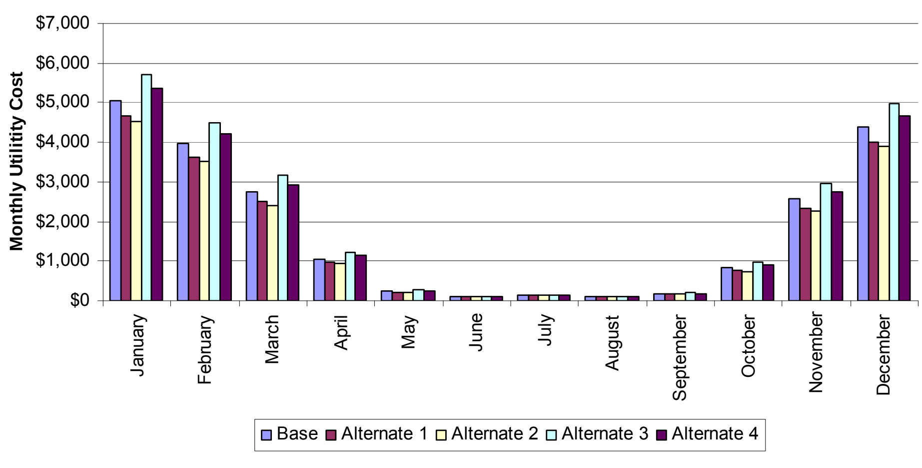


Figure 6-11. Monthly Energy Use for Each Alternative

6.1.4 Payback Analysis with Energy Model

As discussed previously, the program is capable of calculating the lowest first cost and the lowest energy use design. The final feature is to combine the previous items with a payback analysis to determine return on investment. The only input required is the cost of capital. Figure 6-12 shows the output of the payback analysis.

Cost of Capital:	12%

		Alternate 1 - base		Alternate 2 - base		Alternate 3 - base		Alternate 4 - base	
Year	Year	Cash flow	NPV	Cash flow	NPV	Cash flow	NPV	Cash flow	NPV
2010	1	(7,655)	(7,655)	2,309	2,309	(552)	(552)	3,507	3,507
2011	2	1,793	(6,054)	2,402	4,453	(2,961)	(3,196)	(1,366)	2,287
2012	3	1,793	(4,625)	2,402	6,368	(2,961)	(5,556)	(1,366)	1,198
2013	4	1,793	(3,349)	2,402	8,078	(2,961)	(7,664)	(1,366)	226
2014	5	1,793	(2,209)	2,402	9,605	(2,961)	(9,546)	(1,366)	(642)
2015	6	1,793	(1,192)	2,402	10,968	(2,961)	(11,227)	(1,366)	(1,418)
2016	7	1,793	(283)	2,402	12,185	(2,961)	(12,727)	(1,366)	(2,110)
2017	8	1,793	528	2,402	13,271	(2,961)	(14,067)	(1,366)	(2,728)
2018	9	1,793	1,252	2,402	14,241	(2,961)	(15,263)	(1,366)	(3,279)
2019	10	1,793	1,898	2,402	15,108	(2,961)	(16,331)	(1,366)	(3,772)
2020	11	1,793	2,476	2,402	15,881	(2,961)	(17,284)	(1,366)	(4,212)
2021	12	1,793	2,991	2,402	16,572	(2,961)	(18,135)	(1,366)	(4,605)
2022	13	1,793	3,451	2,402	17,188	(2,961)	(18,896)	(1,366)	(4,955)
2023	14	1,793	3,862	2,402	17,739	(2,961)	(19,574)	(1,366)	(5,268)
2024	15	1,793	4,229	2,402	18,230	(2,961)	(20,180)	(1,366)	(5,548)
2025	16	1,793	4,557	2,402	18,669	(2,961)	(20,721)	(1,366)	(5,798)

Figure 6-12. Payback Analysis

The results in Figure 6-12 are based on the input discussed in the previous section. Each option is compared against the base case and if the first cost is more than base case a negative value will appear in year one indicating a higher initial investment. The program then looks at the increase (decrease) in energy cost for each alternative as an incremental cash flow and discounts it to the current year's cash value using Equation 6-4.

$$NPV_y = NPV_{y-1} \frac{CF_y}{(1+r)^{y-y_0}}$$ Equation 6-4

where:

NPV_y	=	Net present value for indicated year
NPV_{y-1}	=	Net present value for previous year
CF_y	=	Incremental cash flow for indicated year in today's dollars
r	=	Cost of capital

Alternate 1 shows a higher first cost with an anticipated payback in the 8th year based on a reduction in energy usage. Alternative 4 was previously shown to be the lowest cost option; however, the higher energy use results in a negative return and a loss of money occurring in year 5.

6.2 Validation of Optimization Model

The output shown in Appendix B and previously in this report is based on a project that has previously been designed by the author. To verify the output of the model and the accuracy of the calculation routing the model results will be compared against the verified calculations and design.

The original design for the project called for 5 ventilation fans at 9,500 CFM each, 16 unit heaters rated for 7.5 kW, and had insulation consistent with the 'base case' used in the previous examples. Refer to Figure 6-13 for a drawing of the building.

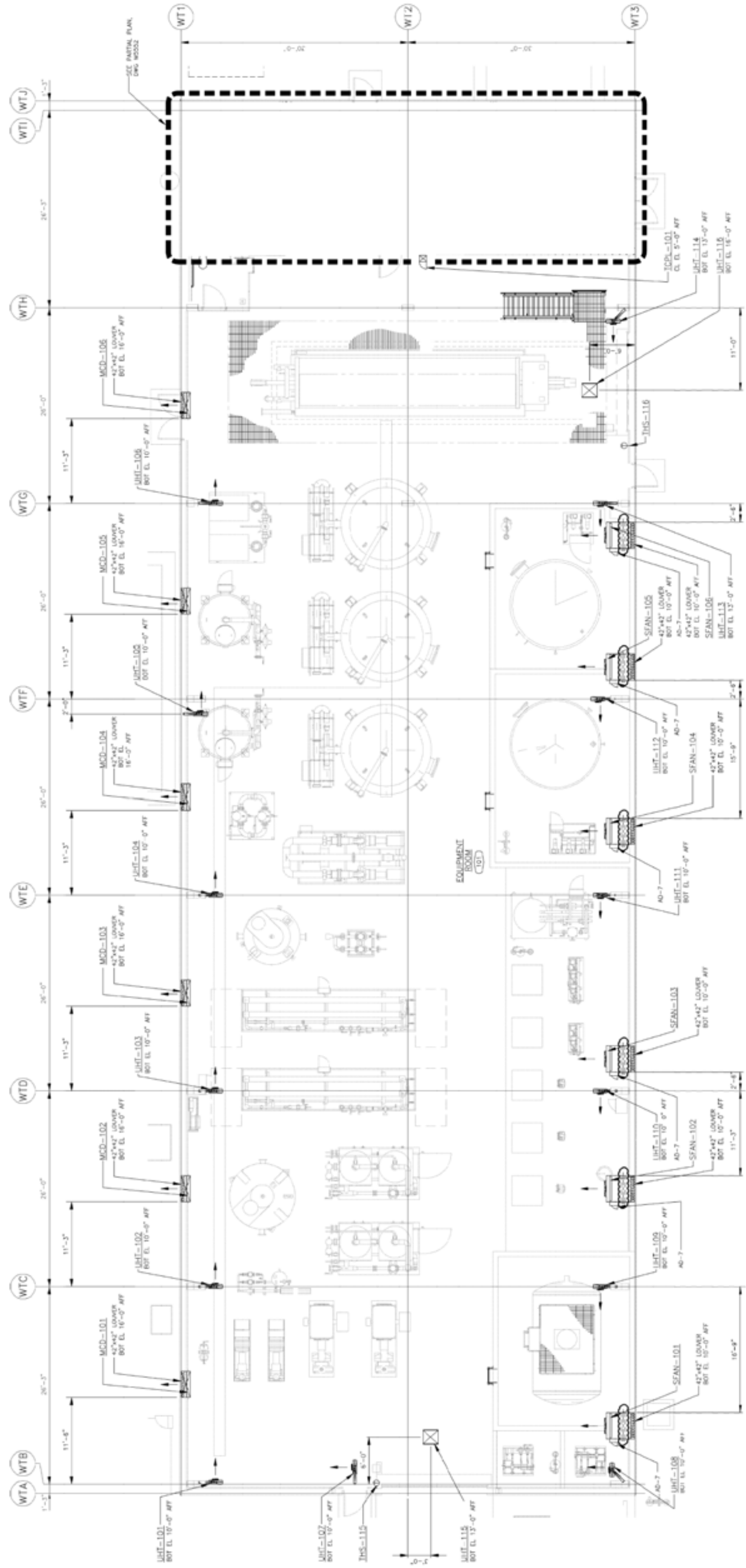


Figure 6-13. Water Treatment Building

The model output for the building indicates a requirement for 5 ventilation fans at approximately 10,000 CFM each and 16 unit heaters at 7.4 kW each, which is consistent with the original design. The output from the model is considered valid based on the results indicated above.

The project focus on the Water Treatment Building was to minimize the first cost of the building while building a code compliant structure. As shown in Table 6-2 the lowest first cost option is Alternative 4. The project was executed with the base case insulation which is the *ASHRAE 90.1-2004* minimum requirement and results in a cost that is approximately 4% higher than Alternative 4. Using today's energy code would result in Alternative 1 (*ASHRAE 90.1-2007*) and an approximate 11% increase over Alternative 4 in first cost.

If the owner requested a design with the lowest energy consumption Alternative 2 would be recommended, as well as having the highest return on investment as shown in Figure 6-11.

6.3 Exterior Insulation Recommendation

Depending upon the project constraints and objectives the model indicates a necessity for analyzing various insulation options versus using the minimum code required values. A national trend and legislation aimed at reducing building energy consumption has resulted in increasing requirements for insulation in new buildings. However, these codes are mainly geared toward air conditioned commercial buildings and careful analysis must be performed to determine the appropriate level of insulation for high internal heat gain ventilated buildings. As demonstrated in the example using the updated insulation standard would result in approximately an 11% increase in building cost compared to the lowest cost option.

6.4 Reduction in Design Man-hours

The original SCPP Water Treatment Building design required approximately 30 man-hours to complete the calculation and verification process. The spreadsheet developed required only 6 hours for a technician to develop a calculation and 2 hours for an engineer to verify the calculation.

The application of this tool, using a billing rate for a Senior Engineer of $112 per hour and a billing rate for a technician of $60, results in a savings of $2,776 per similar building. Typical projects have on average 12 separate buildings that would be applicable, resulting in a total project labor savings of $33,312.

6.5 Reduction in Procurement and Installation Cost

The standard energy code in place for projects is *ASHRAE 90.1-2007* edition. Section 6.1.2 showed a savings from Alternate 1 (*ASHRAE 90.1-2007*) to Alternate 4 of $11,163. Multiplying this by 12 buildings results in a total project savings of approximately $134,000.

The example shown in this paper was for Kansas City, MO; which is a fairly mild climate. Extreme climates would result in higher savings due to the increased cost of equipment required in the base case to account for the higher ventilation and/or heating loads.

6.6 Total Savings

The total savings for equipment procurement, equipment installation and labor expenditures is approximately $167,000 per project. In addition to the cost savings, the engineering schedule can be reduced by 2 ½ days per building due to the increased efficiency of the standard calculation.

The tool also allows for simultaneous calculation of energy consumption and payback analysis which typically would not be completed for the project. This additional analysis allows for a more thorough understanding of the interrelation between the envelope insulation and the mechanical systems required.

7.0 Suggestions for Additional Work

The optimization model developed as part of this research project is helpful for analyzing a particular segment of buildings encountered on typical projects. Additional research should be carried out to fine tune the model and allow for analysis of additional building types.

7.1 Air-conditioned Control Buildings

The model is currently designed to handle ventilation loads and can not calculate air conditioning loads. Modification of the tool to allow for standardized calculation of air conditioning loads, energy consumption, and payback would allow for additional savings to be realized on projects.

7.2 Analysis of Stack Effect on Heating Load

Stack effect is determined by building height and differential temperatures from inside to outside. The taller the building and greater the temperature difference results in a higher stack effect. Higher stack effect results in a lower negative pressure in the lower portion of the building and higher positive pressure in the upper portion of the building; thereby inducing more outside air infiltration. The model currently assumes a user entered air change rate for infiltration airflow. A more accurate model would address the stack effect and calculate the actual infiltration airflow based on the stack effect.

8.0 References

1. Trane Trace 700: HVAC Load Design and Analysis Software. Publication number: CDS-SLB005-EN. 2008.

   Available:
   http://www.trane.com/CPS/Uploads/UserFiles/CDS%20files/TRACE/CDS-SLB005-EN.pdf

2. United States Department of Energy: Energy Renewables and Efficiency. EnergyPlus Description. 2010.

   Available:
   http://apps1.eere.energy.gov/buildings/energyplus

3. International Code Council. January 2006. 2006 International Energy Conservation Code. ISBN-13: 978-1-58001-270-6 (soft).

4. American Society of Heating, Refrigeration and Air-conditioning Engineers. 2007. ASHRAE Standard 90.1: *Energy Standard for Buildings Except for Low-Rise Residential Buildings.*

5. RSMeans Building Construction Cost Data. Reed Construction Data. 2010. ISBN- 978-0-87629-746-9.

6. American Society of Heating, Refrigeration and Air-conditioning Engineers. 2007. ASHRAE Systems and Equipment Handbook. ISBN- 978-1-933742-33-5.

7. American Society of Heating, Refrigeration and Air-conditioning Engineers. 2008. ASHRAE Applications Handbook. ISBN- 978-1-933742-33-5.

8. American Society of Heating, Refrigeration and Air-conditioning Engineers. 2009. ASHRAE Fundamentals Handbook. ISBN- 978-1-933742-33-5.

9. RSMeans Mechanical Cost Data. Reed Construction Data. 2010. ISBN- 978-0-87629-746-9.

Appendix A: Climate Zone 4

TABLE 5.5-4 Building Envelope Requirements for Climate Zone 4 (A, B, C)*

Opaque Elements	Nonresidential Assembly Maximum	Nonresidential Insulation Min. R-Value	Residential Assembly Maximum	Residential Insulation Min. R-Value	Semiheated Assembly Maximum	Semiheated Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.273	R-3.5 c.i.	U-0.273	R-3.5 c.i.	U-0.982	R-0.9 c.i.
Metal Building[a]	U-0.369 U-0.312	~~R-3.3~~ R-2.3 + R-2.3	~~U-0.369~~ U-0.312	~~R-3.3~~ R-2.3 + R-2.3	U-0.551	R-1.8
Attic and Other	U-0.0.153	R-6.7	U-0.153	R-6.7	U-0.300	R-3.3
Walls, Above-Grade						
Mass	U-0.592	R-1.7 c.i.	U-0.513	R-2.0 c.i.	U-3.293	NR
Metal Building	~~U-0.642~~ U-0.477	~~R-2.3~~ R-3.3	~~U-0.642~~ U-0.476	~~R-2.3~~ R-3.3	U-0.642	R-2.3
Steel-Framed	U-0.365	R-2.3 + R-1.3	U-0.365	R-2.3 + R-1.3 c.i.	U-0.705	R-2.3
Wood-Framed and Other	U-0.504	R-2.3	U-0.365	R-2.3 + R-0.7 c.i.	U-0.504	R-2.3
Walls, Below-Grade						
Below-Grade Wall	C-6.473	NR	C-0.678	R-1.3 c.i.	C-6.473	NR
Floors						
Mass	U-0.496	R-1.5 c.i.	U-0.420	R-1.8 c.i.	U-0.780	R-0.7 c.i.
Steel-Joist	U-0.214	R-5.3	U-0.214	R-5.3	U-0.390	R-2.3
Wood-Framed and Other	U-0.188	R-5.3	U-0.188	R-5.3	U-0.376	R-2.3
Slab-On-Grade Floors						
Unheated	F-1.264	NR	F-0.935	R-1.8 for 600 mm	F-1.264	NR
Heated	F-1.489	R-2.6 for 600 mm	F-1.489	R-2.6 for 600 mm	F-1.766	R-1.3 for 300 mm
Opaque Doors						
Swinging	U-3.975		U-3.975		U-3.975	
Nonswinging	U-2.839		U-2.839		U-8.233	

Fenestration	Nonresidential Assembly Max. U	Nonresidential Assembly Max. SHGC	Residential Assembly Max. U	Residential Assembly Max. SHGC	Semiheated Assembly Max. U	Semiheated Assembly Max. SHGC
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[b]	U-2.27	SHGC-0.40 all	U-2.27	SHGC-0.40 all	U-6.81	SHGC-NR all
Metal framing (curtainwall/storefront)[c]	U-2.84		U-2.84		U-6.81	
Metal framing (entrance door)[c]	U-4.83		U-4.83		U-6.81	
Metal framing (all other)[c]	U-3.12		U-3.12		U-6.81	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}–6.64	$SHGC_{all}$–0.49	U_{all}–5.56	$SHGC_{all}$–0.36	U_{all}–11.24	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–6.64	$SHGC_{all}$–0.39	U_{all}–5.56	$SHGC_{all}$–0.19	U_{all}–11.24	$SHGC_{all}$–NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}–7.38	$SHGC_{all}$–0.65	U_{all}–7.38	$SHGC_{all}$–0.62	U_{all}–10.79	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–7.38	$SHGC_{all}$–0.34	U_{all}–7.38	$SHGC_{all}$–0.27	U_{all}–10.79	$SHGC_{all}$–NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}–3.92	$SHGC_{all}$–0.49	U_{all}–3.29	$SHGC_{all}$–0.36	U_{all}–7.72	$SHGC_{all}$–NR
2.1%–5.0%	U_{all}–3.92	$SHGC_{all}$–0.39	U_{all}–3.29	$SHGC_{all}$–0.19	U_{all}–7.72	$SHGC_{all}$–NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a] When using R-value compliance method, a thermal spacer block is required, otherwise use the U-factor compliance method. See Table A2.3.
[~~a~~b] Exception to A3.1.3.1 applies.
[~~b~~c] Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[~~c~~d] Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

2.0 EXTERIOR ENVELOPE INFORMATION

Exterior Wall and Roof Information

DIRECTION	LENGTH	HEIGHT (WIDTH)	AREA (HEIGHT)	VOLUME
	ft	ft	ft²	ft3
NORTH	165	22	3630	
SOUTH	165	22	3630	
EAST	60	23.25	1395	
WEST	60	23.25	1395	
ROOF	165	60	9900	
BUILDING	165	60	23.25	230175

Exterior Doors

DIRECTION	HEIGHT	WIDTH	QUANTITY	AREA
	ft	ft	qty	ft²
NORTH	7	3	2	42
SOUTH	7	3	1	21
EAST				0
WEST	7	3	1	21

Exterior Louvers (Calculated during optimization routine)

DIRECTION	HEIGHT	WIDTH	QUANTITY	AREA
	ft	ft	qty	ft²
NORTH	4.3	4.3	5	93.9
SOUTH	4.3	4.3	5	93.9
EAST	0.0	0.0	0	0.0
WEST	0.0	0.0	0	0.0

Net Wall, Roof, Door and Louver Area (For use in solar heat gain calculation)

DIRECTION	Area, ft²			
	Wall	Door	Louver	
NORTH	3,494	42	94	
SOUTH	3,515	21	94	
EAST	1,395	0	0	
WEST	1,374	21	0	
TOTALS	9,778	84	188	

Wall, Roof, Door and Louver U-value and type

DIRECTION	U-value	ASHRAE TYPE	REFERENCE
	Btu/ft²-°F-h	A-G, 1-13	
NORTH	0.089	G	
SOUTH	0.089	G	
EAST	0.089	G	
WEST	0.089	G	
ROOF	0.065	1	
DOOR	0.7	G	
LOUVER	0.5	G	

2.1 DESIGN CONDITIONS

Project Location

City	Kansas City	
State	MO	
WMO #	724460	ASHRAE 2009 Fundamentals
Latitude	39.3	N
Longitude	94.7	W
Elevation	1024	ft
Density	0.07	lb/ft3

Indoor Design Conditions

Indoor design dry-bulb temperature, summer	104	° F	Ref 1
Indoor design dry-bulb temperature, winter	45	° F	Ref 1
Assumed winter infiltration rate	1.5	ACH	Assume
Calculated infiltration airflow	5,754	CFM	

Outdoor Design Conditions

Annual Heating design temperature, ASHRAE 99.6%	-0.1	° F
Annual Cooling design temperature, ASHRAE 0.4%	96.2	° F
Hottest month dry-bulb temperature range	19	° F
Annual extreme maximum dry-bulb temperature	110.6	° F
Annual extreme minimum dry-bulb temperature	-21.9	° F

Interior Heat Gain

Total equipment heat gain	249938	Btu/hr
Lighting heat gain per sq foot	1.5	W/ft²

2.2 INTERNAL HEAT GAINS

Total equipment heat gain	249,938	Btu/hr	Ref 2
Lighting heat gain per sq foot	1.5	W/ft²	
Lighting heat gain	50,668	Btu/hr	
Total internal heat load	**300,606**	Btu/hr	

2.3 BASE CASE VENTILATION LOAD

Minimum air changes	5	ACH
Minimum ventilation due to air changes	19,181	CFM
Design outdoor air temperature	96.2	° F
Design indoor air temperature	104	° F
Maximum Solar Load occurs at 1400 hours	46,118	Btu/hr
Total internal heat load	300,606	Btu/hr
Estimated fan heat temperature rise	1	° F
Total airflow required	50,584	CFM
Total required summer ventilation	50,584	CFM
Quantity of fans	5	qty
Airflow per fan	10,117	CFM
Calculated static pressure for fans	0.38	in wg

2.4 STATIC PRESSURE DROP DETERMINATION

Maximum allowable free area velocity	1500	fpm
Minimum allowable free area velocity	1100	fpm
Incremental louver size	2	in
Aspect ratio, H/W	1	dimensionless
Calculated louver height	52	in
Louver width	52	in
Supply fan airflow	10,117	CFM
Louver model	CESCO A6SA	
Louver free area	7.27	ft²
Louver free area velocity	1392	
Damper velocity	539	fpm
Intake louver pressure drop	0.14	
Intake louver birdscreen	0.02	engineer judgement
Intake damper pressure drop	0.01	
Relief louver pressure drop	0.14	
Relief damper pressure drop	0.01	
Relief louver birdscreen	0.02	
Safety factor	15%	
Total pressure drop	0.38	in wg

2.5 BASE CASE HEATING LOAD

Design extreme outdoor air temperature	-21.9	° F
Design outdoor air temperature	-0.1	° F
Design indoor air temperature	45	° F
Temperature to protect against freezing	32	° F
Design delta T	53.9	° F
Total wall area	9,778	
Wall U-Value	0.089	
Total roof area	9900	
Roof U-Value	0.065	
Total door area	84	
Door U-Value	0.7	
Total louver area	188	
Louver U-Value	0.5	
Sum of UA	1,666	
Total envelope heat loss	89,822	Btu/hr
Infiltration airflow	5,754	CFM
Infiltration heat loss	312,642	Btu/hr
Total Heat Loss	402,464	Btu/hr
Total Heat Loss	118	kW
Quantity of heaters	16	Qty
Capacity of each heater	7.4	kW

2.6 INTERNAL HEAT GAINS

Total equipment heat gain	249,938	Btu/hr	Ref 2
Lighting heat gain per sq foot	1.5	W/ft²	
Lighting heat gain	50,668	Btu/hr	
Total internal heat load	**300,606**	Btu/hr	

2.7 ALTERNATE CASE VENTILATION LOAD

Minimum air changes	5	ACH
Minimum ventilation due to air changes	19,181	CFM
Design outdoor air temperature	96.2	° F
Design indoor air temperature	104	° F
Maximum Solar Load occurs at 1400 hours	59,590	Btu/hr
Total internal heat load	300,606	Btu/hr
Estimated fan heat temperature rise	1	° F
Total airflow required	52,550	CFM
Total required summer ventilation	52,550	CFM
Quantity of fans	5	qty
Airflow per fan	10,510	CFM
Calculated static pressure for fans	0.48	in wg

2.8 STATIC PRESSURE DROP DETERMINATION

Maximum allowable free area velocity	1500	fpm
Minimum allowable free area velocity	1100	fpm
Incremental louver size	2	in
Aspect ratio, H/W	1	dimensionless
Calculated louver height	50	in
Louver width	50	in
Supply fan airflow	10,510	CFM
Louver model	RUSKIN EME6625-805	
Louver free area	8.16	ft²
Louver free area velocity	1407	
Damper velocity	605	fpm
Intake louver pressure drop	0.17	
Intake louver birdscreen	0.02	engineer judgement
Intake damper pressure drop	0.01	
Relief louver pressure drop	0.19	
Relief damper pressure drop	0.01	
Relief louver birdscreen	0.02	
Safety factor	15%	
Total pressure drop	0.48	in wg

2.9 ALTERNATE CASE HEATING LOAD

Design extreme outdoor air temperature	-21.9	° F
Design outdoor air temperature	-0.1	° F
Design indoor air temperature	45	° F
Temperature to protect against freezing	32	° F
Design delta T	53.9	° F
Total wall area	9,778	
Wall U-Value	0.089	
Total roof area	9900	
Roof U-Value	0.089	
Total door area	84	
Door U-Value	0.7	
Total louver area	174	
Louver U-Value	0.5	
Total envelope heat loss	102,247	Btu/hr
Infiltration airflow	5,754	CFM
Infiltration heat loss	312642.099	Btu/hr
Total Heat Loss	414,889	Btu/hr
Total Heat Loss	122	kW
Quantity of heaters	16	Qty
Capacity of each heater	7.6	kW

BASE CASE INFORMATION (FROM PREVIOUS PAGES)		BASE CASE	Alt 4
Ventilation fan size		52 x 52	50 x 50
Ventilation fan airflow		10,117	10,510
Ventilation fan brake-horsepower		1.80	1.87
Quantity of ventilation fans		5	5
Supply fan installation cost		2600	
Supply fan procurement cost		3400	
Supply fan cost (Each)		6000	6,233
Supply fan cost per CFM		0.59	
Supply fan total cost		30000	31,166
Total quantity of louvers		10	10
Louver installation cost		1200	
Louver procurement cost		1800	
Louver size	ft²	18.78	17.4
Louver cost (Each)		$3,000	$2,774
Louver cost per square foot		$160	
Louver total cost		$30,000	$27,737
Heater capacity		7.4	7.6
Quantity of heaters		16	16
Heater installation cost		$400	
Heater procurement cost		$935	
Heater cost (Each)		$1,335	$1,376
Heater cost per kW		$181	
Heater total cost		$21,360	$22,019
Total wall insulation ft²		10050	10,050
Total roof insulation ft²		9900	9,900
Wall insulation U-value		0.089	0.089
Roof insulation U-value		0.065	0.09
Wall insulation cost/ft²		$0.54	$0.54
Roof insulation cost/ft²		$0.77	$0.54
Wall insulation installation cost/ft²		$0.21	$0.21
Roof insulation installation cost/ft²		$0.29	$0.21
Total insulation cost		$18,032	$14,963
Total system cost (Base Case)		$99,392	$95,884

OPTIMIZATION ROUTINE: MINIMIZE FIRST COST
Method: Alter the u-value of insulation and resize system components to determine minimum overall cost

Base case description (ASHRAE 90.1-2004 requirements)
Roof: Single layer R-19 insulation, overall u-value of 0.065
Walls: Single layer R-13 insulation, overall u-value of 0.113

Alternate case description (ASHRAE 90.1-2007 requirements)
Roof: Double layer R-13 insulation, overall u-value of 0.055
Walls Single layer of R-13 insulation with second layer R-5.6 continuous, overall u-value of 0.069

Run First Cost

	Description	Base	Alt 1	Alt 2	Alt 3	Alt 4
		ASHRAE 90.1-2004, Single layer R-19 roof and R-13 wall	ASHRAE 90.1-2007, Double layer R-13 roof, Single layer R-13/Continuous R5.6 wall	R-30 roof, R-19 walls	R-5.6 walls with R-30 roof	R-13 roof, R-13 walls
Roof	U-value	0.065	0.055	0.040	0.040	0.089
Roof	Insulation cost/ft²	0.770	1.080	0.890	0.890	0.540
Roof	Installation cost/ft²	0.290	0.420	0.340	0.340	0.210
Wall	U-value	0.089	0.064	0.069	0.179	0.089
Wall	Insulation cost/ft²	0.540	1.060	0.770	0.520	0.540
Wall	Installation cost/ft²	0.210	0.630	0.290	0.420	0.210
	Total First Cost	$99,392	$107,047	$97,083	$99,943	$95,884

Binary				Walls		
	4	Insulation cost	Mat		Install	U-value
Value to previous page	4	R-13 blanket	0.54		0.21	0.089
Total first cost (Base case):	99,392	R-19 blanket	0.77		0.29	0.069
Total first cost (Alt case):	95,884	R-30 blanket	0.89		0.34	0.040
	$95,884	R-5.6 board	0.52		0.42	0.179

RS Means Building Construction Cost Data 2010

Energy Analysis

Description	Base	Alt 1	Alt 2	Alt 3	Alt 4
	ASHRAE 90.1-2004, Single layer R-19 roof and R-13 wall	ASHRAE 90.1-2007, Double layer R-13 roof, Single layer R-13/Continuous R5.6 wall	R-30 roof, R-19 walls	R-5.6 walls with R-30 roof	R-13 roof, R-13 walls
Roof U-value	0.065	0.055	0.040	0.040	0.089
Wall U-value	0.089	0.064	0.069	0.179	0.089
Total Energy Use	$21,404	$19,611	$19,002	$24,366	$22,771

Design U-Values	Base	Alt 1	Alt 2	Alt 3	Alt 4
Walls	0.07	0.06	0.04	0.04	0.09
Roofs	0.09	0.06	0.07	0.18	0.09

Run Energy Model

Template

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	9	24	124	374	819	1,556	2,139	1,701	904	381	116	22	
Total heater energy	76,526	60,075	41,823	15,927	2,769	55	0	0	1,762	12,644	39,128	66,572	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	**$5,357**	**$4,207**	**$2,936**	**$1,141**	**$251**	**$113**	**$150**	**$119**	**$187**	**$912**	**$2,747**	**$4,662**	**$22,782**

Base

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	9	25	127	381	823	1,544	2,114	1,686	906	390	120	23	
Total heater energy	72,180	56,522	39,062	14,781	2,557	51	0	0	1,628	11,717	36,532	62,602	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	**$5,053**	**$3,958**	**$2,743**	**$1,061**	**$237**	**$112**	**$148**	**$118**	**$177**	**$847**	**$2,566**	**$4,384**	**$21,404**

Alternate 1

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	10	27	135	398	846	1,563	2,131	1,705	928	409	128	25	
Total heater energy	66,430	51,841	35,461	13,297	2,284	45	0	0	1,455	10,519	33,148	57,376	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	**$4,651**	**$3,631**	**$2,492**	**$959**	**$219**	**$113**	**$149**	**$119**	**$167**	**$765**	**$2,329**	**$4,018**	**$19,611**

Alternate 2

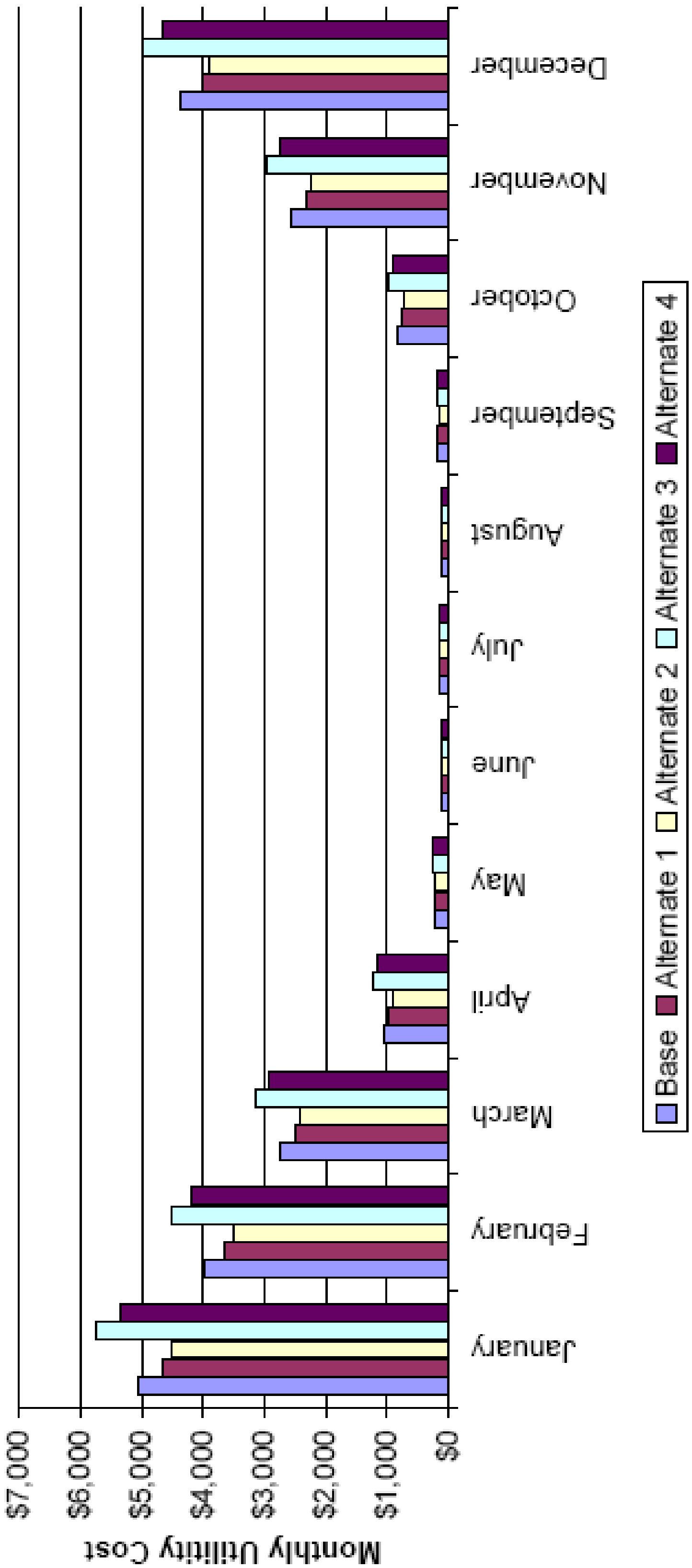
	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	10	28	138	404	855	1,571	2,138	1,713	937	417	131	25	
Total heater energy	64,502	50,261	34,225	12,782	2,188	43	0	0	1,394	10,102	31,986	55,609	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	**$4,516**	**$3,520**	**$2,405**	**$923**	**$213**	**$113**	**$150**	**$120**	**$163**	**$736**	**$2,248**	**$3,894**	**$19,002**

Alternate 3

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	8	22	116	355	789	1,516	2,091	1,658	873	360	108	21	
Total heater energy	81,764	64,289	44,963	17,191	2,998	60	0	0	1,907	13,659	42,075	71,265	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	**$5,724**	**$4,502**	**$3,156**	**$1,228**	**$265**	**$110**	**$146**	**$116**	**$195**	**$981**	**$2,953**	**$4,990**	**$24,366**

Alternate 4

	January	February	March	April	May	June	July	August	September	October	November	December	TOTALS
Total fan energy	9	24	121	367	803	1,527	2,099	1,669	887	374	114	22	
Total heater energy	76,526	60,075	41,823	15,927	2,769	55	0	0	1,762	12,644	39,128	66,572	
Utility rate, $/kWh	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
Total Energy Cost	**$5,357**	**$4,207**	**$2,936**	**$1,141**	**$250**	**$111**	**$147**	**$117**	**$185**	**$911**	**$2,747**	**$4,662**	**$22,771**


Monthly Utility Cost
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$0
January
February
March
April
May
June
July
August
September
October
November
December
Base
Alternate 1
Alternate 2
Alternate 3
Alternate 4

Cost of Capital:	12%

		Alternate 1 - base		Alternate 2 - base		Alternate 3 - base		Alternate 4 - base	
Year	Year	Cash flow	NPV	Cash flow	NPV	Cash flow	NPV	Cash flow	NPV
2010	1	(7,655)	(7,655)	2,309	2,309	(552)	(552)	3,507	3,507
2011	2	1,793	(6,054)	2,402	4,454	(2,962)	(3,196)	(1,366)	2,287
2012	3	1,793	(4,624)	2,402	6,369	(2,962)	(5,557)	(1,366)	1,198
2013	4	1,793	(3,348)	2,402	8,079	(2,962)	(7,665)	(1,366)	225
2014	5	1,793	(2,208)	2,402	9,606	(2,962)	(9,547)	(1,366)	(643)
2015	6	1,793	(1,191)	2,402	10,969	(2,962)	(11,228)	(1,366)	(1,418)
2016	7	1,793	(282)	2,402	12,186	(2,962)	(12,728)	(1,366)	(2,110)
2017	8	1,793	529	2,402	13,273	(2,962)	(14,068)	(1,366)	(2,728)
2018	9	1,793	1,253	2,402	14,243	(2,962)	(15,264)	(1,366)	(3,280)
2019	10	1,793	1,900	2,402	15,109	(2,962)	(16,332)	(1,366)	(3,773)
2020	11	1,793	2,477	2,402	15,883	(2,962)	(17,286)	(1,366)	(4,213)
2021	12	1,793	2,992	2,402	16,573	(2,962)	(18,137)	(1,366)	(4,606)
2022	13	1,793	3,453	2,402	17,190	(2,962)	(18,897)	(1,366)	(4,956)
2023	14	1,793	3,864	2,402	17,741	(2,962)	(19,576)	(1,366)	(5,270)
2024	15	1,793	4,231	2,402	18,232	(2,962)	(20,182)	(1,366)	(5,549)
2025	16	1,793	4,558	2,402	18,671	(2,962)	(20,723)	(1,366)	(5,799)

Room Temp (F)	Outdoor Air Temp (F)	Temp Range (F)	Average Outdoor Air Temp (F)	(1) Attic Fan Factor (f)	(2) Color Factor (K) Walls	(2) Color Factor (K) Roofs	[redacted]	(3) North Latitude (Degrees)	[redacted]	(4) Month
104	96.2	19	86.7	1	1	1	[redacted]	32	[redacted]	Jun

NOTES:
1. Attic fan factor (f): 1.0 for attics without a fan and 0.75 for attics with fan.
2. Color Factor (K): Walls 1.0 dark, 0.65 medium, 0.5 light; Roof 1.0 dark, 0.5 light
3. North Latitude: Input in 8 degree increments beginnning with 0 degrees (eg. 0, 8, 16)
4. Month: Use 1st 3 letters only (eg. JUL for July; only input months JUN through DEC)
5. Wall types are letters A through G and roof types are 1 to 13 (w/o susp ceiling only)
6. Exposure: Input 1 or two letters only (eg. N for north, SE for southeast or R for roof)
7. For metric projects, conversion made from IP to metric to utilize Ashrae F1989 IP Tables.

Maximum Solar Load occurs at 1400 hours	46118	Btu/hr	13513	Watts

	(5) Wall/ Roof Type	(6) Ex-posure	(7) Value (Btu/hr/)(sf/F)	(7) Surface Dimensions Length (ft)	Width (ft)	0100 CLTD corr (F)	0100 Ht Gain Btu/hr	0200 CLTD corr (F)	0200 Ht Gain Btu/hr	0300 CLTD corr (F)	0300 Ht Gain Btu/hr	0400 CLTD corr (F)	0400 Ht Gain Btu/hr	0500 CLTD corr (F)	0500 Ht Gain Btu/hr	0600 CLTD corr (F)	0600 Ht Gain Btu/hr	0700 CLTD corr (F)	0700 Ht Gain Btu/hr	0800 CLTD corr (F)	0800 Ht Gain Btu/hr
N-WALL	G	N	0.089	1	3494	-20.3	-6313	-21.3	-6624	-22.3	-6935	-23.3	-7246	-24.3	-7557	-21.3	-6624	-16.3	-5069	-15.3	-4758
S-WALL	G	S	0.089	1	3515	-24.3	-7602	-26.3	-8228	-27.3	-8541	-28.3	-8854	-29.3	-9166	-28.3	-8854	-27.3	-8541	-23.3	-7289
E-WALL	G	E	0.089	1	1395	-20.3	-2520	-22.3	-2769	-23.3	-2893	-24.3	-3017	-25.3	-3141	-13.3	-1651	6.7	832	22.7	2818
W-WALL	G	W	0.089	1	1374	-18.3	-2238	-19.3	-2360	-21.3	-2605	-22.3	-2727	-23.3	-2849	-23.3	-2849	-22.3	-2727	-19.3	-2360
ROOF	1	R	0.065	1	9900	-21.3	-13707	-24.3	-15637	-25.3	-16281	-25.3	-16281	-27.3	-17568	-25.3	-16281	-16.3	-10489	-3.3	-2124
N-DOOR 1	G	N	0.700	1	42	-20.3	-597	-21.3	-626	-22.3	-656	-23.3	-685	-24.3	-714	-21.3	-626	-16.3	-479	-15.3	-450
S-DOOR 1	G	S	0.700	1	21	-24.3	-357	-26.3	-387	-27.3	-401	-28.3	-416	-29.3	-431	-28.3	-416	-27.3	-401	-23.3	-343
E-DOOR 1	G	E	0.700	1	0	-20.3	0	-22.3	0	-23.3	0	-24.3	0	-25.3	0	-13.3	0	6.7	0	22.7	0
W-DOOR 1	G	W	0.700	1	21	-18.3	-269	-19.3	-284	-21.3	-313	-22.3	-328	-23.3	-343	-23.3	-343	-22.3	-328	-19.3	-284
			Totals				-33603		-36914		-38624		-39553		-41769		-37643		-27202		-14789

(5) Wall/ Roof Type	(6) Ex-posure	(7) U (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	0900 CLTD corr (F)	0900 Ht Gain Btu/hr	1000 CLTD corr (F)	1000 Ht Gain Btu/hr	1100 CLTD corr (F)	1100 Ht Gain Btu/hr	1200 CLTD corr (F)	1200 Ht Gain Btu/hr	1300 CLTD corr (F)	1300 Ht Gain Btu/hr	1400 CLTD corr (F)	1400 Ht Gain Btu/hr	1500 CLTD corr (F)	1500 Ht Gain Btu/hr	1600 CLTD corr (F)	1600 Ht Gain Btu/hr
G	N	.09	1	3,494	-14.3	-4447	-11.3	-3514	-8.3	-2581	-5.3	-1648	-2.3	-715	-0.3	-93	0.7	218	0.7	218
G	S	.09	1	3,515	-16.3	-5099	-6.3	-1971	2.7	845	10.7	3347	16.7	5225	17.7	5537	14.7	4599	8.7	2722
G	E	.09	1	1,395	29.7	3687	30.7	3812	25.7	3191	15.7	1949	8.7	1080	6.7	832	5.7	708	4.7	584
G	W	.09	1	1,374	-16.3	-1993	-13.3	-1626	-9.3	-1137	-5.3	-648	2.7	330	16.7	2042	31.7	3876	42.7	5222
1	R	.07	1	9,900	11.7	7529	26.7	17181	38.7	24903	48.7	31338	55.7	35843	56.7	36486	54.7	35199	47.7	30695
G	N	.7	1	42	-14.3	-420	-11.3	-332	-8.3	-244	-5.3	-156	-2.3	-68	-0.3	-9	0.7	21	0.7	21
G	S	.7	1	21	-16.3	-240	-6.3	-93	2.7	40	10.7	157	16.7	245	17.7	260	14.7	216	8.7	128
G	E	.7	1		29.7	0	30.7	0	25.7	0	15.7	0	8.7	0	6.7	0	5.7	0	4.7	0
G	W	.7	1	21	-16.3	-240	-13.3	-196	-9.3	-137	-5.3	-78	2.7	40	16.7	245	31.7	466	42.7	628
		Totals				-1223		13261		24880		34262		41980		45301		45303		40216

(5) Wall/ Roof Type	(6) Ex-posure	(7) U Value (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	1700 CLTD corr (F)	1700 Ht Gain Btu/hr	1800 CLTD corr (F)	1800 Ht Gain Btu/hr	1900 CLTD corr (F)	1900 Ht Gain Btu/hr	2000 CLTD corr (F)	2000 Ht Gain Btu/hr	2100 CLTD corr (F)	2100 Ht Gain Btu/hr	2200 CLTD corr (F)	2200 Ht Gain Btu/hr	2300 CLTD corr (F)	2300 Ht Gain Btu/hr	2400 CLTD corr (F)	2400 Ht Gain Btu/hr
G	N	.09	1	3,494	1.7	529	2.7	840	-1.3	-404	-8.3	-2581	-12.3	-3825	-14.3	-4447	-16.3	-5069	-18.3	-5691
G	S	.09	1	3,515	2.7	845	-3.3	-1032	-8.3	-2597	-13.3	-4161	-16.3	-5099	-18.3	-5725	-20.3	-6351	-22.3	-6976
G	E	.09	1	1,395	2.7	335	-0.3	-37	-5.3	-658	-9.3	-1155	-12.3	-1527	-14.3	-1775	-16.3	-2024	-18.3	-2272
G	W	.09	1	1,374	47.7	5833	42.7	5222	23.7	2898	4.7	575	-4.3	-526	-9.3	-1137	-13.3	-1626	-16.3	-1993
1	R	.07	1	9,900	36.7	23616	22.7	14607	7.7	4955	-4.3	-2767	-10.3	-6628	-14.3	-9202	-17.3	-11133	-19.3	-12420
G	N	.7	1	42	1.7	50	2.7	79	-1.3	-38	-8.3	-244	-12.3	-362	-14.3	-420	-16.3	-479	-18.3	-538
G	S	.7	1	21	2.7	40	-3.3	-49	-8.3	-122	-13.3	-196	-16.3	-240	-18.3	-269	-20.3	-298	-22.3	-328
G	E	.7	1		2.7	0	-0.3	0	-5.3	0	-9.3	0	-12.3	0	-14.3	0	-16.3	0	-18.3	0
G	W	.7	1	21	47.7	701	42.7	628	23.7	348	4.7	69	-4.3	-63	-9.3	-137	-13.3	-196	-16.3	-240
		Totals				31949		20258		4382		-10459		-18270		-23113		-27175		-30458

Room Temp (F)	Outdoor Air Temp (F)	Temp Range (F)	Average Outdoor Air Temp (F)	(1) Attic Fan Factor (f)	(2) Color Factor (K) Walls	(2) Color Factor (K) Roofs		(3) North Latitude (Degrees)		(4) Month
104	96.2	19	86.7	1	1	1	[redacted]	32	[redacted]	Jun

NOTES:
1. Attic fan factor (f): 1.0 for attics without a fan and 0.75 for attics with fan.
2. Color Factor (K): Walls 1.0 dark, 0.65 medium, 0.5 light; Roof 1.0 dark, 0.5 light
3. North Latitude: Input in 8 degree increments beginnning with 0 degrees (eg. 0, 8, 16)
4. Month: Use 1st 3 letters only (eg. JUL for July; only input months JUN through DEC)
5. Wall types are letters A through G and roof types are 1 to 13 (w/o susp ceiling only)
6. Exposure: Input 1 or two letters only (eg. N for north, SE for southeast or R for roof)
7. For metric projects, conversion made from IP to metric to utilize Ashrae F1989 IP Tables.

Maximum Solar Load occurs at 1400 hours	46118 Btu/hr	13513 Watts

	(5) Wall/ Roof Type	(6) Ex-posure	(7) Value (Btu/hr/)(sf/F)	(7) Surface Dimensions Length (ft)	Width (ft)	Solar Time, h 0100 CLTD corr (F)	0100 Ht Gain Btu/hr	0200 CLTD corr (F)	0200 Ht Gain Btu/hr	0300 CLTD corr (F)	0300 Ht Gain Btu/hr	0400 CLTD corr (F)	0400 Ht Gain Btu/hr	0500 CLTD corr (F)	0500 Ht Gain Btu/hr	0600 CLTD corr (F)	0600 Ht Gain Btu/hr	0700 CLTD corr (F)	0700 Ht Gain Btu/hr	0800 CLTD corr (F)	0800 Ht Gain Btu/hr
N-WALL	G	N	0.089	1	3494	-20.3	-6313	-21.3	-6624	-22.3	-6935	-23.3	-7246	-24.3	-7557	-21.3	-6624	-16.3	-5069	-15.3	-4758
S-WALL	G	S	0.089	1	3515	-24.3	-7602	-26.3	-8228	-27.3	-8541	-28.3	-8854	-29.3	-9166	-28.3	-8854	-27.3	-8541	-23.3	-7289
E-WALL	G	E	0.089	1	1395	-20.3	-2520	-22.3	-2769	-23.3	-2893	-24.3	-3017	-25.3	-3141	-13.3	-1651	6.7	832	22.7	2818
W-WALL	G	W	0.089	1	1374	-18.3	-2238	-19.3	-2360	-21.3	-2605	-22.3	-2727	-23.3	-2849	-23.3	-2849	-22.3	-2727	-19.3	-2360
ROOF	1	R	0.065	1	9900	-21.3	-13707	-24.3	-15637	-25.3	-16281	-25.3	-16281	-27.3	-17568	-25.3	-16281	-16.3	-10489	-3.3	-2124
N-DOOR 1	G	N	0.700	1	42	-20.3	-597	-21.3	-626	-22.3	-656	-23.3	-685	-24.3	-714	-21.3	-626	-16.3	-479	-15.3	-450
S-DOOR 1	G	S	0.700	1	21	-24.3	-357	-26.3	-387	-27.3	-401	-28.3	-416	-29.3	-431	-28.3	-416	-27.3	-401	-23.3	-343
E-DOOR 1	G	E	0.700	1	0	-20.3	0	-22.3	0	-23.3	0	-24.3	0	-25.3	0	-13.3	0	6.7	0	22.7	0
W-DOOR 1	G	W	0.700	1	21	-18.3	-269	-19.3	-284	-21.3	-313	-22.3	-328	-23.3	-343	-23.3	-343	-22.3	-328	-19.3	-284
			Totals				-33603		-36914		-38624		-39553		-41769		-37643		-27202		-14789

(5) Wall/ Roof Type	(6) Ex-posure	(7) U (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	Solar Time, h 0900 CLTD corr (F)	0900 Ht Gain Btu/hr	1000 CLTD corr (F)	1000 Ht Gain Btu/hr	1100 CLTD corr (F)	1100 Ht Gain Btu/hr	1200 CLTD corr (F)	1200 Ht Gain Btu/hr	1300 CLTD corr (F)	1300 Ht Gain Btu/hr	1400 CLTD corr (F)	1400 Ht Gain Btu/hr	1500 CLTD corr (F)	1500 Ht Gain Btu/hr	1600 CLTD corr (F)	1600 Ht Gain Btu/hr
G	N	.09	1	3,494	-14.3	-4447	-11.3	-3514	-8.3	-2581	-5.3	-1648	-2.3	-715	-0.3	-93	0.7	218	0.7	218
G	S	.09	1	3,515	-16.3	-5099	-6.3	-1971	2.7	845	10.7	3347	16.7	5225	17.7	5537	14.7	4599	8.7	2722
G	E	.09	1	1,395	29.7	3687	30.7	3812	25.7	3191	15.7	1949	8.7	1080	6.7	832	5.7	708	4.7	584
G	W	.09	1	1,374	-16.3	-1993	-13.3	-1626	-9.3	-1137	-5.3	-648	2.7	330	16.7	2042	31.7	3876	42.7	5222
1	R	.07	1	9,900	11.7	7529	26.7	17181	38.7	24903	48.7	31338	55.7	35843	56.7	36486	54.7	35199	47.7	30695
G	N	.7	1	42	-14.3	-420	-11.3	-332	-8.3	-244	-5.3	-156	-2.3	-68	-0.3	-9	0.7	21	0.7	21
G	S	.7	1	21	-16.3	-240	-6.3	-93	2.7	40	10.7	157	16.7	245	17.7	260	14.7	216	8.7	128
G	E	.7	1		29.7	0	30.7	0	25.7	0	15.7	0	8.7	0	6.7	0	5.7	0	4.7	0
G	W	.7	1	21	-16.3	-240	-13.3	-196	-9.3	-137	-5.3	-78	2.7	40	16.7	245	31.7	466	42.7	628
		Totals				-1223		13261		24880		34262		41980		45301		45303		40216

(5) Wall/ Roof Type	(6) Ex-posure	(7) U Value (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	Solar Time, h 1700 CLTD corr (F)	1700 Ht Gain Btu/hr	1800 CLTD corr (F)	1800 Ht Gain Btu/hr	1900 CLTD corr (F)	1900 Ht Gain Btu/hr	2000 CLTD corr (F)	2000 Ht Gain Btu/hr	2100 CLTD corr (F)	2100 Ht Gain Btu/hr	2200 CLTD corr (F)	2200 Ht Gain Btu/hr	2300 CLTD corr (F)	2300 Ht Gain Btu/hr	2400 CLTD corr (F)	2400 Ht Gain Btu/hr
G	N	.09	1	3,494	1.7	529	2.7	840	-1.3	-404	-8.3	-2581	-12.3	-3825	-14.3	-4447	-16.3	-5069	-18.3	-5691
G	S	.09	1	3,515	2.7	845	-3.3	-1032	-8.3	-2597	-13.3	-4161	-16.3	-5099	-18.3	-5725	-20.3	-6351	-22.3	-6976
G	E	.09	1	1,395	2.7	335	-0.3	-37	-5.3	-658	-9.3	-1155	-12.3	-1527	-14.3	-1775	-16.3	-2024	-18.3	-2272
G	W	.09	1	1,374	47.7	5833	42.7	5222	23.7	2898	4.7	575	-4.3	-526	-9.3	-1137	-13.3	-1626	-16.3	-1993
1	R	.07	1	9,900	36.7	23616	22.7	14607	7.7	4955	-4.3	-2767	-10.3	-6628	-14.3	-9202	-17.3	-11133	-19.3	-12420
G	N	.7	1	42	1.7	50	2.7	79	-1.3	-38	-8.3	-244	-12.3	-362	-14.3	-420	-16.3	-479	-18.3	-538
G	S	.7	1	21	2.7	40	-3.3	-49	-8.3	-122	-13.3	-196	-16.3	-240	-18.3	-269	-20.3	-298	-22.3	-328
G	E	.7	1		2.7	0	-0.3	0	-5.3	0	-9.3	0	-12.3	0	-14.3	0	-16.3	0	-18.3	0
G	W	.7	1	21	47.7	701	42.7	628	23.7	348	4.7	69	-4.3	-63	-9.3	-137	-13.3	-196	-16.3	-240
		Totals				31949		20258		4382		-10459		-18270		-23113		-27175		-30458

Room Temp (F)	Outdoor Air Temp (F)	Temp Range (F)	Average Outdoor Air Temp (F)	(1) Attic Fan Factor (f)	(2) Color Factor (K) Walls	(2) Color Factor (K) Roofs		(3) North Latitude (Degrees)		(4) Month
104	96.2	19	86.7	1	1	1		32		Jun

NOTES:

1. Attic fan factor (f): 1.0 for attics without a fan and 0.75 for attics with fan.
2. Color Factor (K): Walls 1.0 dark, 0.65 medium, 0.5 light; Roof 1.0 dark, 0.5 light
3. North Latitude: Input in 8 degree increments beginnning with 0 degrees (eg. 0, 8, 16)
4. Month: Use 1st 3 letters only (eg. JUL for July; only input months JUN through DEC)
5. Wall types are letters A through G and roof types are 1 to 13 (w/o susp ceiling only)
6. Exposure: Input 1 or two letters only (eg. N for north, SE for southeast or R for roof)
7. For metric projects, conversion made from IP to metric to utilize Ashrae F1989 IP Tables.

Maximum Solar Load occurs at 1400 hours	59590 Btu/hr	17460 Watts

	(5) Wall/ Roof Type	(6) Ex-posure	(7) Value (Btu/hr/)(sf/F)	(7) Surface Dimensions Length (ft)	Width (ft)	0100 CLTD corr (F)	0100 Ht Gain Btu/hr	0200 CLTD corr (F)	0200 Ht Gain Btu/hr	0300 CLTD corr (F)	0300 Ht Gain Btu/hr	0400 CLTD corr (F)	0400 Ht Gain Btu/hr	0500 CLTD corr (F)	0500 Ht Gain Btu/hr	0600 CLTD corr (F)	0600 Ht Gain Btu/hr	0700 CLTD corr (F)	0700 Ht Gain Btu/hr	0800 CLTD corr (F)	0800 Ht Gain Btu/hr
N-WALL	G	N	0.089	1	3494	-20.3	-6313	-21.3	-6624	-22.3	-6935	-23.3	-7246	-24.3	-7557	-21.3	-6624	-16.3	-5069	-15.3	-4758
S-WALL	G	S	0.089	1	3515	-24.3	-7602	-26.3	-8228	-27.3	-8541	-28.3	-8854	-29.3	-9166	-28.3	-8854	-27.3	-8541	-23.3	-7289
E-WALL	G	E	0.089	1	1395	-20.3	-2520	-22.3	-2769	-23.3	-2893	-24.3	-3017	-25.3	-3141	-13.3	-1651	6.7	832	22.7	2818
W-WALL	G	W	0.089	1	1374	-18.3	-2238	-19.3	-2360	-21.3	-2605	-22.3	-2727	-23.3	-2849	-23.3	-2849	-22.3	-2727	-19.3	-2360
ROOF	1	R	0.089	1	9900	-21.3	-18767	-24.3	-21411	-25.3	-22292	-25.3	-22292	-27.3	-24054	-25.3	-22292	-16.3	-14362	-3.3	-2908
N-DOOR 1	G	N	0.700	1	42	-20.3	-597	-21.3	-626	-22.3	-656	-23.3	-685	-24.3	-714	-21.3	-626	-16.3	-479	-15.3	-450
S-DOOR 1	G	S	0.700	1	21	-24.3	-357	-26.3	-387	-27.3	-401	-28.3	-416	-29.3	-431	-28.3	-416	-27.3	-401	-23.3	-343
E-DOOR 1	G	E	0.700	1	0	-20.3	0	-22.3	0	-23.3	0	-24.3	0	-25.3	0	-13.3	0	6.7	0	22.7	0
W-DOOR 1	G	W	0.700	1	21	-18.3	-269	-19.3	-284	-21.3	-313	-22.3	-328	-23.3	-343	-23.3	-343	-22.3	-328	-19.3	-284
			Totals				-38664		-42688		-44635		-45564		-48255		-43654		-31075		-15573

(5) Wall/ Roof Type	(6) Ex-posure	(7) U (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	0900 CLTD corr (F)	0900 Ht Gain Btu/hr	1000 CLTD corr (F)	1000 Ht Gain Btu/hr	1100 CLTD corr (F)	1100 Ht Gain Btu/hr	1200 CLTD corr (F)	1200 Ht Gain Btu/hr	1300 CLTD corr (F)	1300 Ht Gain Btu/hr	1400 CLTD corr (F)	1400 Ht Gain Btu/hr	1500 CLTD corr (F)	1500 Ht Gain Btu/hr	1600 CLTD corr (F)	1600 Ht Gain Btu/hr
G	N	.09	1	3,494	-14.3	-4447	-11.3	-3514	-8.3	-2581	-5.3	-1648	-2.3	-715	-0.3	-93	0.7	218	0.7	218
G	S	.09	1	3,515	-16.3	-5099	-6.3	-1971	2.7	845	10.7	3347	16.7	5226	17.7	5537	14.7	4599	8.7	2722
G	E	.09	1	1,395	29.7	3687	30.7	3812	25.7	3191	15.7	1949	8.7	1080	6.7	832	5.7	708	4.7	584
G	W	.09	1	1,374	-16.3	-1993	-13.3	-1626	-9.3	-1137	-5.3	-648	2.7	330	16.7	2042	31.7	3876	42.7	5222
1	R	.09	1	9,900	11.7	10309	26.7	23526	38.7	34099	48.7	42910	55.7	49077	56.7	49958	54.7	48196	47.7	42028
G	N	.7	1	42	-14.3	-420	-11.3	-332	-8.3	-244	-5.3	-156	-2.3	-68	-0.3	-9	0.7	21	0.7	21
G	S	.7	1	21	-16.3	-240	-6.3	-93	2.7	40	10.7	157	16.7	245	17.7	260	14.7	216	8.7	128
G	E	.7	1		29.7	0	30.7	0	25.7	0	15.7	0	8.7	0	6.7	0	5.7	0	4.7	0
G	W	.7	1	21	-16.3	-240	-13.3	-196	-9.3	-137	-5.3	-78	2.7	40	16.7	245	31.7	466	42.7	628
		Totals				1557		19605		34075		45834		55214		58773		58299		51549

(5) Wall/ Roof Type	(6) Ex-posure	(7) U Value (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	1700 CLTD corr (F)	1700 Ht Gain Btu/hr	1800 CLTD corr (F)	1800 Ht Gain Btu/hr	1900 CLTD corr (F)	1900 Ht Gain Btu/hr	2000 CLTD corr (F)	2000 Ht Gain Btu/hr	2100 CLTD corr (F)	2100 Ht Gain Btu/hr	2200 CLTD corr (F)	2200 Ht Gain Btu/hr	2300 CLTD corr (F)	2300 Ht Gain Btu/hr	2400 CLTD corr (F)	2400 Ht Gain Btu/hr
G	N	.09	1	3,494	1.7	529	2.7	840	-1.3	-404	-8.3	-2581	-12.3	-3826	-14.3	-4447	-16.3	-5069	-18.3	-5691
G	S	.09	1	3,515	2.7	845	-3.3	-1032	-8.3	-2597	-13.3	-4161	-16.3	-5099	-18.3	-5725	-20.3	-6351	-22.3	-6976
G	E	.09	1	1,395	2.7	335	-0.3	-37	-5.3	-658	-9.3	-1155	-12.3	-1527	-14.3	-1775	-16.3	-2024	-18.3	-2272
G	W	.09	1	1,374	47.7	5833	42.7	5222	23.7	2898	4.7	575	-4.3	-526	-9.3	-1137	-13.3	-1626	-16.3	-1993
1	R	.09	1	9,900	36.7	32336	22.7	20001	7.7	6784	-4.3	-3789	-10.3	-9075	-14.3	-12600	-17.3	-15243	-19.3	-17005
G	N	.7	1	42	1.7	50	2.7	79	-1.3	-38	-8.3	-244	-12.3	-362	-14.3	-420	-16.3	-479	-18.3	-538
G	S	.7	1	21	2.7	40	-3.3	-49	-8.3	-122	-13.3	-196	-16.3	-240	-18.3	-269	-20.3	-298	-22.3	-328
G	E	.7	1		2.7	0	-0.3	0	-5.3	0	-9.3	0	-12.3	0	-14.3	0	-16.3	0	-18.3	0
G	W	.7	1	21	47.7	701	42.7	628	23.7	348	4.7	69	-4.3	-63	-9.3	-137	-13.3	-196	-16.3	-240
		Totals				40669		25651		6212		-11481		-20717		-26511		-31286		-35043

Room Temp (F)	Outdoor Air Temp (F)	Temp Range (F)	Average Outdoor Air Temp (F)	(1) Attic Fan Factor (f)	(2) Color Factor (K) Walls	(2) Color Factor (K) Roofs	(3) North Latitude (Degrees)	(4) Month
104	96.2	19	86.7	1	1	1	32	Jun

NOTES:

1. Attic fan factor (f): 1.0 for attics without a fan and 0.75 for attics with fan.
2. Color Factor (K): Walls 1.0 dark, 0.65 medium, 0.5 light; Roof 1.0 dark, 0.5 light
3. North Latitude: Input in 8 degree increments beginning with 0 degrees (eg. 0, 8, 16)
4. Month: Use 1st 3 letters only (eg. JUL for July; only input months JUN through DEC)
5. Wall types are letters A through G and roof types are 1 to 13 (w/o susp ceiling only)
6. Exposure: Input 1 or two letters only (eg. N for north, SE for southeast or R for roof)

	(5) Wall/ Roof Type	(6) Ex-posure	(7) Value (Btu/hr/(sf/F)	(7) Surface Dimensions Length (ft)	Width (ft)	0100 CLTD corr (F)	0100 Ht Gain Btu/hr	0200 CLTD corr (F)	0200 Ht Gain Btu/hr	0300 CLTD corr (F)	0300 Ht Gain Btu/hr	0400 CLTD corr (F)	0400 Ht Gain Btu/hr	0500 CLTD corr (F)	0500 Ht Gain Btu/hr	0600 CLTD corr (F)	0600 Ht Gain Btu/hr	0700 CLTD corr (F)	0700 Ht Gain Btu/hr	0800 CLTD corr (F)	0800 Ht Gain Btu/hr
Louver	G	N	0.50	1	94	-20.3	-953	-21.3	-1000	-22.3	-1047	-23.3	-1094	-24.3	-1141	-21.3	-1000	-16.3	-765	-15.3	-718
Louver	G	S	0.50	1	94	-24.3	-1141	-26.3	-1235	-27.3	-1282	-28.3	-1329	-29.3	-1375	-28.3	-1329	-27.3	-1282	-23.3	-1094
Louver	G	E	0.50	1	0	-20.3	0	-22.3	0	-23.3	0	-24.3	0	-25.3	0	-13.3	0	6.7	0	22.7	0
Louver	G	W	0.50	1	0	-18.3	0	-19.3	0	-21.3	0	-22.3	0	-23.3	0	-23.3	0	-22.3	0	-19.3	0
	Totals						-2094		-2235		-2328		-2422		-2516		-2328		-2047		-1812

(5) Wall/ Roof Type	(6) Ex-posure	(7) U Value (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	0900 CLTD corr (F)	0900 Ht Gain Btu/hr	1000 CLTD corr (F)	1000 Ht Gain Btu/hr	1100 CLTD corr (F)	1100 Ht Gain Btu/hr	1200 CLTD corr (F)	1200 Ht Gain Btu/hr	1300 CLTD corr (F)	1300 Ht Gain Btu/hr	1400 CLTD corr (F)	1400 Ht Gain Btu/hr	1500 CLTD corr (F)	1500 Ht Gain Btu/hr	1600 CLTD corr (F)	1600 Ht Gain Btu/hr
G	N	.5	1	94	-14.3	-671	-11.3	-530	-8.3	-390	-5.3	-249	-2.3	-108	-0.3	-14	0.7	33	0.7	33
G	S	.5	1	94	-16.3	-765	-6.3	-296	2.7	127	10.7	502	16.7	784	17.7	831	14.7	690	8.7	408
G	E	.5	1		29.7	0	30.7	0	25.7	0	15.7	0	8.7	0	6.7	0	5.7	0	4.7	0
G	W	.5	1		-16.3	0	-13.3	0	-9.3	0	-5.3	0	2.7	0	16.7	0	31.7	0	42.7	0
Totals						-1437		-826		-263		254		676		817		723		441

(5) Wall/ Roof Type	(6) Ex-posure	(7) U Value (Btu/hr-sf-F)	(7) Surface Dimensions Length (ft)	Width (ft)	1700 CLTD corr (F)	1700 Ht Gain Btu/hr	1800 CLTD corr (F)	1800 Ht Gain Btu/hr	1900 CLTD corr (F)	1900 Ht Gain Btu/hr	2000 CLTD corr (F)	2000 Ht Gain Btu/hr	2100 CLTD corr (F)	2100 Ht Gain Btu/hr	2200 CLTD corr (F)	2200 Ht Gain Btu/hr	2300 CLTD corr (F)	2300 Ht Gain Btu/hr	2400 CLTD corr (F)	2400 Ht Gain Btu/hr
G	N	.5	1	94	1.7	80	2.7	127	-1.3	-61	-8.3	-390	-12.3	-577	-14.3	-671	-16.3	-765	-18.3	-859
G	S	.5	1	94	2.7	127	-3.3	-155	-8.3	-390	-13.3	-624	-16.3	-765	-18.3	-859	-20.3	-953	-22.3	-1047
G	E	.5	1		2.7	0	-0.3	0	-5.3	0	-9.3	0	-12.3	0	-14.3	0	-16.3	0	-18.3	0
G	W	.5	1		47.7	0	42.7	0	23.7	0	4.7	0	-4.3	0	-9.3	0	-13.3	0	-16.3	0
Totals						207		-28		-451		-1014		-1343		-1530		-1718		-1906

Interior Gain	73.3	kW
Floor area	9900	ft²
Room temperature	104	°F
K factor for CLTD calculation	0.83	
North and South wall area	7260	ft²
East and West wall area	2790	ft²
Roof area	9900	ft²
Lighting load	1.5	W/ft²
Roof U-value	0.09	
Wall U-value	0.09	
Infiltration CFM	5,754	

Fan BHP	2
Qty fans	5

January

CLIMATE			CONDITIONS										
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²	
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	2	50.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	6	47.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	10	41.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	26	37.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	71	33.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	127	30	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	117	24.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	92	20.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	72	15.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	70	10.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	52	5.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	45	1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	22	-3.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	18	-7.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	10	-12.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	5	-17.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	1	-20.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	746											

	CLTD CALCULATION													TOTAL GAIN			Airside				
		North Wall				West Wall				Roof											
Temperature Bin Dry-bulb	Roof u-value	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F					Btu/hr				Btu/hr				Btu/hr	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

February

CLIMATE: Temperature Bin Dry-bulb (°F)	CLIMATE: Hours (hr)	CLIMATE: Mean coincident wet-bulb (°F)	CONDITIONS: Interior Gain (kW)	CONDITIONS: Interior Gain (Btu/hr)	CONDITIONS: Floor area (ft²)	CONDITIONS: Lighting load (W/ft²)	CONDITIONS: Lighting load (W)	CONDITIONS: Lighting load (Btu/hr)	CONDITIONS: North and South wall area (ft²)	CONDITIONS: East and West wall area (ft²)	CONDITIONS: Roof area (ft²)	CONDITIONS: Wall u-value	CLTD CALCULATION: Roof u-value	North Wall: CLTD	North Wall: LM	North Wall: CLTD corr	North Wall: Heat gain (Btu/hr)	West Wall: CLTD	West Wall: LM	West Wall: CLTD corr	West Wall: Heat gain (Btu/hr)	Roof: CLTD	Roof: LM	Roof: CLTD corr	Roof: Heat gain (Btu/hr)	TOTAL GAIN: Infiltration Loss (Btu/hr)	TOTAL GAIN: **Total Envelope Gain (Btu/hr)**	TOTAL GAIN: Total (Btu/hr)	Airside: Design Airflow Per fan (CFM)	Airside: Qty of fans (qty)	Airside: Airflow per fan (CFM)	Airside: BHP (bhp)	Airside: Total fan horsepower (bhp)
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	3	50.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	7	48.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	12	44.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	27	41.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	49	37.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	85	33.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	129	29.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	91	24.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	79	20.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	58	15.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	43	10.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	35	5.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	25	1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	13	-3.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	8	-7.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	4	-12.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	2	-17	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	1	-21.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0
	671																																

March

CLIMATE			CONDITIONS									
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²	
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	1	62.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	3	60.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	8	57.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	12	56.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	24	53.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	36	49.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	53	45.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	71	41.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	111	37.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	137	33.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	123	29.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	73	24.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	47	20.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	24	15.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	12	10.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	6	6.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	2	1.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	1	-2.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	744											

Temperature Bin Dry-bulb	CLTD CALCULATION	North Wall				West Wall				Roof			
	Roof u-value	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain
°F					Btu/hr				Btu/hr				Btu/hr
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578

Temperature Bin Dry-bulb	TOTAL GAIN			Airside				
	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0	3,194	303,800	50,584	5	10,117	2	9
97	0	-5,684	294,922	50,584	5	10,117	2	9
92	0	-14,562	286,044	50,584	5	10,117	2	9
87	0	-23,440	277,167	50,584	5	10,117	2	9
82	0	-32,317	268,289	50,584	5	10,117	2	9
77	0	-41,195	259,411	8,896	5	10,117	2	2
72	0	-50,073	250,533	7,249	5	10,117	2	1
67	0	-58,951	241,656	6,047	5	10,117	2	1
62	0	-67,828	232,778	5,132	5	10,117	2	1
57	0	-76,706	223,900	4,411	5	10,117	2	1
52	0	-85,584	215,022	3,829	5	10,117	2	1
47	0	-94,462	206,145	3,349	5	10,117	2	1
42	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	-820,344	-227,628	-747,365	0	5	10,117	2	0

April

CLIMATE: Temperature Bin Dry-bulb (°F)	CLIMATE: Hours (hr)	CLIMATE: Mean coincident wet-bulb (°F)	CONDITIONS: Interior Gain (kW)	CONDITIONS: Interior Gain (Btu/hr)	CONDITIONS: Floor area (ft²)	CONDITIONS: Lighting load (W/ft²)	CONDITIONS: Lighting load (W)	CONDITIONS: Lighting load (Btu/hr)	CONDITIONS: North and South wall area (ft²)	CONDITIONS: East and West wall area (ft²)	CONDITIONS: Roof area (ft²)	CONDITIONS: Wall u-value
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	3	65.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	10	64.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	16	62.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	28	58.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	46	56	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	73	53	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	82	49.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	110	45.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	113	42.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	99	38	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	73	33.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	41	29.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	18	25.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	5	20.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	1	15.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	1	10.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	719											

Temperature Bin Dry-bulb (°F)	CLTD CALCULATION: Roof u-value	North Wall: CLTD	North Wall: LM	North Wall: CLTD corr	North Wall: Heat gain (Btu/hr)	West Wall: CLTD	West Wall: LM	West Wall: CLTD corr	West Wall: Heat gain (Btu/hr)	Roof: CLTD	Roof: LM	Roof: CLTD corr	Roof: Heat gain (Btu/hr)	TOTAL GAIN: Infiltration Loss (Btu/hr)	TOTAL GAIN: **Total Envelope Gain (Btu/hr)**	TOTAL GAIN: Total (Btu/hr)	Airside: Design Airflow Per fan (CFM)	Airside: Qty of fans (qty)	Airside: Airflow per fan (CFM)	Airside: BHP (bhp)	Airside: Total fan horsepower (bhp)
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

May

CLIMATE			CONDITIONS										
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²	
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	2	71.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	16	69	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	35	66.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	54	63.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	80	61.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	117	58.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	129	55.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	111	51.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	94	47.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	62	43.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	29	39.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	14	35.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	3	30.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	746											

	CLTD CALCULATION													TOTAL GAIN			Airside				
		North Wall				West Wall				Roof											
Temperature Bin Dry-bulb	Roof u-value	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F					Btu/hr				Btu/hr				Btu/hr	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

June

CLIMATE: Temperature Bin Dry-bulb (°F)	CLIMATE: Hours (hr)	CLIMATE: Mean coincident wet-bulb (°F)	CONDITIONS: Interior Gain (kW)	Interior Gain (Btu/hr)	Floor area (ft²)	Lighting load (W/ft²)	Lighting load (W)	Lighting load (Btu/hr)	North and South wall area (ft²)	East and West wall area (ft²)	Roof area (ft²)	Wall u-value	Roof u-value
102	1	74.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
97	2	74.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
92	19	73.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
87	49	71.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
82	89	68.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
77	115	66.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
72	136	64.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
67	129	61.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
62	94	57.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
57	52	53.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
52	28	49.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
47	6	45.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
42	1	42.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
37	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
32	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
27	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
22	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
17	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
12	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
7	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
2	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-3	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
	721												

Temperature Bin Dry-bulb (°F)	CLTD CALCULATION: North Wall CLTD	North Wall LM	North Wall CLTD corr	North Wall Heat gain (Btu/hr)	West Wall CLTD	West Wall LM	West Wall CLTD corr	West Wall Heat gain (Btu/hr)	Roof CLTD	Roof LM	Roof CLTD corr	Roof Heat gain (Btu/hr)	TOTAL GAIN: Infiltration Loss (Btu/hr)	**Total Envelope Gain (Btu/hr)**	Total (Btu/hr)	Airside: Design Airflow Per fan (CFM)	Qty of fans (qty)	Airflow per fan (CFM)	BHP (bhp)	Total fan horsepower (bhp)
102	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

July

CLIMATE			CONDITIONS									
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²	
102	1	78.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	10	77.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	37	75.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	77	73.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	125	71.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	141	69.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	155	67.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	107	63.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	65	59.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	21	55.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	5	51.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	744											

Temperature Bin Dry-bulb	CLTD CALCULATION	North Wall				West Wall				Roof				TOTAL GAIN			Airside				
	Roof u-value	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F					Btu/hr				Btu/hr				Btu/hr	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

August

CLIMATE			CONDITIONS										
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²	
102	1	78.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	6	78	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	22	77	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	53	74.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	96	71.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	134	69.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	161	67.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	125	63.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	85	59.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	41	55.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	16	51	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	4	47.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	744											

Temperature Bin Dry-bulb	CLTD CALCULATION	North Wall				West Wall				Roof			
°F	Roof u-value	CLTD	LM	CLTD corr	Heat gain (Btu/hr)	CLTD	LM	CLTD corr	Heat gain (Btu/hr)	CLTD	LM	CLTD corr	Heat gain (Btu/hr)
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578

Temperature Bin Dry-bulb	TOTAL GAIN			Airside				
	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0	3,194	303,800	50,584	5	10,117	2	9
97	0	-5,684	294,922	50,584	5	10,117	2	9
92	0	-14,562	286,044	50,584	5	10,117	2	9
87	0	-23,440	277,167	50,584	5	10,117	2	9
82	0	-32,317	268,289	50,584	5	10,117	2	9
77	0	-41,195	259,411	8,896	5	10,117	2	2
72	0	-50,073	250,533	7,249	5	10,117	2	1
67	0	-58,951	241,656	6,047	5	10,117	2	1
62	0	-67,828	232,778	5,132	5	10,117	2	1
57	0	-76,706	223,900	4,411	5	10,117	2	1
52	0	-85,584	215,022	3,829	5	10,117	2	1
47	0	-94,462	206,145	3,349	5	10,117	2	1
42	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	-820,344	-227,628	-747,365	0	5	10,117	2	0

September

CLIMATE			CONDITIONS									
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²	
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	1	75.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	6	74.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	17	72.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	41	69.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	65	67	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	98	64.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	120	61	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	120	57.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	99	53.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	81	49	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	43	44.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	18	40.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	8	36.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	3	32	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	720											

Temperature Bin Dry-bulb	CLTD CALCULATION													TOTAL GAIN			Airside				
		North Wall				West Wall				Roof											
	Roof u-value	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F					Btu/hr				Btu/hr				Btu/hr	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

October

CLIMATE			CONDITIONS									
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²	
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
92	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
87	1	65.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
82	6	66.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
77	15	62.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
72	34	60.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
67	60	58.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
62	86	54.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
57	105	50.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
52	125	46.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
47	116	42.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
42	89	38.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
37	63	34.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
32	32	30.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
27	9	26	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
22	2	21.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
17	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
12	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
7	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
2	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-3	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09
	743											

	CLTD CALCULATION	North Wall				West Wall				Roof				TOTAL GAIN			Airside				
Temperature Bin Dry-bulb	Roof u-value	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F					Btu/hr				Btu/hr				Btu/hr	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

November

CLIMATE			CONDITIONS										CLTD CALCULATION													TOTAL GAIN			Airside				
														North Wall				West Wall				Roof											
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value	Roof u-value	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²						Btu/hr				Btu/hr				Btu/hr	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	3	59.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	9	58.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	24	56.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	45	51.8	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	61	46.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	72	42.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	100	38.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	132	33.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	121	29.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	81	24.7	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	39	20.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	19	15.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	9	11.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	3	6.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	1	0.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	1	-3.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0
	720																																

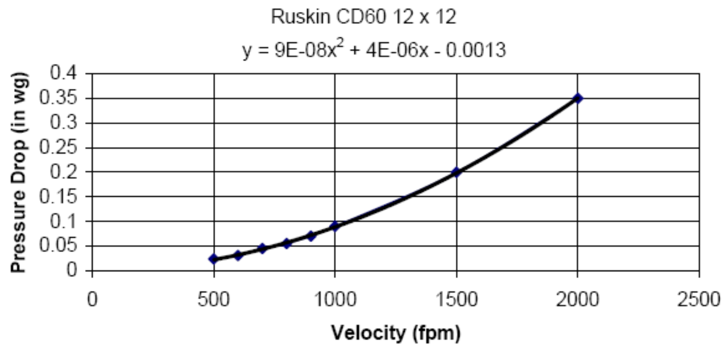
December

CLIMATE			CONDITIONS										
Temperature Bin Dry-bulb	Hours	Mean coincident wet-bulb	Interior Gain		Floor area	Lighting load			North and South wall area	East and West wall area	Roof area	Wall u-value	Roof u-value
°F	hr	°F	kW	Btu/hr	ft²	W/ft²	W	Btu/hr	ft²	ft²	ft²		
102	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
97	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
92	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
87	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
82	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
77	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
72	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
67	1	61.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
62	3	57.5	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
57	8	51.6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
52	13	46.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
47	18	42.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
42	37	38.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
37	104	33.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
32	167	29.9	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
27	122	25	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
22	83	20.2	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
17	61	15.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
12	45	10.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
7	32	6	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
2	24	1.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-3	10	-3.3	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-8	9	-7.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-13	5	-12.1	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-18	2	-16.4	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-23	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
-28	0	0	73.25264	249,938	9,900	2	14,850	50,668	7,260	2,790	9,900	0.09	0.09
	744												

	CLTD CALCULATION												TOTAL GAIN			Airside				
	North Wall				West Wall				Roof											
Temperature Bin Dry-bulb	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	CLTD	LM	CLTD corr	Heat gain	Infiltration Loss	**Total Envelope Gain**	Total	Design Airflow Per fan	Qty of fans	Airflow per fan	BHP	Total fan horsepower
°F				Btu/hr				Btu/hr				Btu/hr	Btu/hr	**Btu/hr**	Btu/hr	CFM	qty	CFM	bhp	bhp
102	11	-5	-4	-2,597	19	-9	-1	-174	38	-19	7	5,965	0	3,194	303,800	50,584	5	10,117	2	9
97	11	-5	-9	-5,828	19	-9	-6	-1,415	38	-19	2	1,560	0	-5,684	294,922	50,584	5	10,117	2	9
92	11	-5	-14	-9,059	19	-9	-11	-2,657	38	-19	-3	-2,846	0	-14,562	286,044	50,584	5	10,117	2	9
87	11	-5	-19	-12,290	19	-9	-16	-3,898	38	-19	-8	-7,251	0	-23,440	277,167	50,584	5	10,117	2	9
82	11	-5	-24	-15,520	19	-9	-21	-5,140	38	-19	-13	-11,657	0	-32,317	268,289	50,584	5	10,117	2	9
77	11	-5	-29	-18,751	19	-9	-26	-6,382	38	-19	-18	-16,062	0	-41,195	259,411	8,896	5	10,117	2	2
72	11	-5	-34	-21,982	19	-9	-31	-7,623	38	-19	-23	-20,468	0	-50,073	250,533	7,249	5	10,117	2	1
67	11	-5	-39	-25,212	19	-9	-36	-8,865	38	-19	-28	-24,873	0	-58,951	241,656	6,047	5	10,117	2	1
62	11	-5	-44	-28,443	19	-9	-41	-10,106	38	-19	-33	-29,279	0	-67,828	232,778	5,132	5	10,117	2	1
57	11	-5	-49	-31,674	19	-9	-46	-11,348	38	-19	-38	-33,684	0	-76,706	223,900	4,411	5	10,117	2	1
52	11	-5	-54	-34,904	19	-9	-51	-12,589	38	-19	-43	-38,090	0	-85,584	215,022	3,829	5	10,117	2	1
47	11	-5	-59	-38,135	19	-9	-56	-13,831	38	-19	-48	-42,495	0	-94,462	206,145	3,349	5	10,117	2	1
42	11	-5	-64	-41,366	19	-9	-61	-15,072	38	-19	-53	-46,901	-385,313	-103,339	-188,046	0	5	10,117	2	0
37	11	-5	-69	-44,597	19	-9	-66	-16,314	38	-19	-58	-51,306	-416,387	-112,217	-227,997	0	5	10,117	2	0
32	11	-5	-74	-47,827	19	-9	-71	-17,556	38	-19	-63	-55,712	-447,460	-121,095	-267,949	0	5	10,117	2	0
27	11	-5	-79	-51,058	19	-9	-76	-18,797	38	-19	-68	-60,117	-478,534	-129,973	-307,900	0	5	10,117	2	0
22	11	-5	-84	-54,289	19	-9	-81	-20,039	38	-19	-73	-64,523	-509,607	-138,850	-347,852	0	5	10,117	2	0
17	11	-5	-89	-57,519	19	-9	-86	-21,280	38	-19	-78	-68,928	-540,681	-147,728	-387,803	0	5	10,117	2	0
12	11	-5	-94	-60,750	19	-9	-91	-22,522	38	-19	-83	-73,334	-571,755	-156,606	-427,754	0	5	10,117	2	0
7	11	-5	-99	-63,981	19	-9	-96	-23,763	38	-19	-88	-77,739	-602,828	-165,484	-467,706	0	5	10,117	2	0
2	11	-5	-104	-67,211	19	-9	-101	-25,005	38	-19	-93	-82,145	-633,902	-174,361	-507,657	0	5	10,117	2	0
-3	11	-5	-109	-70,442	19	-9	-106	-26,246	38	-19	-98	-86,550	-664,976	-183,239	-547,608	0	5	10,117	2	0
-8	11	-5	-114	-73,673	19	-9	-111	-27,488	38	-19	-103	-90,956	-696,049	-192,117	-587,560	0	5	10,117	2	0
-13	11	-5	-119	-76,904	19	-9	-116	-28,729	38	-19	-108	-95,361	-727,123	-200,995	-627,511	0	5	10,117	2	0
-18	11	-5	-124	-80,134	19	-9	-121	-29,971	38	-19	-113	-99,767	-758,196	-209,872	-667,463	0	5	10,117	2	0
-23	11	-5	-129	-83,365	19	-9	-126	-31,213	38	-19	-118	-104,172	-789,270	-218,750	-707,414	0	5	10,117	2	0
-28	11	-5	-134	-86,596	19	-9	-131	-32,454	38	-19	-123	-108,578	-820,344	-227,628	-747,365	0	5	10,117	2	0

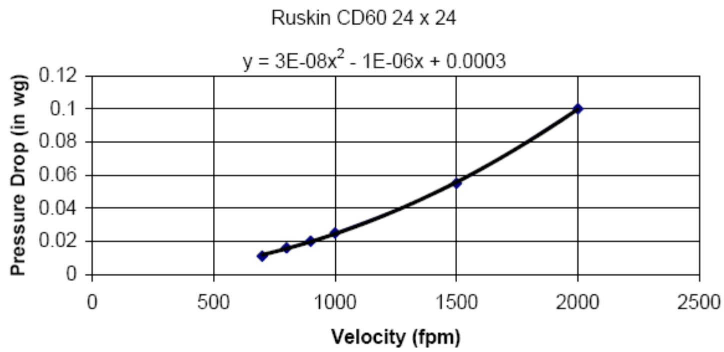
Model: Ruskin CD60 12 x 12

Velocity	Pressure Drop
500	0.024
600	0.031
700	0.045
800	0.055
900	0.07
1000	0.09
1500	0.2
2000	0.35



Model: Ruskin CD60 24 x 24

Velocity	Pressure Drop
700	0.011
800	0.016
900	0.02
1000	0.025
1500	0.055
2000	0.1

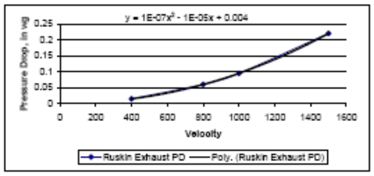


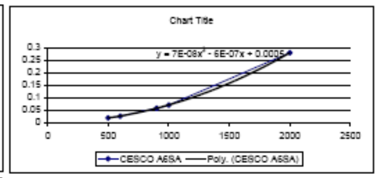
Louver model numbers (:Louver_model)
RUSKIN EME6625-805
CESCO A6SA

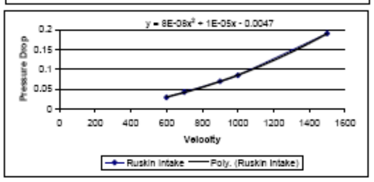
Ruskin		Cesco A6SA	
Exhaust		Intake/Exhaust	
Velocity	PD in wg	Velocity	PD in wg
400	0.015	500	0.018
800	0.06	600	0.025
1000	0.095	900	0.057
1500	0.22	1000	0.07
		2000	0.28
Intake			
600	0.03		
700	0.043		
900	0.07		
1000	0.085		
1500	0.19		

Height

					Ruskin			Cesco A6S			
					Pressure Drop				Pressure Drop		
	Height	Width	Airflow	Free Area	Intake	Exhaust	Velocity	Free Area	Intake	Exhaust	Velocity
BASE CASE	52	52	10,117	8.16	0.13	0.15	1,240	7.27	0.14	0.14	1,392
ALT CASE	50	50	10,510	7.47	0.17	0.19	1,407	6.68	0.17	0.17	1,573







Catalog values

Model: Construction Specialties, RS-5605 RS-5605

Width

	18	24	30	36	42	48	54	60	72	84	96	108	120	132	144
18	0.98	1.33	1.72	2.12	2.52	2.92	3.31	3.71	4.24	5.04	5.84	6.62	7.42	8.48	10.08
24	1.34	1.92	2.5	3.07	3.65	4.22	4.8	5.38	6.14	7.3	8.44	9.6	10.76	12.28	14.6
30	1.76	2.51	3.27	4.02	4.78	5.53	6.29	7.04	8.04	9.56	11.06	12.58	14.08	16.08	19.12
36	2.18	3.11	4.04	4.97	5.91	6.84	7.77	8.71	9.94	11.82	13.68	15.54	17.42	19.88	23.64
42	2.59	3.7	4.81	5.93	7.04	8.15	9.26	10.37	11.86	14.08	16.3	18.52	20.74	23.72	28.16
48	3.01	4.3	5.59	6.88	8.17	9.46	10.75	12.04	13.76	16.34	18.92	21.5	24.08	27.52	32.68
54	3.42	4.89	6.36	7.83	9.3	10.76	12.23	13.7	15.66	18.6	21.52	24.46	27.4	31.32	37.2
60	3.84	5.49	7.13	8.78	10.43	12.07	13.72	15.36	17.56	20.86	24.14	27.44	30.72	35.12	41.72
66	4.26	6.08	7.91	9.73	11.56	13.38	15.21	17.03	19.46	23.12	26.76	30.42	34.06	38.92	46.24
72	4.67	6.68	8.68	10.68	12.69	14.69	16.69	18.69	21.36	25.38	29.38	33.38	37.38	42.72	50.76
78	5.09	7.27	9.45	11.63	13.82	16	18.18	20.36	23.26	27.64	32	36.36	40.72	46.52	55.28
84	5.51	7.87	10.23	12.59	14.94	17.3	19.66	22.02	25.18	29.88	34.6	39.32	44.04	50.36	59.76
90	5.71	8.16	10.61	13.06	15.51	17.96	20.41	22.86	26.12	31.02	35.92	40.82	45.72	52.24	62.04
96	6.13	8.76	11.38	14.01	16.64	19.27	21.89	24.52	28.02	33.28	38.54	43.78	49.04	56.04	66.56
102	6.55	9.35	12.16	14.96	17.77	20.57	23.38	26.19	29.92	35.54	41.14	46.76	52.38	59.84	71.08
108	6.96	9.95	12.93	15.91	18.9	21.88	24.87	27.85	31.82	37.8	43.76	49.74	55.7	63.64	75.6
114	7.38	10.54	13.7	16.87	20.03	23.19	26.35	29.52	33.74	40.06	46.38	52.7	59.04	67.48	80.12
120	7.79	11.14	14.48	17.82	21.16	24.5	27.84	31.18	35.64	42.32	49	55.68	62.36	71.28	84.64
126	8.21	11.73	15.25	18.77	22.29	25.81	29.33	32.85	37.54	44.58	51.62	58.66	65.7	75.08	89.16
132	8.63	12.32	16.02	19.72	23.42	27.12	30.81	34.51	39.44	46.84	54.24	61.62	69.02	78.88	93.68
138	9.04	12.92	16.8	20.67	24.55	28.42	32.3	36.17	41.34	49.1	56.84	64.6	72.34	82.68	98.2
144	9.46	13.51	17.57	21.62	25.68	29.73	33.79	37.84	43.24	51.36	59.46	67.58	75.68	86.48	102.72
150	9.88	14.11	18.34	22.57	26.81	31.04	35.27	39.5	45.14	53.62	62.08	70.54	79	90.28	107.24
156	10.29	14.7	19.11	23.53	27.94	32.35	36.76	41.17	47.06	55.88	64.7	73.52	82.34	94.12	111.76
162	10.71	15.3	19.89	24.48	29.07	33.66	38.24	42.83	48.96	58.14	67.32	76.48	85.66	97.92	116.28
168	11.12	15.89	20.66	25.43	30.2	34.96	39.73	44.5	50.86	60.4	69.92	79.46	89	101.72	120.8
174	11.33	16.19	21.05	25.9	30.76	35.62	40.47	45.33	51.8	61.52	71.24	80.94	90.66	103.6	123.04
180	11.75	16.78	21.82	26.85	31.89	36.93	41.96	47	53.7	63.78	73.86	83.92	94	107.4	127.56
186	12.16	17.38	22.59	27.81	33.02	38.23	43.45	48.66	55.62	66.04	76.46	86.9	97.32	111.24	132.08
192	12.58	17.97	23.37	28.76	34.15	39.54	44.93	50.33	57.52	68.3	79.08	89.86	100.66	115.04	136.6
198	13	18.57	24.14	29.71	35.28	40.85	46.42	51.99	59.42	70.58	81.7	92.84	103.98	118.84	141.12

Pottorff ECV-645

	12	18	24	30	36	42	48	54	60	66	72	78	84	90
12	0.13	0.22	0.31	0.39	0.48	0.55	0.64	0.72	0.81	0.89	0.98	1.06	1.15	1.24
18	0.4	0.66	0.91	1.16	1.42	1.66	1.92	2.18	2.42	2.68	2.94	3.18	3.44	3.7
24	0.67	1.09	1.52	1.93	2.36	2.78	3.21	3.62	4.05	4.47	4.9	5.31	5.73	6.16
30	0.94	1.53	2.12	2.72	3.3	3.89	4.48	5.08	5.67	6.25	6.84	7.44	8.03	8.62
36	1.21	1.97	2.73	3.49	4.25	5.01	5.77	6.52	7.28	8.04	8.8	9.56	10.32	11.08
42	1.48	2.41	3.34	4.26	5.19	6.12	7.05	7.98	8.9	9.83	10.76	11.69	12.62	13.54
48	1.75	2.84	3.94	5.04	6.13	7.23	8.32	9.42	10.53	11.62	12.72	13.81	14.91	16.01
54	2.02	3.28	4.55	5.81	7.07	8.35	9.61	10.87	12.14	13.4	14.66	15.94	17.2	18.47
60	2.29	3.72	5.15	6.59	8.02	9.46	10.89	12.33	13.76	15.19	16.62	18.07	19.5	20.93
66	2.56	4.16	5.02	7.37	8.97	10.58	12.17	13.77	15.37	16.98	18.58	20.18	21.79	23.39
72	2.83	4.6	6.36	8.14	9.91	11.68	13.45	15.23	17	18.78	20.54	22.31	24.08	25.85
78	3.1	5.03	6.98	8.91	10.86	12.79	14.74	16.67	18.62	20.55	22.5	24.43	26.38	28.31
84	3.37	5.47	7.58	9.69	11.8	13.9	16.01	18.13	20.23	22.34	24.46	26.56	28.67	30.78
90	3.64	5.91	8.19	10.47	12.74	15.02	17.3	19.57	21.85	24.13	26.4	28.69	30.97	33.24
96	3.91	6.38	8.84	11.3	13.75	16.22	18.68	21.14	23.6	26.06	28.51	30.98	33.46	35.89

RUSKIN RUSKIN EME6625-805

	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
12	0.11	0.18	0.25	0.32	0.39	0.45	0.52	0.59	0.66	0.73	0.8	0.87	0.94	1.01	1.07	1.14	1.21	1.28	1.35
18	0.33	0.54	0.74	0.95	1.16	1.36	1.57	1.78	1.98	2.19	2.4	2.6	2.81	3.02	3.22	3.43	3.64	3.84	4.05
24	0.55	0.89	1.24	1.58	1.93	2.27	2.62	2.96	3.31	3.65	4	4.34	4.68	5.03	5.37	5.72	6.06	6.41	6.75
30	0.77	1.25	1.73	2.22	2.7	3.18	3.66	4.15	4.63	5.11	5.59	6.08	6.56	7.04	7.52	8.01	8.49	8.97	9.45
36	0.99	1.61	2.23	2.85	3.47	4.09	4.71	5.33	5.95	6.57	7.19	7.81	8.43	9.05	9.67	10.29	10.91	11.53	12.15
42	1.21	1.97	2.73	3.48	4.24	5	5.76	6.52	7.27	8.03	8.79	9.55	10.31	11.06	11.82	12.58	13.34	14.1	14.85
48	1.43	2.32	3.22	4.12	5.01	5.91	6.8	7.7	8.6	9.49	10.39	11.28	12.18	13.08	13.98	14.87	15.75	16.66	17.56
54	1.65	2.68	3.72	4.75	5.78	6.82	7.85	8.88	9.92	10.95	11.99	13.02	14.05	15.09	16.12	17.15	18.19	19.22	20.26

60	1.87	3.04	4.21	5.38	6.55	7.73	8.9	10.07	11.24	12.41	13.58	14.76	15.93	17.1	18.27	19.44	20.61	21.79	22.96
66	2.09	3.4	4.71	6.02	7.33	8.64	9.94	11.25	12.56	13.87	15.18	16.49	17.8	19.11	20.42	21.73	23.04	24.35	25.66
72	2.31	3.76	5.2	6.65	8.1	9.54	10.99	12.44	13.89	15.33	16.78	18.23	19.67	21.12	22.57	24.02	25.46	26.91	28.36
78	2.53	4.11	5.7	7.28	8.87	10.45	12.04	13.62	15.21	16.79	18.38	19.96	21.55	23.13	24.72	26.3	27.89	29.47	31.06
84	2.75	4.47	6.19	7.92	9.64	11.36	13.08	14.81	16.53	18.25	19.98	21.7	23.42	25.15	26.87	28.59	30.31	32.04	33.76
90	2.97	4.83	6.69	8.55	10.41	12.27	14.13	15.99	17.85	19.71	21.57	23.44	25.3	27.16	29.02	30.88	32.74	34.6	36.46

	CESCO A6S																		
	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
12	0.22	0.37	0.52	0.67	0.82	0.96	1.11	1.26	1.41	1.56	1.71	1.85	2	2.15	2.3	2.45	2.6	2.74	2.89
18	0.39	0.65	0.91	1.17	1.43	1.69	1.95	2.21	2.47	2.73	2.99	3.24	3.5	3.76	4.02	4.28	4.54	4.8	5.06
24	0.56	0.93	1.3	1.67	2.04	2.41	2.78	3.15	3.52	3.89	4.26	4.64	5.01	5.38	5.75	6.12	6.49	6.86	7.23
30	0.72	1.21	1.69	2.17	2.65	3.13	3.62	4.1	4.58	5.06	5.54	6.03	6.51	6.99	7.47	7.95	8.44	8.92	9.4
36	0.89	1.48	2.08	2.67	3.26	3.86	4.45	5.04	5.64	6.23	6.82	7.42	8.01	8.6	9.2	9.79	10.38	10.98	11.57
42	1.06	1.76	2.47	3.17	3.88	4.58	5.28	5.99	6.69	7.4	8.1	8.81	9.51	10.22	10.92	11.63	12.33	13.03	13.74
48	1.22	2.04	2.86	3.67	4.49	5.3	6.12	6.93	7.75	8.57	9.38	10.2	11.01	11.83	12.65	13.46	14.28	15.09	15.91
54	1.39	2.32	3.24	4.17	5.1	6.03	6.95	7.88	8.81	9.73	10.66	11.59	12.52	13.44	14.37	15.3	16.22	17.15	18.08
60	1.56	2.6	3.63	4.67	5.71	6.75	7.79	8.8	9.86	10.9	11.94	12.98	14.02	15.06	16.09	17.13	18.17	19.21	20.25
66	1.72	2.87	4.02	5.17	6.32	7.47	8.62	9.77	10.92	12.07	13.22	14.37	15.52	16.67	17.82	18.97	20.12	21.27	22.42
72	1.89	3.15	4.41	5.67	6.93	8.2	9.46	10.72	11.98	13.24	14.5	15.75	17.02	18.28	19.54	20.8	22.06	23.33	24.59
78	2.06	3.43	4.8	6.17	7.55	8.92	10.29	11.66	13.03	14.41	15.78	17.15	18.52	19.9	21.27	22.64	24.01	25.38	26.76
84	2.23	3.71	5.19	6.68	8.16	9.64	11.13	12.61	14.09	15.58	17.06	18.54	20.03	21.51	22.99	24.48	25.96	27.44	28.93
90	2.39	3.99	5.58	7.18	8.77	10.36	11.96	13.55	15.15	16.74	18.34	19.93	21.53	23.12	24.72	26.31	27.91	29.5	31.09
96	2.56	4.26	5.97	7.66	9.38	11.09	12.79	14.5	16.21	17.91	19.62	21.32	23.03	24.73	26.44	28.15	29.85	31.56	33.26
102	2.73	4.54	6.36	8.18	9.99	11.81	13.63	15.45	17.26	19.08	20.9	22.72	24.53	26.35	28.16	29.98	31.8	33.62	35.43
108	2.89	4.82	6.75	8.68	10.61	12.53	14.46	16.39	18.32	20.25	22.18	24.1	26.03	27.96	29.89	31.82	33.75	35.67	37.6
114	3.06	5.1	7.14	9.18	11.22	13.26	15.3	17.34	19.38	21.42	23.46	25.49	27.53	29.57	31.61	33.65	35.69	37.73	39.77
120	3.23	5.38	7.53	9.68	11.83	13.98	16.13	18.28	20.43	22.58	24.73	26.88	29.04	31.19	33.34	35.49	37.64	39.79	41.94

***Solver routine used to set the error percentage to zero value by changing percentage blocked by side, top/bottom

RS-5605			Pottorff ECV-645		
Free area blocked by side framing:	3.52	in	Free area blocked by side framing:	2.42	in
Free area blocked by top/bottom:	4.08	in	Free area blocked by top/bottom:	9.00	in
Free area percentage:	0.68		Free area percentage:	0.67	
Error Percentage:	0.02		Error Percentage:	0.00	
RUSKIN EME6625-805			CESCO A6S		
Free area blocked by side framing:	2.42	in	Free area blocked by side framing:	3.00	in
Free area blocked by top/bottom:	9.00	in	Free area blocked by top/bottom:	4.00	in
Free area percentage:	0.55		Free area percentage:	0.44	
Error Percentage:	0.00		Error Percentage:	0.00	

Calculated Values
Model: Construction Specialties, RS-5605 RS-5605

Width

	18	24	30	36	42	48	54	60	72	84	96	108	120	132	144
18	0.95	1.34	1.74	2.13	2.53	2.92	3.31	3.71	4.50	5.28	6.07	6.86	7.65	8.44	9.22
24	1.36	1.92	2.49	3.05	3.62	4.18	4.74	5.31	6.43	7.56	8.69	9.82	10.95	12.07	13.20
30	1.77	2.50	3.24	3.97	4.70	5.44	6.17	6.91	8.37	9.84	11.31	12.78	14.24	15.71	17.18
36	2.18	3.08	3.99	4.89	5.79	6.70	7.60	8.50	10.31	12.12	13.93	15.73	17.54	19.35	21.15
42	2.59	3.66	4.74	5.81	6.88	7.96	9.03	10.10	12.25	14.40	16.54	18.69	20.84	22.98	25.13
48	3.00	4.24	5.49	6.73	7.97	9.22	10.46	11.70	14.19	16.68	19.16	21.65	24.13	26.62	29.11
54	3.41	4.82	6.24	7.65	9.06	10.47	11.89	13.30	16.13	18.95	21.78	24.61	27.43	30.26	33.08
60	3.82	5.40	6.99	8.57	10.15	11.73	13.32	14.90	18.07	21.23	24.40	27.56	30.73	33.89	37.06
66	4.23	5.98	7.73	9.49	11.24	12.99	14.75	16.50	20.00	23.51	27.02	30.52	34.03	37.53	41.04
72	4.64	6.56	8.48	10.41	12.33	14.25	16.17	18.10	21.94	25.79	29.63	33.48	37.32	41.17	45.01
78	5.05	7.14	9.23	11.33	13.42	15.51	17.60	19.70	23.88	28.07	32.25	36.44	40.62	44.81	48.99
84	5.46	7.72	9.98	12.25	14.51	16.77	19.03	21.29	25.82	30.34	34.87	39.39	43.92	48.44	52.97
90	5.87	8.30	10.73	13.17	15.60	18.03	20.46	22.89	27.76	32.62	37.49	42.35	47.22	52.08	56.94
96	6.28	8.88	11.48	14.08	16.69	19.29	21.89	24.49	29.70	34.90	40.10	45.31	50.51	55.72	60.92
102	6.69	9.46	12.23	15.00	17.78	20.55	23.32	26.09	31.63	37.18	42.72	48.27	53.81	59.36	64.90
108	7.10	10.04	12.98	15.92	18.86	21.81	24.75	27.69	33.57	39.46	45.34	51.22	57.11	62.99	68.87
114	7.51	10.62	13.73	16.84	19.95	23.07	26.18	29.29	35.51	41.73	47.96	54.18	60.40	66.63	72.85
120	7.92	11.20	14.48	17.76	21.04	24.32	27.61	30.89	37.45	44.01	50.58	57.14	63.70	70.26	76.83
126	8.33	11.78	15.23	18.68	22.13	25.58	29.04	32.49	39.39	46.29	53.19	60.10	67.00	73.90	80.80
132	8.74	12.36	15.98	19.60	23.22	26.84	30.46	34.09	41.33	48.57	55.81	63.05	70.30	77.54	84.78
138	9.15	12.94	16.73	20.52	24.31	28.10	31.89	35.68	43.27	50.85	58.43	66.01	73.59	81.17	88.76
144	9.56	13.52	17.48	21.44	25.40	29.36	33.32	37.28	45.20	53.13	61.05	68.97	76.89	84.81	92.73
150	9.97	14.10	18.23	22.36	26.49	30.62	34.75	38.88	47.14	55.40	63.67	71.93	80.19	88.45	96.71
156	10.38	14.68	18.98	23.28	27.58	31.88	36.18	40.48	49.08	57.68	66.28	74.88	83.48	92.09	100.69
162	10.79	15.26	19.73	24.20	28.67	33.14	37.61	42.08	51.02	59.96	68.90	77.84	86.78	95.72	104.66
168	11.20	15.84	20.48	25.12	29.76	34.40	39.04	43.68	52.96	62.24	71.52	80.80	90.08	99.36	108.64
174	11.61	16.42	21.23	26.04	30.85	35.66	40.47	45.28	54.90	64.52	74.14	83.76	93.38	103.00	112.62
180	12.02	17.00	21.98	26.96	31.94	36.92	41.90	46.88	56.83	66.79	76.75	86.71	96.67	106.63	116.59
186	12.43	17.58	22.73	27.88	33.02	38.17	43.32	48.47	58.77	69.07	79.37	89.67	99.97	110.27	120.57
192	12.84	18.16	23.47	28.79	34.11	39.43	44.75	50.07	60.71	71.35	81.99	92.63	103.27	113.91	124.55
198	13.25	18.74	24.22	29.71	35.20	40.69	46.18	51.67	62.65	73.63	84.61	95.59	106.57	117.54	128.52

Pottorff ECV-645

	12	18	24	30	36	42	48	54	60	66	72	78	84	90
12	0.13	0.22	0.30	0.39	0.47	0.56	0.64	0.73	0.81	0.89	0.98	1.06	1.15	1.23
18	0.40	0.66	0.91	1.16	1.42	1.67	1.92	2.18	2.43	2.68	2.93	3.19	3.44	3.69
24	0.67	1.09	1.52	1.94	2.36	2.78	3.20	3.63	4.05	4.47	4.89	5.31	5.73	6.16
30	0.94	1.53	2.12	2.71	3.30	3.89	4.48	5.08	5.67	6.26	6.85	7.44	8.03	8.62
36	1.21	1.97	2.73	3.49	4.25	5.01	5.77	6.53	7.28	8.04	8.80	9.56	10.32	11.08
42	1.48	2.41	3.34	4.26	5.19	6.12	7.05	7.98	8.90	9.83	10.76	11.69	12.61	13.54
48	1.75	2.85	3.94	5.04	6.14	7.23	8.33	9.43	10.52	11.62	12.71	13.81	14.91	16.00
54	2.02	3.28	4.55	5.81	7.08	8.35	9.61	10.88	12.14	13.41	14.67	15.94	17.20	18.47
60	2.29	3.72	5.16	6.59	8.02	9.46	10.89	12.33	13.76	15.19	16.63	18.06	19.49	20.93
66	2.56	4.16	5.76	7.37	8.97	10.57	12.17	13.78	15.38	16.98	18.58	20.19	21.79	23.39
72	2.83	4.60	6.37	8.14	9.91	11.68	13.45	15.23	17.00	18.77	20.54	22.31	24.08	25.85
78	3.10	5.04	6.98	8.92	10.86	12.80	14.74	16.68	18.62	20.56	22.50	24.44	26.38	28.31
84	3.37	5.47	7.58	9.69	11.80	13.91	16.02	18.13	20.23	22.34	24.45	26.56	28.67	30.78
90	3.63	5.91	8.19	10.47	12.74	15.02	17.30	19.58	21.85	24.13	26.41	28.68	30.96	33.24
96	3.90	6.35	8.80	11.24	13.69	16.13	18.58	21.03	23.47	25.92	28.36	30.81	33.26	35.70

RUSKIN RUSKIN EME6625-805

	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
12	0.11	0.18	0.25	0.32	0.39	0.45	0.52	0.59	0.66	0.73	0.80	0.87	0.94	1.01	1.07	1.14	1.21	1.28	1.35
18	0.33	0.54	0.74	0.95	1.16	1.36	1.57	1.78	1.98	2.19	2.40	2.60	2.81	3.02	3.22	3.43	3.64	3.84	4.05
24	0.55	0.89	1.24	1.58	1.93	2.27	2.62	2.96	3.31	3.65	3.99	4.34	4.68	5.03	5.37	5.72	6.06	6.41	6.75
30	0.77	1.25	1.73	2.22	2.70	3.18	3.66	4.15	4.63	5.11	5.59	6.08	6.56	7.04	7.52	8.00	8.49	8.97	9.45
36	0.99	1.61	2.23	2.85	3.47	4.09	4.71	5.33	5.95	6.57	7.19	7.81	8.43	9.05	9.67	10.29	10.91	11.53	12.15
42	1.21	1.97	2.73	3.48	4.24	5.00	5.76	6.52	7.27	8.03	8.79	9.55	10.30	11.06	11.82	12.58	13.34	14.09	14.85
48	1.43	2.33	3.22	4.12	5.01	5.91	6.80	7.70	8.60	9.49	10.39	11.28	12.18	13.07	13.97	14.87	15.76	16.66	17.55
54	1.65	2.68	3.72	4.75	5.78	6.82	7.85	8.88	9.92	10.95	11.99	13.02	14.05	15.09	16.12	17.15	18.19	19.22	20.25
60	1.87	3.04	4.21	5.38	6.56	7.73	8.90	10.07	11.24	12.41	13.58	14.75	15.93	17.10	18.27	19.44	20.61	21.78	22.95
66	2.09	3.40	4.71	6.02	7.33	8.64	9.94	11.25	12.56	13.87	15.18	16.49	17.80	19.11	20.42	21.73	23.04	24.35	25.65
72	2.31	3.76	5.20	6.65	8.10	9.54	10.99	12.44	13.89	15.33	16.78	18.23	19.67	21.12	22.57	24.01	25.46	26.91	28.35
78	2.53	4.11	5.70	7.28	8.87	10.45	12.04	13.62	15.21	16.79	18.38	19.96	21.55	23.13	24.72	26.30	27.89	29.47	31.06
84	2.75	4.47	6.20	7.92	9.64	11.36	13.09	14.81	16.53	18.25	19.98	21.70	23.42	25.14	26.87	28.59	30.31	32.03	33.76
90	2.97	4.83	6.69	8.55	10.41	12.27	14.13	15.99	17.85	19.71	21.57	23.43	25.29	27.15	29.02	30.88	32.74	34.60	36.46

CESCO A6S

	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
12	0.22	0.37	0.52	0.67	0.82	0.96	1.11	1.26	1.41	1.56	1.71	1.85	2.00	2.15	2.30	2.45	2.60	2.74	2.89
18	0.39	0.65	0.91	1.17	1.43	1.69	1.95	2.21	2.47	2.73	2.99	3.25	3.50	3.76	4.02	4.28	4.54	4.80	5.06
24	0.56	0.93	1.30	1.67	2.04	2.41	2.78	3.15	3.52	3.89	4.26	4.64	5.01	5.38	5.75	6.12	6.49	6.86	7.23
30	0.72	1.21	1.69	2.17	2.65	3.13	3.62	4.10	4.58	5.06	5.54	6.03	6.51	6.99	7.47	7.95	8.44	8.92	9.40
36	0.89	1.48	2.08	2.67	3.26	3.86	4.45	5.04	5.64	6.23	6.82	7.42	8.01	8.60	9.20	9.79	10.38	10.98	11.57
42	1.06	1.76	2.47	3.17	3.88	4.58	5.28	5.99	6.69	7.40	8.10	8.81	9.51	10.22	10.92	11.63	12.33	13.03	13.74
48	1.22	2.04	2.86	3.67	4.49	5.30	6.12	6.93	7.75	8.57	9.38	10.20	11.01	11.83	12.65	13.46	14.28	15.09	15.91
54	1.39	2.32	3.24	4.17	5.10	6.03	6.95	7.88	8.81	9.73	10.66	11.59	12.52	13.44	14.37	15.30	16.22	17.15	18.08
60	1.56	2.60	3.63	4.67	5.71	6.75	7.79	8.83	9.86	10.90	11.94	12.98	14.02	15.06	16.09	17.13	18.17	19.21	20.25
66	1.72	2.87	4.02	5.17	6.32	7.47	8.62	9.77	10.92	12.07	13.22	14.37	15.52	16.67	17.82	18.97	20.12	21.27	22.42
72	1.89	3.15	4.41	5.67	6.93	8.20	9.46	10.72	11.98	13.24	14.50	15.76	17.02	18.28	19.54	20.80	22.06	23.32	24.59
78	2.06	3.43	4.80	6.17	7.55	8.92	10.29	11.66	13.03	14.41	15.78	17.15	18.52	19.89	21.27	22.64	24.01	25.38	26.75
84	2.22	3.71	5.19	6.67	8.16	9.64	11.12	12.61	14.09	15.57	17.06	18.54	20.02	21.51	22.99	24.47	25.96	27.44	28.92
90	2.39	3.99	5.58	7.18	8.77	10.36	11.96	13.55	15.15	16.74	18.34	19.93	21.53	23.12	24.72	26.31	27.90	29.50	31.09
96	2.56	4.26	5.97	7.68	9.38	11.09	12.79	14.50	16.20	17.91	19.62	21.32	23.03	24.73	26.44	28.15	29.85	31.56	33.26
102	2.73	4.54	6.36	8.18	9.99	11.81	13.63	15.44	17.26	19.08	20.90	22.71	24.53	26.35	28.16	29.98	31.80	33.61	35.43
108	2.89	4.82	6.75	8.68	10.61	12.53	14.46	16.39	18.32	20.25	22.17	24.10	26.03	27.96	29.89	31.82	33.74	35.67	37.60
114	3.06	5.10	7.14	9.18	11.22	13.26	15.30	17.34	19.38	21.41	23.45	25.49	27.53	29.57	31.61	33.65	35.69	37.73	39.77
120	3.23	5.38	7.53	9.68	11.83	13.98	16.13	18.28	20.43	22.58	24.73	26.88	29.03	31.19	33.34	35.49	37.64	39.79	41.94

Average Error

Width

	18	24	30	36	42	48	54	60	72	84	96	108	120	132	144
18	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.05	0.04	0.04	0.03	0.01	0.08
24	0.02	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.05	0.04	0.03	0.02	0.02	0.02	0.10
30	0.01	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.04	0.03	0.02	0.02	0.01	0.02	0.10
36	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.04	0.03	0.02	0.01	0.01	0.03	0.11
42	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.01	0.01	0.00	0.03	0.11
48	0.00	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.00	0.03	0.11
54	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.00	0.03	0.11
60	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.00	0.00	0.03	0.11
66	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.00	0.00	0.04	0.11
72	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.00	0.00	0.04	0.11
78	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.00	0.00	0.04	0.11
84	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.00	0.00	0.04	0.11
90	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.06	0.05	0.04	0.04	0.03	0.00	0.08
96	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.05	0.04	0.03	0.03	0.01	0.08
102	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.04	0.03	0.03	0.01	0.09
108	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.04	0.04	0.03	0.03	0.01	0.09
114	0.02	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.05	0.04	0.03	0.03	0.02	0.01	0.09
120	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.05	0.04	0.03	0.03	0.02	0.01	0.09
126	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.05	0.04	0.03	0.02	0.02	0.02	0.09
132	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.05	0.04	0.03	0.02	0.02	0.02	0.10
138	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.05	0.04	0.03	0.02	0.02	0.02	0.10
144	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.03	0.03	0.02	0.02	0.02	0.10
150	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.03	0.03	0.02	0.02	0.02	0.10
156	0.01	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.04	0.03	0.02	0.02	0.01	0.02	0.10
162	0.01	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.04	0.03	0.02	0.02	0.01	0.02	0.10
168	0.01	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.04	0.03	0.02	0.02	0.01	0.02	0.10
174	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.06	0.05	0.04	0.03	0.03	0.01	0.08
180	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.04	0.03	0.03	0.01	0.09
186	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.04	0.03	0.03	0.01	0.09
192	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.06	0.04	0.04	0.03	0.03	0.01	0.09
198	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.05	0.04	0.04	0.03	0.02	0.01	0.09

Pottorff ECV-645

	12	18	24	30	36	42	48	54	60	66	72	78	84	90
12	0.04	0.00	0.02	0.01	0.02	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
18	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

RUSKIN RUSKIN EME6625-805

	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
12	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

CESCO A6S

	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120
12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
108	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
114	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

KANSAS CITY WEATHER DATA: WMO NO.

Temperature Range Dry-bulb, °F	January		February		March		April		May		June		July		August		September		October		November		December	
	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F	Hours	MCWB, °F
100 / 104											1	74.6	1	78.9	1	78.7								
95 / 99											2	74.7	10	77.4	6	78	1	75.8						
90 / 94									2	71.7	19	73.6	37	75.9	22	77	6	74.1						
85 / 89							3	65.6	16	69	49	71.4	77	73.5	53	74.2	17	72.1	1	65.9				
80 / 84					1	62.3	10	64.4	35	66.3	89	68.4	125	71.1	96	71.6	41	69.1	6	66.2				
75 / 79					3	60.6	16	62.1	54	63.1	115	66.5	141	69.5	134	69.4	65	67	15	62.7				
70 / 74					8	57.9	28	58.9	80	61.3	136	64.5	155	67.4	161	67.3	98	64.6	34	60.2	3	59.5		
65 / 69					12	56.2	46	56	117	58.6	129	61.6	107	63.8	125	63.7	120	61	60	58.1	9	58.8	1	61.2
60 / 64			3	50.1	24	53.2	73	53	129	55.8	94	57.7	65	59.7	85	59.7	120	57.3	86	54.8	24	56.1	3	57.5
55 / 59	2	50.6	7	48.3	36	49.9	82	49.1	111	51.5	52	53.5	21	55.5	41	55.4	99	53.3	105	50.8	45	51.8	8	51.6
50 / 54	6	47.6	12	44.7	53	45.3	110	45.7	94	47.6	28	49.5	5	51.5	16	51	81	49	125	46.6	61	46.5	13	46.9
45 / 49	10	41.6	27	41.2	71	41.4	113	42.1	62	43.6	6	45.5			4	47.6	43	44.8	116	42.7	72	42.2	18	42.3
40 / 44	26	37.7	49	37.6	111	37.8	99	38	29	39.4	1	42.7					18	40.6	89	38.6	100	38.2	37	38.2
35 / 39	71	33.9	85	33.8	137	33.6	73	33.9	14	35.2							8	36.1	63	34.5	132	33.9	104	33.9
30 / 34	127	30	129	29.8	123	29.4	41	29.5	3	30.7							3	32	32	30.4	121	29.3	167	29.9
25 / 29	117	24.9	91	24.7	73	24.6	18	25.1											9	26	81	24.7	122	25
20 / 24	92	20.2	79	20.2	47	20.1	5	20.4											2	21.3	39	20.4	83	20.2
15 / 19	72	15.2	58	15.2	24	15.4	1	15.8													19	15.6	61	15.3
10 / 14	70	10.5	43	10.5	12	10.6	1	10.3													9	11.1	45	10.4
5 / 9	52	5.8	35	5.8	6	6.2															3	6.3	32	6
0 / 4	45	1	25	1	2	1.3															1	0.6	24	1.1
-5 / -1	22	-3.3	13	-3.1	1	-2.9															1	-3.6	10	-3.3
-10 / -6	18	-7.6	8	-7.2																			9	-7.4
-15 / -11	10	-12.5	4	-12.1																			5	-12.1
-20 / -16	5	-17.2	2	-17																			2	-16.4
-25 / -21	1	-20.8	1	-21.4																				
-30 / -26																								