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The architectural impact of using ground-source heat pumps in commercial buildings in Las Vegas

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THE ARCHITECTURAL IMPACT OF USING GROUND-SOURCE HEAT PUMPS IN COMMERCIAL BUILDINGS IN LAS VEGAS

by

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ABSTRACT

The Architectural Impact of Using Ground-Source Heat Pumps in Commercial Buildings in Las Vegas

by

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Ground-source heat pump systems represent one possible solution toward making buildings more energy efficient since a significant portion of the energy consumed by these systems comes from a renewable energy source. Ground-coupled heat pump systems are a subset of ground-source heat pump systems that utilize a closed ground-loop made of polyethylene pipe as a heat exchanger to transfer heat between the ground and a series of water-source heat pumps located inside a building. In terms of architectural design, these systems are efficient in terms of space utilization both on the building interior and on the site.

Ground-coupled heat pump systems perform well when there is a reasonable balance between annual cooling and heating energy requirements. These systems, in a commercial building in the cooling dominated climate of Las Vegas, transfer substantially more heat to the ground than they remove on an annual basis. This imbalance affects the system causing increased initial costs due to larger ground-loop

sizing requirements and poorer long term performance. While no conclusive data is available, the potential for ecological disruption caused by increased ground temperatures is also a possibility. The architectural impacts of these systems is also evaluated in this context.

A series of parametric studies evaluate the architectural impacts on the design and long term performance of ground-coupled heat pump systems over a fixed period of time. The results are applied to a commercial office building in order to assess the net impact of combining various energy efficiency strategies. The conclusion of the comprehensive study is that energy efficient design strongly contributes to a reduction in the required size of a ground-coupled heat pump system. A comparative life-cycle cost analysis validates these results by using the same commercial office building design to evaluate a ground-coupled heat pump system against two other commonly used HVAC systems for commercial building applications.

The analysis indicates that ground-coupled heat pump systems perform competitively against other systems in terms of life-cycle costs. The impact on the ground temperature at the ground-loop in such a system rises significantly over the simulation period of 25 years. This condition strongly suggests that ground-coupled heat pump systems that do not incorporate a secondary means of heat disposal such as a cooling tower or absorption chiller may not be the most suitable HVAC system type for commercial office buildings in Las Vegas.

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CHAPTER I

INTRODUCTION

In the year 2000, 4.6 million commercial buildings in the United States accounted for 16 quadrillion BTUs of energy or approximately 32% of the country's electricity consumption (DOE, 2001). This is double the amount of energy consumed by commercial buildings in 1982. Growth in commercial energy demand is predicted to increase at a rate of 1.7% annually through the year 2020 (DOE, 2000).

In this context, architectural designs that focus on energy efficiency and the use of renewable energy technologies are becoming increasingly important in the face of rising demand, energy costs and pollution levels. Building energy codes, such as ASHRAE Standard 90.1-1999, establish requirements for building energy efficiency. They do not, however, regulate or prescribe how much energy must be obtained from nonrenewable sources.

An important task of the architect is to integrate both passive and active energy efficiency strategies into the myriad of design considerations that are required for the design of a building. These considerations include programmatic requirements, budgetary constraints, aesthetics and adherence to numerous building codes. By including passive and active energy efficiency strategies as design considerations, architects can design buildings that are both energy efficient and derive a significant portion of their energy requirement from nonrenewable sources.

Typical architectural design solutions for commercial building types treat the building envelope as a thermal barrier to the natural environment to the extent dictated by the ASHRAE 90.1-1999 standard and by local building codes. Mechanical systems powered by nonrenewable energy are then designed to carry the burden of maintaining a comfortable environment in a building regardless of outside climatic conditions (Hyde 2000). This approach may cause the designer and the bui'ding owner to lose out on the long-term cost benefits of optimizing a building design according to prevailing climatic and site conditions. These benefits include long-term cost savings generated by improved energy efficiency as well as initial cost savings due to a reduction in the required capacity of HVAC equipment to maintain thermal comfort.

Climate responsive design is a set of principles that are concerned with the way a building "moderates" climate. (Hyde 2000). In hot-arid climates with hot summers and mild winters, passive design strategies focus on reducing cooling load requirements and heat gain caused by solar loads and conduction through the building envelope (Givoni 1994). Under such conditions, it may be difficult for passive strategies alone to maintain a level of comfort that will be acceptable to people who are used to the conditions that mechanical systems are able to provide. In some office environments, higher required clothing levels may exacerbate this condition. A climate responsive design approach allows architects to prioritize design solutions so as to increase the portion of a building's total energy requirements derived from renewable energy sources and still maintain comfortable conditions (Hyde 2000).

Ground Source Heat Pump (GSHP) systems offer the possibility of significantly reducing the quantity of nonrenewable energy required to maintain thermal comfort

during periods of extreme outside temperatures through the use of the earth's thermal stability as both a source and a sink of heat. Systems are available in a variety of sizes and are easily adaptable to a variety of zoning requirements. They are potentially more efficient than other types of mechanical systems since the compressor-condenser unit found in water-to-air and air-to-air heat pumps is replaced by a ground source such as a lake, aquifer or the ground (Kavanaugh and Rafferty 1997).

This work focuses on a subset of GSHP systems known as Ground Coupled Heat Pump (GCHP) systems. GCHP systems utilize a ground-loop made of polyethylene pipe as a heat exchanger to transfer heat between the ground and a series of water-source heat pumps located in a building. GCHP systems are more flexible than other types of GSHP systems in terms of application in the Las Vegas Valley since they are not dependent on the availability of ground water and surface water sources.

This objective of this work is to evaluate the architectural impacts of GCHP systems in an overall climate responsive design of a commercial office building in Las Vegas. In cooling dominated climates like Las Vegas, there is a potential for the ground heat exchanger to alter the ambient temperature of the soil or body of water over time due to long-term imbalances caused by more heat being added to the ground source than is removed. Permanent changes in temperature could adversely affect the long-term performance of the GSHP system and have unforeseen environmental impacts (ASHRAE 1999). The degree to which architecture is able to reduce cooling loads through energy efficient design and thereby reduce the net amount of heat transferred to the ground source, is a central theme of this work.

Throughout this study, I use the DOE-2 based eQUEST energy simulation software to conduct a series of parametric studies that evaluate the relationship between individual energy efficient architectural design strategies and the design and long-term performance of GCHP systems. I then integrate these results into the design of a commercial office building in order to evaluate the benefits of applying a climate responsive design approach to a building that already achieves minimum compliance with the ASHRAE 90.1-1989 standard. A comparison will also be made in the context of evaluating the long term performance of GCHP systems in Las Vegas and the long term effects of using these systems on the ambient ground temperature around the ground-loop heat exchanger.

The study concludes with a life-cycle cost analysis of the GCHP system designed for the integrated commercial office building. This analysis compares how GCHP systems perform in terms of energy efficiency and cost to two other HVAC systems commonly used in commercial office building applications in Las Vegas.

CHAPTER 2

LITERATURE REVIEW

2.1 Ground Source Heat Pumps

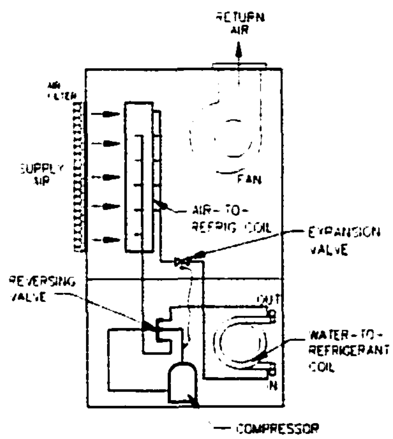


Figure 2.1: Water Source Heat Pump Schematic Diagram (Kavanaugh and Rafferty 1997)

Heat pumps are systems that reverse the flow of heat from its natural course of flowing from a warmer medium to a cooler medium by concentrating heat so that it can be transferred from a cold material to a warmer one. In cooling mode, heat is extracted from the cool air of a building interior and rejected to the warmer outside air or some other heat sink. Heating mode works in the reverse. Heat is removed from a cool source such as outside air and transfers that heat to the warmer air inside a building.

GSHP systems consist of a family of heat pump based systems that share the common feature of utilizing the ground, ground water or surface water as a heat sink or source (ASHRAE 1999). The three most common types of systems are Ground Coupled Heat Pump (GCHP) systems, Ground Water Heat Pump (GWHP) systems, and Surface Water Heat Pumps (SWHP) systems (ASHRAE 1999). These systems typically use water-

source heat pumps as their primary equipment (FEMP 1999). GSHPs utilize the stability of the ground, groundwater or surface water as an efficient heat source or sink. They are more efficient than air-to-air heat pump systems since they do not directly rely on outdoor air temperatures. Air-to-air heat pump systems become less efficient at times of very low temperatures when in heating mode and high temperatures when in cooling mode. Water is inherently a more efficient medium than air due to its higher thermal mass (FEMP 1999). Conventional water-source heat pump systems utilize a boiler as a heat source and a cooling tower to maintain very stable water-loop temperatures. While the ground or ground water sources experience far less severe temperature fluctuations than air, manufacturers have developed extended range heat pump systems to deal with the an extended range of fluid temperatures during times of extreme climatic conditions.

2.1.1 Ground Water Heat Pumps

GWHP systems are open-loop systems that utilize a consistent source of ground water as a heat exchanger. High volume wells are connected through a water-to-water heat exchanger or are directly pumped through a hydronic distribution system to individual water-source heat pump systems located throughout a building. In both configurations, water that is circulated through the system is returned to the environment through injection wells or into a nearby surface body of water (Kavanaugh and Rafferty 1997). In an ideal situation, this water is reintroduced to the aquifer so as to not disrupt the existing natural flows of the groundwater. The availability of adequate ground water sources is a major constraint to their wider use and a reason why the closed-loop GCHP systems are the more widely adopted system. Other constraints include local regulations involving the

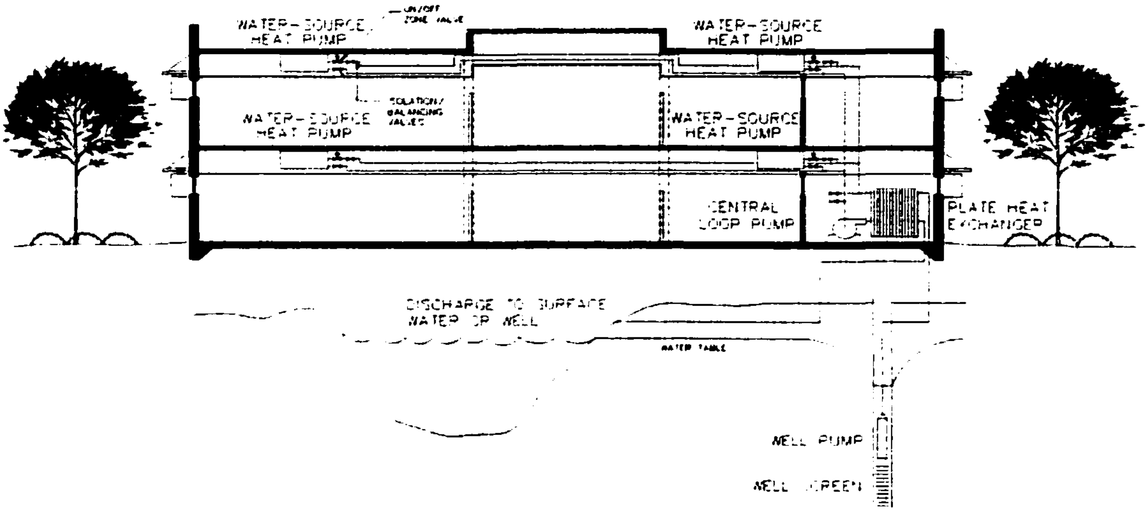


Figure 2.2: Ground Water Heat Pump System Schematic Diagram (adapted from Kavanaugh and Rafferty 1997)

injection of water back into the aquifer. These regulations can cause the design of these systems to become prohibitively expensive or even restrict their use altogether. However, when sufficient conditions do exist, these systems require very little land area, are highly efficient and have lower initial costs than GCHP systems (ASHRAE 1999).

A common GWHP system configuration consists of a centralized system that utilizes a water-to-water plate heat exchanger between the ground-loop and a closed water-loop that circulates water to water-source heat pumps located throughout a building. Other systems circulate ground water directly to the heat pumps in a single loop. In this type of system, poor water quality can cause erosion and equipment problems with the heat pumps. Another system configuration circulates ground-water through a central chiller that utilizes a pipe distribution system to transfer and remove heat from individual HVAC equipment located throughout a building.

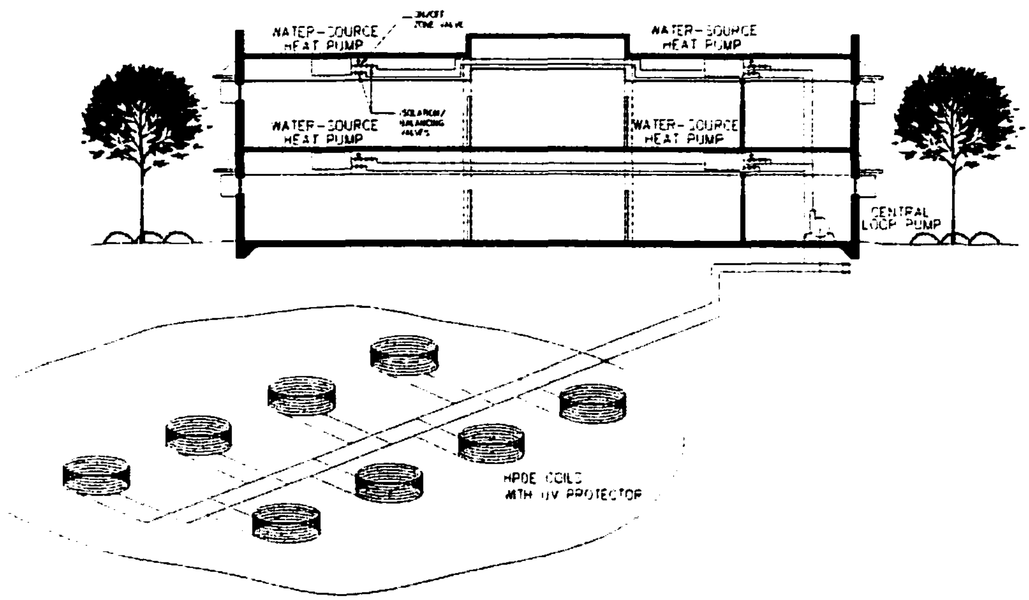


Figure 2.3: Surface Water Heat Pump System Schematic Diagram (adapted from Kavanaugh and Rafferty 1997)

2.1.2 Surface Water Heat Pumps

SWHP systems utilize surface water as a heat exchanger. In a closed-loop configuration, heat is transferred by means of water-to-air or water-to-water heat pumps that circulate water or an anti-freeze solution through a piping network submerged in an open body of water that is directly connected to the heat pumps in a building. In an open-loop configuration, the system utilizes a body of water as a cooling tower. Surface water can either be pumped directly to water-to-air or water-to-water heat pumps or to an intermediate heat exchanger. SWHP systems are generally less expensive than GCHP systems and require lower pumping energy. They perform reliably when water temperatures are stable and have low maintenance and operating costs (Kavanaugh and

Rafferty 1997). In warm climates, lake water can also be utilized as a source of heat during the winter heating period (ASHRAE 1999).

2.1.3 Ground Coupled Heat Pumps

Ground Coupled Heat Pump systems are closed loop systems that utilize the earth as both the source and the sink for heat that is either supplied to or removed from a building. These systems use a reversible vapor compression cycle linked to a closed-loop ground heat exchanger buried in the earth. Water-source heat pumps circulate water or a water anti-freeze solution between a liquid-to-refrigerant heat exchanger in the heat pump units and a buried network of thermoplastic piping known as the ground-loop heat exchanger (Kavanaugh and Rafferty 1997).

There area several GCHP system configurations in use. The most common configuration is one in which the ground-loop heat exchanger is attached to a centralized circulation loop that has all the water-source heat pumps attached to it for an entire building. An alternative configuration is one in which different heat pumps either individually or in groups have their own dedicated ground-loop heat exchangers.

In the dry climate of Las Vegas, GCHP systems may be advantageous over other types of GSHP systems since they are not dependent on the availability of surface water or ground water. These systems only depend on the availability of land area and the thermal properties of the soil to conduct heat to and from the individual boreholes of a ground-loop heat exchanger.

GCHP systems tend to be more efficient than systems that rely on air as a source and sink of heat since they are able to take advantage of the Earth's natural thermal stability.

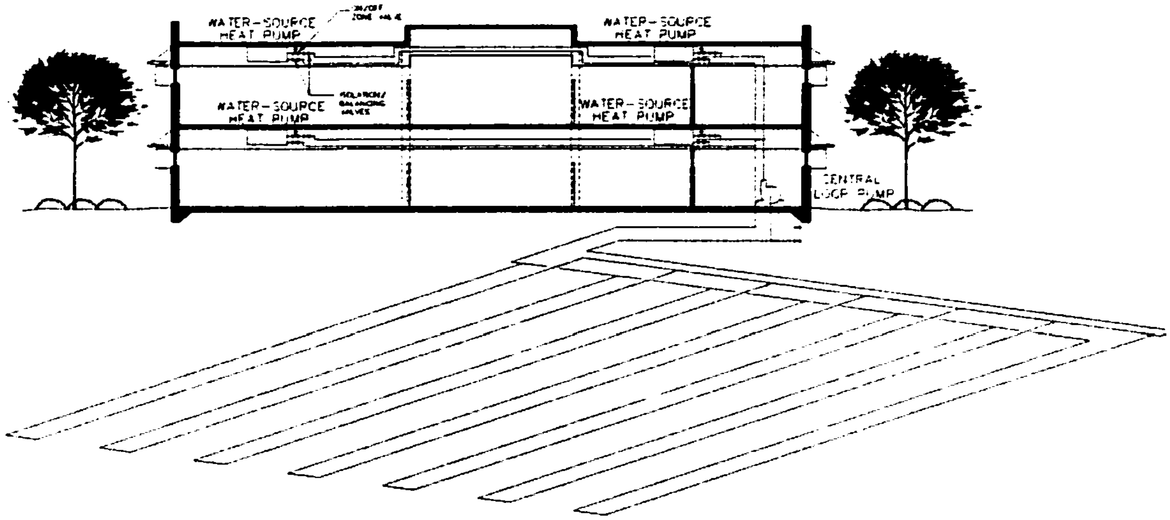


Figure 2.4: Ground Coupled Heat Pump System with a Horizontal Ground-loop Heat Exchanger (adapted from Kavanaugh and Rafferty 1997)

Air-based systems, especially HVAC equipment mounted on building rooftops must transfer heat in the face of severe seasonal temperature fluctuations.

A significant concern with the use of GCHP systems are the potentially high costs associated with the design and installation of the ground-loop heat exchanger. Proper design of the ground-loop heat exchanger requires site specific soil and rock testing (Kavanaugh and Rafferty 1997). Drilling of test bores coupled with laboratory evaluations by skilled contractors and engineers that specialize in GCHP systems are required for proper design and engineering. Alternative methods for estimating ground thermal properties for the conceptual design of the ground-loop heat exchanger are discussed in Section 3.6.

There are two basic types of closed-loop ground heat exchangers for GCHPs: Horizontal and vertical. Each of these configurations have advantages and disadvantages. Detailed discussion of each these systems is provided in sections 2.1.3.1 and 2.1.3.2.

2.1.3.1 Horizontal Ground-loop Heat Exchangers

Horizontal ground-loop heat exchangers are always closed-loop systems. Single pipe ground-loops are placed approximately 4 feet beneath the ground as shown in Figure 2.4. Horizontal ground-loops require the availability of a large land area due to the long lengths of buried piping required for sufficient heat transfer between the water solution and the ground. Placing 2 to 4 pipes in a single trench can reduce the overall trench length. However, a longer overall pipe length is required due to the thermal interference caused by the close proximity of multiple pipes. Coil type horizontal heat exchangers further reduce the amount of required trenching with the trade-off of requiring even more pipe for comparable performance (ASHRAE 1999). Potentially higher ground temperatures in the hot summer season in Las Vegas combined with the limited availability of land make the wide use of a horizontal ground-loop systems problematic.

2.1.3.2 Vertical Ground-loop Heat Exchangers

A vertical closed-loop ground heat exchanger consists of an array of loops in series and/or in parallel that are set in a grid pattern as shown in Figure 2.2. Each bore contains two small diameter polyethylene pipes ranging in diameter from ½" to 2". These two pipes are fused at the bottom of the borehole into a closed U-tube. Bore hole depths can range from 50 feet to 600 feet depending on the thermal properties of the soil, the building

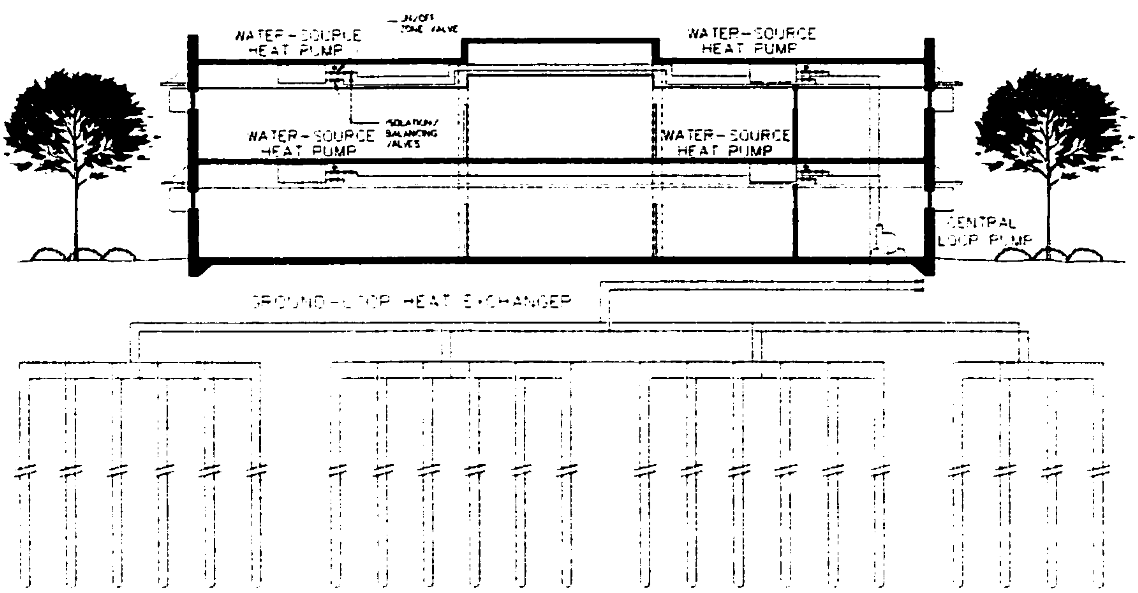


Figure 2.5: Ground Coupled Heat Pump System with a Vertical Ground-loop Heat Exchanger (adapted from Kavanaugh and Rafferty 1997)

loads, and desired system efficiency (ASHRAE 1999). Distances between boreholes should be far enough apart to minimize thermal interference caused by imbalances between annual cooling and heating loads (Kavanaugh 1998).

Vertical ground-loop heat exchangers are more commonly used than horizontal ground-loops since they require much smaller land are. Besides compactness, the vertical ground-loop takes advantage of the small temperature variation that is found at depths beyond 20' below grade in many locations. Vertical ground-loop heat exchangers use less piping than horizontal ground-loop heat exchanges and, therefore, require less pumping energy to circulate water through the system.

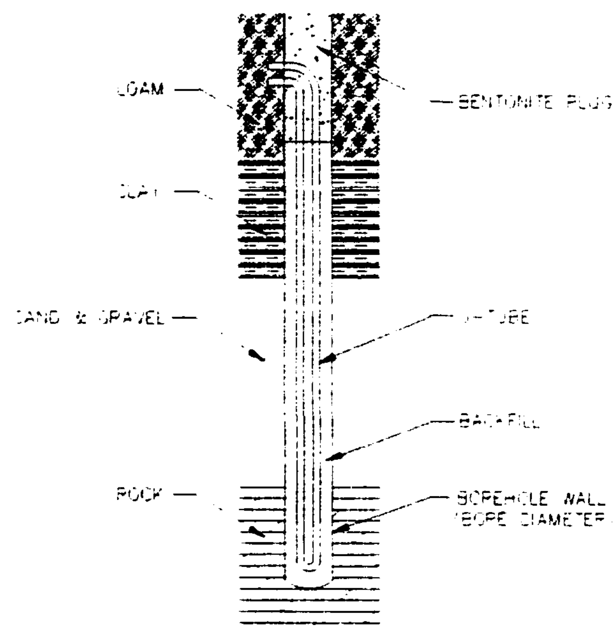


Figure 2.6: U-tube Schematic Diagram (Kavanaugh and Rafferty, 1997)

2.2 Integration of GSHP Systems with Climate Responsive Design Principles

Climate responsive design is concerned with the interaction between buildings and their surroundings. In this approach, the elements of a building are divided into a 3-tier hierarchy according to how they modify the natural environment (Hyde 2000). Elements in the first tier modify the macro-environment in order to improve the micro-environment around the building. These elements include the building orientation, landscaping and the location of the building on a site. The second tier is concerned with the elements of the building skin that act to filter the natural environment such as the form of the building and the materials used in the building's envelope. The last tier deals with the mechanical systems of the building. These systems do not modify the natural environment, but rather,

utilize active systems to create an artificial environment at the building interior (Hyde 2000).

This hierarchy can also be evaluated in terms of energy sources. The first two tiers utilize energy from the natural environment. Hence, all passive design strategies fall under one of these two tiers. The final tier relies on mechanical equipment that is dependent on non-renewable energy sources.

Table 2.1: Climate Responsive Design Model Comparison

	ENERGY EFFICIENCY STRATEGIES	ENERGY EFFICIENCY STRATEGIES
	(Hyde Model)	(Modified Hyde Model)
First Order	Solar Orientation Landscape Building Location on Site	Solar Orientation Landscape Building Location on Site
Second Order	Building Form Building Envelope Thermal Mass Glazing (Type, Size, Location, Shading) Insulation Natural Ventilation Infiltration Control	Building Form Building Envelope Thermal Mass Glazing (Type, Size, Location, Shading) Insulation Natural Ventilation Infiltration Control GSHP Systems
Third Order	HVAC Systems	

HVAC equipment in commercial buildings typically does not make direct use of the natural environment as an energy economizer. Rather, HVAC creates and maintains an isolated environment regulating temperature and humidity by using a series of devices that are exclusively powered by energy that is generated by non-renewable energy sources at remote locations (Stein and Reynolds 1992). In this context, GSHP systems take on a

different role than traditional HVAC systems since they utilize the thermal stability of the earth to provide thermal comfort in buildings.

This model differs from the model described in Richard Hyde's book, *Climate Responsive Design*. Unlike HVAC systems, the ground heat exchangers of GSHP systems possess a passive component that utilizes heat from the ground or a body of water. Therefore, the implementation of a GSHP system must be regarded as second tier design strategy. A comparison of Hyde's model and the modified version is shown in Table 2.1. Since GSHP systems transfer heat between a building and a ground source, it follows that the building's heating and cooling loads could impact the ground in the vicinity of the ground-loop heat exchanger. Changing the temperature of the ground could, in turn, impact the performance of the GSHP system. The degree of that impact in terms of the design of a GCHP system is a topic that is dealt with extensively throughout this study.

CHAPTER 3

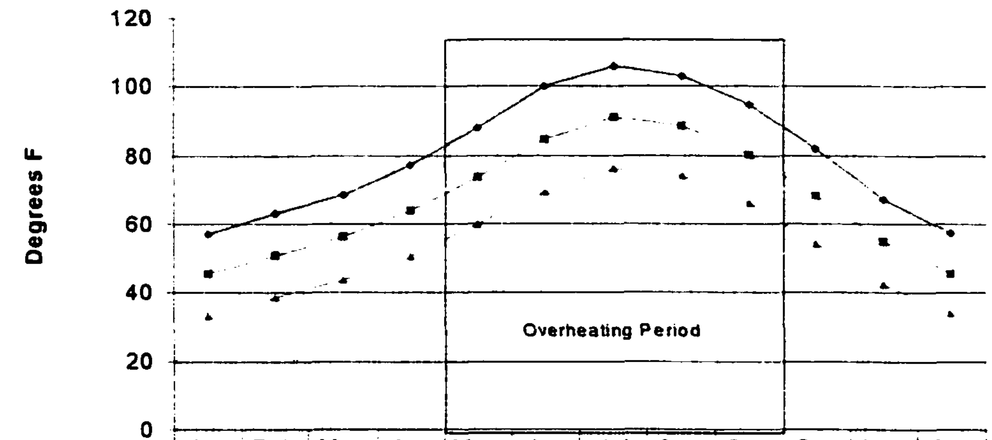
ENVIRONMENTAL FACTORS

Heating and cooling loads generated by buildings are the result of climactic conditions and internal gains. While the design of any HVAC system must take environmental factors into account, Section 2.2 made the case that the inclusion of a GCHP system in the design of a building is a higher order design decision since these systems directly couple the building to the natural environment. For this reason, an understanding of climatic and ground conditions are crucial to the successful design of a climate responsive design that includes a GCHP system. This chapter provides the background information and data sources that are used to conduct the energy simulations in Chapter 4 and Chapter 5.

3.1 Site Impacts

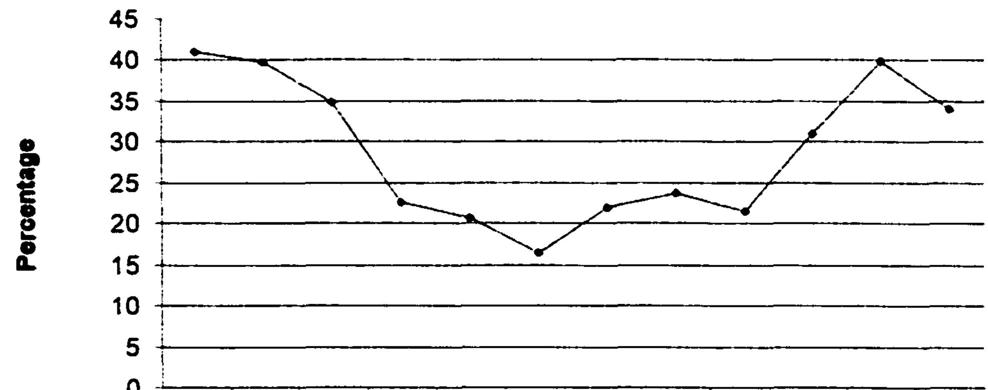
The site is a crucial element in the design of GCHP systems. The site must have land area large enough to support a ground-loop heat exchanger of sufficient size to handle the peak cooling and heating load conditions of the building. The thermal characteristics of the ground are also a key factor in site selection. Small variations in the thermal properties of the ground can have a significant effect on the sizing of the ground heat exchanger and on the long-term performance of the overall GCHP system.

In other types of HVAC systems, architects must be concerned with allocating space for system components throughout a building, on its roof, or on the site. Similarly, the



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave. Max. Temp.	57.2	63.1	68.7	77.4	87.8	100	106	103	94.6	82	67.3	57.4
Ave. Temp.	45.5	51.1	56.3	64.0	73.9	84.7	91.0	88.7	80.4	68.2	54.9	45.7
Ave. Min. Temp.	33.4	38.7	43.7	50.5	60.1	69.3	76.1	74.1	66.2	54.1	42.4	33.8

Figure 3.1a: Las Vegas Annual Average Temperatures



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Relative Humidity	41	39.7	34.9	22.6	20.7	16.3	21.9	23.7	21.5	31	39.9	34

Figure 3.1b: Las Vegas Annual Relative Humidity

design of GCHP systems requires a small mechanical room for circulation pumps and either closet size spaces or sufficient space above a ceiling for the heat pump units. The main difference with GCHP systems lies in the design of the ground-loop heat exchanger. The borefield type chosen must fit with in the confines of the property where the building

is located and still be able to handle peak load conditions. The size of the site can directly affect the efficiency of the system as well as the cost of its installation. This is because the farther apart the boreholes, the less thermal interference will occur. Ground-loops with low thermal interference will perform better and require less piping than systems that must be designed to handle long-term thermal interference.

3.2 Climate

Climate is a crucial design element in any building design. Temperature variation in Las Vegas is extreme with average maximum temperatures reaching 104°F in the summer and 34°F in the winter (NCDC 2001). Temperature and humidity data for Las Vegas are shown in Figures 3.1a-b. The overheating period in which maximum average temperatures exceed 80°F lasts from May to October. Average relative humidity remains in the 20%~34% range throughout this season. Under such conditions, energy efficient design is driven by summer climatic conditions (Givoni 1994).

In cooling load dominated climates like that of Las Vegas, there is a potential for the ground-loop heat exchanger to alter the undisturbed temperature of the ground in the long-term due to imbalances in the amount of heat transferred to the ground relative to the amount being removed (ASHRAE 1997). Such imbalances could eventually lead to a degradation in system performance due to the additional work required by the heat pumps given higher entering water temperatures. In the case of commercial buildings, this condition is made worse by the high internal heat gains generated by occupants, lighting and equipment.

3.3 Climatic Variables and Data Sources

Climate analysis and energy use simulations will use hourly climate data in TMY2 format for Las Vegas developed by the National Energy Research Laboratory (NREL 1995). A summary of that data is shown in Figure 3.2.

Latitude: 36.1
Longitude: 115.2
Elevation: 2178 ft
Design Day Dry Bulb (Winter 99.0%): 25.0 °F
Design Day Dry Bulb (Winter 97.5%): 28.0 °F
Design Day Dry Bulb (Summer 2.5%): 106.0 °F
Design Day Wet Bulb (Summer 2.5%): 65.0 °F

Month	TAA	TMXA	TMNA	TMX	TMN	TWBA	RH	WSA	HS	HDD	CDD
January	44.5	56.9	34.0	70.0	24.0	35.2	41.0	7.3	969	605	0
February	52.3	63.4	41.5	73.0	33.0	40.9	39.7	7.9	1295	351	0
March	53.3	64.5	42.8	79.0	31.0	40.8	34.9	8.8	1693	351	0
April	67.0	78.1	54.2	92.0	45.0	47.5	22.6	13.4	2205	64	100
May	72.8	84.0	60.5	99.0	43.0	50.5	20.7	9.4	2529	40	265
June	86.1	97.2	72.3	112.0	57.0	56.7	16.3	11.9	2663	0	594
July	90.4	101.6	79.5	110.0	68.0	62.3	21.9	9.6	2585	0	792
August	88.8	101.0	75.6	108.0	66.0	62.3	23.7	9.8	2312	0	723
September	81.5	94.9	67.8	105.0	61.0	56.5	21.5	8.0	1989	0	491
October	67.1	79.8	54.9	92.0	47.0	49.8	31.0	9.1	1502	32	104
November	54.4	64.9	44.8	73.0	33.0	42.7	39.9	7.7	1110	305	0
December	46.9	58.9	35.9	74.0	29.0	35.9	34.0	7.5	890	546	0
Year	67.1	78.8	55.3	112.0	24.0	48.4	28.9	9.2	1812	2293	3067

TAA Average Dry Bulb Temperature, °F
TMXA Average Daily Maximum Dry Bulb Temperature, °F
TMNA Average Daily Minimum Dry Bulb Temperature, °F
TMX Maximum Dry Bulb Temperature, °F
TMN Minimum Dry Bulb Temperature, °F
TWBA Average Wet Bulb Temperature, °F
WSA Average Wind Speed, MPH
HS Average Daily Horizontal Solar Radiation, Btu/ft²
RH Relative Humidity, %
HDD Heating Degree Days, Base 65.0 °F
CDD Cooling Degree Days, Base 65.0 °F

Figure 3.2: Summary of TMY2 data for Las Vegas (NREL, 1995)

3.4 Geology

In GCHP systems, ground heat exchanger performance is strongly affected by the geology of the site (ASHRAE 1999). The thermal properties of the soil and rock must be carefully analyzed as part of the ground-loop heat exchanger design. The key to a successful ground-loop heat exchanger is the ability of the soil to dissipate heat from the piping network. This property is dominated by the thermal conductivity of the soil and secondarily by its thermal diffusivity (STS Consultants 1989)[1]. Groundwater is also a key element in the removal of heat from a site and can reduce the potential for long term heat build-up.

The geology of the Las Vegas Valley basin consists of silt and clay beds that came from alluvial deposits caused by the intermittent rain typical of desert climates. The valley is surrounded by mountain ranges that possess sedimentary formations that are primarily made up of limestone mixed with sandstone, shale, dolomite, gypsum and quartzite. These materials have been carried into the valley by means of drainage channels. Lakes formed twice in the valley further resulting in the valley filling in with silts and clay. The soil surveys conducted by the *United States Department of Agriculture's, Soil Conservation Service* indicate that at the heart of the city of Las Vegas, soils are deep and moderately well drained. They are made up of clay loam, silt loam and silty clay loam on alluvial flats. Clay content ranges from 25 to 35 percent (U.S. Dept. of Agriculture 1985).

The size of the particles in the soil will strongly influence the soil's ability to conduct and dissipate heat from the ground exchanger. Part of this phenomenon is determined by

1. Thermal conductivity is defined as the amount of heat transferred through a unit area of soil in unit time under a unit temperature. Thermal diffusivity is defined as the change in temperature produced in a unit volume by the quantity of heat flowing through the volume in unit time under a unit temperature.

the ability of the ground water to move through the site. High amounts of clay inhibit the free movement of ground water and thus can lead to long-term heat build up. Such conditions could adversely affect the long-term performance of the ground heat exchanger (ASHRAE 2001).

3.5 Ground Water

The use of GWHP and SWHP systems is severely limited by the consistent availability of quality ground and surface water. Quality in this case refers to ground water that is not too acidic and that does not contain corrosive pollutants such as salt and iron (ASHRAE 2001).

Ground water conditions across the Las Vegas Valley vary considerably. In the northwestern part of the valley, aquifers allow for consistent flows of high quality water. Geologic conditions prevent an abundance of aquifer water from making its way to the Southern parts of the Valley barely allowing enough water for residential grade water wells. In the downtown region, the water table can be has high as 2 feet below grade but the water that exists in this area is of a poor quality with high salt content and high levels of acidity. Installation of water treatment equipment would be required to improve performance and reduce the long-term maintenance problems associated with low quality water.[2]

2. Detailed information on the ground water conditions in Las Vegas are not well documented. I obtained the information in this section through an interview with Tom Morris, a senior hydronics engineer with the Southern Nevada Water District.

3.6 Geological Data and Sources

In practice, a site-specific survey and analysis of geologic and hydrologic conditions are required in order for engineers to finalize a GSHP system design (STS Consultants 1989). The most accurate method for obtaining site specific values of these variables is done through an elaborate process of field testing, bore sampling and laboratory work. For the conceptual design of the ground-loop heat exchanger, the recommended method suggests using Water Well Completion Reports combined with regional geological and ground water information available from the United States Geological Survey and the Department of Agriculture (Rafferty 2000). Water Well Completion Reports are filed with the Nevada Bureau of Water Resources upon completion of a water well by a licensed drilling contractor. These reports contain information about the type of well, the drilling method and the type of materials encountered throughout the drilling process (Rafferty, 2000). Examination of these reports on or near a specific site can provide information so that the designer can calculate an estimate of the ground thermal properties.

In order to estimate the average thermal conductivity and diffusivity of the ground in the Las Vegas Valley, I surveyed Water Well Completion Reports from three areas of the Las Vegas Valley. The location of these areas is shown in Figure 3.3. In order to estimate ground thermal properties in Las Vegas, I use a sample of six Water Well Completion Reports for each a of these areas. I chose the six reports out of the many reports on file at the Nevada Water Resources Agency according to the detail and clarity of the information contained in the lithographic chart on each of the reports. An example of one of the water well reports is shown in Appendix A. Since soil conditions at the

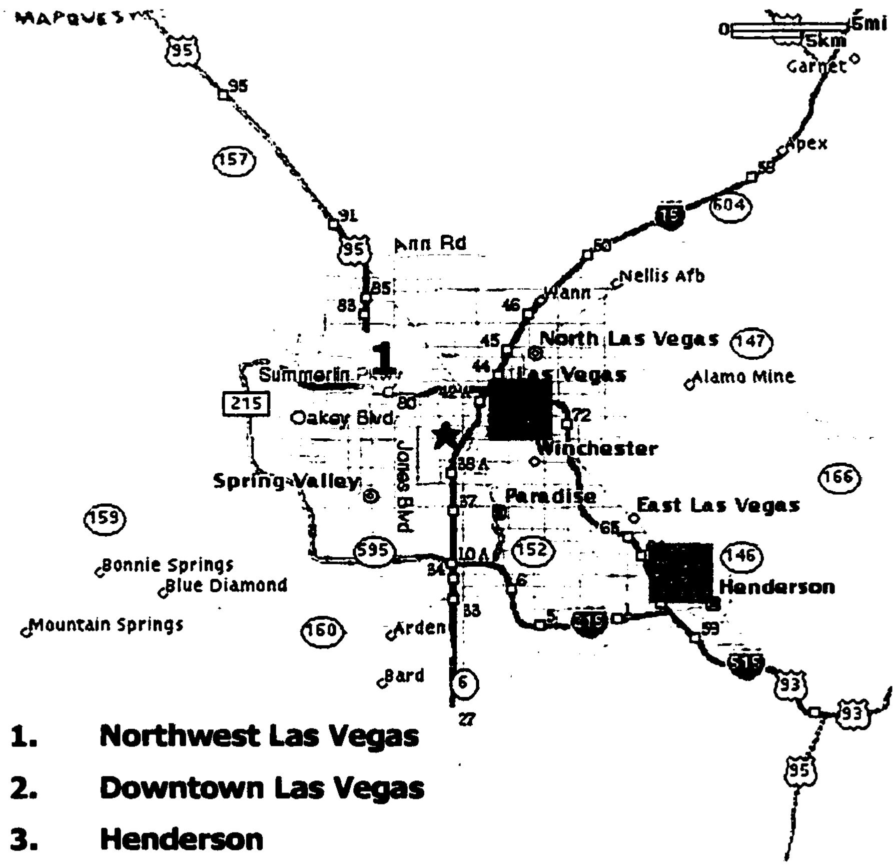


Figure 3.3: Map of Las Vegas with Water Well Completion Report Locations

surface do not necessarily reflect the soil conditions beneath the surface, I compiled the information shown in Figure A.2a-c. by estimating the content of the ground materials in 50' intervals using a weighted average calculation of the materials noted in each report for a particular interval. This method allows the estimates to take into account the variations that occur at different depths and uses weighted average techniques for estimating soil properties as is recommended in *Ground-Source heat Pumps, Design of Geothermal Systems for Commercial and Institutional* ***Buildings*** by S. Kavanaugh and K. Rafferty. This publication also contains predicted ranges of thermal conductivity and diffusivity for sands, clays and rocks. The specific data ranges from this publication are shown in Table 3.1. I assume an average dry density of 100 pounds per cubic-foot for all sands, clays and

Table 3.1: Thermal Conductivity and Diffusivity of Sands, Clays and Rocks (Kavanaugh and Rafferty, 1997)

Soil/Rock[a] Type	Characteristics	Conductivity (k) Range (Btu/h-°F-ft)	Conductivity (k) Value in Study (Btu/h-°F-ft)	Diffusivity (a) Range (ft^2/day)	Diffusivity (a) Value in Study (Btu/ft^2/ day)
Fine Grain Clay	Dry Density: 100 lb/ft^3, 5% Moist	0.5-0.6	.55	0.48-0.58	0.53
Fine Grain Clay	Dry Density: 100 lb/ft^3, 10% Moist	0.5-0.6	.55	0.37-0.48	0.43
Course Sand/Gravel	Dry Density 100 lb/ft^3, 5% Moist	0.8-1.4	1.2	0.77-1.3	1.0
Course Sand/Gravel	Dry Density 100 lb/ft^3, 15% Moist	1.3-1.6	1.5	0.89-1.1	1.0
Sandstone		1.2-2.0	1.6	0.7-1.2	0.95
Limestone		1.4-2.2	1.7	1.0-1.4	1.2
Caliche			1.65		1.1

a. Detailed information on the type or composition of rocks is not described in the water well completion reports. Where possible, I use the data provided in Ground-Source heat Pumps, Design of Geothermal Systems for Commercial and Institutional Buildings by S. Kavanaugh and K. Rafferty. In the case of Caliche, I took an average of the other rocks specifically called out in the reports.

gravel. For moisture content, I assume a moisture content of 15% when water is indicated in the water well completion report and a moisture content of 5% when the report does not indicate the presence of water. The results of the estimates made in Figures A2a-c are summarized in Table 3.2.

The GLHEPRO software that I use to design the GCHP systems in Chapters 4 and 5 requires volumetric heat capacity (V) rather than the diffusivity data provided by Table

Table 3.2: Summary of Water Well Completion Report Data

	Conductivity (Btu/h-°F-ft)	Diffusivity (ft^2/day)	Volumetric Heat Capacity (Btu/ft^2/day)
Downtown Las Vegas	0.88	0.72	29.18
Northwestern Las Vegas	0.99	0.78	30.48
Henderson	0.86	0.71	28.93
Las Vegas Valley Averages	**0.91**	**0.74**	**29.66**

3.1. Volumetric heat capacity can be derived from conductivity and diffusivity with the formula $V=k\ \ a * 24$. The data derived from the water well completion reports is summarized in Table A.2. The data contained in this table is used for the sizing of all the ground-loop heat exchangers in this study.

CHAPTER 4

THE ARCHITECTURAL IMPACT OF GROUND COUPLED HEAT PUMP SYSTEMS

4.1 Architecture and GCHP System Design

A prerequisite for the study of the architectural impact of GSHP systems begins with the analysis of the availability of water at a particular site. Among the different GSHP systems discussed in Chapter 2, Ground Coupled Heat Pump (GCHP) systems are the subset of GSHP systems that are not dependent on the availability of large bodies of ground or surface water. GCHP systems rely on the thermal characteristics of the ground at a particular site to transfer heat to and from a building by means of a ground-loop heat exchanger. This chapter focuses on the relationship between architecture and GCHP systems since these systems are appropriate for most locations in Las Vegas (FEMP1999).

An important task in the design of a GCHP system is the sizing of the ground-loop heat exchanger so that it is able to handle the peak heating and cooling energy requirements of a building. A building's energy requirements are a function of the building's internal loads and the heat gains and losses associated with solar radiation. Internal loads are produced by building occupants, equipment and lighting. All of these heat sources are a function of the building's use. Loads resulting from solar gains and losses are determined by the way the building responds to environmental conditions. Lighting loads are a function of both building use and the way the architectural design permits daylight to penetrate into a building's interior. The architectural impact on GCHP

Table 4.1: Architectural Elements

Variable	Element
Solar Orientation	Window Placement Shading Solar Orientation Building Form
Building Envelope	Glazing Materials Exterior Wall Systems and Materials Roofing Systems and Materials

systems can therefore be determined by examining the effect of architectural design decisions on the heating and cooling loads of a building.

Table 4.1 lists the architectural components that are evaluated in this study in terms of their impact on the design and long-term performance of a GCHP system for a commercial building in Las Vegas. The variables being examined in this study broadly fall under two categories: solar radiation and building envelope. The quantity of solar radiation that strikes the building envelope is a function of the building's solar orientation, latitude, the time of day, the date, surface color, the inclination relative to the sun, shading and form. The choice of envelope materials determine the quantity of radiant energy that reaches the building's interior. Translucent and transparent elements such as windows and glass doors allow a portion of the solar radiation to directly penetrate the building skin with little or no delay. The energy that strikes opaque surfaces is delayed according to the mass and insulation characteristics of the envelope materials. This chapter evaluates each of these components in order to establish a relationship between architectural design and the design of GCHP systems.

GCHP systems are flexible in their design. Heat pump units are available in a variety of sizes and capacities. Depending on the size of the thermal zones, units can be

concealed above ceilings and furred into a wall without taking up much physical space. Larger centralized systems are also available. These systems may be placed on rooftops or in mechanical rooms.

When zoning is broken down into sufficiently small zones, GCHP systems require less space than conventional HVAC since there are no boilers, cooling towers, furnaces or outdoor compressors. Space in mechanical rooms need only to be of sufficient size to house circulation pumps and related equipment. One immediate benefit to the architect in using this system is the freedom to utilize all sides of the building. These systems also allow for more efficient use of the site since there are no exterior spaces required for mechanical equipment outside the building footprint.

4.2 Building Energy Simulation

Building energy simulation software is used to obtain heating and cooling load data for different building configurations that emphasize each of these architectural elements. This data is then input into a second program that sizes the ground-loop heat exchanger and predicts the long-term performance of the system.

The building system information I chose for this study is the eQUEST energy simulation software program.[1] This software allows for the detailed specification of building materials and construction methods, occupancy loads and schedules, lighting loads and schedules and equipment loads and schedules. This information, in combination with hourly weather files, determines the heating and cooling loads of each

1. eQUEST v5.5 uses the DOE2.2 simulation engine. The program is freeware available at www.doe2.com. The software is being developed by J. Hirsh and Associatees in conjunction with the United States Department of Energy and the Lawrence Livermore Laboratory.

conditioned space throughout the building. Detailed information about weather data and sources is explained in Section 3.6

The program also allows for lighting strategies involving daylighting controls. These controls assume the presence of sensors in each of the perimeter zones that dim or shut off electrical lighting according to the amount of daylight that is entering the space in any given hour such that adequate lighting levels are met.

The eQUEST program calculates data on an hourly basis for a period of one year for each one of the air-conditioned zones.[2] The program breaks loads down into their sensible and latent components. For the purposes of this study, total heating and cooling loads are the sum of these components. Building loads are the summation of all individual zone loads.

4.3 Ground Loop Heat Exchanger Design and Simulation

The impact of architectural design on GCHP systems is determined by running building energy simulations, analyzing the effects of different parametric changes on the building heating and cooling loads and inputting that load data into the Professional Ground Loop Heat Exchanger design software, GLHEPRO, for analysis on the effects of the sizing and long-term performance of a GCHP system.[3].

GLHEPRO consists of two program modules. The first module, GLHESIZE, sizes the required length of the ground-loop heat exchanger in order to meet a user input maximum

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2. DOE 2.2 defines three types of zones: conditioned zones, plenum zones and unconditioned zones. Heating and cooling loads are only calculated for conditioned zones.

3. GLHEPRO v3.0 for windows. Developed by the School of Mechanical and Aerospace Engineering, Oklahoma State University. Distributed by the International Ground Source Heat Pump Association. 1999

Table 4.2: GLHEPRO Required Input Parameters-1

GLHESIZE	
Input	**Output**
Ground thermal properties • Conductivity • Volumetric heat capacity • Undisturbed ground temperature	Ground-loop heat exchanger sizing data • Total length of borefield required to maintain fluid temperatures within user defined parameters • Individual borehole length
Description of the ground-loop heat exchanger • Borefield configuration • Borehole spacing • Borehole radius • Borehole thermal resistance • Fluid properties Volumetric heat capacity of the fluid Density of the fluid Flow rate of the fluid	
Description of the heat pump	
Monthly heating and cooling loads on the heat pump • Monthly Cooling Energy (kBtu) • Monthly Heating Energy (kBtu) • Monthly Peak Cooling Demand (Btu/Hr) • Monthly Peak Heating Demand (Btu/Hr) • Duration of Peak Loads	

and minimum fluid temperature entering the heat pump for a given borefield configuration. The second module, GLHESIM, simulates the performance of the ground-loop heat exchanger for a period of up to 1200 months using the sizing information obtained from GLHESIZE (Oklahoma State University 1999). The GLHESIZE program provides borehole depths for a given borefield configuration. Another important variable in designing the system is the simulation period. The simulation period is important because a prolonged imbalance between heat removed from the ground and heat deposited

Table 4.3: GLHEPRO Required Input Parameters-2

GLHESIM	
Input	**Output**
Ground thermal properties • Volumetric heat capacity of the ground • Undisturbed ground temperature	Long-term temperature data • Average monthly long term ground temperatures • Average entering water temperature to heat pump • Average exiting water temperature to heat pump
Description of the ground-loop heat exchanger • Borefield configuration • Borehole spacing • Borehole radius • Borehole thermal resistance • Fluid properties Volumetric heat capacity of the fluid Density of the fluid Flow rate of the fluid ACTIVE BOREHOLE DEPTH (derived from GLHESIZE)	
Description of the heat pump	
Monthly heating and cooling loads on the heat pump • Monthly Cooling Energy (kBtu) • Monthly Heating Energy (kBtu) • Monthly Peak Cooling Demand (Btu/Hr) • Monthly Peak Heating Demand (Btu/Hr) • Duration of Peak Loads	

into the ground may lead to a change in the ground temperature. This change will affect the ability of the ground-loop heat exchanger to remove and/or add heat to the transfer fluid that circulates between the ground-loop and the heat pumps (Kavanaugh and Rafferty 1997).

The simulation results presented in the remainder of this Chapter and in Chapter 5 evaluate and compare sizing scenarios that involve simulations of 10 year and 25 year

duration. Examining two periods allows for the analysis of the long term effects of heat differentials in terms of the ratio of cooling to heating loads. The GLHESIM module allows the user to input the depth of the borehole provided by the GLHESIZE module. This program generates an output file that contains the monthly data concerning the ground temperature around the borefield and the temperature of the fluid as it enters the heat pump.

Table 4.4: Ground Thermal Property Estimates Using Water Well Completion Reports

	Conductivity (Btu/h-°F-ft)	Volumetric Heat Capacity (Btu/°F-ft^3)	Undisturbed Ground Temperature (°F)[a]
Las Vegas Valley	0.91	29.66	69

a. Undisturbed ground temperature data for multiple U.S. cities is listed in the *Closed-Loop/Ground-Source Heat Pump Systems Installation Guide* published by International Ground Source Heat Pump Association.

Tables 4.2 and 4.3 contain a list of variables that must be input into the GLHEPRO software in order to design the ground-loop heat exchanger. The the ground thermal property variables required by the software are the ground conductivity, the volumetric heat capacity and the undisturbed ground temperature. Table 4.4 summarizes the estimation results of these variables. Section 3.6 contains detailed explanation of the estimation methods and data sources.

The next category of data input lies in the determination of the borehole thermal resistance. The borehole thermal resistance is the resistance between the fluid in the U-tube and the borehole wall (Spitler 1999). The components that make up this term consist of the convective resistance between the working fluid and the wall of the tube, the

Table 4.5: Parameters for Determining the Thermal Resistance of the Borehole

Element	Description
Pipe Type	SDR-11
Nominal Pipe Size	1-1/4"
Spacing	Two tubes, equally spaced between the edges of the borehole (refer to Figure 4.1)
Borehole Diameter	6"
Flow Rate per tube	3 gpm
Grout Thermal Conductivity	0.85 (thermally enhanced bentonite)

conductive resistance caused by the U-tube material and the resistance caused by the grouting material. Table 4.5 shows the components of the borehole and U-tube used throughout this study. Circulating fluid is assumed to be pure water.

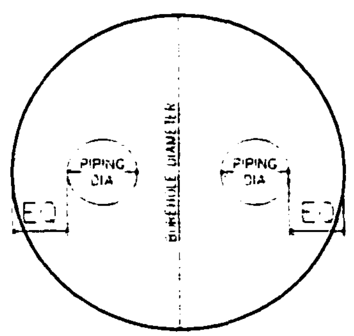


Figure 4.1: Typical Borehole Piping Configuration

GCHP systems utilize a special type of heat pump developed specifically for ground-source applications. These heat pump systems are known as Extended Range Water- source Heat Pumps. These systems are available from a variety of manufacturers. The main advantage of these units over conventional heat pumps is their ability to work with water temperatures that range from as high as 110°F to as low as 20°F.

The last of these categories is the building heating and cooling energy data generated by the eQUEST building energy simulation program. The building load data required for

the sizing of the ground-loop heat exchanger is monthly heating and cooling energy (KBtu) and hourly peak heating and cooling loads for each month (Btu/Hour). These variables are also used to predict the long-term performance of the GCHP system. Monthly data is input into GLHEPRO. Heating and cooling peak demand loads are the hourly peak for each month throughout the year. The duration of peak loading is a number that GLHEPRO uses to determine the duration of time that the system must be able to respond to peak load conditions. This user input is set to the recommended value of 3 hours.[4]

4.4 Specifying the Minimum Compliance Case

The first step in the process of evaluating the impacts of the architectural components listed in Table 4.1 on the design of a GCHP is the specification of a baseline case building. For this portion of the study, I chose a 10,000 square foot commercial office building that meets minimal compliance with the ASHRAE 90.1-1989 Standard as my baseline case. I chose a commercial application since non-residential building types tend to be larger in size and are in operation during peak daytime hours, allowing for the evaluation and validation of a GCHP system that is larger in size and that must cope with more severe load conditions. Using the ASHRAE 90.1-1989 Standard allows for the specification of a baseline case building that satisfies a combination of minimal criteria for building energy efficiency. The results of each parametric study in Section 4.5 utilize this building case in order to evaluate the performance of alternative materials, systems and

4. The GLHEPRO Users Guide recommends setting the Duration of Peak Loads variable input at 3 hours when peak loads are specified.

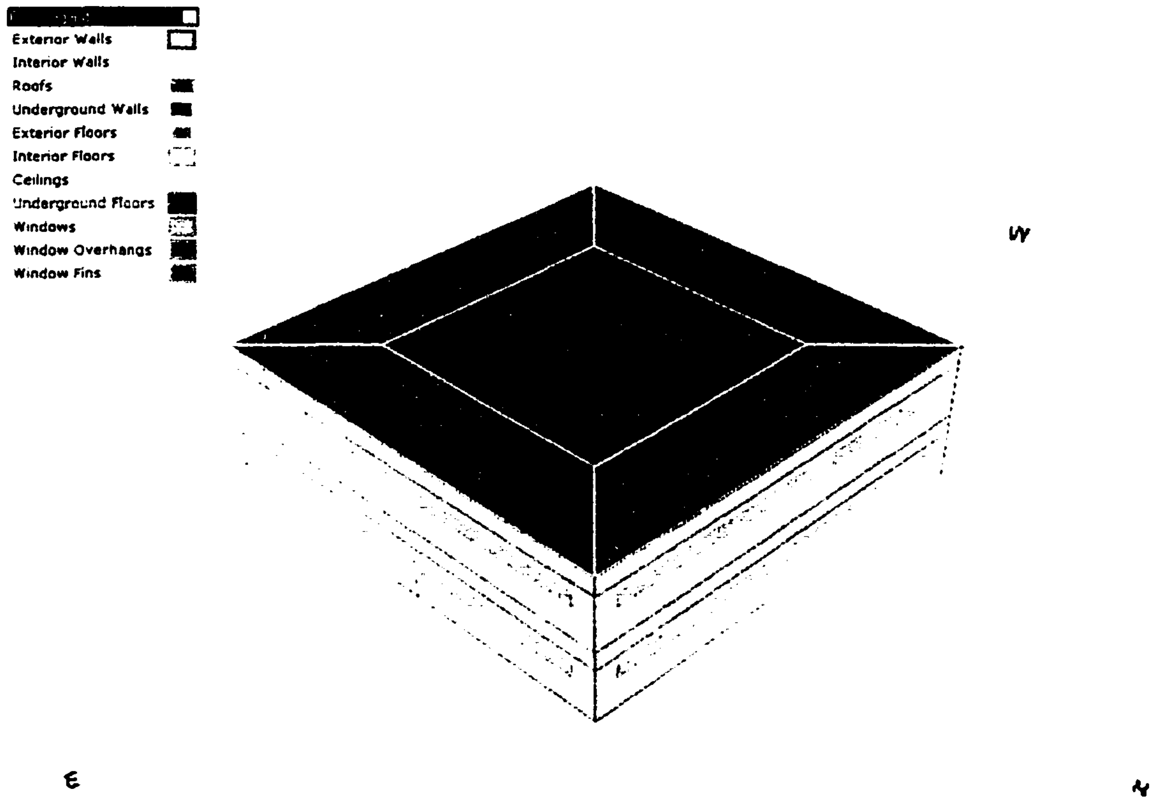


Figure 4.2a: Three-dimensional view of the Minimum Compliance Case building

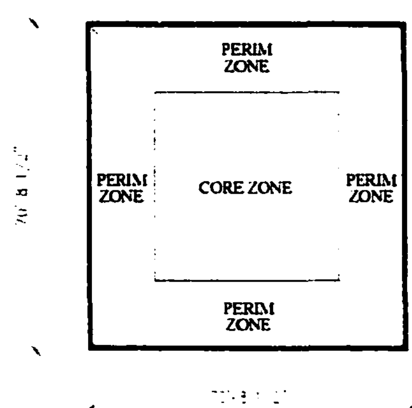


Figure 4.2b: Plan view of the Minimum Compliance Case building with typical zone configuration

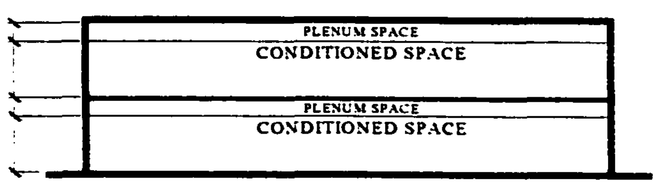
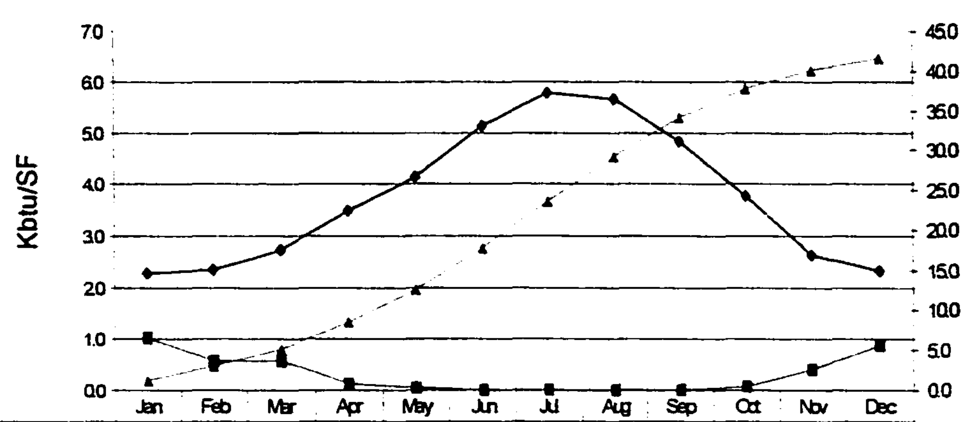


Figure 4.2c: Sectional view of the Minimum Compliance Case building

designs toward the development of a series of energy efficiency strategies for the climate of Las Vegas. Figures 4.2a-c shows a floor plan, a sectional view and three-dimensional view of this Minimum Compliance Case building. The building is square in shape and consists of two identical floors of 5000 square feet each. Each floor consists of five air-conditioned spaces and five plenum spaces. The height of these spaces is 9'-0" and 3'-0", respectively, for each floor.

This configuration is useful since it allows for the differentiation between perimeter and core spaces. The four perimeter spaces are 15 feet deep and receive daylight from all exterior windows and glass doors in that space according to the window size, shading, and solar orientation. The program allows for the definition of daylighting controls in the form of sensors located in each of the perimeter spaces. These sensors control the quantity of light provided by the electrical lighting to maintain the specified lighting level within each space. Another assumption associated with daylighting concerns glare on the.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling Energy	23	24	27	35	42	52	58	57	49	38	26	23
Heating Energy	1.0	06	06	01	00	00	00	00	00	01	04	09
Cumulative Difference	1.3	30	52	86	127	17.9	237	293	342	379	401	41.6

Figure 4.3: Annual Cumulative Load Transfer of Heat

Table 4.6: Minimum Compliance Case Data

Element	Information	R-value
Area	10,000 sf (70.71'x 70.71')	
Height	12' Floor-to-floor with 9' ceilings	
Zoning	5 Conditioned Zones and 5 Plenum Zones per Floor. Refer to Figures 4.2a and 4.2b	
Floor	Slab-on-grade with fiber pad and carpet	3.3
Exterior Walls	8" CMU with perlite insulation, stucco exterior (light color) and interior furring with R-19 batt insulation and 1/2" gypsum board facing	14.3
Glazing	Double Clear Glazing (2004) - SHGC: .78, Tv: .70 N-S Sides: 25% of Ext.Wall Area of Cond. Spaces E-W Sides: 28% of Ext.Wall Area of Cond. Spaces	2.1
Doors	3'x7' Storefront Type (Aluminum Frame) with Double Clear Glazing (2004) - SHGC: .78, Tv: .70	2.1
Shading	None	
Roof	Built-up Roof with Rigid Insulation (light color)	23.8
Occupancy Schedule	Working Days: M-F 8am - 5pm Non-working Days: Sat-Sun	
Occupancy Loads	Ground Floor Perimeter: 209 ft / person Core: 94 ft / person Top Floor Perimeter: 225 ft / person Core: 75 ft / person	
Lighting Loads	Ground Floor Perimeter: 127 W/ft Core: 92 W/ft Top Floor Perimeter: 130 W/ft Core: 99 W/ft	
Equipment Loads	Ground Floor Perimeter: 1.350 W/ft Core: 0.705 W/ft Top Floor Perimeter: 1.500 W/ft Core: 0.865 W/ft	

task surface. The program automatically assumes that the building occupants close interior blinds when direct light is calculated to be striking the task surface. At such times, electrical lighting levels are adjusted so as to maintain the preset lighting levels

Comcheck-Plus[5] is a program that determines the compliance level of different combinations of building components according to the ASHRAE 90.1-1989 Standard. This software, based on the whole building performance approach,[6] calculates a building energy simulation over a period of one year in order to determine the performance of a building relative to a reference case. This approach takes the overall energy performance of a building into consideration and allows for much more flexibility in design than the "Prescriptive Approach" that evaluates each building component according to its individual R-value.[7]

Table 4.6 summarizes the specifications of the Minimum Compliance Case building. The R-values noted in this table are calculated results from the Comcheck-Plus software. Since the building model developed in Comcheck-Plus is only usable for compliance determination, modeling the actual baseline case is done using the eQUEST energy simulation software based on the specifications determined in the Comcheck software. The results are graphically shown in Figure 4.3 and is represented by the "cumulative difference" line.

Table 4.7 shows the annual heating and cooling energy requirements estimated for the Minimum Compliance Building with the eQUEST software. The results include the

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5. This program was developed by the Department of Energy Office of Building Technology.

6. "Comcheck Plus Software." U.S. Dept. of Energy, Office of Building Technology. Updated Jan 2002. Retrieved 3 Feb 2002 <http://www.energycodes.gov/comcheck/>.

7. "Commercial Compliance FAQs." U.S. Dept. of Energy, Office of Building Technology. Updated Jan 2002. Retrieved 3 Feb 2002. <http://www.energycodes.gov/support/com_compliance_faq.stm#3>

Table 4.7: Minimum Compliance Case - eQUEST Simulation Results

eQUEST/PowerDOE		GLHESIZE			
		10 Year Run		25 Year Run	
Annual Heating Energy	3.7 KBtu/SF	Borehole Geometry[a]	Rectangular 5 x 6	Borehole Geometry[a]	Rectangular 5 x 6
Annual Cooling Energy	48.2 KBtu/SF	Borehole Depth (Each)	402 Lineal Ft	Borehole Depth (Each)	532 Lineal Ft
Max Heating Load	4.1 KBtu/Hr/SF	Total Borehole Depth	12,064 Lineal Ft	Total Borehole Depth	15,984 Lineal Ft
Max Cooling Load	17.1 KBtu/Hr/SF				

a. Borehole geometry is a user defined input into GLHEPRO. It has been included in this table for clarity. Refer to Section 2.1.3.2 for additional information regarding borehole geometry.

annual heating and cooling energy requirements and the annual peak loads data. The energy required to cool the building over a one year period is more than 12 times higher than the energy required for heating.

In terms of the GCHP systems, this means that more than 12 times the heat is transferred to the ground than is removed on an annual basis. The result of this continuous imbalance may have permanent effects on the ground temperature around the boreholes (ASHRAE 1999). To reduce the effect of this imbalance, the ground-loop heat exchanger must be of sufficient length to remove heat transferred to the fluid from the heat pumps during peak conditions. Since the ability of the heat exchanger to remove heat is dependent on the temperature differential between the ground and the fluid, an increase in the ground temperature around the boreholes will cause the efficiency of the ground-loop

heat-exchanger to decrease (FEMP 1999). These conditions require an increase in the length of the ground-loop heat exchanger required to handle peak load conditions.

Another means of offsetting potential effects from heat build-up in the ground is to reduce the cooling loads of the building through architectural design. The analysis in Section 4.5 of the impacts of architectural design decisions are integrated into a comprehensive building design in Chapter 5. This applied building case will show the degree of impact architectural design decisions can have on the performance of a GCHP system in Las Vegas.

GLHEPRO estimates changes in ground temperature and designs the ground-loop heat exchanger so that fluid temperatures that do not exceed the maximum and minimum alarm temperatures defined for the water source heat pumps. Table 4.7 shows that in order to keep the fluid temperatures entering the heat pumps from rising over the 90°F alarm level requires a ground-loop length of 12,064 lineal feet over a 10 year simulation period and 15,984 lineal feet over a 25 year period. This means that a 3,920 lineal foot or 24.5% increase in total borehole length between the 10 year and 25 year simulations is required for the heat exchanger to be of sufficient size to cope with the peak load demand put on the system in the face of increasing ground temperatures. These results are the benchmark for evaluating the parametric studies in the following sections.

4.5 Strategy Development

In the following sections, I have conducted a number of parametric studies in order to assess the impact of architectural design on GCHP systems. Each study tests parameters that involve an architectural component listed in Table 4.1. The results of each study are

evaluated by analyzing the changes in the building's annual heating and cooling energy requirements compared to those of the Minimum Compliance Case described in Section 4.4. In addition to a direct quantitative comparison, energy requirement and peak load data are input into GLHEPRO in order to determine the magnitude of the effects on the sizing of the ground-loop heat exchanger and the long-term performance of the GCHP system.

4.5.1 Solar Orientation

The orientation of a building's exterior surfaces affects the way a building interacts with air movement and incident solar radiation at a particular site (Marsh 2002). This study examines three strategies that are affected by solar orientation for designing energy efficient buildings. These strategies are window placement (with respect to solar orientation), shading and building form.

4.5.1.1 Window Placement

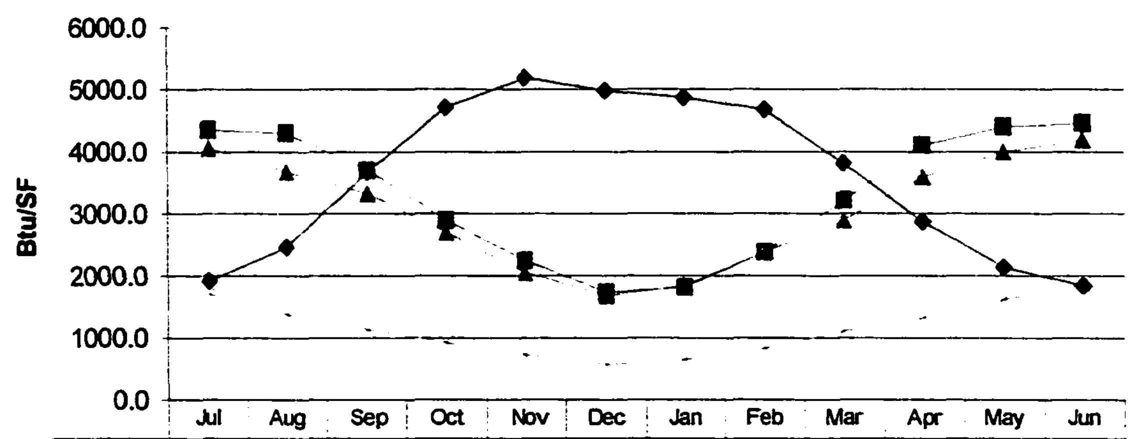
A building's exterior skin is made of up of opaque, translucent and transparent materials. Opaque materials such as stucco or brick absorb, reflect, and conduct solar radiation that strikes the surface of a building's exterior walls. Translucent materials such as glass windows and doors also absorb, reflect, transmit and conduct solar radiation. The windows used to achieve compliance with the ASHRAE 90.1-1989 Standard are Double pane clear glazing. Table 4.8 shows the window area is 25% of the surface area of the exterior walls of the conditioned spaces on the North and South sides of the building and 28% on the East and West sides including the storefront doors. No shading is provided in

Table 4.8: Window Placement Simulation Legend

	North	South	East	West
M-Case	25%	25%	28%	28%
A-Case	40%	35%	15.5%	15.5%
B-Case	40%	25%	20.5%	20.5%
C-Case	50%	35%	10.5%	10.5%
D-Case	50%	25%	15.5%	15.5%

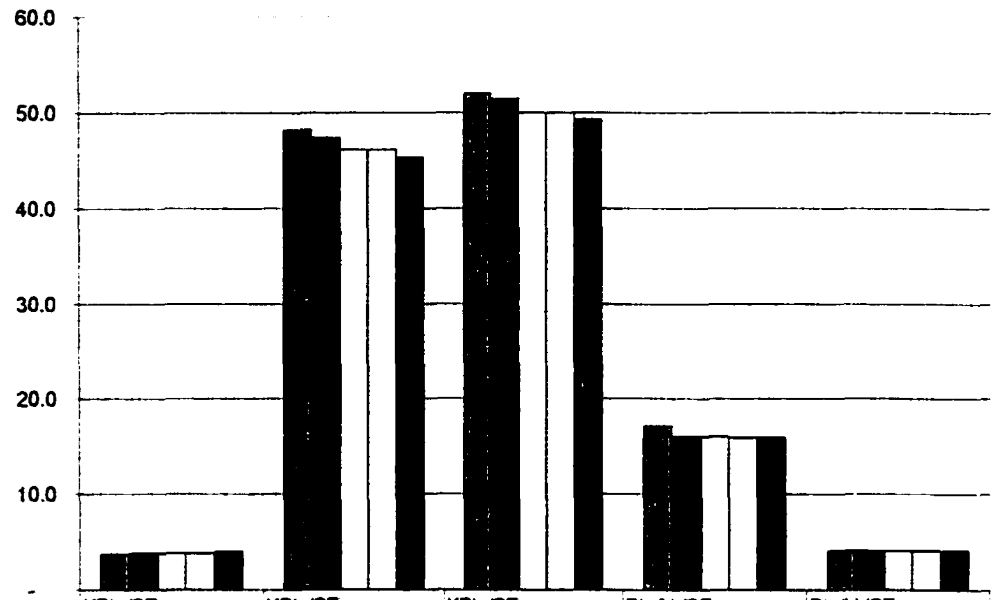
these scenarios. Assumptions regarding daylighting are the same as with the Minimum Compliance Case building. All buildings are oriented in the direction of true North.

Figure 4.4 shows the amount of solar radiation transmitted into the building through the glazing areas of the Minimum Compliance Case building. The transmission pattern of solar radiation on the South side of the building is high during the winter and low during the hot summer. .This is ideal for buildings in hot-arid climates (Lechner 2001). The North side of the building is the next best side for glazing placement since the incident



	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
South	1918.2	2468.8	3681.1	4691.4	5182.0	4982.9	4859.9	4684.7	3816.1	2861.5	2121.7	1832.0
East	4356.5	4305.7	3714.4	2903.3	2251.5	1726.1	1822.6	2383.2	3210.8	4117.3	4402.1	4463.3
West	4052.3	3686.8	3331.2	2715.6	2063.6	1687.9	1839.2	2367.6	2890.3	3594.1	4005.1	4176.7
North	1705.8	1384.2	1139.9	911.8	719.7	573.1	645.7	844.9	1098.7	1333.0	1618.1	1854.3

Figure 4.4: Solar Energy Transmitted into Minimum Compliance Building



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Clg. Load	Btu/Hr/SF Max. Htg. Load
■ M-Case 25% 25% 28.0%	3.7	48.2	51.9	17.1	4.1
■ A-Case 40% 35% 15.5%	3.9	47.4	51.3	16.1	4.1
□ B-Case 40% 25% 20.5%	3.9	46.1	50.0	16.1	4.1
□ C-Case 50% 35% 10.5%	3.9	46.1	50.0	15.9	4.1
■ D-Case 50% 25% 15.5%	4.0	45.3	49.3	15.9	4.1

Figure 4.5: Window Placement - eQUEST Simulation Results

solar radiation level is low in the summer. Windows on the East and West sides are the least desirable since they transmit a great amount of solar radiation into the building during the summer

This study compares the different window configurations to that of the Minimum Compliance Case. The idea is to reduce the size of window area on the East and West facing walls and redistribute it to the North and South facing walls in order to assess the effectiveness of different distribution patterns. Table 4.9 shows the Minimum Compliance Case ('M' Case) and four other cases in which the total window area on each side of the building is redistributed, such that the total glazing area is the same for the

Table 4.9: GCHP Sizing Results -Window Placement Study

	N Side	S Side	E/W Sides	10 Year	% Change (vs. Min. Compl. Case)	25 Year	% Change (vs. Min. Compl. Case)
'M' Case	**25%**	**25%**	**28%**	**12,064 lin.ft.**		**15,984 lin.ft.**	
'A' Case	40%	35%	15.5%	11,325 lin.ft	-6.1%	14,891 lin.ft	-6.8%
'B' Case	40%	25%	20.5%	11,157 lin.ft	-7.5%	14,605 lin.ft	-8.6%
'C' Case	50%	35%	10.5%	11,053 lin.ft	-8.4%	14,384 lin.ft	-10.0%
'D' Case	50%	25%	15.5%	10,960 lin.ft	-9.2%	14,200 lin.ft	-11.2%

entire building. For example, windows in building case 'B' are redistributed so that the total area of the windows on the North wall are 40% of the surface area at the conditioned space, 25% of the total wall area of the South facing exterior wall and 20.5% each of the East and West exterior walls. The other scenarios follow in like manner. The results of these simulations are summarized in Figure 4.5.

In the building case 'A,' window area on the East and West sides of the building is reduced by 12.5% on each side. Window area is increased on the North side by 15% and the South Side by 10%. The result is a reduction in cooling energy requirements of 1.7% and an additional heating energy requirement of 1.5%. Table 4.9 shows the difference in the required length of the ground-loop heat exchanger to be 6.1% shorter than the Minimum Compliance Case for a 10 year interval and 6.8% for a 25 year interval. The effect in the reduction in cooling energy demand and an increase in the ratio between cooling energy and heating energy contribute to the shortened ground-loop requirement.

Compared to the previous case, the area of the windows on the South face of the 'B' Case building are the same as the Minimum Compliance Case building and that of the

East and West faces are only reduced by 7.5%. The data in Figure 4.5 indicates that there is less solar heat gain per square foot on the South facing windows than that of either the East or West facing windows on a per square foot basis. In this scenario, the annual cooling load created by the total heat gain through the windows on the South, East and West faces of the building is 18.2 KBtu/SF versus 19.9 KBtu/SF for the previous scenario. This comparison indicates that increasing South facing glazing over East or West glazing does not always reduce solar heat gain in building designs over a one year period. This is due to the annual quantity of solar radiation that penetrates through the South glazing being 14% higher at 21.0 KBtu/SF than the 18.4 KBtu/SF for the East and West glazing. The same pattern exists in the comparison of building cases 'C' and 'D.'

In building case 'D,' window area on the East and West sides is reduced by 12.5% on each side, the South side is left unchanged and the area of the North facing windows is doubled. With a 6.0% reduction in total energy requirements, this scenario requires 9.2% less piping in the ground-loop than the Minimum Compliance Case for a 10 year simulation and 11.2% less in a 25 year simulation indicating once again some contribution from the reduction in the ratio of cooling energy to heating energy. The conclusion is twofold. The first part is that the most efficient designs for the climate of Las Vegas are those that use more glazing on the North face and less glazing on the other orientations. The second part is that increasing the amount of glazing on the South side of a building is less efficient than placing the same total amount of glazing on the East and West sides.

4.5.1.2 Shading

Shading is an important strategy that prevents short-wave infrared radiation from penetrating into a building though windows and other transparent surfaces (Lechner 2001). In the Minimum Compliance Case building, windows account for 25% of the total wall area of the building's conditioned spaces. Glass Aluminum-framed doors on the East and West sides of the building account for 3% each. Unshaded, 40% of the total annual cooling load comes from direct heat gain from solar radiation and 16% from heat conductance through these windows and doors. This portion of the study examines the benefits of shading using the Minimum Compliance Building as a baseline in order to determine the order of magnitude of energy reduction that shading may provide.

Shading design is dependent on window orientation, building use and climate (Marsh, 2002). Shading devices provide shading for windows in the summer and allow for solar gains in the winter. This study will define the upper boundary of the overheat period for Las Vegas to be a dry bulb temperature of 80°F. This temperature is consistent with an approximation of the effective temperature that defines the upper boundary of the thermal comfort zone at relative humidity levels that are below 30%. Figure 3.1a shows that the overheat period for Las Vegas begins in May and lasts until October. During this period, the average maximum temperature and the average temperature fall above and below the 80°F dry bulb temperature level (NCDC 2000). Based on these definitions, I have defined the overheating period for this shading study to be from May 1 to October 1.

Shading devices come in a variety of forms and configurations. They generally consist of a combination of horizontal overhangs and vertical fins. Shading can also be detached from the surface on which the opening is located. Walls, landscape features,

berms and adjacent structures are some examples of detached shading. This study examines the use of horizontal and vertical shading elements as well as detached shading in the form of deciduous and evergreen trees. Exterior overhangs and fins can be designed for each window according to size, orientation, the occupancy schedule of the space where the window is located and the period of desired shading for that space.

The use of trees as shading devices is advantages not only for their shading capabilities but for their aesthetic properties as well. Deciduous trees work well in climates with cold winters since by loosing their leaves, they allow nearly full daylight to reach the windows. Evergreen trees do not loose their leaves and therefore provide shade year round. Again, in colder climates this may lead to higher heating costs due to the blockage of sunlight by these trees during the winter season. This section examines the impacts of these shading devices on the cooling and heating loads of a building and how these changes impact the design and performance of GCHP systems.

The eQUEST software is only capable of simulating a shading device that has one horizontal overhang and two vertical fins. Overhangs and fins for the different window sizes and orientations are designed using the SUNTECT shading design program.[8]

Shading device design requires the determination of an overheated period that requires full shading. In an office building, the occupancy schedule, 8am to 5pm, should define this period. However, it is difficult to provide shading for the low angle inclination of early morning and late afternoon summer sunlight without severely diminishing the amount of winter sunlight that is able to penetrate into the building interior. Table 4.10 defines the time periods calculated for full shading when the building is orientated toward

8. Marsh, Andrew. Suntect v2.50 Sun Shading and Solar Penetration Analysis. ESCAPE Consulting. The University of Western Australia. 1993-98

Table 4.10: Daily Shading Schedule

Side	Fin and Overhang Depth	Time Interval
South Side	3'-10"	9am-5pm
North Side	1'-1"	9am-5pm
East Side	4'-3"	9am-12pm
West Side	4'-3"	12pm-3pm

true North. These time periods allow for the analysis of window shading 100% of the occupancy schedule on the South side of the building and 75% on the East and West sides.

This study also simulates detached shading that approximates the characteristics of both deciduous and evergreen trees placed 10 feet from the building. .These scenarios are modeled as detached walls that are twenty feet in height, 80 feet in length and suspended 10 feet in the air. In order to approximate the characteristics of deciduous trees, an annual

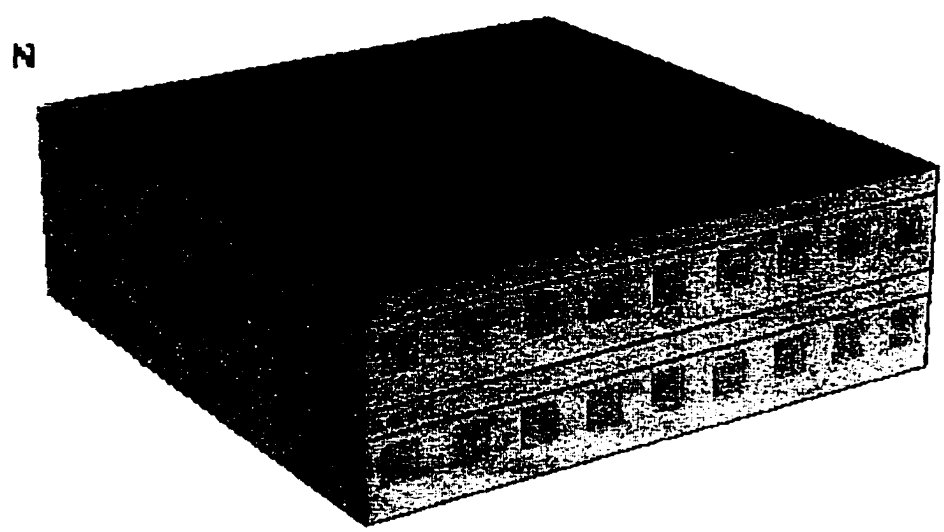
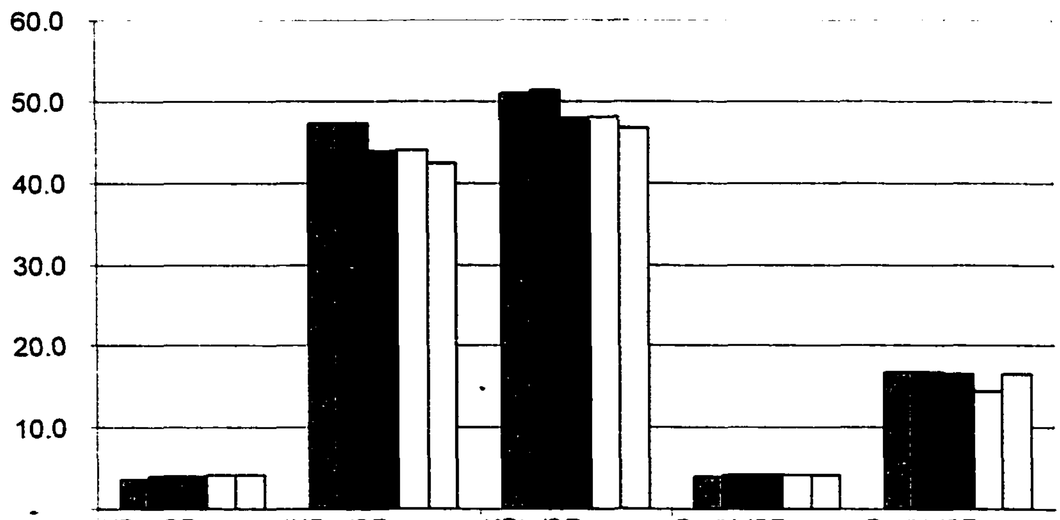


Figure 4.6: No Shading Case Building

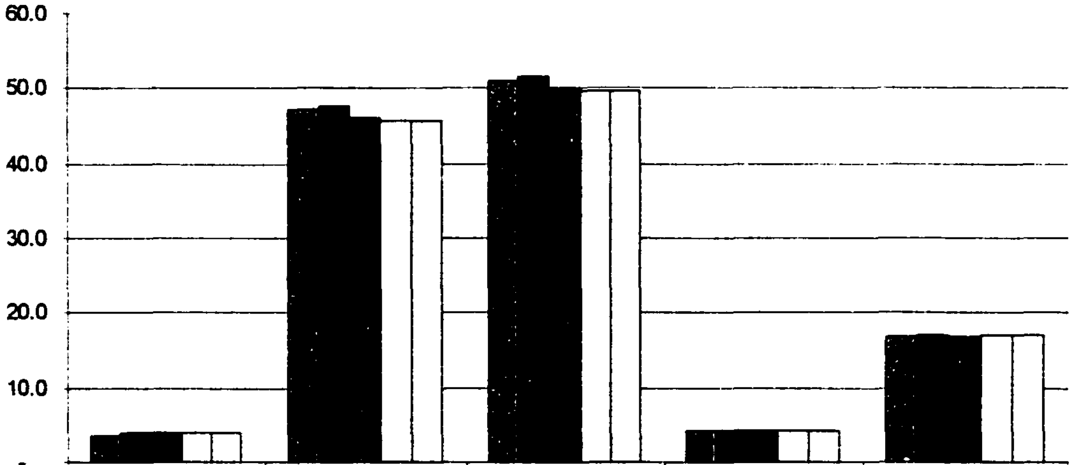
"tree shading schedule" is required. This fractional schedule defines the opacity of these walls to be 10% from May 15 to September 15 and 90% throughout the remainder of the year. The 10% opacity models the diffused lighting caused by trees with full canopies and the 90% opacity the diffused light of trees that have lost their leaves and have only their branches and trunk. Evergreen trees are modeled with the same dimensional characteristics as the deciduous trees. The difference lies in the annual "tree shading schedule." In the case of evergreen trees, the opacity is set to10% for the entire year representing a full canopy year round.

The "No Shading Case" building for the shading studies is shown in Figure 4.6. This model uses the same material specifications as the Minimum Compliance Case. The



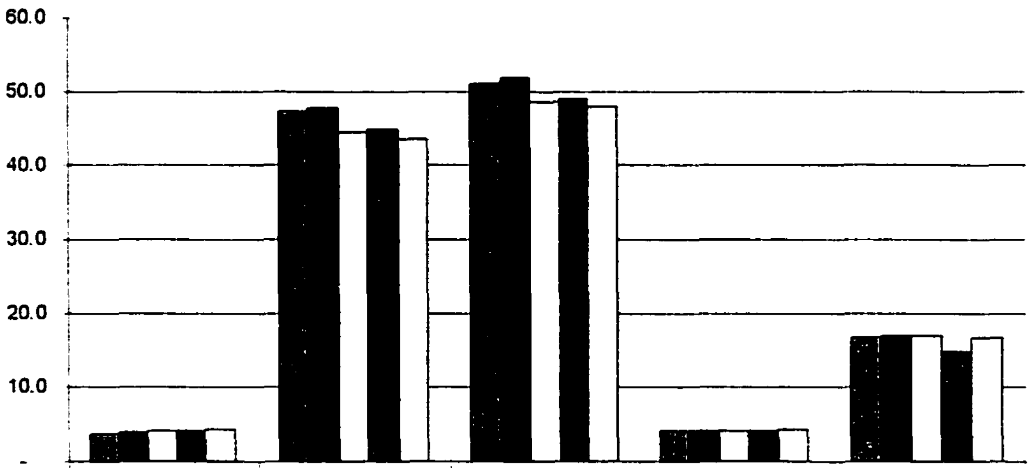
	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
No Shading	3.6	47.3	50.9	4.1	16.7
North Side	4.0	47.3	51.3	4.2	16.8
East Side	4.1	43.7	47.8	4.2	16.5
West Side	4.2	43.9	48.1	4.2	14.5
South Side	4.3	42.4	46.7	4.3	16.5

Figure 4.7a: "Fin & Overhang" Shading System Analysis - eQUEST Simulation Results



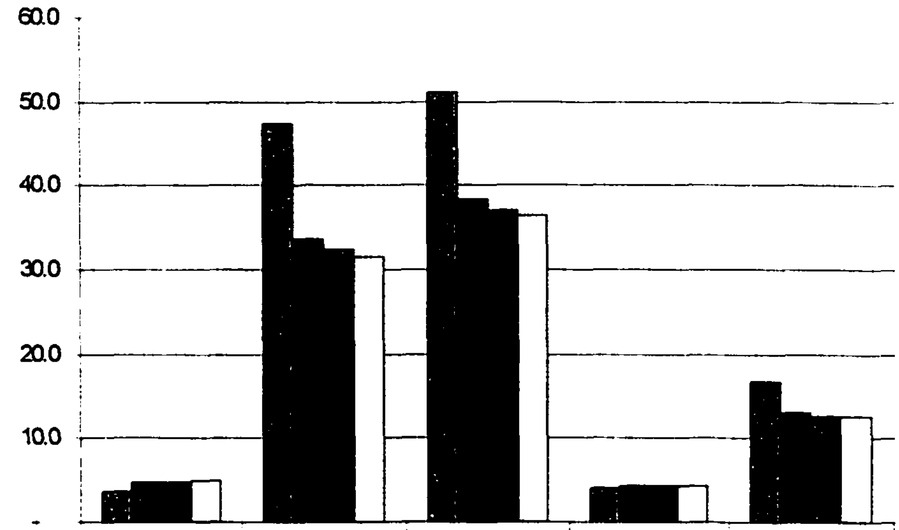
	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
■ No Shade	3.6	47.3	50.9	4.1	16.7
■ North Side	4.0	47.7	51.7	4.2	16.9
■ South Side	4.0	46.0	50.0	4.2	16.8
□ East Side	4.0	45.6	49.6	4.2	16.9
□ West Side	4.0	45.6	49.6	4.2	16.9

Figure 4.7b: "Deciduous Tree" Shading Device Analysis - eQUEST Simulation Results



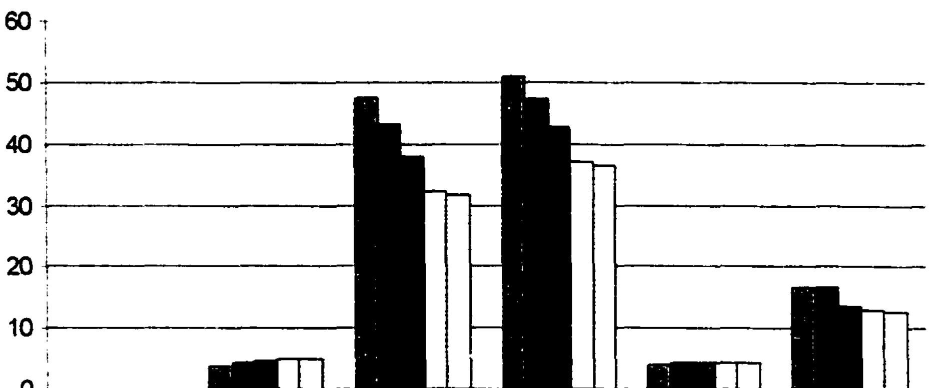
	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
■ No Shade	3.6	47.3	50.9	4.1	16.7
■ North Side	4.0	47.7	51.7	4.2	16.9
□ East Side	4.1	44.4	48.5	4.2	16.9
■ West Side	4.1	44.8	48.9	4.2	14.7
□ South Side	4.3	43.5	47.8	4.3	16.7

Figure 4.7c: "Evergreen Tree" Shading System Analysis - eQUEST Simulation Results



	Heating Energy	Cooling Energy	Total Energy	Max. Htg. Load	Max. Clg. Load
No Shading	3.6	47.3	50.9	4.1	16.7
Fins & Overhangs - All Sides	4.7	33.6	38.3	4.2	13.1
Deciduous Trees - All Sides	4.7	32.4	37.1	4.2	12.6
Evergreen Trees - All Sides	4.9	31.5	36.4	4.2	12.6

Figure 4.7d: Shading System Performance Comparison - eQUEST Simulation Results



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max Htg. Load	Btu/Hr/SF Max Clg. Load
No Shading	3.6	47.3	50.9	4.1	16.7
Add East Shading	4.2	43.0	47.2	4.2	16.7
Add West Shading	4.5	38.0	42.5	4.2	13.5
Add South Shading	4.9	32.1	37.0	4.3	12.8
Add North Shading	4.9	31.5	36.4	4.3	12.6

Figure 4.7e: Additive Analysis of Shading Systems (Using Evergreen Trees) - eQUEST Simulation Results

difference between the two is that the window shape is changed to 4' x 4.5' from the single strip windows shown in Figure 4.2a and the doors on the East and West sides of the building are replaced with glazing. The change to the windows is required in order to be able to effectively model shading devices that utilize vertical fins.

A description of the shading simulation case buildings and the simulation results are shown in Figures 4.7a-e. Figures 4.7a, 4.7b and 4.7c respectively show the annual cooling and heating loads of using attached fins and overhangs, deciduous trees and evergreen trees on each side of the "No Shading" Case building. The results indicate that horizontal overhangs and vertical fins on the South, East and West sides of the model building reduce annual energy requirements by 6%~8%. This is the largest reduction across all types of shading evaluated in this study. Evergreen and deciduous shading applied to the same sides of the building reduces energy requirements by 4%~6% and 2%~3%, respectively. Attached and detached shading devices applied to the North side of the building increases total energy use due to the increase in heating energy requirements and has an insignificant effect on cooling energy requirements.

Figure 4.7d compares the results of using only fins and overhangs with those of using fins and overhangs in combination with deciduous trees and evergreen trees on all sides of the building. The results indicate that the use of fins and overhangs on all sides of the building reduces building cooling energy requirements by 29% compared to that of the "No Shading" Case building. Adding deciduous or evergreen trees increases that reduction by 3.6% and 6.3%, respectively. Heating energy increases from 3.6% to 4.7% with the use of fins and overhangs and to 4.9% with the use of evergreen shading. The increase in heating energy requirements is caused by a decrease in direct solar gain during

Table 4.11a: GCHP Sizing Results - Shading Devices Located on all Sides of a Building

	10 Year	% Change	25 Year	% Change
No Shading	**11,490 lin. ft.**		**15,195 lin. ft.**	
Fins & Overhangs - All Sides	8,192 lin. ft.	-28.7%	10,304 lin. ft.	-32.2%
Fins & Overhangs w/ Deciduous Trees - All Sides	7,782 lin. ft.	-32.3%	9,777 lin. ft.	-35.7%
Fins & Overhangs w/ Evergreen Trees - All Sides	7,171 lin. ft.	-37.6%	8,875 lin. ft.	-41.6%

Table 4.11b: GCHP Sizing Results - Contribution By Side of Building

	10 Year	% Change	25 Year	% Change
No Shading	**11,490 lin. ft.**		**15,195 lin. ft.**	
Fins & Overhangs w/ Evergreen Trees - East Side Only	10,705 lin. ft.	-6.8%	13,597 lin. ft.	-10.5%
Fins & Overhangs w/ Evergreen Trees - East+West	9,066 lin. ft.	-21.1%	11,348 lin. ft.	-25.3%
Fins & Overhangs w/ Evergreen Trees - East+West+South	7,789 lin. ft.	-32.2%	9,758 lin. ft.	-35.8%
Fins & Overhangs w/ Evergreen Trees - All Sides	7,171 lin. ft.	-37.6%	8,875 lin. ft.	-41.6%

the winter months. While the percentage increase is high, the absolute increase in the heating energy requirement is only 8% of the decrease in the cooling energy requirement. Deciduous trees do not increase the heating energy requirement over that of fins and

overhangs since, during the winter months, these trees shed their leaves allowing solar radiation to strike the windows and building surfaces.

Figure 4.7e shows the cumulative results of adding fins, overhangs and evergreen shade trees to each side of the building. The graph shows that shading on the East, West and South sides of the building significantly reduce energy requirements while the contribution from shading the North side of the building is relatively less. The final result is identical to the "Evergreen Trees - All Sides" case shown in Figure 4.7d.

Table 4.11a-b show the results of the GCHP simulations that utilize the heating and cooling energy data from the scenarios shown in Figures 4.7d and 4.7e. The results in Table 4.11a parallel those of Figure 4.7d. The use of evergreen trees with fins and overhangs leads to a reduction in the required length of the ground-loop heat exchanger of 37.6% and 41.6% for the 10 year and 25 year simulations, respectively. This is a respective 5.3% and 5.9% improvement over the building that used fins and overhangs with deciduous trees. Hence, based on the assumptions and limitations of this study, the use of attached shading has a larger effect on the reduction of the allowable ground-loop heat exchanger length than either the deciduous or evergreen trees. This relationship is consistent with the quantity of solar radiation that the fins and overhangs prevent from striking the windows of the building. Nevertheless, using trees for shading is an important strategy for shading, light filtration and aesthetic considerations. Another consideration outside the scope of this study is to look at the effects of ground covering on the surface temperature of the building. The cumulative results shown in Table 4.11b indicate that additional shading added to the South, East and West sides of the baseline

building significantly improve the buildings efficiency, thereby reducing the required length of the ground-loop heat exchanger.

4.5.1.3 Solar Orientation

The form and orientation of the walls of a building are crucial aspects of climate responsive design (Givoni 1994). In this section, I analyze the effects of solar orientation, aspect ratio and courtyards on the cooling and heating loads of a building and GCHP system design.

In the hot-dry climate of Las Vegas, one energy efficiency strategy is to orient a building so as to minimize the solar access of a building's exterior skin (Givoni 1994). The first part of this section examines the relationship between the surface to area ratio of

	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	KBtu/Hr/SF Max. Clg. Load	Btu/Hr/SF Max. Htg. Load	Btu/SF Window Solar Rad.
0 Deg (N-S)	3.6	47.3	50.9	16.8	4.1	16.8
15 Deg	3.6	47.6	51.2	17.3	4.1	19.5
30 Deg	3.7	47.4	51.1	17.0	4.1	20.2
45 Deg	3.7	47.7	51.4	17.5	4.1	19.5

Figure 4.8: 70.1' x 70.1' "No Shading Case" Building Solar Orientation - eQUEST Simulation Results

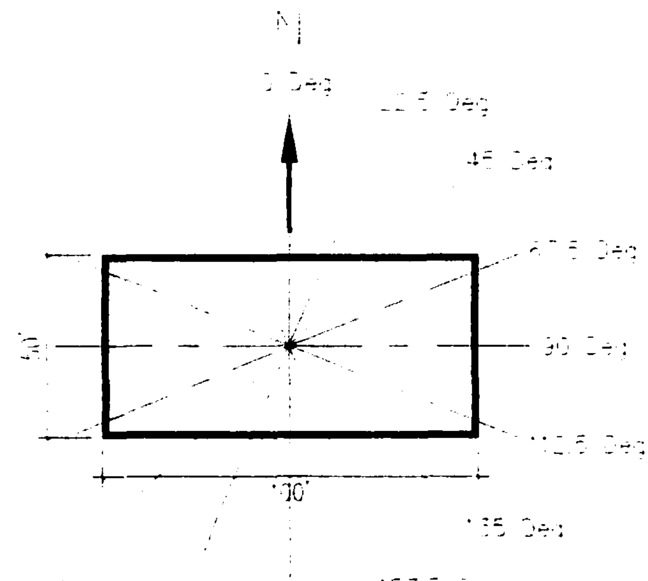
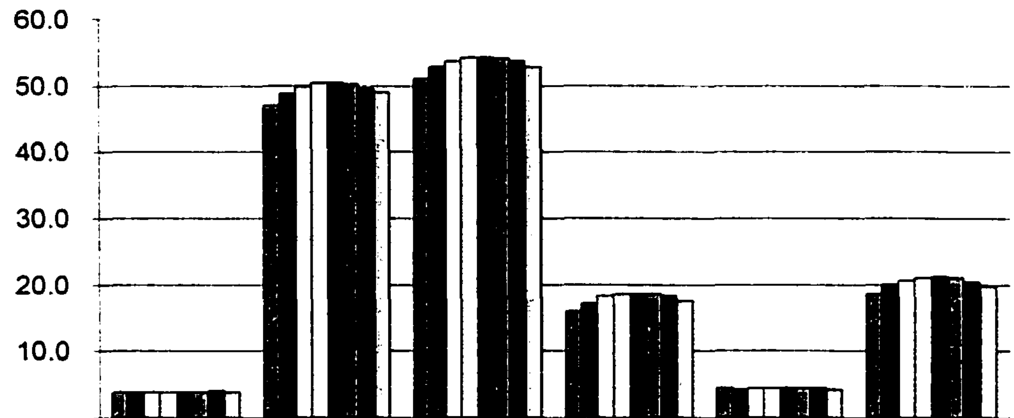


Figure 4.9a: 50'x100'
Building Orientation Legend



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	KBtu/Hr/SF Max. Clg. Load	Btu/Hr/SF Max. Htg. Load	Btu/SF Window Solar Rad.
0 Deg (N-S)	3.9	47.0	50.9	15.9	4.3	18.5
22.5 Deg	3.9	48.8	52.7	17.2	4.3	19.9
45 Deg	3.9	49.7	53.6	18.3	4.4	20.5
67.5 Deg	3.9	50.3	54.2	18.6	4.4	21.0
90 Deg	3.8	50.3	54.1	18.5	4.4	21.1
112.5 Deg	3.8	50.2	54.0	18.6	4.4	20.9
135 Deg	3.9	49.6	53.5	18.4	4.4	20.4
157.5 Deg	3.9	48.9	52.8	17.5	4.3	19.7

Figure 4.9b: 50'x100' Building Solar Orientation - eQUEST Simulation Results

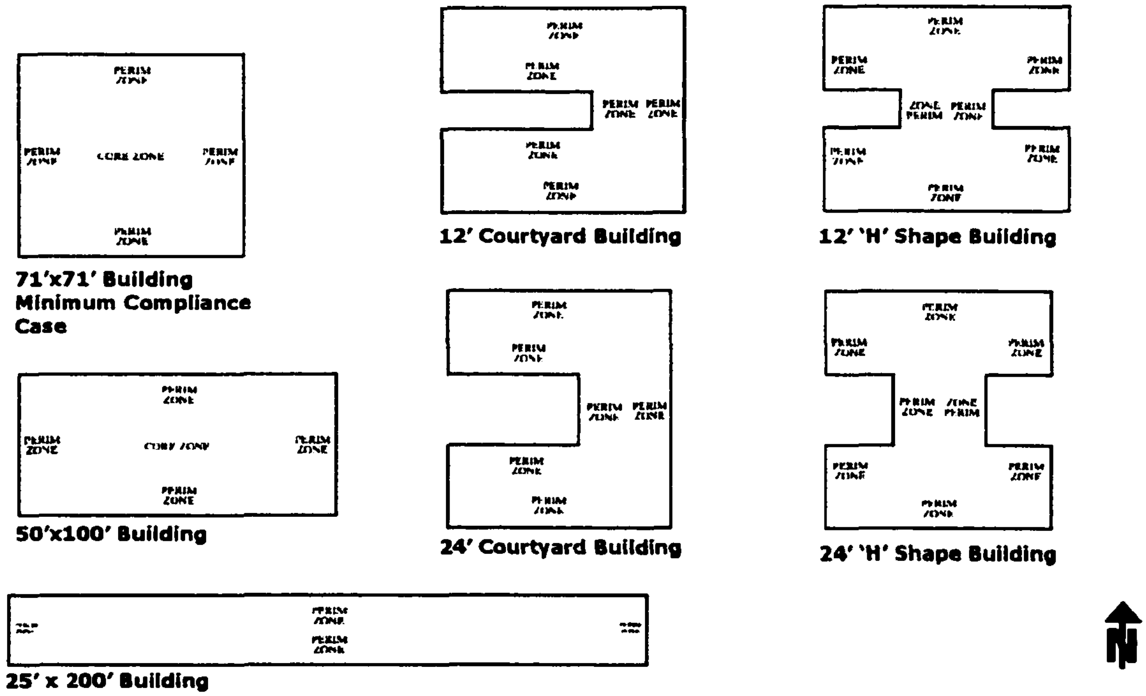


Figure 4.10: Building Forms with Thermal Zone Layout

a building, heating and cooling energy use and the most efficient orientations for building surfaces. Figure 4.8a shows the results of rotating the Minimum Compliance Case building at 15 degree increments. In this study, the '0 Deg (N-S)' position corresponds to due North. The data show that for a 70.1' x70.1' square shaped building, there is no change in heating loads over a one year period and less than a 1% change in the cooling loads.

In order to examine the effects of solar orientation on a rectangular building, a 50'x100' building made up of the same materials as the Minimum Compliance Case building is rotated at 22.5 degree increments. The results of these simulations are shown in Figure 4.9b. Similar to the Minimum Compliance Case building, the rectangular building orientated in the North-South direction (corresponding to the '0 Deg (N-S)'

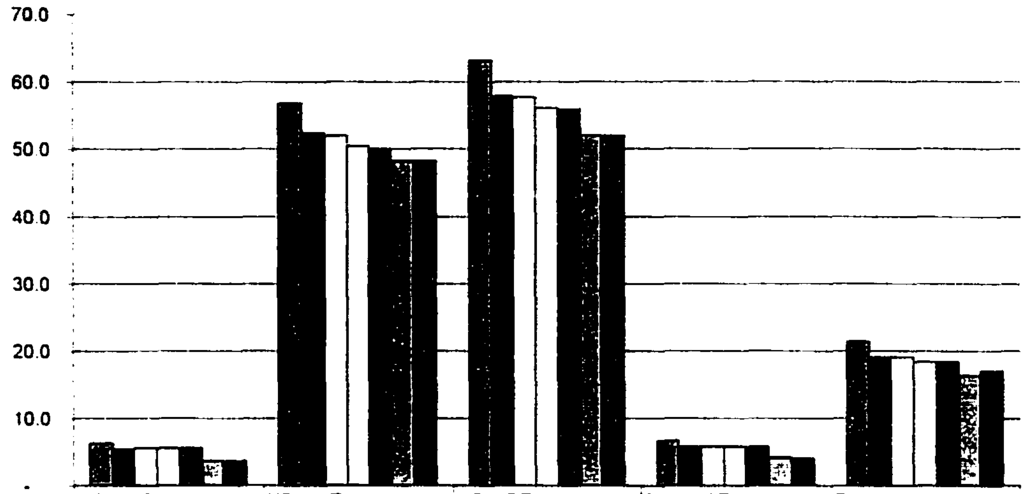
orientation in Figure 4.9a) performs better since more exterior wall and window surface area is exposed in the North-South direction. The figure also shows that the cooling load rises as the building orientation approaches the '90 Deg' orientation where the 100' long side of the building faces in the East-West direction. This trend correlates positively with the increase in the Window Solar Gain noted in the last column of Figure 4.9b.

4.5.1.4 Building Form

The aspect ratio of a building determines the amount of surface area exposed to incident solar radiation and conduction. Minimizing this ratio is an important strategy in hot-dry climates (Givoni 1994). In this section, evaluate different building forms to in order to determine their relative efficiencies with regard to energy efficiency. The building forms that I analyze are summarized in Figure 4.10. All these buildings have the same sectional configuration: They are two stories in height, have a total enclosed floor area of 10,000 square feet and use the same materials as the Minimum Compliance Case. The building orientations shown in the figure represent the most efficient orientation with regard to heating and cooling loads for each building.[9]

Courtyards provide an opportunity for one part of a building to partially shade another accept when the sun is directly overhead. At night, heat from the surrounding surfaces of a building re-radiate to the night sky allowing the spaces adjacent to these surfaces to cool. During the day, the air in these spaces starts out relatively cooler than that of areas outside of the courtyard (Brown et al. 2001) Courtyards also provide protection from dust and wind depending on their orientation relative to predominant wind direction (Brown et al.

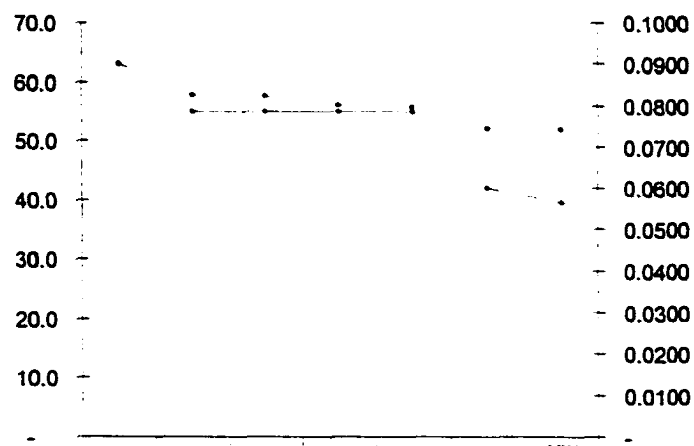
9. Each building is simulated at four different orientations, 45 degrees apart. The results presented in this study are the most energy efficient for each building form.



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
Building A	6.4	56.7	63.1	6.7	21.4
Building B	5.5	52.3	57.8	5.9	19.1
Building C	5.7	51.9	57.6	5.9	19.1
Building D	5.7	50.4	56.1	5.9	18.3
Building E	5.7	50.1	55.8	5.9	18.3
Building F	3.8	48.2	52.0	4.3	16.5
MIN COMP CASE	3.7	48.2	51.9	4.1	17.1

Figure 4.11a: Building Form - eQUEST Simulation Results

Building A	25' x 200' Building
Building B	24' Courtyard Building
Building C	24' 'H' Shape Building
Building D	12' Courtyard Building
Building E	12' 'H' Shape Building
Building F	50'x100' Building
Minimum Compliance Case Bldg.	71'x71' Building



	Building A	Building B	Building C	Building D	Building E	Building F	MIN COMP CASE
Total Energy (Kbtu/sf)	63.1	57.8	57.6	56.1	55.8	52.0	51.9
Perimeter/Area Ratio	0.0900	0.0786	0.0786	0.0786	0.0786	0.0600	0.0566

Figure 4.11b: Relationship Between Energy Usage and Aspect Ratio

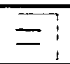
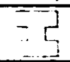
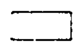
		10 Year Simulation	% Change (vs. Min. Compl. Case)	25 Year Simulation	% Change (vs. Min. Compl. Case)
Building A		14,763 lin. ft.	22.4%	19,104 lin. ft.	19.5%
Building B		13,457 lin. ft.	11.6%	17,452 lin. ft.	9.2%
Building C		13,314 lin. ft.	10.4%	17,291 lin. ft.	8.2%
Building D		12,864 lin. ft.	6.6%	16,741 lin. ft.	4.7%
Building E		12,767 lin. ft.	5.8%	16,633 lin. ft.	4.1%
Minimum Compliance Case Bldg.		**12,064 lin.ft.**		**15,984 lin.ft.**	
Building F		11,920 lin. ft.	-1.2%	15,800 lin. ft.	-1.2%

Table 4.12: GCHP Sizing Results - Building Form Study

2001). Buildings with courtyards, however, tend to have substantially higher aspect ratios relative to other building forms as shown in Figure 4.11b. Buildings with courtyards are included in this portion of the study in order to evaluate the trade-offs between the cooling benefits of the courtyard and the increase in aspect ratio.

Figure 4.11a shows energy usage and load demands for each building form in Figure 4.10. Figure 4.11b compares total energy usage to the aspect ratio of each building form. Both figures clearly show the positive correlation between a smaller aspect ratio and lower energy usage. Table 4.12 shows the results of sizing a ground-loop heat exchanger for each building. Examining the impact of building form on the design and performance of a ground-loop heat exchanger shows that though Building F has higher energy requirements, the 50' x 100' building requires a 1.2% smaller ground-loop heat exchanger than that of the Minimum Compliance Case for both the 10 year and 25 year simulations. This is due to the fact that the North-South orientation of the 50'x100' building has less glazing exposure in the East-West direction, such that the combined heat gain from

window conductance and solar radiation is 1.5% less than that of the square building form of the Minimum Compliance Case.

4.5.2 Building Envelope

4.5.2.1 Glazing

Without shading, windows allow solar radiation to be directly transmitted into a space having an immediate effect on internal temperatures (Marsh 2002). Tinted glazing uses chemicals in the glass to absorb radiation, preventing that radiation from immediate transmission to the building interior. Compared to clear glazing, tinted glazing has a small effect on reducing solar transmission into a building, since a portion of the radiation is re-radiated to the building interior after a period of time (DOE 2002). Spectrally sensitive glazing allows the maximum amount of light to penetrate a space while minimizing the heat gain from solar radiation. It reduces the transmission of solar radiation outside the visible range. Spectrally sensitive glazing uses low-emissivity films applied to the glass panes that reflect heat generated by UV radiation while allowing visible light to penetrate to the interior of a building. Using this type of glazing reduces the cooling loads caused by solar heat gain. This allows for the use of additional glazing for better daylighting and/or a reduction in the sizing of mechanical equipment in cooling dominated climates (DOE 2002).

The characteristics of spectrally selective glazing vary according to the type of the low emissivity film or coating, the location of the film or coating (on double and triple glazed windows) and the type of glass. Low emissivity films and coatings are designed to either filter or reflect specific spectrums of ultra-violet radiation at the exterior of a building.

Table 4.13: Terms and Definitions (FEMP 1999)

Terms	Definitions
DOE2.2 Glass Type Code	The code DOE2 uses to identify a particular glazing type.
U-Value	The center-of-glass U-value in inch-pound units (Btu/ft2-h-F)
Tv	The center-of-glass visible transmittance for all glazing layers (%)
SHGC	The center-of-glass solar heat gain coefficient. This is a measure of total solar heat gain (direct solar heat gain + inward heat flow absorption)
LSG	The light to solar gain ratio.

These films may be located on the inside face of the outer pane of glass in a double glazing system, or on either side of the inside pane depending on the climate, and the window orientation. They are also sometimes combined with an exterior tinted pane of glass in order to minimize the re-radiation of heat absorbed by the glazing to the interior of the building.

Table 4.13 outlines several important terms that are used in this study in order to compare spectrally sensitive glazings with other glazing systems. The key variable for comparing different glazing types is the Light to Solar Gain Coefficient (LSG). This term is defined as the visible transmittance (Tv) divided by the solar heat gain coefficient (SHGC). Tv is the percentage of visible light that passes through the glazing. SHGC is a measure of the total heat gain through the glass. This term includes both the solar radiation transmitted directly into the building and the inward flowing heat that is absorbed by the glazing. LSG measures the performance of a glazing system in terms of the ratio between

the amount of light transmitted to the building's interior and the amount of solar radiation that is reflected and/or absorbed by the glazing (DOE 2002).

The U-value of a glazing system also plays an important role in the control of conduction between the interior and exterior of a building. The U-value is a function of the glazing thickness, the type of glazing, amount of air or gas in the air space between the glazing, the number of sheets of glazing in the system and the frame.

Seven different types of glazing are compared in this study. The glazing types noted in

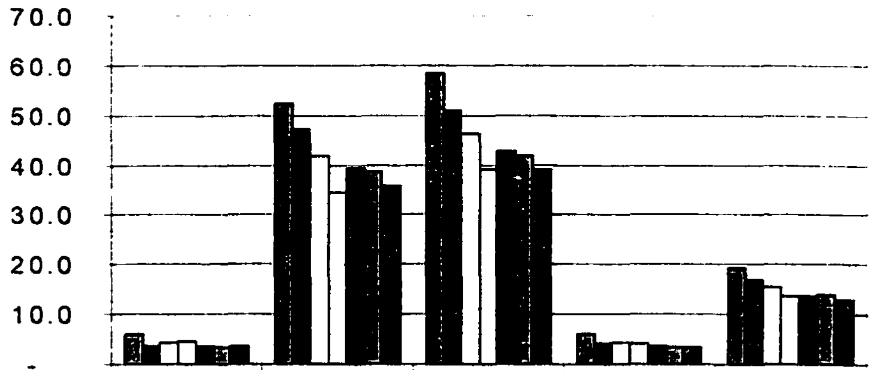
Table 4.14: Glazing Properties

Description	DOE2 Glass Type Code[a]	U-Value	Tv	SHGC	LSG (Tv/ SHGC)
Single, Clear	1001	1.09	.88	.81	1.09
Double, Clear	2004	.48	.78	.70	1.11
Double Tint, Bronze	2204	.48	.47	.49	.96
Double Reflective, Clear	2404	.41	.13	.17	.76
Double Low-E, Tint	2637	.31	.44	.37	1.19
Double Selective, Clear	2664	.29	.68	.42	1.62
Double Selective, Tint	2667	.29	.41	.29	1.41

a. All definitions and values in this table are those used in the eQUEST and PowerDOE energy simulation programs that run on the DOE2.2 engine.

Table 4.14 is based on a study done by the Department of Energy regarding the performance of spectrally selective glazing.[10] The building used in these simulations is the same as the "No Shading Case" building shown in Figure 4.6 with the same amount of

10.U.S. Department of Energy. Federal Technology Alert - Spectrally Selective Glazings. pg 16.



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	KBtu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
Single Clear	6.0	52.5	58.5	6.0	19.4
Double Clear	3.7	47.3	51.0	4.2	17.0
Double Tint Bronze	4.4	41.8	46.2	4.4	15.3
Double Reflective	4.6	34.6	39.2	4.1	13.6
Double Low-e, Tint	3.6	39.3	42.9	3.6	13.8
Double Selective, Clear	3.3	38.6	41.9	3.5	13.9
Double Selective, Tint	3.6	35.7	39.3	3.5	13.0

Figure 4.12: Glazing Study - eQUEST Simulation Results

glazing on all sides arranged in 4'-0" x 4'-6" panes. The windows in the Minimum Compliance Case building are clear double glazed. All of the windows have aluminum frames without thermal breaks.

The simulation results are shown in Figure 4.12. These results are discussed in terms of the performance of each glazing type compared to the Single Glazing Case and the Double-Clear Glazing Case. The best performance in terms of overall energy reduction are the Double Reflective Case and Double Selective-Tint Case with reductions of 23.1% and 22.9%, respectively. Peak cooling demand follows a similar pattern with reductions of 26.8% for the Double Reflective Case and 24.5% for the Double Selective-Tint Case. These results indicate that the energy performance of reflective glazing is comparable to that of the selective glazing. The main disadvantage to reflective glazing is in terms of

daylighting. Double Selective Tint glazing has a Tv that is over 3-times that of Double Reflective glazing. This is consistent with the simulation results that show that the Double Reflective Case used more than 28% more energy for electric lighting than the Selective-Tint Case. This implies that the Selective-Tint Case provides much better daylighting access at approximately the same level of energy efficiency.

Table 4.15: GCHP Sizing Results - Glazing Study

	10 Year	% Change	25 Year	% Change
Single Glazing, Clear	13,142 lin. ft.	14.4%	17,064 lin. ft.	12.3%
Double Glazing, Clear Case	**11,490 lin. ft.**		**15,195 lin. ft.**	
Double Tint, Bronze	10,542 lin. ft.	-8.3%	13,318 lin. ft.	-12.4%
Double Reflective	8,651 lin. ft.	-24.7%	10,838 lin. ft.	-28.7%
Double Low-e, Tint	9,531 lin. ft.	-17.0%	11,897 lin. ft.	-21.7%
Double Selective, Clear	9,499 lin. ft.	-17.3%	12,130 lin. ft.	-20.2%
Double Selective, Tint	8,842 lin. ft.	-23.0%	11,136 lin. ft.	-26.7%

Table 4.15 shows the results from sizing the GCHP system. The reduction in the sizing of the GCHP system follows a similar pattern to the reduction of the cooling loads in Figure 4.12. All of the double glazed windows improve the efficiency of the building significantly over the Double Clear Case. The Double Reflective Case required the shortest ground-loop heat exchanger with a reduction from the Double Clear Glazing Case of 24.7% for a 10 year simulation and 28.7% for a 25 year simulation. The length of the Selective Tint Case ground-loop heat exchanger is 1.7% and 2.0%longer for each time interval, respectively. The difference is smaller than that of their respective cooling

	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
4" Concrete Inside	4.3	48.3	52.6	5.3	17.3
6" Concrete Inside	4.0	48.0	52.0	5.0	17.0
8" Concrete Inside	3.9	47.9	51.8	4.7	16.9
10" Concrete Inside	3.8	47.8	51.6	4.6	16.7
12" Concrete Inside	3.7	47.8	51.5	4.4	16.7

Figure 4.13 Walls with Mass Located ON the Building's Interior - eQUEST Energy Simulation Results

energy requirements due to the Selective Tint Case's 4% lower peak cooling requirement. The small drop in energy efficiency of this glazing type compared to that of double-reflective glazing is a reasonable trade-off for the daylighting benefits to the building occupants.

4.5.2.2 Exterior Walls and Materials

The amount of heat flow through a building envelope is a function of the temperature differential between the inside and outside of the building, the thermal resistance of the building's exterior wall and roof materials and the surface area of the building envelope. In desert climates where there is a large diurnal temperature variation, large quantities of

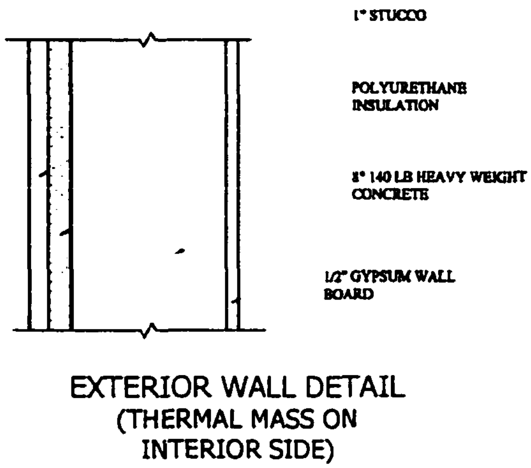


Figure 4.14a: Exterior Wall Detail - Mass on Interior

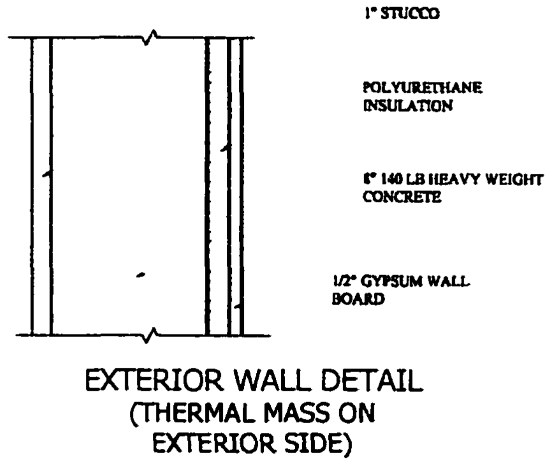
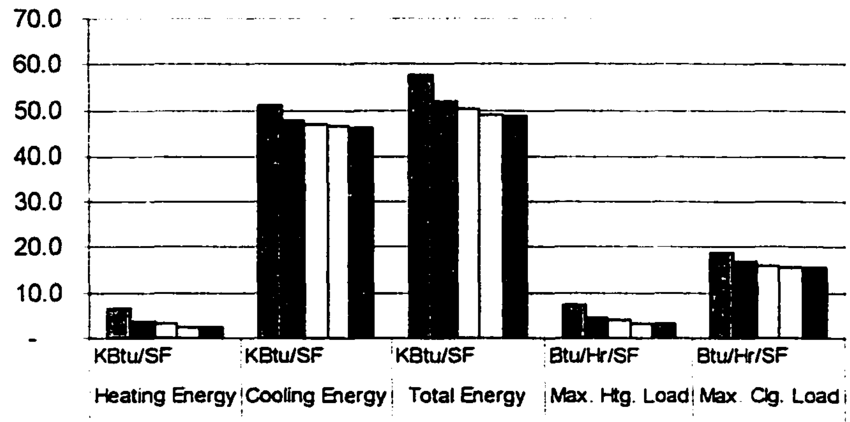


Figure 4.14b: Exterior Wall Detail - Mass on Exterior

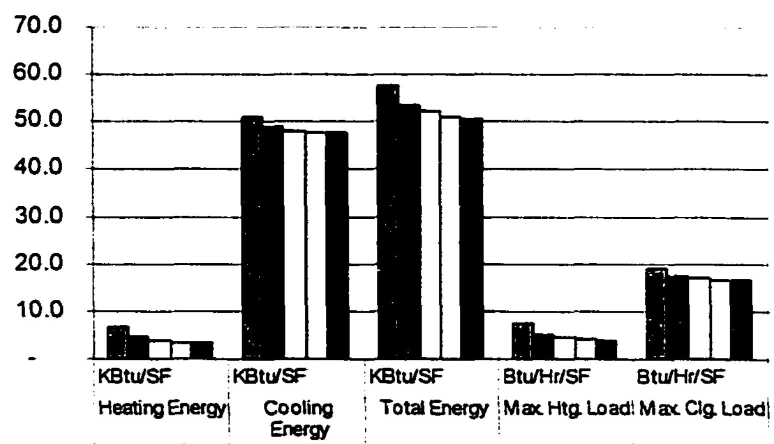
thermal mass absorb and store heat from solar radiation or internal loads. The use of thermal mass allows the transfer of the heat to be delayed until such time as it is required to meet internal heating load requirements or until the external air temperature becomes cool enough to be re-radiated back into the atmosphere. The amount of thermal mass dictates the timing and direction that the incident solar radiation conducts through the building envelope (Lechner 2001).

Figure 4.13 show the eQUEST simulation results using thermal mass in the exterior walls of the "No Shading Case" building in Figure 4.6. The mass used in these scenarios is 140 pound per cubic foot heavy weight concrete. Exterior wall details are shown in Figures 4.14a-b. In these simulations, the mass is combined with a 1/2" thick sheet of insulation on the exterior side of the concrete. The small 2% reduction in energy requirements between the most extreme cases, the scenario using 4" concrete and the one that used 12" of concrete, demonstrate that more mass does not improve the energy efficiency of the building in the climate of Las Vegas.



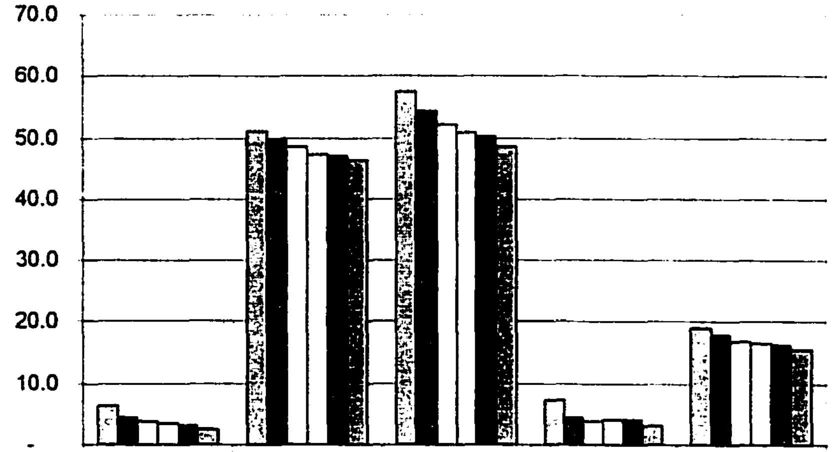
	Heating Energy (KBtu/SF)	Cooling Energy (KBtu/SF)	Total Energy (KBtu/SF)	Max. Htg. Load (Btu/Hr/SF)	Max. Clg. Load (Btu/Hr/SF)
8" Concrete, No Insulation	6.5	51.1	57.6	7.3	19.1
8" Concrete-IN w/ 1/2" Polyurethane Bd	3.9	47 8	51.7	4.7	16.9
8" Concrete-IN w/ 1" Polyurethane Bd	3.2	47.1	50.3	4.0	16.2
8" Concrete-IN w/ 2" Polyurethane Bd	2.6	46.5	49.1	3.5	15.8
8" Concrete-IN w/ 3" Polyurethane Bd	2.4	46.3	48.7	3.3	15.6

Figure 4.15a: Walls with Insulation on the Outer Side of the Insulation Wall - eQUEST Simulation Results



	Heating Energy (KBtu/SF)	Cooling Energy (KBtu/SF)	Total Energy (KBtu/SF)	Max. Htg. Load (Btu/Hr/SF)	Max. Clg. Load (Btu/Hr/SF)
8" Concrete, No Insulation	6.5	51.1	57.6	7.3	19.1
8" Concrete-OUT w/ 1/2" Polyurethane Bd	4.4	48.9	53.3	5.1	17.5
8" Concrete-OUT w/ 1" Polyurethane Bd	3.8	48.2	52.0	4.5	17.0
8" Concrete-OUT w/ 2" Polyurethane Bd	3.4	47.7	51.1	4.0	16.6
8" Concrete-OUT w/ 3" Polyurethane Bd	3.2	47.5	50.7	3.7	16.4

Figure 4.15b: Walls with Insulation on the Outer Side of the Exterior Wall - eQUEST Simulation Results



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
□ 8" Concrete, No Insulation	6.5	51.1	57.6	7.3	19.1
■ 2x6 Wall w/ R-19	4.5	49.9	54.4	4.6	17.8
□ 2x6 Wall w/ R-19 & 3" PolyU Insulation	3.7	48.5	52.2	3.9	16.8
□ Perlite Filled CMU w/ 2x6/R-19 Furring	3.6	47.3	50.9	4.1	16.7
■ 8" Concrete-IN w/ 1" PolyU Insulation	3.2	47.1	50.3	4.0	16.2
□ 8" Concrete-IN w/ 3" PolyU Insulation	2.4	46.3	48.7	3.3	16.6

Figure 4.16: Comparison of Different Wall Constructions - eQUEST Simulation Results

Wall	R-Value
8" Concrete, No Insulation	2.2
2x6 Wall w/ R-19	10.8
2x6 Wall w/ R-19 & 3" Polyurethane Insulation	29.4
Perlite Filled CMU w/ 2x6/R-19 Furring (Min. Compliance Case)	14.3
8" Concrete-IN w/ 1" Polyurethane Insulation	8.5
8" Concrete-IN w/ 3" Polyurethane Insulation	20.4

Figure 4.17: Effective R-values of Wall Types used in Figure 4.16

In the hot-dry climate of Las Vegas, insulation in exterior walls is an important component in reducing heat flow penetration into a building. Figures 4.16a-b show the results of simulating buildings with 8" of concrete located on the interior and exterior sides of the exterior walls. Details of these wall types are shown in Figures 4.15a-b. The results indicate that mass contributes to the performance of a wall whether it is located in the interior or the exterior side of the wall. The data in figure 4.15b also shows that walls with insulation placed on the exterior of the building reduce the cooling energy requirements

by an average of 3.5%. While a large amount of mass is not necessary in a climate like that of Las Vegas , the presence of mass in an exterior wall system contributes to the energy efficiency of the building. Figure 4.16 compares the energy requirements of six buildings that use a variety of exterior wall types. Examining the R-values of each wall type in Figure 4.17, the results show that R-value alone is not sufficient to guarantee the best design of exterior walls. A building with exterior walls made up of 2x6 stud walls with R-19 batts furred on the interior side and 3" of sheet insulation on the exterior did not perform as well as the walls used in the Minimum Compliance Case building that utilized Perlite filled CMU and R-19 furring despite its effective R-value being twice as high. This is because the 2x6 stud wall has no mass. The best performing buildings are the ones that use the Perlite filled CMU with R-19 furring. Based on these results, it can be

Table 4.16: GCHP Sizing Results - Exterior Wall Study

	10 Year	% Change	25 Year	% Change
8" Concrete, No Insulation	13,383 lin. ft.	16.5%	17,280 lin. ft.	13.7%
2" x 6" Wall w/ R-19 Batt Insulation	12,425 lin. ft.	8.1%	15,947 lin. ft.	4.9%
2" x 6" Wall w/ R-19 Batt & 3" Polyurethane Insulation	11,620 lin. ft.	1.1%	15,369 lin. ft.	1.1%
8" Concrete -IN w/ 1" Polyurethane Insulation	11,857 lin. ft.	3.1%	15,701 lin. ft.	3.3%
8" Concrete -IN w/ 3" Polyurethane Insulation	11,590 lin. ft.	1.1%	15,231 lin. ft.	2.4%
2" x 6" Wall w/ R-19 Batt & 3" Polyurethane Insulation	11,620 lin. ft.	1.1%	15,369 lin. ft.	1.1%
Perlite Filled CMU w/ 2" x 6" Studs & R-19 Batt Insulation	**11,490 lin. ft.**		**15,195 lin. ft.**	

concluded that the best wall construction for the climate of Las Vegas is one that is well insulated and contains components that have mass.

In terms of the ground-loop sizing, the ground-loop heat exchanger for the Minimum Compliance Case building is the most efficient by a small percentage of 1.1%. The buildings with 2x6 walls with R-19 Batt and 3" polyurethane insulation exterior walls and 8" concrete with 3" polyurethane exterior walls performed nearly as well. These results are consistent with those of the energy simulations in terms of confirming the importance of insulation in the climate of Las Vegas.

4.5.2.3 Roofing

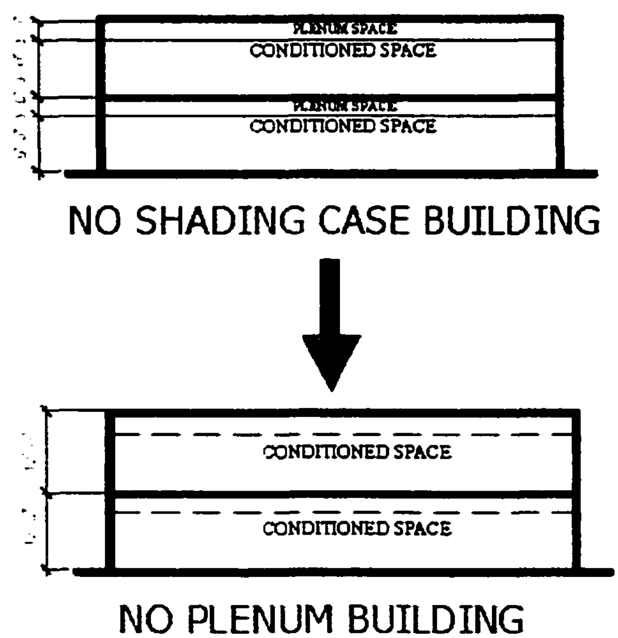


Figure 4.18: No Plenum Building Schematic Section

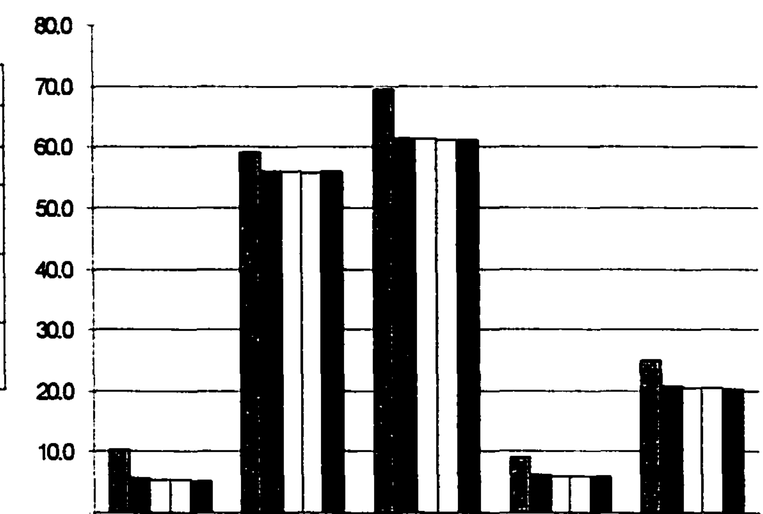
The importance of the roofing system is dependent on the building configuration. The percentage of total heat gained or lost through the roof of a building depends on the number of stories the building possess as well as the roof's capacity to minimize heat gains and losses. This study uses the roof as a thermal barrier in a low-rise building.

When a plenum exists, as in the case of the Minimum Compliance Case building, the eQUEST software assumes that all heat in the plenum is absorbed by building elements or is consumed by mechanical

processes. (Hirsh et al. 2001). In order to analyze the performance of different roof systems and insulation R-values, it is necessary to configure an alternative No Shading Case building, such that the space between the roof and the ceiling is not a plenum. Figure 4.18 graphically shows this “No Plenum Case” building.

The results of the eQUEST energy simulation are shown in Figure 4.19. Because of the assumptions made in the DOE2 engine, a building without a plenum will be much less efficient than a building that has one. The figure shows that insulation levels with an overall effective roof R-value that exceeds 24 is wasted due to diminishing returns. The “No Plenum Case” building with R-30 still requires 20% more energy than the No Shading Case building which has the same amount of insulation and has a plenum. These numbers are consistent with the analysis of the ground-loop heat exchanger in Table 4.17.

Roof	R-Value
Built-up, No Insulation	5.9
Built-up, R-18 Rigid Insulation	24.4
Built-up, R-30 Batt Insulation w/ radiant barrier	35.7
Built-up, R-49 Batt Insulation w/ radiant barrier	40.0
Built-up, R-60 Batt Insulation w/ radiant barrier	52.6



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg Load	Btu/Hr/SF Max. Clg. Load
Built-up Roof, No Insulation	10.3	59.2	69.5	9.0	24.8
Built-up Roof, R-18 Rigid Insulation	5.6	55.8	61.4	6.2	20.8
Built-up Roof, R-30 Batt Insulation	5.5	55.8	61.3	6.0	20.5
Built-up Roof, R-49 Batt Insulation	5.4	55.7	61.1	5.9	20.4
Built-up Roof, R-60 Batt Insulation	5.2	55.8	61.0	5.8	20.3

Figure 4.19: Roof Analysis - eQUEST Simulation Results

Table 4.17: GCHP Sizing Results - Roofing Study

	10 Year	% Change	25 Year	% Change
Built-up, No Insulation	15,721 lin. ft.	36.8%	20,100 lin. ft.	32.2%
Built-up, R18 Rigid Insulation	14,643 lin. ft.	27.4%	19,000 lin. ft.	25.0%
Built-up, R-30 Batt Insulation w/ radiant barrier	14,518 lin. ft.	26.4%	18,933 lin. ft.	24.6%
Built-up, R-49 Batt Insulation w/ radiant barrier	14,506 lin. ft.	26.2%	18,919 lin. ft.	24.5%
Built-up, R-60 Batt Insulation w/ radiant barrier	14,490 lin. ft.	26.1%	18,900 lin. ft.	24.4%
Built-up, R-30 Rigid Insulation w/ PLENUM (No Shading Case Bldg.)	**11,490 lin. ft.**		**15,195 lin. ft.**	

The length of the ground-loop for the "No Plenum" building with R-30 batt insulation in the roof requires 24.6% more ground-loop than that of the Minimum Compliance Case building. These results, combined with the assumptions of the eQUEST software, indicate that the application building in Chapter 5 should be designed with the same roof construction and plenum configuration as the Minimum Compliance Case and No Shading Case buildings.

4.6 Conclusions

This chapter clearly shows that architectural design decisions that affect building energy usage and efficiency have a positive impact on the design and estimated long term performance of GCHP systems. An increase in energy efficiency decreases the required length of ground-loop required for the system to function over a period of time. The opposite condition is true as well.

Table 4.18: Summary of Parametric Study Results

Element	Conclusions
Solar Orientation	
Window Placement	• Efficient designs use more glazing on the North side of a building and less on East, West and South faces • Increasing the amount of glazing on the South side of a building is less efficient than placing the same total amount of glazing on the East and West sides.
Shading	• Shading added to the South, East and West sides of a building significantly improve the building's energy efficiency.
Building Solar Orientation	• Designing a building so that wall and window surface areas are exposed in the North-South direction improves building energy efficiency. • Minimizing the surface-volume ratio of a building improves building energy efficiency.
Building Envelope	
Glazing	• The use of reflective glazing and spectrally selective glazing significantly improves building energy efficiency. While reflective glazing is the most efficient glazing type in terms of solar heat gain, tinted spectrally selective glazings perform nearly as well and allow more daylight to penetrate into the building interior than reflective glazing.
Exterior Walls & Materials	• Exterior walls must contain sufficient amounts of insulation to perform well in the desert climate of insulation. The presence of mass in the wall system also contributes to building energy efficiency.
Roofing	• Roofing systems with an effective R-value of 24 or more provide adequate insulation given the assumptions of the DOE2 simulation engine. An extension of these assumptions is that a building with a plenum is significantly more efficient than a building without one.

Table 4.18 show the results of the parametric studies conducted in this chapter in terms of building energy efficiency. It is important to emphasize the fact that these strategies are evaluated in isolation to one another. When combined into a single building design, there is no guarantee how much each individual strategy will impact energy efficiency

and, by extension, the design and perfotmance of a GCHP system since, in reality, these strategies are not mutually exclusive. For example, the improvement in energy efficiency by changing from Double-Clear glazing to Double-Tint Spectrally Selective glazing is achieved without any use of window shading. This improvement to energy efficiency by the inclusion of shading devices and the use of Spectrally Selective glazings will offset one another when implemented together. The purpose of Chapter 5 is to explore the results from the parametric studies in these chapters in order to evaluate the "net" effect of the architectural impacts on GCHP systems. Likewise, the impact of GCHP systems on the design of a building on a finite site will also be evaluated to show how GCHP systems impact architectural design as well.

CHAPTER 5

THE DESIGN OF A CLIMATE RESPONSIVE BUILDING THAT INCORPORATES A GCHP SYSTEM

Chapter 4 examines the relationship between individual architectural elements and the design of a ground-loop heat exchanger through a series of parametric studies. This chapter applies the information obtained from those parametric studies in order to determine the net impact of all the strategies when they are integrated into a comprehensive building design. In a realistic application, the effect of the energy efficiency strategies on the overall performance of a building are not mutually exclusive.

This chapter also examines important factors associated with the implementation of a GCHP into the actual building design. These factors include issues of land area requirements, borefield configurations, building layout and thermal zoning.

5.1 The Application Building Design

Figure 5.1 shows the site plan and building footprint of a 2-story commercial office building. The building and its site are oriented toward true North. The size of the site is 172' x 187' for a total area of 32,164 ft^2. The site is of sufficient size to support the parking requirements according to the local zoning codes for the City of Las Vegas.[1] This is an important consideration since the availability of land is an important constraint on

1. Parking requirements according to Title 30 of the Clark County Zoning Code require 6 spaces per 1000 square feet of office space. The total office space of the application building shown in Figures 5.1~5.4 is 8,655 spaces for a parking requirement of 52 spaces.

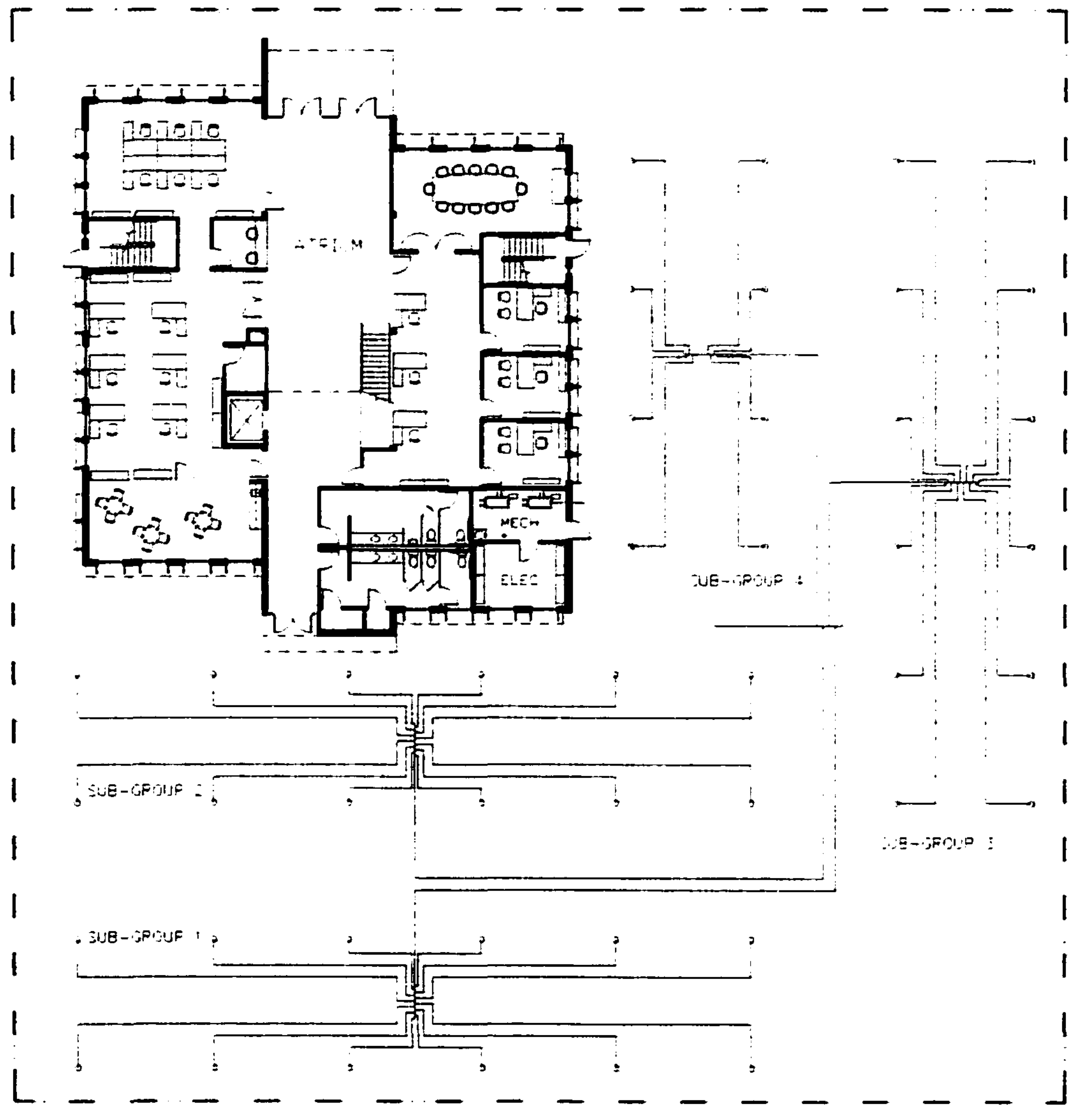


Figure 5.1: Site Plan with Level 1 Floor Plan and Borefield

the size of the borefield of the ground-loop heat exchanger. The site is also of sufficient size to provide adequate space for landscape and walkways between the building and the parking area on the East and South sides and between the building and the public sidewalk on the North and West sides.

The borefield consists of 3 sub-groupings that are configured into 2 x 6 rectangles and

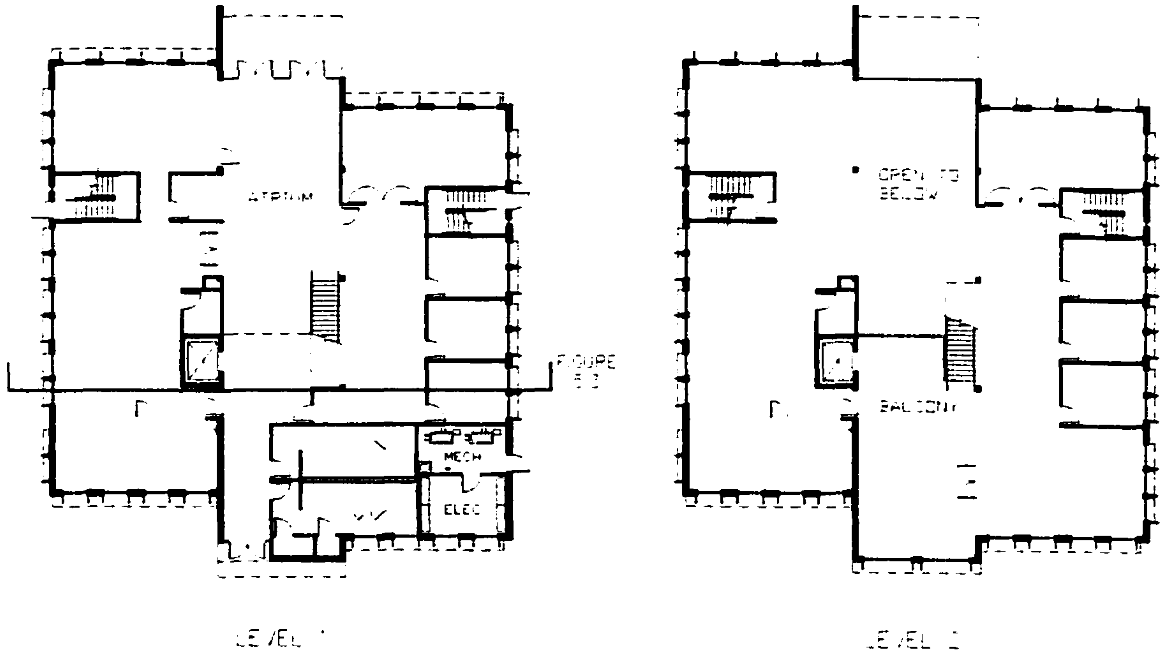


Figure 5.2: Level 1 and Level 2 Floor Plans

1 sub-grouping that is configured into a 2 x 4 rectangle for a total of 44 boreholes. The individual bores are located a minimum of 22 feet apart in all directions from other bores. Borehole thermal resistance is 0.24°F/(Btu*hr*ft), .the same as parametric studies in Chapter 4. Section 4.3 has a detailed explanation of the thermal resistance calculation including an explanation of the parameters and assumptions for the design of the U-tubes that make up the ground-loop heat exchanger.

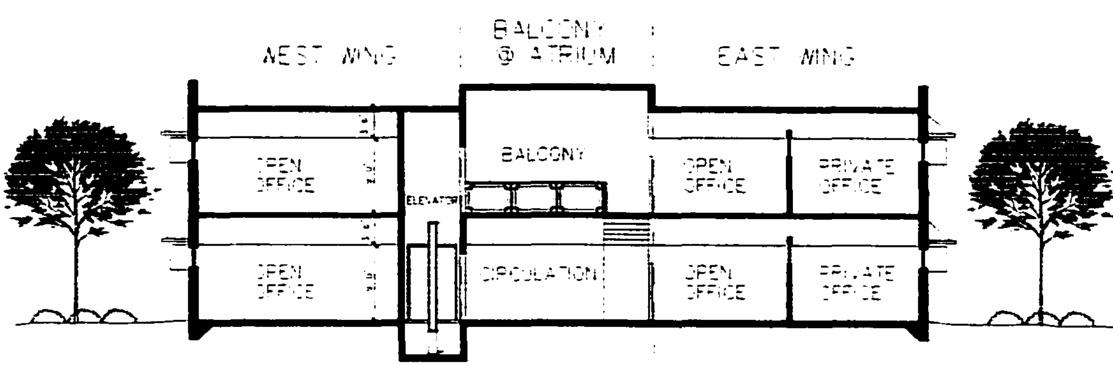


Figure 5.3: Building Section

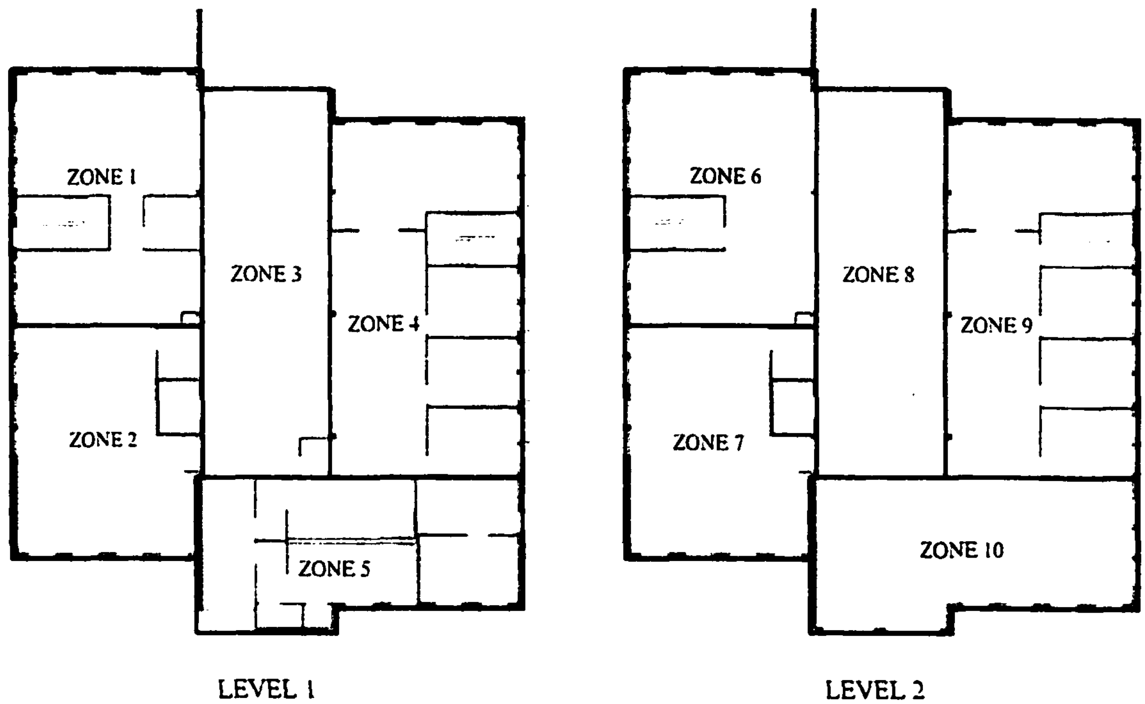


Figure 5.4: Level 1 and 2 Thermal Zones

The total enclosed area of the building is 13,200 feet. The building consists of office and meeting spaces centered around a clerestory space that extends from the North entrance to the middle of the stairway located in the center of the building. Figure 5.2 shows the floor plans for the first and second levels. Vertical access to the second floor is possible by either elevator or stairs. The building design conforms with egress requirements of the *Uniform Building Codes, 1997 edition*. The layout of the spaces is an open plan in which the office spaces have visual access onto the central clerestory space. The open office spaces are separated from the central clerestory space by partial height walls that are either open at the top or have clear glazing installed. A small mechanical and electrical room is located on the Southwest corner of level 1 behind the toilet rooms.

The building is designed so that all occupied spaces have at least partial access to daylight.

Thermal zone configurations are shown in Figure 5.4. There are 5 conditioned and 5 plenum zones for each floor. The building is identical to the Minimum Compliance Case building in Chapter 4 with 9' ceiling heights and a floor to floor height of 12'. Several assumptions regarding the modeling of the Applied Minimum compliance Case building require explanation. The first is that the eQUEST software calculates the average air temperature in a space and cannot calculate thermal stratification accurately across a multi-story atrium (Hirsh et al, 2001). Therefore, since this work is concerned with total building loads and their effect on Ground-Source Heat Pump Systems, the model used in this work does not actually model an atrium. Instead, the model shows two identical floors which consist of conditioned and plenum zones and interior walls, ceilings and floors. Occupancy, equipment and lighting loads for each zone is calculated as a weighted average of the uses on a particular floor. The second assumption concerns interior partitions. Since many spaces are at least partially separated from one another, the model constructed in the eQUEST software has interior wall partitions between all thermal zones. Table 5.1 shows a summary of the materials and specifications used in the Applied Minimum Compliance Case building.

5.2 Application of Parametric Studies

The first step in conducting this portion of the study is the establishment of a baseline case building similar to the Minimum Compliance Case building in Chapter 4. This "Application Minimum Compliance Case" building reflects the building footprint of the Application Building Design described in Section 5.1 Like the Minimum Compliance

Table 5.1: Application Minimum Compliance Case Building Component Summary

Element	Information	R-value
Area	13,192 SF (refer to Figure 5.2)	
Height	12' Floor-to-floor with 9' ceilings	
Zoning	5 Conditioned Zones and 5 Plenum Zones per Floor. Refer to Figure 5.3 and 5.4	
Floor	6" Slab-on-grade with fiber pad and carpet	3.3
Exterior Walls	8" CMU with perlite insulation, stucco exterior and interior furring with R-19 batt insulation and 1/2" gypsum board facing (abs.=0.4)	14.3
Interior Partitions	2"x4" Metal Studs with R-11 Batt Insulation	7.1
Glazing	Double Clear Glazing (2004) - SHGC: .78, Tv: .70 N-S Sides: 25% of Ext.Wall Area of Cond. Spaces E-W Sides: 28% of Ext.Wall Area of Cond. Spaces	2.1
Doors	3'x7' Storefront Type (Aluminum Frame) with Double Clear Glazing (2004) - SHGC: .78, Tv: .70	2.1
Shading	None	
Roof	Built-up Roof with Rigid Insulation	23.8
Occupancy Schedule	Working Days: M-F 8am - 5pm Non-working Days: Sat-Sun	
Occupancy Loads	Ground Floor 147 ft / person Top Floor 138 ft / person	
Lighting Loads	Ground Floor 127 W/ft Top Floor 130 W/ft	
Equipment Loads	Ground Floor 1.350 W/ft Top Floor 1.500 W/ft	

Table 5.2: Application Design Building Component Summary

Element	Information	Effective R-Value
Area	13,200 Ft^2	N/A
Height	12' Floor-to-floor with 9' Ceilings	N/A
Thermal Zones	5 Conditioned Zones and 5 Plenum Zones per floor	N/A
Floor	6" Slab-on-grade with fiber pad and carpet (6" concerete slab with carpet on second floor)	3.3
Exterior Walls	8" CMU with perlite insulation, stucco exterior and interior furring with R-19 batt insulation and 1/2" gypsum board facing (abs.=0.4)	20.4
Interior Partitions	2"x4" Metal Studs with R-11 Batt Insulation	7.1
Glazing	Double Selective, Tint (2667)	3.4
Doors(Exterior)	- Aluminum with Double Selective Glazing (North & South Sides) - Solid Metal Doors (East and West Sides)	3.4
Shading Devices	Fins and Overhangs, Evergreen Trees	N/A
Roof	Built-up Roof with 3" Polyurethane Rigid Insulation, Light Color (abs.=0.3)	23.8
Daylighting	Yes	N/A
HVAC System	Centralized Heat Pump Loop with 3 6x2 and 1 4x2 Vertical Borefields	N/A
Occupancy Schedule	Working Days: M-F 8am - 5pm Non-working Days: Sat-Sun	
Occupancy Loads	<u>Ground Floor</u> 147 ft / person <u>Top Floor</u> 138 ft / person	
Lighting Loads	<u>Ground Floor</u> 127 W/ft <u>Top Floor</u> 130 W/ft	

Table 5.2: Application Design Building Component Summary

Element	Information	Effective R-Value
Equipment Loads	<u>Ground Floor</u> 1.350 W/ft <u>Top Floor</u> 1.500 W/ft	

Case in Chapter 4, this building is organized into perimeter and core zones and contains conditioned and plenum spaces like those described in Figure 4.2c. The building envelope construction is a identical. The area of double-clear glazing is 25% of the exterior walls of the conditioned spaces with glass and aluminum doors on the North and South Faces. Internal loads are determined by a weighted average of uses typical of a commercial office building.

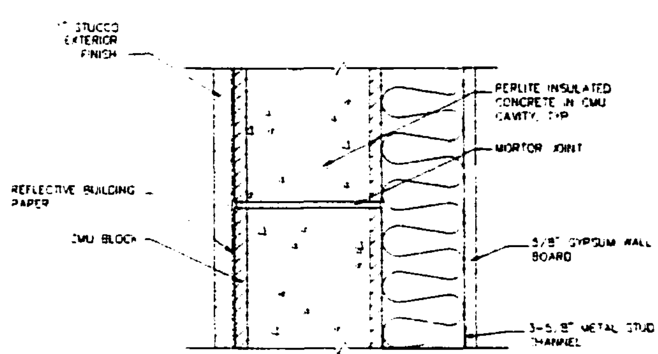


Figure 5.5: Exterior Wall Detail

The Comcheck Plus program is again used to determine a minimal compliance building against the ASHRAE 90.1-1989 Energy Standard[2]. Complete data for the Application Minimum Compliance Case building is summarized in Table 5.1. The results of the Comcheck simulation showed that the building exceeded the ASHRAE standard by a margin of 3%.

2. Refer to footnote 5 in Section 4.4.

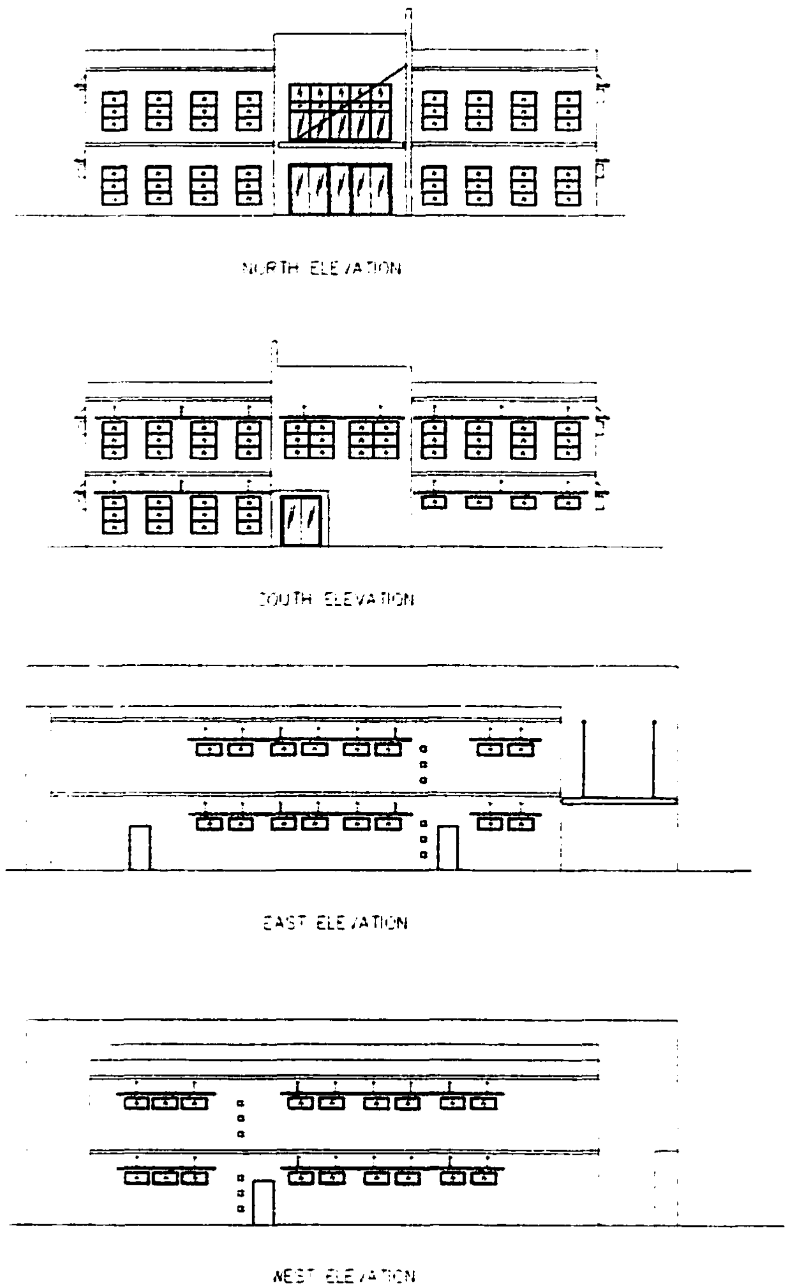
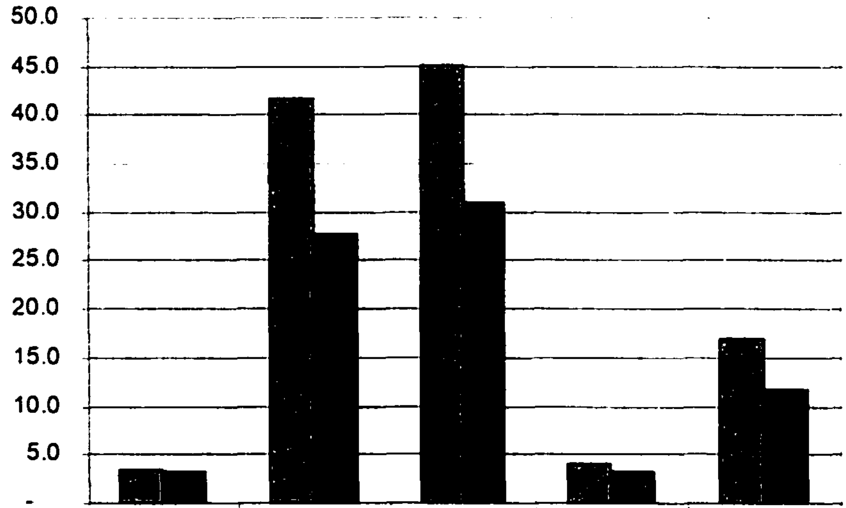


Figure 5.6: Application Design Building Elevations

The materials and components of the "Application Design Building" are summarized in Table 5.2 A detail of the exterior walls is shown in Figure 5.7. The glazing confirms to



	KBtu/SF Heating Energy	KBtu/SF Cooling Energy	KBtu/SF Total Energy	Btu/Hr/SF Max. Htg. Load	Btu/Hr/SF Max. Clg. Load
Application Min Compliance Case	3.4	41.7	45.1	4.1	17.1
Application Design Case	3.2	27.8	31.0	3.2	11.7

Figure 5.7: eQUEST Simulation Result Comparison

the 50%-North, 25%-South and the 12.5%-East/West configuration that was shown in Section 4.6.1. Figure 5.6 shows the elevations of Application Design building. The doors and windows in these elevations are identical to that which is simulated in the eQUEST program. The shading devices shown on the 4'x6' windows on the North and South facades are modeled using a single horizontal overhang with two vertical fins. Detached shading in the form of evergreen trees are modeled in eQUEST to match the design shown in the site plan in Figure 5.1.

The results of the energy use simulations are shown in Figure 5.6. The improvement in total energy usage is 31.3% with a 33.3% improvement in cooling energy usage. These results indicate two facts. The first is that using the results from the parametric studies results in a building that uses over 30% less energy for cooling and heating. The second

Table 5.3: Summary of Heating and Cooling Loads from Chapter 5 - eQUEST Simulation Results

Building Description	Annual Building Heating Loads (Mbtu)	Annual Building Cooling Loads (Mbtu)
Application Minimum Compliance Case Building	45.0	**541.7**
Application Design Case Building	44.1	**356.8**
Percent Difference	-2%	**-34.1%**

point is that when multiple strategies are used in combination with one another that many strategies mitigate their influence on the reduction of energy. This means that the total result from integrating the individual strategies will be less than the sum of the total.energy usage reduction of the individual strategies.

Table 5.4: GCHP Sizing Results

Application Minimum Compliance Case				Application Design Case			
Borehole Geometry: 3 Rectangular 2 x 6 1 Rectangular 2 x 4				Borehole Geometry: 3 Rectangular 2 x 6 1 Rectangular 2 x 4			
10 Year Run		25 Year Run		10 Year Run		25 Year Run	
Borehole Depth (Each)	300 Lineal Ft.	Borehole Depth (Each)	391 Lineal Ft.	Borehole Depth (Each)	188 Lineal Ft.	Borehole Depth (Each)	232 Lineal Ft.
Total Borehole Depth	12,611 Lineal Ft.	Total Borehole Depth	16,416 Lineal Ft.	Total Borehole Depth	7,886 Lineal Ft.	Total Borehole Depth	9,724 Lineal Ft.
				% Change	37.5%	% Change	40.8%

The same principle applies to the sizing of ground-loop heat exchanger since the size of a heat exchanger is based on annual building heating and cooling loads. Table 5.4

shows the results of sizing the ground-loop heat exchanger using the heating and cooling loads from the Application Minimum Compliance Case and the Application Design Case. The results show that by reducing the energy requirements of the building using the energy efficiency strategies of Chapter 4, the required size of the ground-loop heat exchanger improves by 37.5% over a 10 year period and by 40.8% over a 25 year period.

These results show that architectural design that integrates energy efficiency strategies into a building's design process can lead to a reduction in the required size of the ground-loop heat exchanger and a more efficient GCHP system The improvement will not necessarily be a summation of all the different energy efficiency strategies applied to a given building design, but will nevertheless lead to a significant improvement in energy efficiency as demonstrated in this chapter.

CHAPTER 6

LIFE-CYCLE COST ANALYSIS

6.1 Principles of Life-Cycle Cost Methodology

Chapter 5 showed the application of a GCHP system designed for an energy efficient commercial office building in the climate of Las Vegas. The final part of the work is to determine whether such a GCHP system is a cost effective alternative compared to other types of HVAC systems. To do this, I conducted a simple life-cycle cost study that compared a GCHP to several alternatives.

Table 6.1: Cost Components of the Life-cycle Cost Analysis (Dell'Isola 1995)

Current Costs	Future Costs
Initial Costs (incl. capital and installation costs)	Energy Costs Operation and Maintenance Costs Alteration and Replacement Costs Terminal Costs / Salvage Value Associated Costs

A Life-cycle Cost Analysis (LCCA) is a cost-centered analysis method that allows for the determination of costs for alternative solutions over a period of time (Dell'Isola 1995). The centerpiece to LCCA is the recognition of the time value of money (Addison 1999). Decision making often centers around the initial costs of a project with little or no regard to future costs. In terms of HVAC systems, the initial cost of a system includes capital

LCC = Initial investment costs

+ Present Value Energy Costs

+ Present Value Replacement Costs

+ Present Value Residual Value

Figure 6.1: Basic Life-cycle Cost Equation (Addison, 1999)

and installation costs. Future costs include operational costs, energy costs and replacement costs. These costs are listed in Table 6.1.

Money spent today does not have the same value as money spent in the future due to inflation and the use of existing capital for a particular project over other investment alternatives. In order to evaluate HVAC system alternatives in terms of both current and future costs, it is important to be able to estimate the value of a project over a period of time in terms of the total cost of the project in current dollars. The Federal Energy Management Program has developed a Life-cycle Cost Analysis method known as the Building Life-cycle Cost Procedure (BLCC). This study utilizes a spreadsheet implementation of this procedure known as *"User-Friendly" Life-Cycle Costing* developed by M.S. Addison and Associates.

The BLCC procedure uses the present value (PV) method for calculating Life-cycle costs according to the equation in Figure 6.1. This method discounts all future costs to their current dollar values in order to obtain the total cost of a project over a period of time in current dollars. The equations in Figure 6.2 define the discount rate for goods and services used by the BLCC spreadsheet. The first equation defines the present value, PV, to be equal to the future value of goods or services multiplied by the REAL discount rate,

$$PV = C_t \times \frac{1}{(1+r)^t} \qquad \text{where} \qquad r = \frac{1+R}{1+p} - 1$$

PV	=	present value of the future costs of goods and services
C_t	=	The future cost of goods and services in year t (equal the present costs of goods and services in year 0 when d is real)
r	=	the real discount rate (exclusive of inflation)
R	=	the assumed "nominal" discount rate for existing capital
p	=	the assumed rate of general inflation

Figure 6.2: Present Value Method Equations (Addison 1999)

d. The second equation defines *d* to be a function of the assumed nominal discount rate, *D* divided by the assumed rate of inflation, *i*. This assumed rate, *D*, is the nominal minimum rate-of-return that would be earned on that alternative investment (Addison 1999). The real discount rate, *d*, is an assumed net rate-of-return after inflation. Inflation, *i*, like the nominal discount rate D, is an assumed rate published by the Department of Energy each April (Addison 1999).

The BLCC procedure assumes that the inflation rate of energy is different than the rate applied to goods and services. The spreadsheet utilizes annual projections from the Department of Energy for energy inflation rates that are broken down according to the region of the country under consideration. These modified energy discount rates may be found in Appendix D.

6.2 Data Sources

Figure 6.1 outlines the data required to conduct a complete Life-cycle cost analysis. The first element of that formula is the initial cost of a project. For the estimation of the costs of a GCHP system for the office building described in Chapter 5, this work uses the methods and recommendations in the book *Ground-Source Heat Pumps* published by ASHRAE. I use the *1998 Edition Mechanical Cost Data* edition to estimate the cost of the GCHP system water-to-air heat pumps and the polyethylene pipe for the ground-loop heat exchanger. I also use this publication to estimate the equipment cost of the alternative HVAC systems based on square foot calculations from this publication. The cost of the other GCHP system components are derived using the recommendations in Ground-Source Heat Pumps and from guidance received from a practicing mechanical engineer in the Las Vegas area. In each case, the method and source is cited in footnotes and references.

Table 6.2: Utility Rate Schedules

	Meter Charge	Demand Charge	Consumption Charge
Electricity[a]	$ 21.00/meter	$ 3.29/kW	$0.072860/kWh
Natural Gas[b]	$ 20.00/meter	n/a	$0.574080/therm

a. Source: Nevada Power Company, Tariff no. 1-B (47th Revised)
b. Source: Southwest Gas Corporation, Nevada Gas Tariff No. 6 (11th Revised)

Equipment replacement costs and service lives are based on the tables in *Life Cycle Costing For Design Professionals* and on my discussions with a local mechanical engineer.[1] Replacement costs consist of the HVAC system and not of the components of

longer service duty such as ductwork and polyethylene piping. Residual costs are the present value of the estimated value of the system in the last year of the study.

Energy costs for each HVAC system are estimated using the eQUEST software using the Application Design Case building developed in Chapter 5. Utility rates are shown in Table 6.2. The utility rates assume meter charges for two meters since the building design allows for separate tenants on each floor.

Table 6.3: GCHP System Total Initial Costs (includes material and labor costs)

System Component	Estimated Cost	% of Total Cost	Cost Calculation	Data Source
Water-source Heat Pumps	$29,172	18%	Refer to Table 6.2	
Ductwork	$38,916	24%	$2.95/SF	Kavanaugh and Rafferty 1997
Control System	$3,298	2%	$0.25/SF	Coke Interview 2002
Interior Piping, Pumps, Fittings	$20,448	12%	$1.55/SF	Kavanaugh and Rafferty 1997
9,724 lineal feet[a] 1-1/4" polyethylene piping	$5,640	3%	$0.58/LF	RS Means 1998
Ground-loop installation cost[b]	$68,068	41%	$7.00/LF	Kavanaugh and Rafferty 1997
Subtotal - Ground-loop U-tube Cost	**$73,708**			
Total System Cost	**$165,542**	**100%**		

a. Result of ground-loop heat exchanger simulation. Refer to Section 5.2.
b. Includes U-tube insertion, backfilling, header installation @ 4ft. ground-loop purge. 6in. bore for 1-1/4" U-tubes, Bentonite grout to 28 ft., max. header to equipment room of 150 ft. and surface casing of less than 40 ft.

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1. On August 30,2002, I conducted an interview with Don Coke, a registered mechanical engineer in Nevada who reviewed the results of this life-cycle cost study.

6.3 GCHP System Installed Costs

GCHP systems are generally considered to have higher initial costs than other HVAC systems (Bloomquist 2001). The cost of various components of the ground-loop heat exchanger vary greatly according to soil and rock types and the availability of drilling expertise (Kavanaugh and Rafferty 1997). Among the different types of GCHP systems those that utilize a vertical ground-loop heat exchanger are the most expensive due to the labor-intensive nature of drilling the boreholes and installation. Table 6.3 shows significant components of a typical GCHP system. A breakdown of the water-source heat pumps by zone is shown in Table 6.4. Since the eQUEST software does not "autosize"

Table 6.4: Heat Pump Cost for GCHP System

Zone[a]	Equipment Capacity	Estimated Base Cost[b]	Additional Cost for Extended Range[c]	Total Cost
1	3.0 Ton	$2,352	+ $300	$2,652
2	2.5 Ton	$1,960	+ $250	$2,210
3	2.5 Ton	$1960	+ $250	$2,210
4	4.0 Ton	$3,136	+ $400	$3,536
5	3.0 Ton	$2,352	+ $300	$2,652
6	3.5 Ton	$2,744	+ $350	$3,094
7	3.0 Ton	$2,352	+ $300	$2,652
8	3.0 Ton	$2,352	+ $300	$2,652
9	5.0 Ton	$3,920	+ $500	$4,420
10	3.5 Ton	$2,744	+ $350	$3,094
Total	**33 Tons**			**$29,172**

a. Refer to Figure 5.4 for Thermal Zone Layout
b. Based on $784 / Ton cost. Source: (Kavanaugh and Rafferty, 1997)
c. Additional $100/Ton for extended range heat pump cost (Kavanaugh and Rafferty, 1997)

Table 6.5: Rooftop Multi-zone System Capacity

Zone	Thermal Zone Area	Calculated SF/Ton[a]	Equipment Size
Ground Floor	6,596 SF	458	(14.4) 15.0 Ton
Second Floor	6,596 SF	422	(15.6) 16.0 Ton
Total	**13,192 SF**		**30.0 Tons**

a. Equipment Sizing calculation result of eQUEST simulation - autosizing function. Data is derived by dividing SF/ton by area of thermal zone.

Table 6.6: Rooftop Single-zone System Capacities

Zone	Thermal Zone Area	Calculated SF/Ton[a]	Equipment Size
1	1,255 SF	492	(2.6) 3.0 Ton
2	1,132 SF	500	(2.3) 2.5 Ton
3	1,270 SF	525	(2.4) 2.5 Ton
4	1,754 SF	503	(3.5) 3.5 Ton
5	1,185 SF	489	(2.4) 2.5 Ton
6	1,255 SF	435	(2.9) 3.0 Ton
7	1,132 SF	432	(2.6) 3.0 Ton
8	1,270 SF	457	(2.8) 3.0 Ton
9	1,754 SF	434	(4.0) 4.0 Ton
10	1,185 SF	430	(2.8) 3.0 Ton
Total	**13,192 SF**		**30.0 Tons**

a. Equipment Sizing calculation result of eQUEST simulation - autosizing function. Data is derived by dividing SF/ton by area of thermal zone.

GCHP systems, the capacity of each unit is determined by entering the capacity data into the eQUEST software package from the manufacturers engineering specifications for each thermal zone.[2] The extended range water-source heat pumps are designed specifically for use with GSHP systems and work with entering fluid temperatures up to 110°F and as low as 20°F. The additional cost for the extended range capability is shown in Table 6.4 and is

Table 6.7: Rooftop Multi-zone and Single-zone System Costs Estimates

HVAC System Description	Estimated Cost	Cost Calculation[a]	Data Source
Rooftop Multi-zone (31 Ton[b] Total Capacity) (Electric Cooling, Gas Heating)	$170,836	$12.95 / SF	RS Means, 1998
Rooftop Single-zone (30 Ton[c] Total Capacity) (Electric Cooling, Gas Heating)	$92,740	$7.03 / SF	RS Means, 1998

a. System cost taken from *RS Means* is for an office of 10,000 SF with a 31.67 Ton System
b. Refer to Table 6.6 for sizing breakdown by zone.
c. Refer to Table 6.7 for sizing breakdown by zone.

estimated to be $100 per ton of capacity over the values provided in *RS Means Mechanical Cost Data* (Kavanaugh and Rafferty 1997). Ductwork, interior piping, pumps, fittings and ground-loop installation costs are all based on the cost per square-foot data provided in *Ground-Source Heat Pumps* that was multiplied by a factor of 1.0627 to account for inflation between the 1995 base year cost used in that document and the other data derived from the 1998 cost data used in this study.

6.4 Alternative HVAC System Installed Costs

The systems chosen for comparison with the GCHP system are a Rooftop Multi-zone system and a Rooftop Single-zone system. Both systems have electric cooling and gas heat and utilize return air plenums. The system capacities are estimated using the

2. The equipment specified in the energy simulations is the Climatemaster GR series water-to-air heat pumps. Simulations were conducted using the performance curves for extended range units provided by J. Hirsh and Associates for use with the eQUEST software.

Table 6.8: Summary of Inputs and Outputs from BLCC

	GCHP System	Rooftop Multi-zone	Rooftop Single-zone
Initial Costs	$165,542	$170,836	$96,634
First Year Electrical Costs	$4,774	$8,100	$3,622
First year Natural Gas Costs		$3,785	$575
Subtotal - Energy Cost	**$4,774**	**$11,885**	**$4,197**
First Year Maintenance Costs	$1,426	$1,800	$6,500
Subtotal - Annual O & M Costs	**$5,847**	**$13,685**	**$10,697**
Salvage Value (current dollars)	($7,526)	($25,910)	($29,312)
Life-cycle Costs	**$279,321**	**$459,194**	**$298,490**
	$22.40/SF	**$34.80/SF**	**$22.63/SF**

eQUEST software "autosizing" function which uses the building heating and cooling loads to determine the necessary capacity to satisfy those loads (Hirsh et al. 2001). The results are summarized in Table 6.7

The costs for these systems are taken directly out of *R. S. Means* publications. The method consists of choosing a square footage cost based on the building square footage, the required equipment capacity (calculated by eQUEST) and the building occupancy type. The system cost is then derived by multiplying the square footage cost by the building square footage.

6.5 Life-cycle Cost Analysis

Table 6.8 summarizes the data input into the BLCC spreadsheet to determine the Life-cycle costs for the GCHP system and the two alternative systems over a period of 25 years. The spreadsheet calculates present value in constant dollars for all initial costs and

recurring maintenance costs using dollar values from the 1998 edition of RS Means Mechanical Cost Data using the 2002 U.S. Department of Energy real discount rate of 3.2% and the energy escalation rate projections published by the National Institute of Standards and Technology for electricity and natural gas (Addison 1999).

The life-cycle cost study only considers energy costs attributable to HVAC loads. Other energy uses in the building are identical in all three simulations and thus do not affect the comparison. The results of the analysis show that the energy cost of the GCHP system is higher than that of the Single-zone rooftop system. This is directly related to the fact that in each of the thermal zones, the required capacity of the water-source heat pumps is higher than that of the single-zone rooftop units. According to the interview with Coke, this should not be the case. The reason being that typically, water-source heat pumps are inherently the more efficient of the two systems since the water-source heat pumps rely on a water-to-air heat exchange process to cool and heat air while the rooftop units rely on a less efficient air-to-air heat exchange process (Coke 2002).

The figures in Table 6.8 for the GCHP system first year maintenance cost is taken from a survey on commercial GCHP systems, *Operating Experiences with Commercial Ground Source Heat Pumps - Part 2* by Cane et al. 1998. The survey collected data from various locations throughout the United States and Canada on the maintenance and operating costs for GSHP systems in various building types. The figure of $10.81/SF used in this study is the mean cost in commercial office buildings averaged over all the years the systems were in use (Cane et al. 1998). The maintenance cost for the rooftop multi-zone and single zone systems are taken directly from the book, *Life Cycle Costing for Design Professionals* by A. Dell'Isola and S. Kirk. The figures for the GCHP system are

the lowest of all three HVAC systems. This is due to the simplicity of the system and the lack of maintenance required by the ground-loop heat exchanger. The system consisting of rooftop single-zone units has a total estimated maintenance cost that is more than four times the cost of the other two systems due to the amount of rooftop equipment required to condition ten separate thermal zones.

Dell'Isola' book lists rooftop multi-zone and single-zone equipment as having a service life of 20 years (Dell'Isola 1995). However, based on discussions I had with a local mechanical engineer, I have calculated life-cycle costs with a service life of 15 years since this is the service life predicted in practice given the severe climate of Las Vegas (Coke 2002). The replacement costs of the rooftop units requires that the entire unit be replaced with the exception of the ductwork. In the case of the GCHP, the heat pumps and the circulation pump also require replacement after 15 years but at a much lower cost than that of the other two systems. At the end of the twenty-fifth year, the salvage value is calculated as the present value of the remaining value of the equipment.

An overall comparison of the three systems indicates that from a life-cycle costing perspective, the GCHP system is the most economically viable system compared to the single-zone and multi-zone rooftop systems. Life-cycle costs of the GCHP system are 6.4% lower than those of the single-zone rooftop units and 36% than the multi-zone rooftop system. This is attributable to the GCHP system's lower first year maintenance costs and annual operational costs compared to either of the other two systems. The single-zone rooftop units have initial costs that are considerably lower than either of the other two systems. The most costly aspect of these systems is their maintenance and operational costs.

In terms of energy efficiency, the rooftop multi-zone system is by far the least efficient of the three systems, using more than 35% more energy than the single-zone rooftop units and 39% more than the GCHP system. The single-zone rooftop units are the most efficient of the three systems, outperforming the GCHP system by 11.5% and the rooftop multi-zone system by 64.7%. The GCHP system uses energy for heating and cooling with the water-source heat pumps and for pumps that circulate water through the heat pump loop and ground-loop heat exchanger. The energy use by the circulation pumps increases the amount of energy required for the overall system by 12%, making the GCHP system specified in this study less efficient from an energy efficiency standpoint.

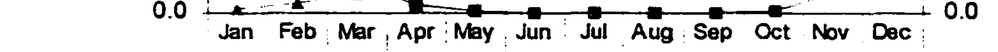
CHAPTER 7

CONCLUSION

7.1 Conclusions

The results of the parametric studies in Chapters 4 and their integration into a comprehensive design in Chapter 5 demonstrate that architectural design can significantly impact the sizing and long term performance of GCHP systems. GCHP systems also lend themselves to efficient architectural design. The design of the commercial office building in Chapter 5 shows that GCHP systems do not require large mechanical rooms and can incorporate heat pump units concealed above ceilings thus making extensive rooftop equipment or equipment located outside the building unnecessary.

The 38.9% reduction in the required size of the ground-loop heat exchanger in the



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cooling Energy	17.0	16.2	18.2	26.0	32.3	43.1	50.8	49.7	39.9	28.9	17.8	17.0
Heating Energy	12.3	7.0	7.1	1.6	0.6	0.0	0.0	0.0	0.0	0.5	4.8	10.3
Cumulative Difference	4.7	13.9	25.0	49.4	81.1	124.1	175.0	224.7	264.6	293.0	306.1	312.8

Figure 7.1: Application Building Design - Annual Cumulative Load Transfer of Heat

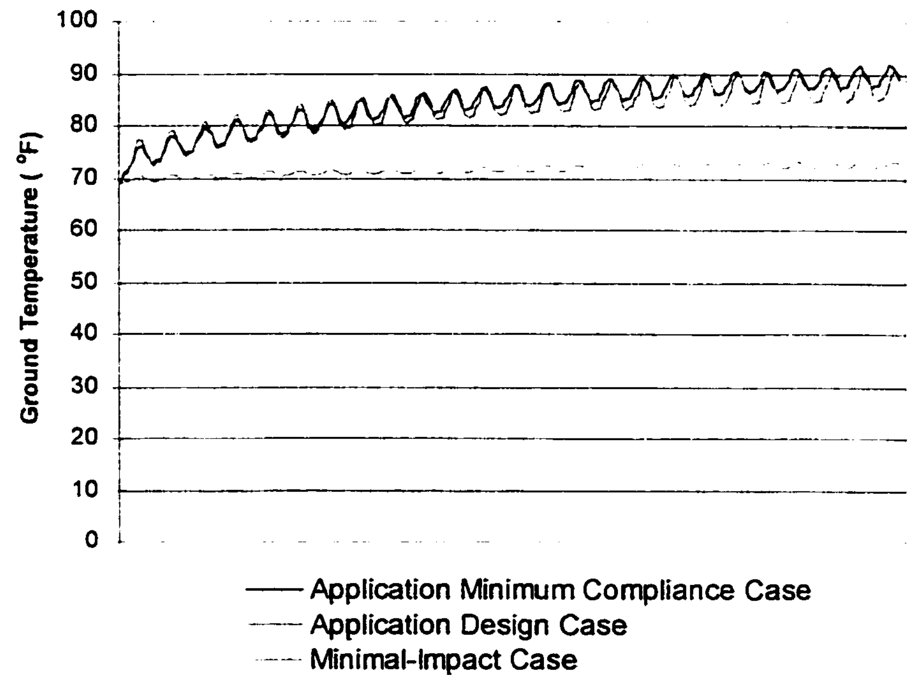


Figure 7.2: 25 -Year Ground Temperature Analysis

Application Design Case is a significant improvement over that of the Application Minimum Compliance Case. However, while there is a 34.1% reduction in cooling load requirements between these two buildings, Figure 7.1 shows that the amount of heat transfer to the ground versus the amount removed is still predicted to be over 8 times more annually. While these simulations assume very conservative ground thermal properties and minimal ground water conditions, such a dramatic imbalance is a concern to long-term system performance as well as a serious ecological concern.

Figure 7.2 shows the monthly ground temperature predicted over a period of 25 years for the Application Minimum Compliance Case and the Application Design Case buildings. The graph indicates that with the maximum temperature limit of 90°F for the entering fluid temperature into the heat pumps, that the ground temperature will rise over

Table 7.1: Minimal Ground-Temperature Impact Case - Life-cycle Cost Analysis Cost Comparison

	Minimal Ground Temperature Impact Case	Application Design Case	Percent Change
Initial Costs	$430,097	$165,542	160%
56,471 lineal feet - 1-1/4" polyethylene piping	$32,753	$5,670	478%
Ground-loop installation cost	$395,297	$68,068	481%
Energy Costs (PV cost over 25 years)	$94,000	$118,600	-21%
Total Life-cycle Costs	**$530,169 ($40.18/SF)**	**$279,321 ($22.40/SF)**	**90%**
Annual Energy Usage	117.5 Mbtu /Year	152.0 Mbtu/Year	-22.7%
Total Energy Usage (over 25 years)	**2937.5 Mbtu/Year**	**3,800 Mbtu/Year**	

time toward that limit given the size and configuration of the ground-loop heat exchanger. Figure 7.2 also shows the results of simulating a third scenario. The "Minimal Ground Temperature Impact Case" is the result of simulating a ground-loop heat exchanger for the Application Design Case building such that the maximum temperature of the fluid entering the heat pumps is 70°F. Each of the boreholes in this simulation is 1,351 feet deep for a total loop length of 56,741 feet. Table 7.1 shows the cost comparison between this simulation and the Application Design Case building from Chapter 5. The cost of the ground-loop heat exchanger assuming no increase in installation cost for such deep drilling would go from $165,542 to $430,097, an increase of 160%. Energy efficiency for the GCHP system increases by 22% for a life-cycle cost savings of $24,600 in present value dollars. This savings would only offset the additional cost of the system by about

20%. The total life-cycle cost increases to $530,169 making this system the most expensive when compared to the life-cycle cost of the multi-zone rooftop system and the single-zone rooftop systems in Chapter 6.

7.2 Recommendations for Further Research

The results described in Section 7.1 indicate that even with a climate responsive energy efficient building, a standard GCHP system is not necessarily the ideal solution for a commercial building in Las Vegas given the ground thermal properties assumed in this work. Since even small changes in the ground thermal properties can have profound effects on the efficiency of the system and on the long term effects of system use, it is important to better characterize the soil conditions for specific sites throughout the Las Vegas Valley to more precisely determine the thermal properties of the ground. By extension, it is also important to evaluate the impact of transferring a net balance of heat into the ground over an extended period of time. As of this writing, research into the long term effects of heat build-up in the ground is still inconclusive due to the short usage history of GCHP systems (ASHRAE, 1999).

The use of GCHP systems in other building types should also be investigated for Las Vegas. Other building types in which GCHPs are becoming more and more popular are schools (Kavanaugh, 2002). Schools tend to have abundant land area for ground-loops so that boreholes can be spaced farther apart than in the confines of a typical commercial office building. These building types also have extended holiday periods that might allow for any heat built up in the ground to naturally dissipate during periods of non-use.

Besides the standard GCHP system discussed in this study, there are several

alternative system configurations that are designed specifically to cope with severe imbalances between heating and cooling loads. For cold climates, boilers are sometimes included in a GCHP system design to add heat during cold winter months. For cooling dominated climates, several hybrid solutions exist. One such solution is a system where a portion of the heat being removed from the interior of a building is used to heat water for use in the building. When the system is in heating mode, the flow of heat is reversed and heat taken from the ground is used for water heating (Oklahoma State University 1988). A more substantial configuration incorporates a cooling tower. Adding a cooling tower reduces the amount of heat transferred to the ground and allows for a smaller ground-loop reducing the initial cost of the system (Kavanaugh and Rafferty 1997). A logical extension of this work is to investigate how hybrid GCHP systems could be implemented as a part of a climate responsive building design. Further research needs to include detailed studies of the ground thermal properties using the procedures describes in Chapter 2.

Examining architectural design priorities through models such as Hyde's Climate Responsive Design model allows architects and engineers to better prioritize passive and active strategies and design energy efficient buildings. GSHP systems, whether stand alone or combined with other systems and equipment, are an important part of this ongoing effort.

APPENDIX A

DATA FOR ESTIMATING GROUND THERMAL PROPERTIES

Downtown Las Vegas

Section	Depth	Description 1	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Soil, Gyp. Rock, White Clay	24	6	20	1.0	0.9
2	51-100	White Clay	50			0.6	0.5
3	101-150	White Clay	50			0.6	0.5
4	151-200	White Clay, Gyp. Rock	47		3	0.6	0.6
5	201-250	White Clay	50			0.6	0.5
6	251-300	White Clay	50			0.6	0.5
7	301-350	Red Sand & Sandstone		25	25	1.4	1.1
8	351-400	Red Sand, Sandstone, Shale		25	25	1.4	1.1
9	401-450	White Sand, Gravel, Blue Mud		50		1.2	1.0
10	451-500	White Sand, Red Sand		50		1.2	1.0
11	501-550	White Sand, Red Sand		50		1.2	1.0
12	551-600	Gravel, Red Sand		50		1.2	1.0
		Average To 300 ft.	90%	2%	8%	0.64	0.59
		Average To 600 ft	45%	43%	12%	0.96	0.81

Section	Depth	Description 4	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Sandy Clay, White Caliche	3		47	1.5	1.2
2	51-100	White Caliche, Clay, Gravel	12	12	26	1.3	1.0
3	101-150	Red Clay, Gravel, Sand	25	25		0.9	0.8
4	151-200	Red Clay, Gravel, Sand, Wr	30	20		0.8	0.7
5	201-250	Red Clay, Gravel, Sand, Wr	25	25		0.9	0.8
6	251-300	Gravel, Sand, Red Clay	15	35		1.2	0.9
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	37%	39%	24%	1.09	0.88

Section	Depth	Description 2	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Caliche			50	1.6	1.2
2	51-100	Caliche, White & Gray Clay	40		10	0.8	0.7
3	101-150	White & Gray Clay	50			0.6	0.5
4	151-200	Caliche and Limestone			50	1.7	1.2
5	201-250	Caliche and Limestone			50	1.7	1.2
6	251-300	Rock, sandy clay	40		10	0.8	0.7
7	301-350	Brown Sandy Clay, Gravel	25	25		0.9	0.8
8	351-400	Sandy Clay, Sandstone	35		15	0.9	0.7
9	401-450	Clay	50			0.6	0.5
10	451-500	Clay	50			0.6	0.5
11	501-550	Clay, Sand, Gravel	25	25		0.9	0.8
12	551-600	Clay, Gravel, Limestone	20	20	10	1.0	0.9
		Average To 300 ft.	43%	0%	57%	1.18	0.91
		Average To 600 ft	56%	12%	33%	0.99	0.80

Section	Depth	Description 5	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Soil, Clay, Limestone	15	12	23	1.3	1.0
2	51-100	Clay, Limestone	35		15	0.9	0.7
3	101-150	Clay, Limestone	35		15	0.9	0.7
4	151-200	Clay, Limestone	35		15	0.9	0.7
5	201-250	Clay, Limestone	35		15	0.9	0.7
6	251-300	Clay, Limestone	35		15	0.9	0.7
7	301-350	Clay, Sand, Water	45	5		0.6	0.6
8	351-400	Clay & Gravel, Sand	10	40		1.1	0.9
9	401-450	Clay	50			0.6	0.5
10	451-500	Clay	50			0.6	0.5
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	63%	4%	33%	0.93	0.77

Section	Depth	Description 3	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Soil, Caliche & Clay	37	3	10	0.8	0.7
2	51-100	Caliche, Sand & Clay	24	6	20	1.1	0.9
3	101-150	Clay	50			0.6	0.5
4	151-200	Clay, Gravel, Sand	22	28		1.1	0.8
5	201-250	Gravel, Sand & Clay	40	10		0.7	0.6
6	251-300	Clay with Limeshells	45		5	0.7	0.6
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	73%	16%	12%	0.81	0.68
		Average To 600 ft					

Section	Depth	Description 6	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Gravel, Clay	35	15		0.7	0.7
2	51-100	Clay	50			0.6	0.5
3	101-150	Clay	50			0.6	0.5
4	151-200	Clay	50			0.6	0.5
5	201-250	Clay	50			0.6	0.5
6	251-300	Clay	50			0.6	0.5
7	301-350	Sand, Clay	40	10		0.7	0.6
8	351-400	Clay	50			0.6	0.5
9	401-450	Clay	50			0.6	0.5
10	451-500	Clay	50			0.6	0.5
11	501-550	Clay and Gravel	41	9		0.7	0.6
12	551-600					0.0	0.0
		Average To 300 ft.	95%	5%	0%	0.58	0.55

	Conductivity	Diffusivity	Volumetric Heat Cap.
Average To 300 ft.	0.87	0.73	28.70

Henderson

Section	Depth	Description 1	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Soil, Sand, Clay	20	30		0.9	0.9
2	51-100	Clay, Gravel	37	13		0.7	0.9
3	101-150	Clay, Gravel, Sand	35	15		0.7	0.9
4	151-200	Clay, Gravel, Sand	35	15		0.7	0.9
5	201-250	Sand & Gravel, some clay	5	45		1.1	1.0
6	251-300	Sand & Gravel, some clay	15	35		1.0	0.9
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft. Average To 600 ft	49%	51%	0%	0.88	0.90

Section	Depth	Description 2	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Clay, Sand & Water	18	32		1.2	0.9
2	51-100	Clay, Gravel & Water	25	25		1.0	0.9
3	101-150	Clay, Cemented Gravel	10	40		1.3	1.0
4	151-200	Clay, Volcanic Gravel	10	40		1.3	1.0
5	201-250	Clay	50			0.6	0.8
6	251-300	Clay, Volcanic Gravel & Wtr	10	40		1.3	1.0
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft. Average To 600 ft	41%	59%	0%	1.11	0.92

Section	Depth	Description 3	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Sand & Clay	10	40		1.1	1.0
2	51-100	Clay & Gravel	30	20		0.9	0.9
3	101-150	Clay & Sand	40	10		0.7	0.8
4	151-200	Clay, Sand & Gravel	25	25		1.0	0.9
5	201-250	Clay, Sand & Gravel	25	25		0.9	0.9
6	251-300	Clay	50			0.6	0.8
7	301-350	Clay & Sand	25	25		0.9	0.9
8	351-400	Clay & Sand	25	25		0.9	0.9
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft. Average To 600 ft	60%	40%	0%	0.86	0.88

Section	Depth	Description 4	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Clay	50			0.6	0.8
2	51-100	Clay & Water	50			0.6	0.8
3	101-150	Clay	50			0.6	0.8
4	151-200	Clay & Gravel	30	20		0.8	0.9
5	201-250	Clay & Gravel	30	20		0.8	0.9
6	251-300	Clay, Gravel & Water	40	10		0.7	0.8
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	83%	17%	0%	0.67	0.83

Section	Depth	Description 5	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Sandy Clay	35	15		0.7	0.9
2	51-100	Clay, Gravel	47	3		0.6	0.8
3	101-150	Clay	50			0.6	0.8
4	151-200	Clay	50			0.6	0.8
5	201-250	Gravelly Clay	40	10		0.7	0.8
6	251-300	Gravelly Clay, Sandstone	35	10	5	0.8	0.9
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	86%	13%	2%	0.67	0.83

Section	Depth	Description 6	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Sand & Clay	25	25		0.9	0.9
2	51-100	Brown Clay	50			0.6	0.8
3	101-150	Sand, Gravel & Clay	25	25		0.9	0.9
4	151-200	Gravel & Clay	25	25		0.9	0.9
5	201-250	Clay, Cemented Gravel	20	30		1.1	0.9
6	251-300	Cemented Gravel		50		1.5	1.0
7	301-350	Gravel, White Clay & Sand	20	30		0.9	0.9
8	351-400	Sand & Clay	25	25		0.9	0.9
9	401-450	Gravel		50		1.2	1.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft. Average To 600 ft	48%	52%	0%	0.97	0.90

	Conductivity	Diffusivity	Volumetric Heat Cap.
Average To 300 ft.	0.86	0.88	23.46

Northwest Las Vegas

Section	Depth	Description 1	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Gravel, Rock & Clay	10	13	27	1.6	1.1
2	51-100	Clay & Gravel (water)	18	12	20	1.4	1.0
3	101-150	Clay	45	5		0.6	0.8
4	151-200	Sand, Clay & Gravel (water)	43	7		0.6	0.8
5	201-250	Gravel (water)		50		1.2	1.0
6	251-300	Gravel (water)		50		1.2	1.0
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	39%	46%	16%	1.11	0.95
		Average To 600 ft					

Section	Depth	Description 4	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Gravel, Clay	25	25		0.9	0.9
2	51-100	Gravel, Clay	25	25		0.9	0.9
3	101-150	Gravel, Clay	25	25		0.9	0.9
4	151-200	Gravel, Sand, Clay	25	25		0.9	0.9
5	201-250	Hard Gravel	15	35		1.0	0.9
6	251-300	Hard Gravel (water)		50		1.5	1.0
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	38%	62%	0%	1.00	0.92

Section	Depth	Description 2	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Gravel & Limestone	4	5	41	1.5	1.1
2	51-100	Lstone & Grvl (water), Clay	17	16	17	1.1	1.0
3	101-150	Red Clay	50			0.6	0.8
4	151-200	Yellow Clay, Gravel (water)	20	30		1.1	0.9
5	201-250	Yellow Clay	50			0.6	0.8
6	251-300	Gravel & Sand (water)		50		1.5	1.0
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	47%	34%	19%	1.05	0.94
		Average To 600 ft					

Section	Depth	Description 5	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Clay, Gravel, Rock	40	10	5	0.8	1.0
2	51-100	Clay, Gravel, Limestone	40	7	3	0.7	0.9
3	101-150	Clay, Gravel	40	10		0.7	0.8
4	151-200	Sand (water), Clay	3	47		1.4	1.0
5	201-250	Gravel, Sand (water)		50		1.5	1.0
6	251-300	Gravel, Sand (water)		50		1.5	1.0
7	301-350					0.0	0.0
8	351-400					0.0	0.0
9	401-450					0.0	0.0
10	451-500					0.0	0.0
11	501-550					0.0	0.0
12	551-600					0.0	0.0
		Average To 300 ft.	41%	58%	3%	1.11	0.94

Section	Depth	Description 3	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Clay & Sand	25	25		0.9	0.9
2	51-100	Clay, Sand, Gravel	40	10		0.7	0.8
3	101-150	Clay	50			0.6	0.8
4	151-200	Clay	50			0.6	0.8
5	201-250	Clay	50			0.6	0.8
6	251-300	Clay	50			0.6	0.8
7	301-350	Clay & Gravel	25	25		0.9	0.9
8	351-400	Clay, Sand, Caliche	20	20	10	1.0	1.0
9	401-450	Hard Gravel		50		1.2	1.0
10	451-500	Gravel, Sandstone		25	25	1.4	1.1
11	501-550	Clay	50			0.6	0.8
12	551-600	Clay	50			0.6	0.8
		Average To 300 ft.	103%	12%	0%	0.64	0.82
		Average To 600 ft	68%	26%	6%	0.78	0.88

Section	Depth	Description 6	Clay	Sand/Gravel	Rock	Conductivity	Diffusivity
1	0-50	Fill, Caliche, Clay	32	9	9	0.9	0.9
2	51-100	Clay, Caliche	43		7	0.7	0.9
3	101-150	Clay	50			0.6	0.8
4	151-200	Clay, Gravel	13	37		1.3	0.9
5	201-250	Gravel		50		1.5	1.0
6	251-300	Sand, Gravel		50		1.5	1.0
7	301-350	Sand, Gravel, Clay	36	14		0.7	0.9
8	351-400	Sand, Gravel		50		1.2	1.0
9	401-450	Sand, Gravel, Rock		46	4	1.2	1.0
10	451-500	Gravel, Clay	14	36		1.0	0.9
11	501-550	Gravel, Clay	14	36		1.0	0.9
12	551-600	Gravel		50		1.2	1.0
		Average To 300 ft.	58%	126%	5%	1.06	0.92
		Average To 600 ft	34%	63%	3%	1.06	0.94

	Conductivity	Diffusivity	Volumetric Heat Cap.
Average To 300 ft.	0.99	0.92	26.01

APPENDIX B

eQUEST SIMULATION DATA

Minimum Compliance Case DOE-B2.2D38c 3/22/2002 21:55:00 BDL RUN 1

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - E L E C - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	22.80966	17	15	67.F	46.F	131.325	-10.321	11	6	26.F	21.F	-41.160	4365.	20.736
FEB	23.52002	27	15	71.F	49.F	137.149	-5.599	3	6	34.F	26.F	-30.686	3716.	16.966
MAR	27.23593	22	15	70.F	46.F	128.504	-5.593	3	4	31.F	24.F	-33.079	4054.	16.168
APR	35.04138	22	15	89.F	58.F	142.669	-1.216	7	5	46.F	44.F	-17.178	4079.	14.983
MAY	41.60480	31	16	99.F	61.F	151.998	-0.436	21	4	43.F	38.F	-17.490	4122.	14.840
JUN	51.47204	27	16	112.F	65.F	171.355	0.000	15	4	51.F	42.F	-6.377	3838.	14.551
JUL	57.99835	24	16	110.F	65.F	169.200	0.000	0	0	0.F	0.F	0.000	4121.	14.584
AUG	56.81970	30	16	103.F	65.F	166.992	0.000	0	0	0.F	0.F	0.000	4124.	14.627
SEP	48.47853	20	16	99.F	60.F	163.752	0.000	0	0	0.F	0.F	0.000	3849.	14.757
OCT	37.70027	3	15	92.F	60.F	156.654	-0.569	23	6	47.F	37.F	-11.465	4192.	20.310
NOV	26.40711	8	15	71.F	50.F	135.974	-4.064	30	6	34.F	27.F	-26.649	3924.	20.633
DEC	23.31129	5	15	74.F	49.F	131.272	-6.771	13	6	29.F	21.F	-34.562	4333.	21.443
TOTAL	452.399						-36.569						48717.	
MAX						171.355						-41.160		21.443

Minimum Compliance Case DOE-B2.2D38c 3/22/2002 21:55:00 BDL RUN 1
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

	(UNITS=MBTU)	WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.433	0.000	0.000	-1.125	-2.647	-9.446	1.979	0.067	0.369	2.897	0.000	-10.321
JAN	SEN CL	-1.707	0.000	0.000	-0.767	-0.877	-0.047	12.237	2.937	3.342	7.692	0.000	22.810
	LAT CL					0.000			2.554		0.000	0.000	2.554
	HEATNG	-1.165	0.000	0.000	-1.215	-1.597	-5.755	1.634	0.059	0.169	2.261	0.000	-5.599
FEB	SEN CL	-1.163	0.000	0.000	-1.016	-0.647	1.166	12.856	2.559	2.680	7.084	0.000	23.520
	LAT CL					0.003			2.208		0.000	0.000	2.211
	HEATNG	-1.115	0.000	0.000	-1.290	-1.624	-5.924	1.818	0.065	0.150	2.327	0.000	-5.593
MAR	SEN CL	-1.257	0.000	0.000	-1.228	-0.686	1.589	15.141	2.835	2.823	8.021	0.000	27.236
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.082	0.000	0.000	-0.595	-0.490	-1.904	0.758	0.024	0.051	1.025	0.000	-1.216
APR	SEN CL	0.078	0.000	0.000	-1.576	0.006	4.207	17.022	3.002	2.899	9.413	0.000	35.041
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.056	0.000	0.000	-0.109	-0.201	-0.775	0.285	0.009	0.018	0.395	0.000	-0.436
MAY	SEN CL	1.207	0.000	0.000	-1.032	0.498	6.311	18.482	3.622	2.912	10.205	0.000	41.605
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.001	0.000	0.000	0.000	-0.002	-0.006	0.002	0.000	0.000	0.004	0.000	0.000
JUN	SEN CL	3.405	0.000	0.000	-0.041	1.978	12.306	18.454	2.761	2.683	9.925	0.000	51.472
	LAT CL					0.046			2.324		0.000	0.000	2.371
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.437	0.000	0.000	0.910	2.613	14.886	18.617	3.025	2.920	10.590	0.000	57.998
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.058	0.000	0.000	1.514	2.386	13.979	18.296	3.036	2.942	10.608	0.000	56.820
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	2.793	0.000	0.000	1.516	1.377	9.710	17.710	2.752	2.706	9.912	0.000	48.478
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.089	0.000	0.000	0.143	-0.373	-1.438	0.363	0.015	0.034	0.775	0.000	-0.569
OCT	SEN CL	0.268	0.000	0.000	0.934	-0.117	3.726	16.936	3.014	3.118	9.822	0.000	37.700
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.006	0.000	0.000	0.068	-1.461	-5.438	1.333	0.053	0.176	2.211	0.000	-4.064
NOV	SEN CL	-1.085	0.000	0.000	0.077	-0.670	1.151	13.867	2.570	3.042	7.455	0.000	26.407
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.161	0.000	0.000	-0.531	-2.407	-6.749	1.806	0.078	0.366	2.627	0.000	-8.771
DEC	SEN CL	-1.560	0.000	0.000	-0.384	-0.811	0.164	12.092	2.810	3.499	7.501	0.000	23.311
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-8.107	0.000	0.000	-4.655	-10.791	-39.437	9.978	0.390	1.333	14.719	0.000	-36.569
TOT	SEN CL	9.474	0.000	0.000	-1.093	5.049	69.153	191.710	34.321	35.557	108.233	0.000	452.404
	LAT CL					0.728			29.282		0.000	0.000	30.011

No Shading Case   DOE-B2.2D58c   3/30/2002   9:51:28 BDL RUN 1

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas   NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - E L E C - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	22.51283	17	15	67.F	46.F	129.540	-10.173	11	6	26.F	21.F	-40.623	4399.	20.863
FEB	23.09634	7	15	71.F	46.F	134.557	-5.516	3	6	34.F	26.F	-30.365	3743.	17.687
MAR	26.59022	21	15	70.F	46.F	125.674	-5.535	5	4	31.F	24.F	-32.669	4064.	17.047
APR	34.14654	22	15	89.F	58.F	149.522	-1.267	7	5	46.F	44.F	-16.984	4384.	15.106
MAY	40.53935	31	16	99.F	61.F	148.372	-0.434	21	4	43.F	36.F	-17.252	4125.	15.929
JUN	50.27290	27	16	112.F	65.F	167.549	0.005	25	4	57.F	42.F	-0.189	3840.	14.551
JUL	56.74369	24	16	110.F	65.F	165.443	0.000	0	0	0.F	0.F	0.000	4122.	14.719
AUG	55.63945	30	16	103.F	65.F	163.212	0.000	0	0	0.F	0.F	0.000	4127.	14.766
SEP	47.52390	20	16	99.F	60.F	160.099	0.000	0	0	0.F	0.F	0.000	3854.	14.888
OCT	37.08288	5	15	92.F	60.F	153.415	-0.552	23	6	47.F	37.F	-21.252	4221.	20.507
NOV	25.99265	8	15	71.F	50.F	133.981	-3.976	30	6	34.F	27.F	-26.145	3947.	20.742
DEC	23.01822	5	15	74.F	49.F	123.559	-8.636	13	6	29.F	21.F	-34.596	4059.	21.452
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TOTAL	443.159						-36.032						48886.	
MAX						167.549						-40.623		21.452

No Shading Case
REPORT- LS-F Building Monthly Load Components in MBTU

DOE-B2.2D36c 3/30/2002 9:51:26 BDL RUN 1
WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.473	0.000	0.000	-1.128	-2.650	-9.221	1.924	0.086	0.388	2.900	0.000	-10.173
JAN	SEN CL	-1.724	0.000	0.000	-0.767	-0.874	-0.013	11.820	2.940	3.435	7.695	0.000	22.513
	LAT CL					0.000			2.556		0.000	0.000	2.556
	HEATNG	-1.186	0.000	0.000	-1.221	-1.594	-5.629	1.588	0.059	0.191	2.276	0.000	-5.516
FEB	SEN CL	-1.173	0.000	0.000	-1.013	-0.640	1.170	12.372	2.559	2.745	7.676	0.000	23.096
	LAT CL					0.003			2.208		0.000	0.000	2.211
	HEATNG	-1.131	0.000	0.000	-1.296	-1.027	-5.789	1.352	0.065	0.157	2.335	0.000	-5.535
MAR	SEN CL	-1.272	0.000	0.000	-1.225	-0.663	1.551	14.515	2.836	2.851	8.020	0.000	26.590
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.082	0.000	0.000	-0.597	-0.493	-1.869	0.726	0.024	0.052	1.034	0.000	-1.207
APR	SEN CL	0.080	0.000	0.000	-1.576	0.010	4.078	16.239	3.003	2.905	9.408	0.000	34.147
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.058	0.000	0.000	-0.109	-0.201	-0.760	0.271	0.009	0.018	0.396	0.000	-0.434
MAY	SEN CL	1.227	0.000	0.000	-1.034	0.498	6.104	17.589	3.023	2.922	10.210	0.000	40.539
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.002	0.000	0.000	0.000	-0.002	-0.007	0.002	0.000	0.000	0.005	0.000	0.000
JUN	SEN CL	3.454	0.000	0.000	-0.041	1.976	11.949	17.553	2.762	2.688	9.930	0.000	50.273
	LAT CL					0.046			2.324		0.000	0.000	2.370
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.499	0.000	0.000	0.911	2.613	14.462	17.715	3.026	[illegible]	10.597	0.000	56.744
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.115	0.000	0.000	1.516	2.366	13.590	17.428	3.037	2.953	10.615	0.000	55.640
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	2.032	0.000	0.000	1.518	1.377	9.457	16.944	2.753	2.725	9.918	0.000	47.524
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.087	0.000	0.000	0.131	-0.360	-1.369	0.330	0.014	0.037	0.753	0.000	-0.552
OCT	SEN CL	0.268	0.000	0.000	0.948	-0.130	3.614	16.305	3.016	3.210	9.851	0.000	37.083
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.019	0.000	0.000	0.068	-1.467	-5.317	1.293	0.054	0.189	2.221	0.000	-3.978
NOV	SEN CL	-1.101	0.000	0.000	0.077	-0.664	1.166	13.387	2.571	3.106	7.451	0.000	25.993
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.200	0.000	0.000	-0.531	-2.415	-8.554	1.766	0.078	0.376	2.843	0.000	-8.638
DEC	SEN CL	-1.572	0.000	0.000	-0.383	-0.865	0.214	11.686	2.810	3.575	7.491	0.000	23.018
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-6.235	0.000	0.000	-4.665	-10.610	-38.514	9.650	0.369	1.466	14.764	0.000	-36.032
TOT	SEN CL	9.634	0.000	0.000	-1.069	5.068	67.345	183.545	34.335	36.039	108.269	0.000	443.166
	LAT CL					0.726			29.284		0.000	0.000	30.012

Window Placement - Building Case A — DOE-B2.2D... 3/30/2002 16:23:54 BDL RUN 1

REPORT- LS-D Building Monthly Loads Summary — WEATHER FILE- Las Vegas NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	25.45045	30	14	65.F	43.F	136.406	-10.529	11	6	26.F	21.F	-41.000	4625.	20.840
FEB	25.02612	7	14	69.F	47.F	143.230	-5.694	5	6	34.F	26.F	-30.992	3939.	18.030
MAR	27.48387	21	14	70.F	46.F	130.757	-5.967	6	4	31.F	24.F	-33.406	4265.	17.889
APR	33.13405	22	15	89.F	58.F	136.665	-1.504	7	5	45.F	44.F	-18.260	4361.	17.036
MAY	38.36578	31	16	99.F	61.F	139.980	-0.570	21	4	43.F	38.F	-16.469	4332.	17.764
JUN	47.65598	27	16	112.F	65.F	159.460	-0.007	15	4	57.F	42.F	-2.589	4621.	16.644
JUL	54.09705	24	16	110.F	65.F	157.269	0.000	0	0	0.F	0.F	0.000	4329.	17.262
AUG	53.43311	30	14	104.F	66.F	156.060	0.000	0	0	0.F	0.F	0.000	4342.	17.166
SEP	46.79194	27	14	95.F	63.F	160.872	-0.002	14	1	61.F	49.F	-0.442	4062.	17.410
OCT	38.40437	3	14	91.F	59.F	156.890	-6.767	23	6	47.F	37.F	-12.327	4459.	20.471
NOV	28.45605	6	14	72.F	50.F	144.204	-4.326	30	6	41.F	27.F	-27.624	4119.	20.879
DEC	26.03959	5	14	74.F	49.F	142.410	-6.977	19	6	29.F	21.F	-34.546	4549.	21.461
TOTAL	444.338						[illegible]						[illegible]	
MAX						160.872						-41.000		21.461

Window Placement - Building Case A
REPORT- LS-F Building Monthly Load Components in MBTU

DOE-B2.2D38c 3/30/2002 16:23:54 BDL RUN 1
WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATING	-2.480	0.000	0.000	-1.136	-2.684	-9.084	2.093	0.141	0.491	2.130	0.000	-10.529
	SEN CL	-1.658	0.000	0.000	-0.756	-0.840	0.185	13.060	2.853	4.332	6.275	0.000	25.450
	LAT CL					0.000			2.545		0.000	0.000	2.545
FEB	HEATING	-1.170	0.000	0.000	-1.236	-1.608	-5.569	1.670	0.085	0.274	1.646	0.000	-5.894
	SEN CL	-1.148	0.000	0.000	-0.995	-0.627	1.219	13.602	2.501	3.544	7.529	0.000	25.026
	LAT CL					0.003			2.208		0.000	0.000	2.211
MAR	HEATING	-1.094	0.000	0.000	-1.306	-1.634	-5.791	1.624	0.098	0.248	1.688	0.000	-5.967
	SEN CL	-1.244	0.000	0.000	-1.211	-0.676	1.433	14.163	2.771	3.749	8.472	0.000	27.484
	LAT CL					0.000			2.440		0.000	0.000	2.440
APR	HEATING	-0.066	0.000	0.000	-0.628	-0.503	-2.007	0.804	0.037	0.085	0.773	0.000	-1.504
	SEN CL	0.108	0.000	0.000	-1.542	0.019	3.689	14.582	2.958	3.632	9.486	0.000	33.134
	LAT CL					0.000			2.557		0.000	0.000	2.557
MAY	HEATING	-0.044	0.000	0.000	-0.125	-0.217	-0.888	0.329	0.015	0.034	0.326	0.000	-0.570
	SEN CL	1.254	0.000	0.000	-1.016	0.514	5.431	15.263	2.985	3.645	10.091	0.000	38.366
	LAT CL					0.000			2.557		0.000	0.000	2.557
JUN	HEATNG	0.005	0.000	0.000	0.000	-0.006	-0.031	0.011	0.000	0.001	0.013	0.000	-0.007
	SEN CL	3.451	0.000	0.000	-0.041	1.982	11.017	15.240	2.732	3.542	9.732	0.000	47.656
	LAT CL					0.044			2.324		0.000	0.000	2.368
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.485	0.000	0.000	0.910	2.613	13.438	15.386	2.995	3.863	10.407	0.000	54.097
	LAT CL					0.286			2.557		0.000	0.000	2.843
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.106	0.000	0.000	1.514	2.386	12.675	15.403	3.005	3.920	10.426	0.000	53.433
	LAT CL					0.341			2.557		0.000	0.000	2.898
SEP	HEATNG	0.002	0.000	0.000	0.000	-0.001	-0.010	0.002	0.000	0.000	0.005	0.000	-0.002
	SEN CL	2.824	0.000	0.000	1.516	1.379	8.905	16.060	2.724	3.662	9.723	0.000	46.792
	LAT CL					0.047			2.324		0.000	0.000	2.371
OCT	HEATNG	-0.080	0.000	0.000	0.145	-0.372	-1.536	0.397	0.024	0.366	0.569	0.000	-0.787
	SEN CL	0.273	0.000	0.000	0.931	-0.118	3.639	16.636	2.975	4.224	9.845	0.000	38.404
	LAT CL					0.005			2.557		0.000	0.000	2.561
NOV	HEATNG	-1.001	0.000	0.000	0.669	-1.161	-5.255	1.397	0.061	0.256	1.603	0.000	-4.326
	SEN CL	-1.091	0.000	0.000	0.076	-0.651	1.290	14.560	2.515	3.664	7.874	0.000	28.456
	LAT CL					0.000			2.206		0.000	0.000	2.206
DEC	HEATNG	-2.192	0.000	0.000	-0.539	-2.439	-8.407	1.913	0.126	0.466	2.072	0.000	-5.979
	SEN CL	-1.533	0.000	0.000	-0.376	-0.779	0.451	13.146	2.732	4.352	8.567	0.000	26.040
	LAT CL					0.000			2.435		0.000	0.000	2.435
TOT	HEATNG	-8.121	0.000	0.000	-4.755	-10.944	-38.577	18.448	0.613	1.943	10.826	0.000	-38.567
	SEN CL	9.828	0.000	0.000	-0.991	5.202	63.351	176.546	33.747	46.728	109.924	0.000	444.335
	LAT CL					0.726			29.270		0.000	0.000	29.996

Window Placement - Building Case B   DOE-B2.2D36c   3/24/2002   21:58:01   BDL RUN 6

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas   NV TMY2

MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
	- - - COOLING - - -						- - - HEATING - - -						- - - ELEC - - -	
JAN	22,98943	17	15	67.F	46.F	125,089	-10,646	11	6	26.F	21.F	-40,901	4547.	20,905
FEB	23,04261	27	15	71.F	49.F	130,462	-5,975	3	6	34.F	26.F	-31,070	3859.	18,763
MAR	26,11399	21	14	70.F	46.F	121,547	-5,986	5	4	31.F	24.F	-33,283	4192.	18,594
APR	32,75590	22	15	89.F	58.F	134,771	-1,477	7	5	46.F	44.F	-16,113	4210.	16,245
MAY	38,71230	31	16	99.F	61.F	142,185	-0,545	21	4	43.F	36.F	-18,213	4243.	18,101
JUN	48,21950	27	16	112.F	65.F	161,104	-0,005	15	4	57.F	42.F	-1,910	3936.	15,894
JUL	54,50009	24	16	110.F	65.F	158,935	0.000	0	0	0.F	0.F	0,000	4233.	16,553
AUG	53,31176	30	16	103.F	65.F	156,550	0,000	0	0	0.F	0.F	0,000	4249.	16,391
SEP	45,63663	20	16	99.F	60.F	153,660	-0,062	14	4	61.F	49.F	-0,470	3977.	16,939
OCT	36,29387	3	15	92.F	60.F	148,867	-0,827	29	6	47.F	37.F	-12,348	4374.	20,573
NOV	25,94969	8	14	72.F	50.F	131,245	-4,453	30	6	34.F	27.F	-27,143	4042.	21,028
DEC	23,39679	5	14	74.F	49.F	128,167	-9,126	13	6	29.F	21.F	-34,616	4466.	21,471
TOTAL	430,925						-39,042						50328.	
MAX						161,104						-40,901		21,471

Window Placement - Building Case B   DOE-B2.2D38c 3/24/2002 21:58:01 BDL RUN 8
REPORT- LS-F Building Monthly Load Components in MBTU   WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.445	0.000	0.000	-1.135	-2.675	-9.647	1.912	0.146	0.470	2.129	0.000	-10.646
JAN	SEN CL	-1.687	0.000	0.000	-0.758	-0.850	-0.194	11.252	2.849	4.096	8.280	0.000	22.989
	LAT CL					0.000			2.540		0.000	0.000	2.540
	HEATNG	-1.155	0.000	0.000	-1.231	-1.604	-5.549	1.561	0.091	0.265	1.647	0.000	-5.975
FEB	SEN CL	-1.151	0.000	0.000	-1.001	-0.630	0.879	11.624	2.501	3.290	7.532	0.000	23.043
	LAT CL					0.002			2.208		0.000	0.000	2.211
	HEATNG	-1.095	0.000	0.000	-1.304	-1.641	-5.740	1.752	0.100	0.240	1.702	0.000	-5.986
MAR	SEN CL	-1.246	0.000	0.000	-1.215	-0.669	1.200	13.359	2.771	3.451	6.462	0.000	26.114
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.065	0.000	0.000	-0.625	-0.511	-1.955	0.771	0.038	0.084	0.787	0.000	-1.477
APR	SEN CL	0.105	0.000	0.000	-1.547	0.027	3.595	14.608	2.958	3.532	9.478	0.000	32.756
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.047	0.000	0.000	-0.123	-0.216	-0.840	0.312	0.015	0.033	0.322	0.000	-0.545
MAY	SEN CL	1.253	0.000	0.000	-1.019	0.513	5.481	15.846	2.986	3.553	10.098	0.000	38.712
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.004	0.000	0.000	0.000	-0.004	-0.021	0.007	0.000	0.001	0.009	0.000	-0.005
JUN	SEN CL	3.463	0.000	0.000	-0.041	1.980	11.082	16.062	2.733	3.260	9.740	0.000	48.220
	LAT CL					0.045			2.324		0.000	0.000	2.369
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.507	0.000	0.000	0.911	2.613	13.440	16.076	2.996	3.547	10.410	0.000	54.500
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.133	0.000	0.000	1.515	2.386	12.535	15.696	3.006	3.611	10.430	0.000	53.312
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.002	0.000	0.000	0.000	-0.002	-0.011	0.002	0.000	0.000	0.006	0.000	-0.002
SEP	SEN CL	2.861	0.000	0.000	1.517	1.379	8.567	15.480	2.725	3.384	9.726	0.000	45.639
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.082	0.000	0.000	0.151	-0.396	-1.575	0.377	0.025	0.065	0.599	0.000	-0.827
OCT	SEN CL	0.305	0.000	0.000	0.927	-0.104	3.201	15.168	2.975	3.943	9.819	0.000	36.294
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-0.994	0.000	0.000	0.069	-1.480	-5.276	1.287	0.082	0.252	1.608	0.000	-4.453
NOV	SEN CL	-1.076	0.000	0.000	0.076	-0.652	0.896	12.703	2.515	3.616	7.872	0.000	25.950
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.162	0.000	0.000	-0.536	-2.431	-8.383	1.732	0.128	0.463	2.064	0.000	-9.126
DEC	SEN CL	-1.550	0.000	0.000	-0.380	-0.787	0.008	11.195	2.732	4.099	8.079	0.000	23.397
	LAT CL					0.000			2.432		0.000	0.000	2.432
	HEATNG	-8.039	0.000	0.000	-4.736	-10.949	-38.400	9.712	0.625	1.872	10.872	0.000	-39.043
TOT	SEN CL	9.915	0.000	0.000	-1.015	5.208	60.752	169.010	33.746	43.362	109.920	0.000	430.919
	LAT CL					0.726			29.261		0.000	0.000	29.988

Window Placement - Building Case C   DOE-B2.2D38c   3/24/2002   22:26:17   BDL RUN 13

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas   NV TMY2

MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
	COOLING						HEATING						ELEC	
JAN	24.97839	17	13	64.F	44.F	137.096	-10.597	11	6	26.F	21.F	-40.683	4908.	20.673
FEB	24.41964	7	14	69.F	47.F	141.846	-5.967	3	6	34.F	26.F	-36.897	4046.	18.107
MAR	26.56810	21	14	70.F	46.F	128.922	-6.042	5	4	31.F	24.F	-33.232	4410.	16.074
APR	31.81364	22	13	90.F	59.F	135.849	-1.572	7	5	46.F	44.F	-18.294	4432.	17.585
MAY	36.86553	31	16	99.F	61.F	134.145	-0.604	21	4	43.F	38.F	-16.402	4465.	18.001
JUN	46.14622	27	16	112.F	65.F	154.016	-0.011	15	1	57.F	42.F	-3.285	4142.	17.335
JUL	52.48137	26	13	105.F	69.F	153.231	0.000	0	0	0.F	0.F	0.000	4455.	17.713
AUG	51.75719	22	13	100.F	68.F	154.312	0.000	0	0	0.F	0.F	0.000	4472.	17.660
SEP	45.33587	20	13	97.F	59.F	158.843	-0.006	14	4	61.F	49.F	-0.797	4177.	17.798
OCT	37.46190	3	13	89.F	58.F	154.329	-0.906	23	6	47.F	37.F	-12.306	4574.	20.213
NOV	27.83744	8	13	72.F	50.F	144.320	-4.391	30	6	34.F	27.F	-26.874	4212.	20.602
DEC	25.58713	5	13	73.F	49.F	141.567	-9.030	13	6	29.F	21.F	-34.330	4632.	21.457
TOTAL	431.252						-39.124						52725.	
MAX						158.843						-40.683		21.457

Window Placement - Building Case C   DOE-2[illegible]   3/24/2002   2[illegible]:17   BDL RUN 13
REPORT- LS-F Building Monthly Load Components in MBTU   WEATHER FILE- Las Vegas   NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.499	0.000	0.000	-1.145	-2.701	-9.057	2.003	0.149	0.490	2.165	0.000	-10.597
JAN	SEN CL	-1.621	0.000	0.000	-0.746	-0.624	0.073	12.596	2.645	4.615	8.242	0.000	24.978
	LAT CL					0.000			2.535		0.000	0.000	2.535
	HEATNG	-1.168	0.000	0.000	-1.257	-1.614	-5.574	1.611	0.089	0.291	1.655	0.000	-5.967
FEB	SEN CL	-1.128	0.000	0.000	-0.973	-0.626	1.053	12.185	2.501	3.861	7.520	0.000	24.420
	LAT CL					0.002			2.208		0.000	0.000	2.211
	HEATNG	-1.075	0.000	0.000	-1.325	-1.630	-5.799	1.752	0.096	0.258	1.660	0.000	-6.042
MAR	SEN CL	-1.236	0.000	0.000	-1.192	-0.680	1.156	13.075	2.775	4.154	8.480	0.000	26.568
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.059	0.000	0.000	-0.632	-0.468	-2.056	0.777	0.036	0.088	0.755	0.000	-1.572
APR	SEN CL	0.126	0.000	0.000	-1.538	0.004	3.568	13.127	2.959	4.260	9.506	0.000	31.814
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.042	0.000	0.000	-0.126	-0.212	-0.931	0.333	0.015	0.035	0.325	0.000	-0.604
MAY	SEN CL	1.283	0.000	0.000	-1.015	0.510	5.048	13.677	2.985	4.285	10.692	0.000	36.866
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.005	0.000	0.000	0.000	-0.006	-0.040	0.014	0.000	0.001	0.015	0.000	-0.011
JUN	SEN CL	3.478	0.000	0.000	-0.041	1.983	10.561	13.764	2.732	3.940	9.730	0.000	46.146
	LAT CL					0.044			2.324		0.000	0.000	2.368
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.516	0.000	0.000	0.910	2.613	12.909	13.852	2.995	4.280	10.466	0.000	52.481
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.141	0.000	0.000	1.514	2.366	12.123	13.814	3.005	4.349	10.425	0.000	51.757
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.004	0.000	0.000	0.000	-0.003	-0.025	0.006	0.000	0.001	0.013	0.000	-0.006
SEP	SEN CL	2.856	0.000	0.000	1.515	1.381	8.449	14.652	2.723	4.644	9.715	0.000	45.336
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.069	0.000	0.000	0.131	-0.332	-1.621	0.395	0.022	0.055	0.513	0.000	-0.906
OCT	SEN CL	0.290	0.000	0.000	0.946	-0.159	3.411	15.478	2.977	4.615	9.901	0.000	37.462
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-0.978	0.000	0.000	0.069	-1.466	-5.256	1.337	0.078	0.251	1.576	0.000	-4.391
NOV	SEN CL	-1.093	0.000	0.000	0.076	-0.665	1.127	13.791	2.518	4.182	7.901	0.000	27.837
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.197	0.000	0.000	-0.542	-2.448	-8.383	1.843	0.130	0.475	2.092	0.000	-9.030
DEC	SEN CL	-1.510	0.000	0.000	-0.373	-0.770	0.321	12.505	2.728	4.639	8.047	0.000	25.587
	LAT CL					0.000			2.426		0.000	0.000	2.426
	HEATNG	-8.077	0.000	0.000	-4.826	-10.900	-38.739	10.072	0.616	1.945	10.786	0.000	-39.124
TOT	SEN CL	10.105	0.000	0.000	-0.919	5.158	59.640	162.315	33.743	51.247	109.961	0.000	431.250
	LAT CL					0.725			29.252		0.000	0.000	29.977

Window Placement - Building D   DOE-B2.2D38c   3/24/2002   22:03:51 BDL RUN 3

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	22,55061	17	15	67.F	46.F	121,716	-10.914	11	6	26.F	21.F	-41.469	4614.	20,712
FEB	22,55692	27	15	71.F	49.F	126.184	-6.155	3	6	34.F	26.F	-31,640	3938.	18,093
MAR	25,47853	21	14	70.F	46.F	120,725	-6.169	5	4	31.F	24.F	-33,645	4287.	17,889
APR	31,95222	22	15	89.F	58.F	[illegible]	-1.573	7	5	46.F	44.F	-16,545	4302.	17,038
MAY	37,68618	31	16	99.F	61.F	[illegible]	-0.592	[illegible]	4	43.F	36.F	-18,626	4332.	17,764
JUN	47,60273	27	16	112.F	65.F	[illegible]	-0,009	15	1	57.F	42.F	-2,678	4022.	16,644
JUL	53,86599	24	16	110.F	65.F	156,088	0.000	0	0	0.F	0.F	0,000	4329.	17,262
AUG	52,52211	2	16	104.F	72.F	153,636	0,000	0	0	0.F	0.F	0,000	4342.	17.166
SEP	44,82865	10	15	100.F	64.F	150,603	-0,006	14	4	61.F	49.F	-6,797	4062.	17,410
OCT	35,63110	3	14	91.F	59.F	145,557	-0.933	23	6	47.F	37.F	-12,760	4456.	20,274
NOV	25,43790	8	14	72.F	50.F	129.163	-4.617	30	6	34.F	27.F	-27,678	4116.	20,914
DEC	22,98136	5	14	74.F	49.F	126,602	[illegible]	[illegible]	6	29.F	21.F	-35,216	4536.	21,464
TOTAL	423,294						-40,436						51338.	
MAX						[illegible]						-41,469		21,464

Window Placement - Building Case D
REPORT- LS-F Building Monthly Load Components in MBTU

DOE-B2.2D3dc 5/24/2002 22:06:5. BDL RUN 9
WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATNG	-2.420	0.000	0.000	-1.137	-2.692	-9.321	1.877	0.150	0.479	2.150	0.000	-10.914
	SEN CL	-1.656	0.000	0.000	-0.754	-0.833	-0.225	10.610	2.844	4.310	6.256	0.000	22.551
	LAT CL					0.000			2.535		0.000	0.000	2.535
FEB	HEATNG	-1.128	0.000	0.000	-1.242	-1.613	-5.742	1.548	0.091	0.277	1.653	0.000	-6.155
	SEN CL	-1.134	0.000	0.000	-0.988	-0.621	0.326	10.914	2.500	4.537	7.523	0.000	22.557
	LAT CL					0.003			2.208		0.000	0.000	2.211
MAR	HEATNG	-1.056	0.000	0.000	-1.307	-1.636	-5.923	1.719	0.098	0.248	1.690	0.000	-6.169
	SEN CL	-1.255	0.000	0.000	-1.215	-0.674	1.374	12.526	2.771	3.755	6.471	0.000	25.479
	LAT CL					0.000			2.440		0.000	0.000	2.440
APR	HEATNG	-0.058	0.000	0.000	-0.630	-0.503	-2.054	0.772	0.037	0.066	0.777	0.000	-1.573
	SEN CL	0.125	0.000	0.000	-1.541	0.019	3.464	13.607	2.958	3.835	9.485	0.000	31.952
	LAT CL					0.000			2.557		0.000	0.000	2.557
MAY	HEATNG	-0.044	0.000	0.000	-0.125	-0.217	-0.911	0.326	0.015	0.034	0.330	0.000	-0.592
	SEN CL	1.268	0.000	0.000	-1.016	0.514	5.352	14.849	2.985	3.845	10.088	0.000	37.886
	LAT CL					0.000			2.557		0.000	0.000	2.557
JUN	HEATNG	0.004	0.000	0.000	0.000	-0.005	-0.031	0.010	0.000	0.001	0.011	0.000	-0.009
	SEN CL	3.457	0.000	0.000	-0.041	1.981	11.050	15.145	2.733	3.543	9.735	0.000	47.603
	LAT CL					0.044			2.324		0.000	0.000	2.369
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.497	0.000	0.000	0.910	2.613	13.424	15.156	2.995	3.864	10.407	0.000	53.866
	LAT CL					0.286			2.557		0.000	0.000	2.843
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.132	0.000	0.000	1.514	2.386	12.486	14.653	3.005	3.920	10.427	0.000	52.522
	LAT CL					0.341			2.557		0.000	0.000	2.898
SEP	HEATNG	0.004	0.000	0.000	0.000	-0.003	-0.026	0.006	0.006	0.001	0.013	0.000	-0.006
	SEN CL	2.871	0.000	0.000	1.515	1.361	8.494	14.467	2.724	3.662	9.726	0.000	44.629
	LAT CL					0.047			2.324		0.000	0.000	2.371
OCT	HEATNG	-0.071	0.000	0.000	0.148	-0.371	-1.607	0.389	0.024	0.062	0.573	0.000	-0.933
	SEN CL	0.323	0.000	0.000	0.929	-0.119	3.216	14.238	2.975	4.226	9.842	0.000	35.631
	LAT CL					0.005			2.557		0.000	0.000	2.561
NOV	HEATNG	-0.958	0.000	0.000	0.069	-1.483	-5.464	1.279	0.081	0.257	1.602	0.000	-4.617
	SEN CL	-1.071	0.000	0.000	0.075	-0.649	0.867	11.967	2.515	3.857	7.576	0.000	25.438
	LAT CL					0.000			2.208		0.000	0.000	2.208
DEC	HEATNG	-2.130	0.000	0.000	-0.539	-2.447	-8.650	1.750	0.134	0.475	2.589	0.000	-9.369
	SEN CL	-1.529	0.000	0.000	-0.376	-0.771	-0.005	10.563	2.725	4.326	6.051	0.000	22.981
	LAT CL					0.000			2.426		0.000	0.000	2.426
TOT	HEATNG	-7.859	0.000	0.000	-4.763	-15.968	-39.411	9.626	0.631	1.913	10.384	0.000	-40.336
	SEN CL	10.048	0.000	0.000	-0.951	5.226	60.027	158.676	33.730	46.676	109.871	0.000	423.291
	LAT CL					0.726			29.252		0.000	0.000	29.978

Fins & Overhangs All Sides   DOE-B2.2D38   4/27/2002   16:31:28   BDL RUN 5

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas   NV TMY2

MONTH	COOLING ENERGY (MBTU)	COOLING TIME OF MAX DY	COOLING TIME OF MAX HR	COOLING DRY-BULB TEMP	COOLING WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	HEATING TIME OF MAX DY	HEATING TIME OF MAX HR	HEATING DRY-BULB TEMP	HEATING WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	14.12664	17	13	64.F	44.F	82.745	-12.430	11	6	26.F	21.F	-42.453	4655.	21.152
FEB	13.50833	7	17	68.F	47.F	83.507	-7.266	3	6	34.F	26.F	-32.678	3918.	19.603
MAR	15.38117	26	17	66.F	49.F	87.688	-7.341	5	4	31.F	24.F	-35.336	4217.	19.041
APR	22.83766	29	16	88.F	56.F	102.663	-1.896	7	5	46.F	44.F	-19.217	4231.	17.426
MAY	28.35264	31	16	99.F	61.F	113.711	-0.720	21	4	43.F	38.F	-19.664	4261.	18.439
JUN	37.54233	28	16	108.F	64.F	131.204	-0.664	15	4	57.F	42.F	-1.796	3951.	16.426
JUL	43.50900	25	16	109.F	68.F	128.352	0.000	0	0	0.F	0.F	0.000	4247.	16.577
AUG	42.78545	1	16	106.F	69.F	126.025	0.000	0	0	0.F	0.F	0.000	4267.	16.639
SEP	34.34061	3	16	99.F	62.F	120.936	0.000	14	4	61.F	49.F	-0.019	4008.	17.001
OCT	23.65069	3	16	92.F	58.F	112.337	-0.364	15	5	47.F	35.F	-13.758	4444.	20.955
NOV	15.22330	8	16	71.F	50.F	85.381	-5.450	16	7	33.F	27.F	-24.634	4112.	21.163
DEC	14.40511	5	13	71.F	49.F	67.414	-16.[illegible]	13	6	[illegible].F	21.F	-36.[illegible]	4[illegible]9.	21.485
TOTAL	305.663						-46.[illegible]						[illegible].	
MAX						131.204						-42.[illegible]		21.485

Fins & Overhangs All Sides DOE-B2.2D38c 4/27/2002 16:32:26 BDL RUN 5

REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATNG	-2.960	0.000	0.000	-1.254	-2.916	-9.566	1.099	0.159	0.646	2.384	0.000	-12.430
	SEN CL	-1.418	0.000	0.000	-0.640	-0.609	-1.653	3.310	2.837	4.269	8.030	0.000	14.127
	LAT CL					0.000			2.547		0.000	0.000	2.547
FEB	HEATNG	-1.550	0.000	0.000	-1.409	-1.606	-5.913	0.974	0.110	0.369	1.945	0.000	-7.260
	SEN CL	-1.010	0.000	0.000	-0.825	-1.428	-0.736	3.410	2.463	3.377	7.238	0.000	13.508
	LAT CL					0.002			2.208		0.000	0.000	2.210
MAR	HEATNG	-1.462	0.000	0.000	-1.474	-1.915	-6.027	1.022	0.117	0.323	1.975	0.000	-7.341
	SEN CL	-1.178	0.000	0.000	-1.046	-0.495	-0.761	4.463	2.755	3.449	8.194	0.000	15.381
	LAT CL					0.000			2.440		0.000	0.000	2.440
APR	HEATNG	-0.126	0.000	0.000	-0.783	-0.595	-2.030	0.466	0.049	0.129	0.993	0.000	-1.896
	SEN CL	-0.037	0.000	0.000	-1.391	0.111	2.049	6.323	2.949	3.557	9.277	0.000	22.836
	LAT CL					0.000			2.557		0.000	0.000	2.557
MAY	HEATNG	-0.078	0.000	0.000	-0.162	-0.271	-0.914	0.211	0.021	0.050	0.423	0.000	-0.720
	SEN CL	1.095	0.000	0.000	-0.981	0.568	3.975	7.118	2.982	3.593	10.003	0.000	28.353
	LAT CL					0.000			2.557		0.000	0.000	2.557
JUN	HEATNG	0.006	0.000	0.000	0.000	-0.007	-0.024	0.004	0.000	0.001	0.015	0.000	-0.004
	SEN CL	3.335	0.000	0.000	-0.041	1.983	9.692	6.792	2.735	3.306	9.739	0.000	37.542
	LAT CL					0.043			2.324		0.000	0.000	2.367
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.372	0.000	0.000	0.911	2.613	12.017	6.592	2.997	3.591	10.416	0.000	43.509
	LAT CL					0.286			2.557		0.000	0.000	2.843
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	3.972	0.000	0.000	1.516	2.386	11.174	6.625	3.007	3.671	10.435	0.000	42.786
	LAT CL					0.341			2.557		0.000	0.000	2.898
SEP	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.001	0.000	0.000
	SEN CL	2.609	0.000	0.000	1.518	1.378	6.890	6.000	2.726	3.485	9.736	0.000	34.341
	LAT CL					0.047			2.324		0.000	0.000	2.371
OCT	HEATNG	-0.107	0.000	0.000	0.229	-0.527	-1.776	0.226	0.036	0.121	0.832	0.000	-0.964
	SEN CL	0.056	0.000	0.000	0.849	0.037	1.369	4.650	2.964	4.115	9.591	0.000	23.651
	LAT CL					0.005			2.557		0.000	0.000	2.561
NOV	HEATNG	-1.320	0.000	0.000	0.083	-1.709	-5.756	0.756	0.103	0.357	1.950	0.000	-5.486
	SEN CL	-0.995	0.000	0.000	0.062	-0.422	-0.658	3.497	2.495	3.734	7.536	0.000	15.223
	LAT CL					0.000			2.208		0.000	0.000	2.208
DEC	HEATNG	-2.646	0.000	0.000	-0.662	-2.670	-8.958	1.007	0.141	0.617	2.341	0.000	-10.670
	SEN CL	-1.297	0.000	0.000	-0.314	-0.548	-1.395	3.154	2.720	4.279	7.807	0.000	14.405
	LAT CL					0.000			2.438		0.000	0.000	2.438
TOT	HEATNG	-10.242	0.000	0.000	-5.371	-12.316	-40.838	5.766	0.738	2.615	12.858	0.000	-46.790
	SEN CL	9.505	0.000	0.000	-0.382	6.574	41.950	61.934	33.651	44.432	107.991	0.000	305.654
	LAT CL					0.724			29.275		0.000	0.000	30.000

Fins & Overhangs w/ Deciduous Trees All Sides DOE-B2.2D36c 4/27/2002 16:12:09 BDL RUN 3

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
	- - - - - - - - C O O L I N G - - - - - - - -						- - - - - - - - H E A T I N G - - - - - - - -						- - - E L E C - - -	
JAN	14.41873	17	13	64.F	44.F	83.512	-12.463	21	6	26.F	21.F	-42.201	4627.	21.343
FEB	13.67827	7	17	68.F	47.F	84.921	-7.321	1	6	34.F	26.F	-32.368	4191.	20.566
MAR	15.38292	26	17	68.F	49.F	88.478	-7.401	5	4	31.F	24.F	-35.222	4533.	20.359
APR	22.56925	29	16	88.F	58.F	103.608	-1.921	7	5	46.F	44.F	-19.196	4523.	18.567
MAY	27.86449	31	16	99.F	61.F	114.253	-0.741	21	4	43.F	38.F	-19.692	4523.	20.070
JUN	35.10088	27	16	112.F	65.F	126.006	-0.004	15	4	57.F	42.F	-2.100	4183.	17.588
JUL	41.23075	25	16	109.F	68.F	123.825	0.000	0	0	0.F	0.F	0.000	4502.	18.765
AUG	40.29846	19	16	105.F	65.F	120.497	0.000	0	0	0.F	0.F	0.000	4541.	18.440
SEP	32.08892	1	16	99.F	62.F	115.333	0.000	0	0	0.F	0.F	0.000	4289.	19.138
OCT	22.22751	3	16	92.F	58.F	105.684	-1.066	15	5	47.F	35.F	-14.134	4753.	21.251
NOV	14.27440	8	17	69.F	49.F	82.147	-5.679	30	7	35.F	27.F	-30.162	4358.	21.342
DEC	14.64696	5	13	73.F	49.F	89.175	-10.670	11	6	29.F	21.F	-35.945	4606.	21.497
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TOTAL	293.774						-47.466						54131.	
MAX						126.006						-42.201		21.497

Fins & Overhangs w/ Deciduous Trees All Sides DOE-B2.2D36c 4/27/2002 16:12:03 BDL RUN 3
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.964	0.000	0.000	-1.256	-2.921	-9.539	0.940	0.166	0.716	2.401	0.000	-12.463
JAN	SEN CL	-1.387	0.000	0.000	-0.636	-0.603	-1.736	2.836	2.836	5.090	8.013	0.000	14.411
	LAT CL					0.000			2.544		0.000	0.000	2.544
	HEATNG	-1.580	0.000	0.000	-1.412	-1.620	-5.892	0.667	0.169	0.434	1.971	0.000	-7.321
FEB	SEN CL	-0.971	0.000	0.000	-0.822	-0.414	-0.830	2.815	2.484	4.205	7.212	0.000	13.678
	LAT CL					0.002			2.208		0.000	0.000	2.210
	HEATNG	-1.500	0.000	0.000	-1.486	-1.831	-6.009	0.965	0.118	0.396	2.006	0.000	-7.401
MAR	SEN CL	-1.153	0.000	0.000	-1.035	-0.479	-0.907	3.626	2.754	4.413	8.163	0.000	15.383
	LAT CL					0.000			2.438		0.000	0.000	2.438
	HEATNG	-0.136	0.000	0.000	-0.786	-0.603	-2.015	0.414	0.049	0.147	1.009	0.000	-1.921
APR	SEN CL	-0.033	0.000	0.000	-1.387	0.119	1.866	5.281	2.948	4.496	9.261	0.000	22.569
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.087	0.000	0.000	-0.161	-0.274	-0.908	0.183	0.021	0.057	0.427	0.000	-0.741
MAY	SEN CL	1.102	0.000	0.000	-0.982	0.571	3.807	5.937	2.982	4.449	9.998	0.000	27.865
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.007	0.000	0.000	0.000	-0.008	-0.026	0.004	0.000	0.002	0.018	0.000	-0.004
JUN	SEN CL	3.094	0.000	0.000	-0.041	1.984	9.198	4.325	2.735	4.071	9.736	0.000	35.101
	LAT CL					0.042			2.324		0.000	0.000	2.367
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.110	0.000	0.000	0.911	2.613	11.538	4.213	2.997	4.432	10.416	0.000	41.231
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	3.688	0.000	0.000	1.516	2.386	10.633	4.060	3.007	4.574	10.435	0.000	40.299
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	2.306	0.000	0.000	1.518	1.377	6.379	3.639	2.726	4.407	9.736	0.000	32.089
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.174	0.000	0.000	0.238	-0.554	-1.524	0.160	0.040	0.154	0.595	0.000	-1.066
OCT	SEN CL	-0.144	0.000	0.000	0.841	0.964	1.056	2.825	2.961	5.096	9.528	0.000	22.228
	LAT CL					0.035			2.557		0.000	0.000	2.561
	HEATNG	-1.567	0.000	0.000	0.085	-1.775	-5.655	0.614	0.106	0.436	2.074	0.000	-5.879
NOV	SEN CL	-0.977	0.000	0.000	0.060	-0.357	-0.649	2.031	2.491	4.464	7.412	0.000	14.274
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.629	0.000	0.000	-0.602	-2.670	-8.783	0.866	0.139	0.666	2.545	0.000	-10.670
DEC	SEN CL	-1.274	0.000	0.000	-0.314	-0.548	-1.476	2.716	2.722	5.015	7.605	0.000	14.647
	LAT CL					0.000			2.438		0.000	0.000	2.438
	HEATNG	-10.629	0.000	0.000	-5.380	-12.455	-40.852	4.954	0.744	3.010	13.144	0.000	-47.465
TOT	SEN CL	8.361	0.000	0.000	-0.373	6.713	38.698	44.305	33.645	54.711	107.705	0.000	293.764
	LAT CL					0.723			29.270		0.000	0.000	29.993

Fins & Overhangs w/ Evergreen Trees East Side Only DOE-B2.2D38c 4/27/2002 21:20:30 BDL RUN 11

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	21.45422	17	15	67.F	46.F	129.791	-11.402	11	6	26.F	21.F	-42.149	4565.	20.799
FEB	21.27546	7	15	71.F	48.F	134.729	-6.496	3	6	34.F	26.F	-31.937	3904.	17.551
MAR	23.68072	28	16	69.F	48.F	123.460	-6.521	5	4	31.F	24.F	-34.540	4252.	16.975
APR	29.86065	11	16	84.F	55.F	137.555	-1.626	7	5	46.F	44.F	-18.384	4284.	16.461
MAY	35.20471	31	16	99.F	61.F	147.256	-0.612	21	4	41.F	38.F	-19.349	4321.	16.491
JUN	44.63747	27	16	112.F	65.F	166.754	-0.003	15	4	57.F	42.F	-1.682	4010.	16.184
JUL	50.98999	25	16	109.F	66.F	164.845	0.000	0	0	0.F	0.F	0.000	4514.	16.274
AUG	50.01273	30	16	103.F	65.F	163.627	0.000	0	0	0.F	0.F	0.000	4520.	16.253
SEP	43.01675	20	16	99.F	60.F	166.974	0.000	14	4	61.F	49.F	-0.069	4035.	16.365
OCT	33.92826	3	15	92.F	60.F	153.906	-0.825	29	6	47.F	37.F	-13.103	4418.	20.409
NOV	24.15956	8	15	71.F	50.F	134.240	-4.824	30	6	34.F	27.F	-27.982	4065.	20.723
DEC	22.04291	5	15	71.F	49.F	130.286	-9.776	13	6	29.F	21.F	-35.570	4505.	21.425
TOTAL	400.263						-42.079						51012.	
MAX						166.754						-42.149		21.425

Fins & Overhangs w/ Evergreen Trees East Side Only   DOE-B2.2D38c 4/27/2002 21:20:36 BDL RUN 11
REPORT- LS-F Building Monthly Load Components in MBTU   WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.708	0.000	0.000	-1.186	-2.777	-9.438	1.799	0.151	0.524	2.233	0.000	-11.402
JAN	SEN CL	-1.569	0.000	0.000	-0.709	-0.748	-0.269	9.619	2.846	4.103	8.181	0.000	21.454
	LAT CL					0.000			2.541		0.000	0.000	2.541
	HEATNG	-1.364	0.000	0.000	-1.307	-1.699	-5.818	1.532	0.097	0.299	1.783	0.000	-6.496
FEB	SEN CL	-1.076	0.000	0.000	-0.927	-0.535	0.771	9.745	2.496	3.403	7.400	0.000	21.275
	LAT CL					0.002			2.208		0.000	0.000	2.210
	HEATNG	-1.320	0.000	0.000	-1.372	-1.731	-5.980	1.673	0.106	0.267	1.829	0.000	-6.521
MAR	SEN CL	-1.227	0.000	0.000	-1.143	-0.579	0.320	10.990	2.766	3.620	8.340	0.000	23.681
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.111	0.000	0.000	-0.686	-0.552	-2.021	0.711	0.012	0.098	0.852	0.000	-1.626
APR	SEN CL	-0.036	0.000	0.000	-1.494	0.369	3.298	11.938	2.955	3.765	9.365	0.000	29.881
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.069	0.000	0.000	-0.134	-0.239	-0.873	0.282	0.017	0.039	0.365	0.000	-0.612
MAY	SEN CL	1.051	0.000	0.000	-1.008	0.536	5.116	12.660	2.985	3.804	10.061	0.000	35.205
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.005	0.000	0.000	0.000	-0.005	-0.020	0.005	0.000	0.001	0.011	0.000	-0.003
JUN	SEN CL	3.280	0.000	0.000	-0.041	1.982	10.850	12.587	2.735	3.504	9.742	0.000	44.637
	LAT CL					0.044			2.324		0.000	0.000	2.368
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.314	0.000	0.000	0.911	2.613	13.231	12.631	2.947	3.816	10.416	0.000	50.990
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	3.923	0.000	0.000	1.316	2.386	12.133	12.465	3.007	3.847	10.435	0.000	50.013
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.002	0.003	0.000	0.000	0.001	0.000	0.000
SEP	SEN CL	2.664	0.000	0.000	1.518	1.378	8.533	12.889	2.726	3.574	9.735	0.000	43.017
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.113	0.000	0.000	0.179	-0.449	-1.625	0.357	0.030	0.095	0.700	0.000	-0.825
OCT	SEN CL	0.173	0.000	0.000	0.899	-0.041	3.179	12.965	2.971	4.059	9.723	0.000	33.926
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.188	0.000	0.000	0.074	-1.561	-5.536	1.267	0.090	0.290	1.760	0.000	-4.824
NOV	SEN CL	-1.019	0.000	0.000	0.071	-0.551	0.863	10.842	2.509	3.720	7.725	0.000	24.160
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.409	0.000	0.000	-0.564	-2.528	-8.729	1.652	0.128	0.509	2.171	0.000	-9.770
DEC	SEN CL	-1.432	0.000	0.000	-0.352	-0.690	-0.010	9.633	2.733	4.184	7.977	0.000	22.043
	LAT CL					0.000			2.438		0.000	0.000	2.438
	HEATNG	-9.299	0.000	0.000	-4.388	-11.561	-40.041	9.290	0.663	2.122	11.737	0.000	-42.079
TOT	SEN CL	9.044	0.000	0.000	-0.766	5.819	56.975	138.965	33.726	45.598	109.112	0.000	400.274
	LAT CL					0.725			29.269		0.000	0.000	29.994

Fins & Overhangs w/ Evergreen Trees East & West Sides DOE-B2.2D38c 4/27/2002 21:26:11 BDL RUN 12

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - C O O L I N G - -						- - H E A T I N G - -						- - E L E C - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	19.52664	17	13	64.F	44.F	110.933	-11.955	11	6	26.F	21.F	-42.066	4746.	20.998
FEB	18.68034	7	13	68.F	47.F	114.172	-6.998	3	6	34.F	26.F	-32.113	4036.	18.765
MAR	19.99901	29	13	72.F	52.F	102.976	-7.099	5	4	31.F	24.F	-34.987	4374.	17.980
APR	25.03240	22	13	90.F	53.F	114.399	-1.867	7	5	46.F	44.F	-19.779	4367.	17.192
MAY	29.30610	15	13	93.F	56.F	113.984	-3.720	21	4	43.F	36.F	-19.756	4414.	17.836
JUN	38.46263	27	16	112.F	65.F	133.075	-0.364	15	4	57.F	42.F	-2.135	4093.	16.676
JUL	44.71671	26	13	105.F	69.F	131.961	0.000	0	0	0.F	0.F	0.000	4404.	17.396
AUG	44.41420	30	14	104.F	66.F	132.601	0.000	0	0	0.F	0.F	0.000	4420.	17.288
SEP	38.16483	20	13	97.F	59.F	135.137	0.000	14	4	61.F	49.F	-0.088	4143.	17.521
OCT	30.12093	3	13	89.F	58.F	130.087	-0.937	15	5	47.F	35.F	-13.276	4566.	20.717
NOV	21.69043	8	13	72.F	50.F	117.970	-5.204	30	7	33.F	27.F	-28.403	4223.	21.037
DEC	20.19201	5	13	73.F	49.F	11[illegible].705	-16.[illegible]	1[illegible]	6	29.F	21.F	-35.648	4659.	21.449
TOTAL	350.306						-45.[illegible]						524[illegible].	
MAX						135.137						-4[illegible].066		21.449

Fins & Overhangs w/ Evergreen Trees East & West Sides DOE-B2.2D38c 4/27/2002 21:36:11 BDL RUN 12
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATNG	-2.876	0.000	0.000	-1.219	-2.835	-9.496	1.379	0.157	0.619	2.316	0.000	-11.955
	SEN CL	-1.469	0.000	0.000	-0.676	-0.696	-0.706	7.537	2.839	4.593	8.098	0.000	19.527
	LAT CL					0.000			2.541		0.000	0.000	2.541
FEB	HEATNG	-1.554	0.000	0.000	-1.361	-1.755	-5.885	1.198	0.104	0.363	1.892	0.000	-6.998
	SEN CL	-0.999	0.000	0.000	-0.872	-0.479	6.247	7.233	2.469	3.770	7.292	0.000	18.680
	LAT CL					0.002			2.208		0.000	0.000	2.210
MAR	HEATNG	-1.493	0.000	0.000	-1.437	-1.792	-6.072	1.309	0.113	0.326	1.947	0.000	-7.099
	SEN CL	-1.177	0.000	0.000	-1.884	-0.518	0.209	7.629	2.759	3.960	8.222	0.000	19.999
	LAT CL					0.000			2.440		0.000	0.000	2.440
APR	HEATNG	-0.154	0.000	0.000	-0.735	-0.597	-2.112	0.575	0.047	0.124	0.968	0.000	-1.867
	SEN CL	-0.105	0.000	0.000	-1.435	0.113	2.493	7.662	2.550	4.674	9.282	0.000	25.032
	LAT CL					0.000			2.557		0.000	0.000	2.557
MAY	HEATNG	-0.086	0.000	0.000	-0.152	-0.268	-0.948	0.239	0.020	0.052	0.425	0.000	-0.720
	SEN CL	0.925	0.000	0.000	-0.991	0.566	4.099	7.629	2.982	4.095	10.002	0.000	29.306
	LAT CL					0.000			2.557		0.000	0.000	2.557
JUN	HEATNG	0.006	0.000	0.000	0.000	-0.007	-0.025	0.005	0.000	0.001	0.015	0.000	-0.004
	SEN CL	3.143	0.000	0.000	-0.041	1.983	9.755	7.369	2.735	3.776	9.739	0.000	38.463
	LAT CL					0.043			2.324		0.000	0.000	2.367
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.175	0.000	0.000	0.411	2.611	12.151	7.317	2.997	4.166	10.416	0.000	44.717
	LAT CL					0.286			2.557		0.000	0.000	2.843
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	3.799	0.000	0.000	1.516	2.386	11.426	7.672	3.007	4.175	10.435	0.000	44.414
	LAT CL					0.341			2.557		0.000	0.000	2.898
SEP	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.001	0.000	0.000
	SEN CL	2.530	0.000	0.000	1.516	1.378	7.635	8.717	2.726	3.926	9.735	0.000	38.165
	LAT CL					0.047			2.324		0.000	0.000	2.371
OCT	HEATNG	-0.145	0.000	0.000	0.200	-0.486	-1.692	0.256	0.034	0.119	0.777	0.000	-0.937
	SEN CL	0.096	0.000	0.000	0.876	-0.604	2.524	9.497	2.967	4.516	9.646	0.000	30.121
	LAT CL					0.005			2.557		0.000	0.000	2.561
NOV	HEATNG	-1.331	0.000	0.000	0.676	-1.634	-5.563	0.962	0.095	0.346	1.664	0.000	-5.204
	SEN CL	-0.954	0.000	0.000	0.567	-0.494	0.493	6.446	2.504	1.313	7.621	0.000	21.690
	LAT CL					0.000			2.208		0.000	0.000	2.208
DEC	HEATNG	-2.573	0.000	0.000	-0.585	-2.581	-8.750	1.231	0.133	0.500	2.235	0.000	-10.223
	SEN CL	-1.330	0.000	0.000	-0.331	-3.637	-0.415	7.678	2.128	4.667	7.895	0.000	20.192
	LAT CL					0.000			2.438		0.000	0.000	2.438
TOT	HEATNG	-10.208	0.000	0.000	-5.213	-11.955	-40.564	7.215	0.705	2.536	12.479	0.000	-45.006
	SEN CL	8.634	0.000	0.000	-6.540	6.213	49.816	94.415	33.664	49.706	108.370	0.000	350.296
	LAT CL					0.724			29.269		0.000	0.000	29.993

Fins & Overhangs w/ Evergreen Trees East, West & South Sides DOE-B2.2 [illegible] 4/27/2002 21:55:11 BDL RUN 1

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

MONTH	COOLING ENERGY (MBTU)	COOLING TIME OF MAX DY	COOLING TIME OF MAX HR	COOLING DRY-BULB TEMP	COOLING WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	HEATING TIME OF MAX DY	HEATING TIME OF MAX HR	HEATING DRY-BULB TEMP	HEATING WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	13.18188	18	13	68.F	40.F	74.668	-12.969	11	6	26.F	21.F	-42.750	4763.	21.160
FEB	12.77236	27	13	70.F	49.F	77.763	[illegible]	[illegible]	6	34.F	26.F	[illegible]	4051.	19.940
MAR	14.60521	29	17	70.F	50.F	79.330	-7.769	4	5	32.F	25.F	-36.237	4392.	19.099
APR	21.23200	22	16	89.F	58.F	98.257	-2.065	7	5	46.F	44.F	-19.598	4309.	17.501
MAY	26.67789	31	16	99.F	61.F	108.024	-0.782	21	4	43.F	38.F	[illegible]	4400.	16.864
JUN	36.52931	27	16	112.F	65.F	127.883	-0.065	15	4	57.F	42.F	-2.140	4073.	16.950
JUL	42.48810	24	16	110.F	65.F	124.874	0.000	0	0	0.F	0.F	0.000	4394.	17.910
AUG	41.03325	2	16	104.F	72.F	122.686	0.000	0	0	0.F	0.F	0.000	4412.	17.676
SEP	32.42252	3	16	99.F	62.F	115.698	0.000	14	4	61.F	49.F	-0.088	4153.	18.183
OCT	22.35131	3	16	92.F	58.F	[illegible]	-1.119	[illegible]	[illegible]	47.F	35.F	[illegible]	[illegible]	20.968
NOV	14.31698	6	17	69.F	49.F	[illegible]	[illegible]	[illegible]	7	[illegible]	[illegible]	[illegible]	4221.	21.242
DEC	13.43508	5	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21.F	[illegible]	[illegible]	21.491
TOTAL	291.046						[illegible]						[illegible]	
MAX						[illegible]						[illegible]		21.491

Fins & Overhangs w/ Evergreen Trees East, West & South Sides   DOE-B2.2D38c   4/27/2002   21:55:11   BDL RUN 1
REPORT- LS-F Building Monthly Load Components in MBTU   WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.195	0.000	0.000	-1.256	-2.956	-9.784	0.964	0.173	0.695	2.451	0.000	-12.909
JAN	SEN CL	-1.425	0.000	0.000	-0.638	-0.569	-1.656	2.309	2.824	1.574	7.963	0.000	13.182
	LAT CL					0.000			2.534		0.000	0.000	2.534
	HEATNG	-1.776	0.000	0.000	-1.401	-1.846	-6.104	0.678	0.113	0.405	2.016	0.000	-7.715
FEB	SEN CL	-1.029	0.000	0.000	-0.833	-0.389	-0.910	2.509	2.480	3.776	7.168	0.000	12.772
	LAT CL					0.002			2.206		0.000	0.000	2.210
	HEATNG	-1.711	0.000	0.000	-1.490	-1.872	-6.260	0.996	0.122	0.363	2.063	0.000	-7.789
MAR	SEN CL	-1.202	0.000	0.000	-1.031	-0.437	-0.936	3.372	2.750	3.983	8.106	0.000	14.605
	LAT CL					0.000			2.439		0.000	0.000	2.439
	HEATNG	-0.207	0.000	0.000	-0.792	-0.622	-2.149	0.453	0.052	0.140	1.062	0.000	-2.065
APR	SEN CL	-0.195	0.000	0.000	-1.382	0.139	1.691	4.759	2.946	4.066	9.208	0.000	21.232
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.105	0.000	0.000	-0.163	-0.281	-0.961	0.199	0.022	0.055	0.452	0.000	-0.762
MAY	SEN CL	0.842	0.000	0.000	-0.979	0.578	3.596	5.640	2.980	4.047	9.973	0.000	26.678
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.007	0.000	0.005	0.000	-0.008	-0.027	0.005	0.000	0.002	0.018	0.000	-0.005
JUN	SEN CL	3.103	0.000	0.000	-0.041	1.984	9.471	5.830	2.735	3.712	9.736	0.000	36.529
	LAT CL					0.042			2.324		0.000	0.000	2.367
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.124	0.000	0.000	0.911	2.613	11.762	5.622	2.997	4.042	10.416	0.000	42.488
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	3.680	0.000	0.000	1.516	2.386	10.718	5.144	3.007	4.148	10.435	0.000	41.033
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.001	0.000	0.000
SEP	SEN CL	2.281	0.000	0.000	1.518	1.378	6.356	4.468	2.726	3.960	9.735	0.000	32.423
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.184	0.000	0.000	0.243	-0.562	-1.924	0.209	0.041	0.143	0.915	0.000	-1.119
OCT	SEN CL	-0.161	0.000	0.000	0.835	0.072	1.110	3.476	2.960	4.557	9.508	0.000	22.351
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.550	0.000	0.000	0.084	-1.759	-5.932	0.602	0.108	0.392	2.047	0.000	-5.926
NOV	SEN CL	-1.023	0.000	0.000	0.061	-0.373	-0.643	2.504	2.491	4.062	7.439	0.000	14.317
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.872	0.000	0.000	-0.601	-2.697	-9.034	0.661	0.145	0.650	2.367	0.000	-11.160
DEC	SEN CL	-1.320	0.000	0.000	-0.316	-0.521	-1.629	2.174	2.716	4.569	7.761	0.000	13.435
	LAT CL					0.000			2.436		0.000	0.000	2.436
	HEATNG	-11.594	0.000	0.000	-5.375	-12.603	-42.177	5.247	0.776	2.844	13.411	0.000	-49.471
TOT	SEN CL	7.676	0.000	0.000	-0.379	6.961	38.550	47.801	33.613	49.497	107.438	0.000	291.037
	LAT CL					0.724			29.259		0.000	0.000	29.983

Fins & Overhangs w/ Evergreen Trees All Sides DOE-B2.2D33c 4/27/2002

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	13,31142	16	14	69.F	49.F	74.491	-12.901	11	6	26.F	21.F	-42.431	4927.	21.343
FEB	12,68972	7	17	68.F	47.F	78.280	-7,711	3	7	34.F	26.F	-33.106	4191.	20.560
MAR	14,23579	26	17	68.F	49.F	79.737	-7,819	4	5	32.F	25.F	-35,908	4533.	20.359
APR	20,66071	22	16	69.F	58.F	96.319	-2,079	7	5	46.F	44.F	-19,478	4523.	18,567
MAY	25,65811	31	16	99.F	61.F	106.519	-0.608	21	4	43.F	38.F	-19,919	4523.	20.070
JUN	35,08099	27	16	112.F	65.F	126.006	-0.005	15	4	57.F	42.F	-2,101	4163.	17,568
JUL	41,23075	25	16	109.F	68.F	123,625	0.000	0	0	0.F	0.F	0.000	4502.	18.765
AUG	40,29846	19	16	105.F	65.F	120.497	0.000	0	0	0.F	0.F	0.000	4541.	18.440
SEP	32,06892	3	16	99.F	62.F	115.333	0.000	0	0	0.F	0.F	0.000	4289.	19.138
OCT	22,22751	3	16	92.F	56.F	105.664	-1.066	15	5	47.F	35.F	-14.134	4753.	21.251
NOV	14,27448	6	17	69.F	49.F	82.147	-5.879	30	7	33.F	27.F	-30.182	4358.	21.342
DEC	13,55655	5	13	73.F	49.F	81.056	-11.117	13	6	29.F	21.F	-36.256	4808.	21.497
TOTAL	285,313						-49.364						54131.	
MAX						126.006						-42.431		21.497

Fins & Overhangs w/ Evergreen Trees All Sides
REPORT- LS-F Building Monthly Load Components in MBTU

WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATNG	-3.194	0.000	0.000	-1.260	-2.358	-9.672	0.820	0.167	0.714	2.452	0.000	-12.901
	SEN CL	-1.397	0.000	0.000	-0.634	-0.567	-1.892	1.948	2.630	5.061	7.962	0.000	15.311
	LAT CL					0.000			2.541		0.000	0.000	2.541
FEB	HEATNG	-1.802	0.000	0.000	-1.422	-1.862	-6.042	0.798	0.113	0.460	2.046	0.000	-7.711
	SEN CL	-0.980	0.000	0.000	-0.812	-0.372	-0.942	1.998	2.480	4.180	7.137	0.000	12.690
	LAT CL					0.002			2.208		0.000	0.000	2.210
MAR	HEATNG	-1.724	0.000	0.000	-1.504	-1.883	-6.184	0.856	0.122	0.417	2.062	0.000	-7.819
	SEN CL	-1.173	0.000	0.000	-1.017	-0.426	-1.036	2.658	2.750	4.392	8.087	0.000	14.236
	LAT CL					0.000			2.438		0.000	0.000	2.438
APR	HEATNG	-0.210	0.000	0.000	-0.803	-0.627	-2.100	0.363	0.052	[illegible]	1.070	0.000	-2.079
	SEN CL	-0.181	0.000	0.000	-1.371	0.143	1.586	3.650	2.946	4.488	9.200	0.000	20.661
	LAT CL					0.000			2.557		0.000	0.000	2.557
MAY	HEATNG	-0.115	0.000	0.000	-0.168	-0.290	-0.962	0.176	0.023	0.062	0.466	0.000	-0.808
	SEN CL	0.852	0.000	0.000	-0.975	0.587	3.436	4.372	2.980	4.445	9.959	0.000	25.658
	LAT CL					0.000			2.557		0.000	0.000	2.557
JUN	HEATNG	0.006	0.000	0.000	0.000	-0.008	-0.026	0.003	0.000	0.002	0.018	0.000	-0.005
	SEN CL	3.085	0.000	0.000	-0.041	1.984	9.198	4.313	2.735	4.071	9.736	0.000	35.081
	LAT CL					0.042			2.324		0.000	0.000	2.367
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.110	0.000	0.000	0.911	2.613	11.538	4.213	2.997	4.432	10.416	0.000	41.231
	LAT CL					0.286			2.557		0.000	0.000	2.843
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	3.688	0.000	0.000	1.516	2.386	10.633	4.060	3.007	4.574	10.435	0.000	40.299
	LAT CL					0.341			2.557		0.000	0.000	2.898
SEP	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	2.306	0.000	0.000	1.518	1.377	6.379	3.639	2.726	4.407	9.736	0.000	32.089
	LAT CL					0.047			2.324		0.000	0.000	2.371
OCT	HEATNG	-0.174	0.000	0.000	0.238	-0.554	-1.824	0.160	0.046	0.154	0.495	0.000	-1.066
	SEN CL	-0.144	0.000	0.000	0.841	0.764	1.056	2.625	2.361	5.096	9.526	0.000	22.226
	LAT CL					0.005			2.557		0.000	0.000	2.561
NOV	HEATNG	-1.567	0.000	0.000	0.085	-1.775	-5.655	0.614	0.108	0.438	2.074	0.000	-5.879
	SEN CL	-0.977	0.000	0.000	0.060	-0.357	-0.849	2.031	2.491	4.464	7.412	0.000	14.274
	LAT CL					0.000			2.208		0.000	0.000	2.208
DEC	HEATNG	-2.867	0.000	0.000	-0.604	-2.702	-8.911	0.748	0.142	0.682	2.395	0.000	-11.117
	SEN CL	-1.288	0.000	0.000	-0.312	-0.516	-1.638	1.841	2.719	4.999	7.753	0.000	13.557
	LAT CL					0.000			2.437		0.000	0.000	2.437
TOT	HEATNG	-11.647	0.000	0.000	-5.438	-12.659	-41.576	4.560	0.767	3.113	13.498	0.000	-49.383
	SEN CL	7.902	0.000	0.000	-0.316	6.918	37.470	37.749	33.622	54.608	107.352	0.000	285.304
	LAT CL					0.723			29.266		0.000	0.000	29.989

Building A - 25' x 200' Building   DOE-B2.2D38c   5/06/2002   22:45:46   BDL RUN 3

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas   NV TMY2

MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
JAN	29,25465	17	13	64.F	44.F	186,766	-17,163	11	6	26.F	21.F	-66,737	3764.	20,421
FEB	29,41603	7	13	68.F	47.F	193,851	-9,806	3	6	34.F	26.F	-50,167	3159.	15,220
MAR	30,47233	21	13	69.F	45.F	163,987	-10,177	5	4	31.F	24.F	-55,178	3437.	13,394
APR	36,64095	1	13	79.F	57.F	173,839	-2,723	7	5	46.F	44.F	-30,611	3429.	11,976
MAY	43,02683	15	13	93.F	56.F	161,992	-1,027	21	4	43.F	38.F	-31,493	3466.	12,147
JUN	58,53483	27	16	112.F	65.F	186,187	-0,066	15	4	57.F	42.F	-3,743	3233.	11,976
JUL	67,82261	26	13	105.F	69.F	194,241	0,000	0	0	0.F	0.F	0,000	3465.	11,976
AUG	67,49586	22	13	100.F	68.F	206,116	0,000	0	0	0.F	0.F	0,000	3468.	11,976
SEP	60,11216	30	13	93.F	57.F	214,227	0,000	14	4	61.F	49.F	-0,237	3213.	11,976
OCT	47,86510	25	13	80.F	55.F	208,332	-1,376	23	6	47.F	37.F	-20,855	3537.	19,822
NOV	35,40380	8	13	72.F	50.F	196,096	-7,162	30	6	34.F	27.F	-43,791	3405.	20,370
DEC	31,01058	5	13	73.F	49.F	192,477	-14,494	23	6	29.F	26.F	-55,652	3799.	21,421
TOTAL	537,056						-63,672						41404.	
MAX						214,227						-66,737		21,421

Building A - 25' x 200' Building
REPORT- LS-F Building Monthly Load Components in MBTU

DOE-2.1E [illegible] BDL RUN 3
WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATNG	-3.810	0.000	0.000	-1.800	-4.262	-14.799	3.540	0.219	0.639	3.172	0.000	-17.100
	SEN CL	-2.571	0.000	0.000	-0.990	-1.251	0.799	22.225	2.722	1.273	7.047	0.000	29.255
	LAT CL					0.000			2.535		0.000	0.000	2.535
FEB	HEATNG	-1.882	0.000	0.000	-1.961	-2.589	-9.141	2.799	0.142	0.329	2.497	0.000	-9.806
	SEN CL	-1.733	0.000	0.000	-1.329	-0.306	2.377	21.234	2.402	0.655	6.515	0.000	29.416
	LAT CL					0.004			2.206		0.000	0.000	2.212
MAR	HEATNG	-1.918	0.000	0.000	-2.110	-2.692	-9.576	3.023	0.158	0.364	2.643	0.000	-10.177
	SEN CL	-1.961	0.000	0.000	-1.554	-0.321	2.467	21.670	2.659	0.820	7.333	0.000	30.472
	LAT CL					0.000			2.441		0.000	0.000	2.441
APR	HEATNG	-0.165	0.000	0.000	-1.112	-0.996	-3.410	1.336	0.066	0.132	1.345	0.000	-2.723
	SEN CL	-0.167	0.000	0.000	-2.090	0.139	5.722	20.523	2.875	0.841	8.732	0.000	36.641
	LAT CL					0.000			2.557		0.000	0.000	2.557
MAY	HEATNG	-0.097	0.000	0.000	-0.227	-0.390	-1.500	0.531	0.028	0.055	0.573	0.000	-1.027
	SEN CL	1.486	0.000	0.000	-1.456	0.655	6.166	20.509	2.918	0.899	9.656	0.000	43.027
	LAT CL					0.000			2.557		0.000	0.000	2.557
JUN	HEATNG	0.009	0.000	0.000	0.000	-0.010	-0.039	0.012	0.000	0.002	0.020	0.000	-0.006
	SEN CL	4.980	0.000	0.000	-0.061	3.101	17.151	20.261	2.662	0.871	9.549	0.000	58.535
	LAT CL					0.068			2.324		0.000	0.000	2.392
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	6.622	0.000	0.000	1.342	4.066	21.115	20.547	2.941	0.947	10.221	0.000	67.823
	LAT CL					0.446			2.557		0.000	0.000	3.005
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	6.063	0.000	0.000	2.233	5.752	23.976	21.245	2.950	0.960	10.257	0.000	67.496
	LAT CL					0.534			2.557		0.000	0.000	3.090
SEP	HEATNG	0.001	0.000	0.000	0.000	-0.001	-0.005	0.001	0.000	0.000	0.004	0.000	0.000
	SEN CL	4.230	0.000	0.000	2.236	3.156	14.262	23.985	2.675	0.819	9.550	0.000	60.112
	LAT CL					0.074			2.324		0.000	0.000	2.398
OCT	HEATNG	-0.183	0.000	0.000	0.283	-0.698	-2.646	0.689	0.046	0.106	1.022	0.000	-1.376
	SEN CL	0.477	0.000	0.000	1.299	-0.069	6.354	26.627	2.899	1.072	9.205	0.000	47.665
	LAT CL					0.007			2.557		0.000	0.000	2.564
NOV	HEATNG	-1.579	0.000	0.000	0.111	-2.383	-8.626	2.412	0.127	0.341	2.435	0.000	-7.162
	SEN CL	-1.566	0.000	0.000	0.103	-0.951	2.677	24.501	2.421	1.349	6.870	0.000	35.404
	LAT CL					0.000			2.208		0.000	0.000	2.208
DEC	HEATNG	-3.298	0.000	0.000	-0.847	-3.855	-13.639	3.240	0.168	0.664	3.053	0.000	-14.494
	SEN CL	-2.363	0.000	0.000	-0.503	-1.179	1.233	22.676	2.619	1.623	6.904	0.000	31.011
	LAT CL					0.000			2.437		0.000	0.000	2.437
TOT	HEATNG	-12.941	0.000	0.000	-7.665	-17.776	-63.382	17.583	0.974	2.571	16.765	0.000	-63.871
	SEN CL	13.557	0.000	0.000	-0.610	6.795	102.514	266.016	32.763	12.409	101.620	0.000	537.058
	LAT CL					1.134			29.261		0.000	0.000	30.395

Building B - 24' Courtyard Building   DOE-B2.2D38c   5/05/2002   18:11:02 BDL RUN 1

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas   NV TMY2

MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
	- - COOLING - -						- - HEATING - -						- - ELEC - -	
JAN	21.66419	17	15	67.F	46.F	137.465	-15.111	11	6	26.F	21.F	-58.763	3797.	20.537
FEB	23.47729	7	15	71.F	46.F	144.999	-8.667	3	6	34.F	26.F	-44.369	3191.	15.735
MAR	27.51218	21	14	70.F	46.F	136.275	-4.649	5	4	31.F	24.F	-47.730	3449.	14.846
APR	36.83601	22	15	83.F	56.F	153.380	-2.109	7	5	46.F	44.F	-25.751	3433.	12.495
MAY	44.71825	31	16	99.F	61.F	163.532	-0.776	21	4	43.F	38.F	-20.211	3408.	13.206
JUN	58.54391	27	16	112.F	65.F	190.631	-0.004	15	4	57.F	42.F	[illegible]	3234.	11.984
JUL	66.89475	24	16	110.F	65.F	187.833	0.000	0	0	0.F	0.F	0.000	3465.	11.998
AUG	65.76733	30	16	103.F	65.F	185.848	0.000	0	0	0.F	0.F	0.000	3471.	11.974
SEP	56.00883	20	15	98.F	60.F	182.310	0.000	14	4	61.F	49.F	-0.070	3252.	12.226
OCT	41.60533	3	15	92.F	60.F	174.010	-1.036	23	6	47.F	37.F	-17.556	3572.	20.007
NOV	27.96911	8	14	72.F	50.F	149.170	-6.306	30	6	34.F	27.F	-38.660	3422.	20.425
DEC	22.65857	5	14	74.F	49.F	136.829	-13.140	13	6	29.F	21.F	-49.706	[illegible]	21.380
TOTAL	493.656						[illegible]						41562.	
MAX						190.631						-58.763		21.380

Building B - 24' Courtyard Building DOE-B2.2D38c 5/05/2002 16:11:02 BDL RUN 1
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.581	0.000	0.000	-1.613	-3.771	-13.193	2.635	0.214	0.663	3.235	0.000	-15.411
JAN	SEN CL	-2.306	0.000	0.000	-0.838	-1.046	-6.308	14.996	2.747	1.372	7.053	0.000	21.664
	LAT CL					0.000			2.540		0.000	0.000	2.540
	HEATNG	-1.761	0.000	0.000	-1.757	-2.283	-8.096	2.196	0.140	0.351	2.543	0.000	-8.667
FEB	SEN CL	-1.591	0.000	0.000	-1.131	-0.771	1.331	15.744	2.422	0.947	6.526	0.000	23.477
	LAT CL					0.003			2.207		0.000	0.000	2.210
	HEATNG	-1.660	0.000	0.000	-1.855	-2.329	-8.327	2.459	0.151	0.309	2.603	0.000	-8.649
MAR	SEN CL	-1.740	0.000	0.000	-1.407	-0.628	1.874	16.624	2.665	0.862	7.441	0.000	27.512
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.124	0.000	0.000	-0.910	-0.746	-2.830	1.111	0.058	0.122	1.210	0.000	-2.109
APR	SEN CL	0.051	0.000	0.000	-1.903	0.084	5.420	20.467	2.904	0.676	8.936	0.000	36.837
	LAT CL					0.000			2.556		0.000	0.000	2.556
	HEATNG	-0.080	0.000	0.000	-0.182	-0.319	-1.210	0.451	0.023	0.046	0.492	0.000	-0.776
MAY	SEN CL	1.602	0.000	0.000	-1.297	0.725	8.093	21.924	2.943	0.921	9.806	0.000	44.718
	LAT CL					0.000			2.556		0.000	0.000	2.556
	HEATNG	0.006	0.000	0.000	0.000	-0.006	-0.026	0.006	0.000	0.001	0.013	0.000	-0.004
JUN	SEN CL	4.672	0.000	0.000	-0.053	2.706	16.206	21.807	2.700	0.882	9.620	0.000	58.544
	LAT CL					0.061			2.323		0.000	0.000	2.384
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	6.117	0.000	0.000	1.179	3.572	19.743	22.070	2.961	0.959	10.290	0.000	66.895
	LAT CL					0.391			2.556		0.000	0.000	2.947
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.602	0.000	0.000	1.962	3.261	18.621	22.068	2.970	0.978	10.306	0.000	65.767
	LAT CL					0.466			2.556		0.000	0.000	3.022
	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.001	0.000	0.000
SEP	SEN CL	3.851	0.000	0.000	1.364	1.883	12.963	22.093	2.693	0.939	9.617	0.000	56.009
	LAT CL					0.064			2.323		0.000	0.000	2.388
	HEATNG	-0.122	0.000	0.000	0.225	-0.579	-2.186	0.567	0.039	0.100	0.919	0.000	-1.026
OCT	SEN CL	0.331	0.000	0.000	1.170	-0.091	5.072	21.615	2.926	1.205	9.377	0.000	41.605
	LAT CL					0.006			2.556		0.000	0.000	2.562
	HEATNG	-1.483	0.000	0.000	0.101	-2.111	-7.667	1.896	0.127	0.319	2.465	0.000	-6.306
NOV	SEN CL	-1.505	0.000	0.000	0.687	-0.806	1.566	17.671	2.439	1.414	6.984	0.000	27.969
	LAT CL					0.000			2.207		0.000	0.000	2.207
	HEATNG	-3.161	0.000	0.000	-0.768	-3.437	-12.216	2.428	0.191	0.668	3.153	0.000	-13.140
DEC	SEN CL	-2.122	0.000	0.000	-0.417	-0.963	0.537	14.343	2.635	1.674	6.872	0.000	22.659
	LAT CL					0.000			2.433		0.000	0.000	2.433
	HEATNG	-11.966	0.000	0.000	-6.751	-15.582	-55.751	13.752	0.943	2.612	16.655	0.000	-56.099
TOT	SEN CL	12.962	0.000	0.000	-0.667	7.735	90.638	234.222	33.025	13.030	102.727	0.000	493.652
	LAT CL					0.992			29.249		0.000	0.000	30.241

Building C - 24' 'H' Shaped Building   DOE-B2.2D36c   5/01/2002   22:31:40 BDL RUN 2

REPORT- LS-D Building Monthly Loads Summary   WEATHER FILE- Las Vegas   NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	21,21850	17	15	67.F	46.F	143,828	-15,506	11	6	26.F	21.F	-59,678	3799.	20,516
FEB	23,04794	27	15	71.F	49.F	142,711	-5,315	3	6	34.F	26.F	-44,670	3190.	15,646
MAR	26,82024	21	14	70.F	46.F	134,150	-8,726	5	4	31.F	24.F	-46,150	3454.	14,546
APR	36,37115	22	15	89.F	58.F	152,369	-2,142	7	5	46.F	44.F	-26,031	3438.	12,338
MAY	44,41827	31	16	99.F	61.F	163,386	-0,798	21	4	43.F	38.F	-26,531	3472.	12,961
JUN	58,32172	27	16	112.F	65.F	190,783	-0,005	15	4	57.F	42.F	-2,498	3238.	12,004
JUL	66,67981	24	16	110.F	65.F	187,782	0,000	0	0	0.F	0.F	0,000	3469.	12,023
AUG	65,53104	30	16	103.F	65.F	165,073	0,000	0	0	0.F	0.F	0,000	3475.	12,005
SEP	55,58948	20	15	98.F	60.F	180,006	0,000	14	4	61.F	49.F	-0,092	3256.	12,059
OCT	40,99908	3	15	92.F	60.F	170,769	-1,067	25	6	47.F	37.F	-17,757	3576.	19,959
NOV	27,34881	8	14	72.F	50.F	135,489	-6,384	30	6	34.F	27.F	-39,034	3426.	20,416
DEC	22,26485	5	14	74.F	49.F	137,964	-13,232	13	6	23.F	21.F	[illegible]	3809.	21,444
TOTAL	488,611						-56,588						41610.	
MAX						190,783						-59,678		21,444

Building C - 24' 'H' Shaped Building DOE-B2.2D36c 5/07/2002 22:34:40 BDL RUN 2
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- las Vegas NV THY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.607	0.000	0.000	-1.622	-3.780	-13.257	2.646	0.217	0.646	3.250	0.000	-15.506
JAN	SEN CL	-2.305	0.000	0.000	-0.834	-1.042	-0.406	14.591	2.754	1.389	7.072	0.000	21.218
	LAT CL					0.000			2.534		0.000	0.000	2.534
	HEATNG	-1.762	0.000	0.000	-1.754	-2.239	-6.106	2.178	0.136	0.350	2.519	0.000	-8.715
FEB	SEN CL	-1.619	0.000	0.000	-1.142	-0.778	1.221	15.395	2.433	0.956	6.561	0.000	23.048
	LAT CL.					0.003			2.210		0.000	0.000	2.213
	HEATNG	-1.665	0.000	0.000	-1.853	-2.316	-8.320	2.407	0.147	0.369	2.570	0.000	-8.720
MAR	SEN CL	-1.774	0.000	0.000	-1.415	-0.844	1.682	18.093	2.699	0.874	7.505	0.000	26.820
	LAT CL					0.000			2.442		0.000	0.000	2.442
	HEATNG	-0.120	0.000	0.000	-0.909	-0.733	-2.807	1.079	0.055	0.120	1.173	0.000	-2.142
APR	SEN CL	0.026	0.000	0.000	-1.909	0.071	5.316	20.058	2.916	0.887	9.006	0.000	36.371
	LAT CL					0.006			2.559		0.000	0.000	2.559
	HEATNG	-0.077	0.000	0.000	-0.182	-0.317	-1.213	0.444	0.022	0.046	0.480	0.000	-0.798
MAY	SEN CL	1.586	0.000	0.000	-1.299	3.724	6.074	21.602	2.954	0.925	9.852	0.000	44.418
	LAT CL					0.060			2.559		0.000	0.000	2.559
	HEATNG	0.007	0.000	0.000	0.000	-0.007	-0.030	0.009	0.000	0.001	0.015	0.000	-0.005
JUN	SEN CL	4.670	0.000	0.000	-0.653	2.711	16.246	21.504	2.709	0.865	9.650	0.000	58.322
	LAT CL					0.060			2.326		0.000	0.000	2.386
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	6.118	0.000	0.000	1.181	3.575	19.793	21.755	2.971	0.962	10.324	0.000	66.680
	LAT CL					0.392			2.559		0.000	0.000	2.951
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.600	0.000	0.000	1.966	3.264	18.656	21.743	2.979	0.984	10.340	0.000	65.531
	LAT CL					0.467			2.559		0.000	0.000	3.026
	HEATNG	0.001	0.000	0.000	0.000	-0.001	-0.002	0.000	0.000	0.000	0.002	0.000	0.000
SEP	SEN CL	3.835	0.000	0.000	1.968	1.885	12.930	21.675	2.702	0.946	9.648	0.000	55.589
	LAT CL					0.064			2.326		0.000	0.000	2.391
	HEATNG	-0.116	0.000	0.000	0.234	-0.587	-2.227	0.576	0.037	0.097	0.899	0.000	-1.087
OCT	SEN CL	0.296	0.000	0.000	1.164	-0.083	4.996	21.047	2.537	1.211	9.431	0.000	40.999
	LAT CL					0.006			2.559		0.000	0.000	2.565
	HEATNG	-1.483	0.000	0.000	0.100	-2.116	-1.677	1.071	0.122	0.343	2.453	0.000	-6.384
NOV	SEN CL	-1.529	0.000	0.000	0.088	-0.806	1.430	17.342	2.452	1.426	6.946	0.000	27.349
	LAT CL					0.000			2.210		0.000	0.000	2.210
	HEATNG	-3.175	0.000	0.000	-0.766	-3.428	-12.242	2.391	0.169	0.656	3.146	0.000	-13.231
DEC	SEN CL	-2.136	0.000	0.000	-0.420	-0.974	-0.078	14.635	2.647	1.078	6.912	0.000	22.265
	LAT CL					0.000			2.434		0.000	0.000	2.434
	HEATNG	-11.996	0.000	0.000	-6.754	-15.559	-55.883	15.604	0.925	2.569	16.507	0.000	-56.587
TOT	SEN CL	12.770	0.000	0.000	-0.706	7.704	59.859	229.440	33.155	13.123	103.264	0.000	488.607
	LAT CL					0.993			29.273		0.000	0.000	30.266

Building D - 12' Courtyard Building DOE-B2.2D38c 5/05/2002 18:58:45 BDL RUN 2

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	C O O L I N G						H E A T I N G						E L E C	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	21.14899	17	15	67.F	46.F	131.514	-15.560	11	6	26.F	21.F	-56.704	3821.	20.601
FEB	22.71149	7	15	71.F	48.F	142.693	-8.833	3	6	34.F	26.F	-44.367	3199.	16.227
MAR	25.68315	21	14	70.F	46.F	120.856	-6.925	5	4	31.F	24.F	-48.032	3453.	15.276
APR	35.07668	22	15	89.F	58.F	147.516	-2.199	7	5	46.F	44.F	-25.921	3435.	12.411
MAY	42.41631	31	16	99.F	61.F	155.789	-0.810	21	4	43.F	38.F	-26.429	3471.	13.705
JUN	56.17049	27	16	112.F	65.F	183.324	-0.004	15	4	57.F	42.F	-2.121	3236.	12.093
JUL	64.50710	24	16	110.F	65.F	160.344	0.000	0	0	0.F	0.F	0.000	3468.	12.154
AUG	63.68096	30	16	103.F	65.F	175.471	0.000	0	0	0.F	0.F	0.000	3473.	12.088
SEP	54.67455	27	14	95.F	63.F	179.265	0.000	14	4	61.F	49.F	-0.059	3252.	12.349
OCT	39.58725	3	15	92.F	60.F	166.724	-1.069	23	6	47.F	37.F	-17.751	3579.	20.104
NOV	26.68875	8	14	72.F	50.F	142.937	-6.492	30	6	34.F	27.F	-36.877	3436.	20.547
DEC	22.30517	5	14	74.F	49.F	138.473	-13.272	13	6	29.F	21.F	-49.655	3628.	21.423
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TOTAL	474.651						-57.163						41651.	
MAX						183.324						-56.704		21.423

Building D - 12' Courtyard Building DOE-B2.2D38c 5/05/2002 18:58:45 BDL RUN 2
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.656	0.000	0.000	-1.630	-3.705	-13.202	2.572	0.217	0.675	3.260	0.000	-15.560
JAN	SEN CL	-2.282	0.000	0.000	-0.620	-1.022	-0.396	14.463	2.743	1.437	7.028	0.000	21.149
	LAT CL					0.000			2.537		0.000	0.000	2.537
	HEATNG	-1.825	0.000	0.000	-1.773	-2.300	-8.104	2.117	0.141	0.351	2.561	0.000	-8.833
FEB	SEN CL	-1.590	0.000	0.000	-1.116	-0.754	1.200	15.070	2.420	0.971	6.510	0.000	22.711
	LAT CL					0.003			2.207		0.000	0.000	2.210
	HEATNG	-1.740	0.000	0.000	-1.898	-2.357	-8.375	2.329	0.153	0.318	2.645	0.000	-6.925
MAR	SEN CL	-1.733	0.000	0.000	-1.362	-0.650	1.534	17.095	2.683	0.870	7.397	0.000	25.683
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.143	0.000	0.000	-0.946	-0.764	-2.868	1.066	0.060	0.126	1.250	0.000	-2.199
APR	SEN CL	0.010	0.000	0.000	-1.865	0.103	5.200	18.957	2.901	0.678	6.894	0.000	35.077
	LAT CL					0.000			2.556		0.000	0.000	2.556
	HEATNG	-0.066	0.000	0.000	-0.186	-0.329	-1.236	0.443	0.024	0.050	0.512	0.000	-0.810
MAY	SEN CL	1.548	0.000	0.000	-1.292	0.736	7.757	20.010	2.942	0.930	9.786	0.000	42.416
	LAT CL					0.000			2.556		0.000	0.000	2.556
	HEATNG	0.006	0.000	0.000	0.000	-0.007	-0.026	0.007	0.000	0.001	0.014	0.000	-0.004
JUN	SEN CL	4.612	0.000	0.000	-0.053	2.708	15.831	19.864	2.700	0.890	9.618	0.000	56.170
	LAT CL					0.061			2.324		0.000	0.000	2.384
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	6.055	0.000	0.000	1.179	3.572	19.361	20.125	2.961	0.966	10.269	0.000	64.507
	LAT CL					0.391			2.556		0.000	0.000	2.947
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.550	0.000	0.000	1.961	3.261	18.305	20.343	2.970	0.966	10.305	0.000	63.681
	LAT CL					0.466			2.556		0.000	0.000	3.022
	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.001	0.000	0.000
SEP	SEN CL	3.820	0.000	0.000	1.963	1.883	12.801	20.957	2.693	0.941	9.616	0.000	54.675
	LAT CL					0.064			2.324		0.000	0.000	2.388
	HEATNG	-0.134	0.000	0.000	0.255	-0.608	-2.264	0.556	0.042	0.107	0.957	0.000	-1.089
OCT	SEN CL	0.274	0.000	0.000	1.140	-0.062	4.764	19.971	2.922	1.219	9.336	0.000	39.587
	LAT CL					0.006			2.556		0.000	0.000	2.562
	HEATNG	-1.537	0.000	0.000	0.103	-2.131	-7.676	1.773	0.128	0.351	2.497	0.000	-6.492
NOV	SEN CL	-1.498	0.000	0.000	0.085	-0.783	1.339	16.762	2.438	1.457	6.870	0.000	26.689
	LAT CL					0.000			2.207		0.000	0.000	2.207
	HEATNG	-3.224	0.000	0.000	-0.773	-3.451	-12.205	2.361	0.191	0.664	3.165	0.000	-13.272
DEC	SEN CL	-2.106	0.000	0.000	-0.412	-0.947	-0.019	14.556	2.636	1.736	6.859	0.000	22.305
	LAT CL					0.000			2.433		0.000	0.000	2.433
	HEATNG	-12.340	0.000	0.000	-6.850	-15.741	-55.959	13.244	0.956	2.644	16.862	0.000	-57.183
TOT	SEN CL	12.660	0.000	0.000	-0.593	7.893	67.696	218.194	33.008	13.283	102.510	0.000	474.649
	LAT CL					0.992			29.247		0.000	0.000	30.240

Building E - 12' 'H' Shaped Building DOE-B2.2D38 5/07/2002 22:40:36 BDL RUN 3

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
	- - - COOLING - - -						- - - HEATING - - -						- - - ELEC - - -	
JAN	20,90081	17	15	67.F	46.F	129,929	-15,612	11	6	26.F	21.F	-56,986	3615.	20,538
FEB	22,36038	7	15	71.F	48.F	140,699	-8,846	3	6	34.F	26.F	-44,609	3205.	15,779
MAR	25,26012	21	14	70.F	46.F	128,685	-8,915	5	4	31.F	24.F	-46,350	3461.	14,701
APR	34,64565	22	15	89.F	58.F	146,788	-2,215	7	5	46.F	44.F	-26,167	3442.	12,241
MAY	42,14564	31	16	99.F	61.F	155,82[illegible]	-0,62[illegible]	21	4	43.F	38.F	-26,71[illegible]	3476.	13,097
JUN	55,94706	27	16	112.F	65.F	183,460	-[illegible],005	1[illegible]	4	[illegible]7.F	42.F	-2,63[illegible]	3241.	12,107
JUL	64,31190	24	16	110.F	65.F	180,463	0,000	0	0	0.F	0.F	0,000	347[illegible].	12,354
AUG	63,47683	30	16	103.F	65.F	177,911	0,000	0	0	0.F	0.F	0,000	3477.	12,216
SEP	54,27530	27	14	95.F	63.F	177,654	0,000	14	4	61.F	49.F	-0,672	3[illegible]58.	12,514
OCT	39,38876	3	15	92.F	60.F	165,959	-1,135	23	6	47.F	37.F	-17,[illegible]7	3563.	19,994
NOV	26,39495	8	14	72.F	50.F	142,671	-6,507	30	6	34.F	27.F	-39,163	3435.	20,441
DEC	22,11437	5	14	74.F	49.F	138,038	-13,301	13	6	29.F	21.F	-49,412	3[illegible].	21,445
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TOTAL	471,222						-57,364						41692.	
MAX						183,460						-56,986		21,445

Building E - 12' 'H' Shaped Building DOE-B2.2D363 5/07/2002 22:40:36 BDL RUN 3
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

	(UNITS=MBTU)	WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATNG	-3.667	0.000	0.000	-1.637	-3.797	-13.247	2.587	0.221	0.659	3.271	0.000	-15.612
	SEN CL	-2.284	0.000	0.000	-0.817	-1.524	-0.457	14.257	2.749	1.429	7.648	0.000	20.901
	LAT CL					0.000			2.530		0.000	0.000	2.530
FEB	HEATNG	-1.817	0.000	0.000	-1.776	-2.293	-8.304	2.119	0.136	0.350	2.536	0.000	-8.848
	SEN CL	-1.606	0.000	0.000	-1.117	-0.763	1.104	14.765	2.433	0.987	6.561	0.000	22.360
	LAT CL					0.003			2.210		0.000	0.000	2.213
MAR	HEATNG	-1.727	0.000	0.000	-1.889	-2.336	-8.340	2.318	0.148	0.316	2.595	0.000	-8.915
	SEN CL	-1.770	0.000	0.000	-1.376	-0.824	1.397	16.772	2.696	0.888	7.478	0.000	25.260
	LAT CL					0.000			2.442		0.000	0.000	2.442
APR	HEATNG	-0.133	0.000	0.000	-0.933	-0.745	-2.826	1.056	0.057	0.121	1.169	0.000	-2.215
	SEN CL	-0.016	0.000	0.000	-1.883	0.083	5.075	18.591	2.914	0.895	8.987	0.000	34.646
	LAT CL					0.000			2.559		0.000	0.000	2.559
MAY	HEATNG	-0.083	0.000	0.000	-0.186	-0.326	-1.232	0.439	0.022	0.046	0.491	0.000	-0.827
	SEN CL	1.532	0.000	0.000	-1.294	0.733	7.726	19.724	2.952	0.936	9.837	0.000	42.146
	LAT CL					0.000			2.559		0.000	0.000	2.559
JUN	HEATNG	0.007	0.000	0.000	0.000	-0.006	-0.030	0.009	0.000	0.001	0.016	0.000	-0.005
	SEN CL	4.607	0.000	0.000	-0.055	2.712	15.657	19.574	2.708	0.897	9.645	0.000	55.947
	LAT CL					0.060			2.326		0.000	0.000	2.386
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	6.050	0.000	0.000	1.180	3.575	19.400	19.842	2.970	0.974	10.320	0.000	64.312
	LAT CL					0.392			2.559		0.000	0.000	2.951
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	5.544	0.000	0.000	1.964	3.264	18.334	20.066	2.978	0.931	10.336	0.000	63.477
	LAT CL					0.467			2.559		0.000	0.000	3.025
SEP	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.001	0.000	0.000
	SEN CL	3.803	0.000	0.000	1.966	1.685	12.756	20.567	2.701	0.952	9.645	0.000	54.275
	LAT CL					0.064			2.326		0.000	0.000	2.391
OCT	HEATNG	-0.126	0.000	0.000	0.258	-0.610	-2.285	0.568	0.039	0.102	0.915	0.000	-1.135
	SEN CL	0.257	0.000	0.000	1.139	-0.661	4.772	19.709	2.934	1.231	9.408	0.000	39.389
	LAT CL					0.006			2.559		0.000	0.000	2.565
NOV	HEATNG	-1.522	0.000	0.000	0.102	-2.119	-7.661	1.788	0.122	0.339	2.445	0.000	-6.507
	SEN CL	-1.522	0.000	0.000	0.086	-0.797	1.243	16.522	2.452	1.461	6.950	0.000	26.395
	LAT CL					0.000			2.210		0.000	0.000	2.210
DEC	HEATNG	-3.225	0.000	0.000	-0.773	-3.141	-12.219	2.352	0.190	0.655	3.160	0.000	-13.301
	SEN CL	-2.117	0.000	0.000	-0.414	-0.961	-0.090	14.423	2.645	1.734	6.895	0.000	22.114
	LAT CL					0.000			2.432		0.000	0.000	2.432
TOT	HEATNG	-12.292	0.000	0.000	-6.835	-15.676	-55.946	13.236	0.936	2.592	16.622	0.000	-57.363
	SEN CL	12.479	0.000	0.000	-0.619	7.821	87.117	214.809	33.130	13.374	103.115	0.000	471.226
	LAT CL					0.993			29.270		0.000	0.000	30.262

Building F - 50' x 100' Building DOE-B2.2D38c 6/21/2002 21:0r:16 BDL RUN 1

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - C O O L I N G - -						- - H E A T I N G - -						- - E L E C - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	24.00987	17	15	67.F	46.F	138.915	-10.741	11	6	26.F	21.F	-43.167	4294.	20.679
FEB	24.25327	7	15	71.F	48.F	143.697	-5.679	3	6	34.F	26.F	-32.092	3636.	16.668
MAR	26.98695	21	14	70.F	46.F	130.679	-5.976	5	4	31.F	24.F	-34.978	3965.	15.772
APR	33.70756	22	15	89.F	56.F	139.656	-1.346	7	5	46.F	44.F	-16.349	3981.	14.275
MAY	39.67806	31	16	99.F	61.F	143.662	-0.466	21	4	43.F	38.F	-15.731	4025.	14.356
JUN	50.08395	27	16	112.F	65.F	165.079	0.000	15	4	57.F	42.F	-0.239	3752.	14.009
JUL	56.87630	24	16	110.F	65.F	162.553	0.000	0	0	0.F	0.F	0.000	4024.	14.011
AUG	56.07544	30	16	103.F	65.F	160.196	0.000	0	0	0.F	0.F	0.000	4027.	14.042
SEP	48.72947	20	14	97.F	59.F	162.482	0.000	0	0	0.F	0.F	0.000	3760.	14.126
OCT	38.68948	3	14	91.F	59.F	157.902	-0.621	23	6	47.F	37.F	-11.985	4092.	20.221
NOV	27.87981	8	14	72.F	50.F	142.961	-4.213	30	6	34.F	27.F	-27.904	3860.	20.601
DEC	24.81341	5	14	74.F	49.F	140.246	-9.072	13	6	29.F	21.F	-36.642	4275.	21.440
TOTAL	451.784						-38.334						47691.	
MAX						165.079						-43.167		21.440

Building F - 50' x 100' Building   DOE-B2.1E-062   6/21/2002   21:06:1e   BDL RUN 1
REPORT- LS-F Building Monthly Load Components in MBTU   WEATHER FILE- Las Vegas NV TMY2

(UNITS-MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.553	0.000	0.000	-1.191	-2.861	-9.367	2.148	0.094	0.393	3.132	0.000	-10.741
JAN	SEN CL	-1.782	0.000	0.000	-0.788	-0.325	0.151	13.924	2.928	2.985	7.515	0.000	24.010
	LAT CL					0.000			2.553		0.000	0.000	2.553
	HEATNG	-1.241	0.000	0.000	-1.288	-2.881	-6.579	1.724	0.063	0.172	2.451	0.000	-5.879
FEB	SEN CL	-1.204	0.000	0.000	-1.045	-0.680	1.338	14.018	2.552	2.324	6.951	0.000	24.253
	LAT CL					0.003			2.208		0.000	0.000	2.211
	HEATNG	-1.221	0.000	0.000	-1.381	-1.738	-6.324	1.697	0.071	0.155	2.565	0.000	-5.976
MAR	SEN CL	-1.327	0.000	0.000	-1.252	-0.703	1.643	15.535	2.826	2.424	7.846	0.000	26.987
	LAT CL					0.000			2.441		0.000	0.000	2.441
	HEATNG	-0.106	0.000	0.000	-0.645	-0.513	-2.671	0.774	0.027	0.654	1.154	0.000	-1.346
APR	SEN CL	0.019	0.000	0.000	-1.625	0.021	4.117	16.340	2.997	2.469	9.333	0.000	33.708
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.070	0.000	0.000	-0.121	-0.222	-0.856	0.300	0.016	0.019	0.453	0.000	-0.486
MAY	SEN CL	1.163	0.000	0.000	-1.673	0.538	6.157	17.174	3.019	2.495	10.206	0.000	39.678
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.001	0.000	0.000	0.000	-0.001	-0.006	0.002	0.000	0.000	0.004	0.000	0.000
JUN	SEN CL	3.490	0.000	0.000	-0.043	2.090	12.438	17.061	2.759	2.303	9.988	0.000	50.084
	LAT CL					0.049			2.324		0.000	0.000	2.373
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.583	0.000	0.000	0.952	2.762	16.158	17.240	3.025	2.506	10.652	0.000	56.876
	LAT CL					0.303			2.557		0.000	0.000	2.859
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.194	0.000	0.000	1.584	2.522	14.306	17.246	3.033	2.522	10.669	0.000	56.076
	LAT CL					0.361			2.557		0.000	0.000	2.917
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	2.903	0.000	0.000	1.586	1.456	10.065	17.680	2.753	2.321	9.974	0.000	48.729
	LAT CL					0.050			2.324		0.000	0.000	2.374
	HEATNG	-0.104	0.000	0.000	0.355	-0.393	-1.543	0.372	0.017	0.036	0.652	0.000	-0.621
OCT	SEN CL	0.297	0.000	0.000	0.572	-0.119	4.013	18.019	3.011	2.691	9.507	0.000	38.689
	LAT CL					0.005			2.557		0.000	0.000	2.562
	HEATNG	-1.058	0.000	0.000	0.070	-1.519	-5.648	1.373	0.055	0.177	2.338	0.000	-4.213
NOV	SEN CL	-1.108	0.000	0.000	0.081	-0.734	1.324	15.628	2.566	2.732	7.392	0.000	27.880
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.252	0.000	0.000	-0.561	-2.539	-9.197	1.964	0.083	0.390	3.041	0.000	-9.072
DEC	SEN CL	-1.622	0.000	0.000	-0.396	-0.863	0.394	13.961	2.603	3.186	7.351	0.000	24.813
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-8.604	0.000	0.000	-4.962	-11.434	-41.698	10.553	0.421	1.396	15.993	0.000	-38.334
TOT	SEN CL	9.605	0.000	0.000	-1.049	5.364	71.125	193.625	34.267	30.956	107.688	0.000	451.782
	LAT CL					0.770			29.286		0.000	0.000	30.055

Single Glazing Clear Case DOE-B2.2D38c 2/23/2002 19:47:02 BDL RUN 8

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	23.56887	17	15	67.F	46.F	137.990	-15.922	11	6	26.F	21.F	-60.031	4356.	20.453
FEB	24.87644	27	15	71.F	49.F	148.554	-8.945	3	6	34.F	26.F	-43.610	3740.	16.875
MAR	28.95145	21	15	70.F	46.F	139.003	-9.063	5	4	31.F	24.F	-48.743	4087.	15.935
APR	38.16233	22	15	89.F	58.F	160.568	-2.445	17	3	45.F	38.F	-26.530	4130.	15.237
MAY	45.45437	31	16	99.F	61.F	167.368	-0.947	21	4	43.F	38.F	-28.089	4171.	15.136
JUN	58.39812	27	16	112.F	65.F	194.000	-0.016	15	4	57.F	42.F	-4.932	3876.	15.136
JUL	66.05221	25	16	109.F	68.F	189.718	0.000	0	0	0.F	0.F	0.000	4170.	15.136
AUG	64.46371	30	16	103.F	65.F	187.525	0.000	0	0	0.F	0.F	0.000	4173.	15.136
SEP	53.74681	10	15	100.F	64.F	182.507	-0.003	14	4	61.F	49.F	-0.937	3885.	15.136
OCT	40.42633	3	15	92.F	60.F	173.378	-1.623	15	5	47.F	35.F	-20.679	4227.	19.872
NOV	27.78849	8	14	72.F	50.F	144.597	-7.357	30	6	34.F	27.F	-40.283	3922.	20.466
DEC	24.11402	5	14	74.F	49.F	140.288	-14.010	23	6	29.F	26.F	-51.251	4311.	21.402
TOTAL	496.003						-60.330						49049.	
MAX						194.000						-60.031		21.402

Single Glazing Clear Case DOE-B2.2D38c 2/23/2002 19:47:02 BDL RUN 8

REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.565	0.000	0.000	-1.150	-2.776	-15.283	2.948	0.185	0.472	2.247	0.000	-15.922
JAN	SEN CL	-1.546	0.000	0.000	-0.709	-0.748	-2.843	15.199	2.765	3.446	8.006	0.000	23.569
	LAT CL					0.000			2.505		0.000	0.000	2.505
	HEATNG	-1.233	0.000	0.000	-1.248	-1.673	-9.316	2.453	0.103	0.247	1.724	0.000	-8.945
FEB	SEN CL	-1.079	0.000	0.000	-0.944	-0.561	-1.353	16.143	2.450	2.901	7.318	0.000	24.876
	LAT CL					0.002			2.204		0.000	0.000	2.206
	HEATNG	-1.176	0.000	0.000	-1.316	-1.710	-9.673	2.710	0.109	0.217	1.776	0.000	-9.063
MAR	SEN CL	-1.178	0.000	0.000	-1.158	-0.599	-1.389	19.208	2.719	3.113	8.236	0.000	28.951
	LAT CL					0.000			2.438		0.000	0.000	2.438
	HEATNG	-0.066	0.000	0.000	-0.672	-0.576	-3.489	1.312	0.044	0.090	0.911	0.000	-2.445
APR	SEN CL	0.065	0.000	0.000	-1.461	0.091	2.435	21.672	2.907	3.254	9.201	0.000	38.162
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.037	0.000	0.000	-0.145	-0.258	-1.541	0.575	0.019	0.038	0.402	0.000	-0.947
MAY	SEN CL	1.181	0.000	0.000	-0.976	0.555	5.002	23.591	2.937	3.301	9.863	0.000	45.454
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.012	0.000	0.000	0.000	-0.011	-0.065	0.021	0.001	0.002	0.024	0.000	-0.016
JUN	SEN CL	3.373	0.000	0.000	-0.040	1.987	14.069	23.687	2.692	3.052	9.579	0.000	58.398
	LAT CL					0.042			2.324		0.000	0.000	2.366
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.408	0.000	0.000	0.894	2.613	17.648	23.954	2.951	3.330	10.255	0.000	66.052
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.031	0.000	0.000	1.488	2.386	16.361	23.613	2.961	3.351	10.273	0.000	64.464
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.004	0.000	0.000	0.000	-0.003	-0.017	0.004	0.000	0.001	0.009	0.000	-0.003
SEP	SEN CL	2.770	0.000	0.000	1.490	1.380	9.844	22.930	2.684	3.072	9.577	0.000	53.747
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.063	0.000	0.000	0.232	-0.526	-3.093	0.850	0.039	0.100	0.838	0.000	-1.623
OCT	SEN CL	0.240	0.000	0.000	0.826	0.036	2.164	21.407	2.916	3.414	9.424	0.000	40.426
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.072	0.000	0.000	0.075	-1.589	-9.053	2.187	0.094	0.256	1.745	0.000	-7.357
NOV	SEN CL	-1.005	0.000	0.000	0.068	-0.543	-1.222	17.236	2.464	3.196	7.594	0.000	27.789
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.275	0.000	0.000	-0.548	-2.531	-14.187	2.693	0.162	0.489	2.186	0.000	-14.010
DEC	SEN CL	-1.421	0.000	0.000	-0.351	-0.687	-2.444	15.020	2.655	3.538	7.805	0.000	24.114
	LAT CL					0.000			2.407		0.000	0.000	2.407
	HEATNG	-8.470	0.000	0.000	-4.773	-11.652	-65.718	15.752	0.756	1.912	11.861	0.000	-60.331
TOT	SEN CL	9.840	0.000	0.000	-0.876	5.910	58.271	243.657	33.102	38.966	107.130	0.000	496.001
	LAT CL					0.723			29.196		0.000	0.000	29.919

Double Tint Bronze Case DOE-B2.2D38c 2/23/2002 19:44:14 BDL RUN 7

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	19.92987	17	15	67.F	46.F	114.598	-11.658	11	6	26.F	21.F	-43.017	4549.	20.990
FEB	20.00698	7	15	71.F	48.F	123.957	-6.738	3	6	34.F	26.F	-33.130	3842.	18.527
MAR	22.62491	28	16	69.F	48.F	112.888	-6.850	5	4	31.F	24.F	-35.437	4150.	17.921
APR	28.88422	11	16	84.F	55.F	121.726	-1.834	7	5	46.F	44.F	-19.777	4173.	16.372
MAY	34.78291	31	16	99.F	61.F	134.887	-0.687	21	4	43.F	38.F	-20.060	4201.	16.884
JUN	44.22018	27	16	112.F	65.F	153.338	-0.005	15	4	57.F	42.F	-2.455	3900.	15.690
JUL	50.76509	25	16	109.F	68.F	152.330	0.000	0	0	0.F	0.F	0.000	4192.	15.847
AUG	49.82810	30	16	103.F	65.F	149.562	0.000	0	0	0.F	0.F	0.000	4208.	15.944
SEP	42.08110	20	16	99.F	60.F	147.214	0.000	14	4	61.F	49.F	-0.153	3948.	16.317
OCT	32.17406	3	16	92.F	58.F	140.538	-0.944	15	5	47.F	35.F	-13.987	4364.	20.704
NOV	22.48023	25	15	66.F	46.F	116.488	-5.103	30	6	34.F	27.F	-29.153	4046.	20.997
DEC	20.45189	17	14	65.F	45.F	115.441	-10.054	13	6	29.F	21.F	-36.763	4477.	21.458
TOTAL	388.230						-43.873						50052.	
MAX						153.338						-43.017		21.458

Double Tint Bronze Case DOE-B2.2D38c 2/23/2002 19:44:14 BDL RUN 7

REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.602	0.000	0.000	-1.172	-2.752	-9.365	1.349	0.146	0.528	2.210	0.000	-11.658
JAN	SEN CL	-1.594	0.000	0.000	-0.723	-0.772	1.215	6.704	2.650	4.044	8.204	0.000	19.930
	LAT CL					0.000			2.550		0.000	0.000	2.550
	HEATNG	-1.281	0.000	0.000	-1.294	-1.686	-5.802	1.147	0.101	0.297	1.780	0.000	-6.738
FEB	SEN CL	-1.079	0.000	0.000	-0.940	-0.548	2.494	6.981	2.492	3.202	7.403	0.000	20.007
	LAT CL					0.002			2.208		0.000	0.000	2.210
	HEATNG	-1.215	0.000	0.000	-1.382	-1.726	-5.990	1.250	0.110	0.261	1.843	0.000	-6.850
MAR	SEN CL	-1.188	0.000	0.000	-1.139	-0.583	2.963	8.190	2.762	3.293	8.326	0.000	22.625
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.068	0.000	0.000	-0.732	-0.575	-2.143	0.589	0.047	0.107	0.942	0.000	-1.834
APR	SEN CL	0.066	0.000	0.000	-1.442	0.091	5.209	9.291	2.951	3.389	9.328	0.000	28.884
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.048	0.000	0.000	-0.151	-0.255	-0.943	0.251	0.019	0.041	0.399	0.000	-0.687
MAY	SEN CL	1.216	0.000	0.000	-0.992	0.553	7.404	10.183	2.983	3.408	10.027	0.000	34.783
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.007	0.000	0.000	0.000	-0.007	-0.029	0.006	0.000	0.001	0.016	0.000	-0.005
JUN	SEN CL	3.448	0.000	0.000	-0.041	1.984	12.962	10.253	2.735	3.143	9.738	0.000	44.220
	LAT CL					0.043			2.324		0.000	0.000	2.367
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.499	0.000	0.000	0.911	2.613	15.568	10.345	2.997	3.415	10.416	0.000	50.765
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.115	0.000	0.000	1.516	2.386	14.721	10.169	3.007	3.480	10.435	0.000	49.828
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.002	0.000	0.000	0.000	0.001	0.000	0.000
SEP	SEN CL	2.832	0.000	0.000	1.518	1.378	10.770	9.834	2.726	3.289	9.735	0.000	42.081
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.074	0.000	0.000	0.202	-0.481	-1.806	0.321	0.034	0.103	0.757	0.000	-0.944
OCT	SEN CL	0.255	0.000	0.000	0.876	-0.009	5.199	9.345	2.967	3.873	9.666	0.000	32.174
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.101	0.000	0.000	0.076	-1.588	-5.647	0.983	0.094	0.298	1.782	0.000	-5.103
NOV	SEN CL	-1.018	0.000	0.000	0.069	-0.543	2.586	7.598	2.504	3.582	7.703	0.000	22.480
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.312	0.000	0.000	-0.559	-2.506	-8.715	1.226	0.132	0.515	2.165	0.000	-10.054
DEC	SEN CL	-1.460	0.000	0.000	-0.357	-0.712	1.515	6.671	2.729	4.084	7.983	0.000	20.452
	LAT CL					0.000			2.439		0.000	0.000	2.439
	HEATNG	-8.694	0.000	0.000	-5.011	-11.579	-40.440	7.122	0.684	2.151	11.894	0.000	-43.872
TOT	SEN CL	10.093	0.000	0.000	-0.743	5.837	82.607	105.564	33.705	42.203	106.954	0.000	388.220
	LAT CL					0.725			29.280		0.000	0.000	30.004

Double Reflective Case DOE-B2.2D38c 2/23/2002 19:40:07 BDL RUN 6

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

MONTH	COOLING ENERGY (MBTU)	COOLING TIME OF MAX DY	COOLING TIME OF MAX HR	COOLING DRY-BULB TEMP	COOLING WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	HEATING TIME OF MAX DY	HEATING TIME OF MAX HR	HEATING DRY-BULB TEMP	HEATING WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	16.04786	29	14	64.F	44.F	89.438	-11.850	11	6	26.F	21.F	-41.054	5018.	21.367
FEB	15.62861	7	15	71.F	48.F	99.610	-7.102	3	6	34.F	26.F	-32.462	4258.	20.690
MAR	17.28760	28	16	69.F	48.F	94.665	-7.241	4	5	32.F	25.F	-34.443	4605.	20.524
APR	22.66940	29	16	88.F	58.F	104.727	-2.090	7	5	46.F	44.F	-19.651	4691.	19.206
MAY	27.85101	31	16	99.F	61.F	118.466	-0.803	21	4	43.F	38.F	-19.719	4765.	20.239
JUN	36.67317	26	16	110.F	64.F	135.280	-0.008	15	4	57.F	42.F	-3.107	4460.	19.390
JUL	43.06428	25	16	109.F	68.F	135.939	0.000	0	0	0.F	0.F	0.000	4799.	19.261
AUG	42.20719	1	16	106.F	69.F	131.268	0.000	0	0	0.F	0.F	0.000	4769.	19.106
SEP	34.91430	20	16	99.F	60.F	125.733	0.000	14	4	61.F	49.F	-0.162	4439.	19.407
OCT	25.92131	3	16	92.F	58.F	117.724	-1.014	15	5	47.F	35.F	-14.020	4856.	21.288
NOV	17.51922	25	16	66.F	46.F	93.478	-5.365	30	7	33.F	27.F	-28.603	4425.	21.369
DEC	16.42612	17	14	65.F	45.F	92.353	-10.206	13	6	29.F	21.F	-35.456	4889.	21.495
TOTAL	316.210						-45.679						55975.	
MAX						135.939						-41.054		21.495

Double Reflective Case DOE-B2.2D38c 2/23/2002 19:40:07 BDL RUN 6
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.736	0.000	0.000	-1.223	-2.842	-8.638	0.430	0.147	0.701	2.310	0.000	-11.850
JAN	SEN CL	-1.472	0.000	0.000	-0.677	-0.682	0.926	1.571	2.856	5.400	8.126	0.000	16.048
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-1.388	0.000	0.000	-1.381	-1.768	-5.412	0.377	0.107	0.445	1.917	0.000	-7.102
FEB	SEN CL	-0.978	0.000	0.000	-0.859	-0.466	2.089	1.655	2.492	4.411	7.286	0.000	15.629
	LAT CL					0.002			2.208		0.000	0.000	2.210
	HEATNG	-1.314	0.000	0.000	-1.493	-1.810	-5.598	0.410	0.119	0.448	1.997	0.000	-7.241
MAR	SEN CL	-1.096	0.000	0.000	-1.035	-0.500	2.414	1.959	2.759	4.591	8.194	0.000	17.288
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.060	0.000	0.000	-0.858	-0.619	-2.078	0.198	0.054	0.188	1.085	0.000	-2.090
APR	SEN CL	0.058	0.000	0.000	-1.322	0.135	4.368	2.276	2.950	4.996	9.207	0.000	22.669
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.035	0.000	0.000	-0.190	-0.291	-0.968	0.092	0.024	0.079	0.486	0.000	-0.803
MAY	SEN CL	1.207	0.000	0.000	-0.955	0.588	6.339	2.515	2.985	5.210	9.961	0.000	27.851
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.010	0.000	0.000	0.000	-0.010	-0.034	0.002	0.001	0.002	0.021	0.000	-0.008
JUN	SEN CL	3.455	0.000	0.000	-0.041	1.986	11.250	2.560	2.740	4.969	9.754	0.000	36.673
	LAT CL					0.042			2.324		0.000	0.000	2.366
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.512	0.000	0.000	0.914	2.613	13.609	2.585	3.004	5.390	10.438	0.000	43.064
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.126	0.000	0.000	1.520	2.386	12.850	2.543	3.014	5.311	10.457	0.000	42.207
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.001	0.000	0.000	0.000	-0.001	-0.003	0.000	0.000	0.000	0.002	0.000	0.000
SEP	SEN CL	2.839	0.000	0.000	1.522	1.378	9.334	2.468	2.732	4.887	9.754	0.000	34.914
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.055	0.000	0.000	0.231	-0.524	-1.797	0.100	0.038	0.144	0.849	0.000	-1.014
OCT	SEN CL	0.236	0.000	0.000	0.850	0.034	4.479	2.321	2.969	5.436	9.596	0.000	25.921
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.193	0.000	0.000	0.083	-1.680	-5.360	0.325	0.102	0.413	1.945	0.000	-5.365
NOV	SEN CL	-0.932	0.000	0.000	0.063	-0.452	2.259	1.812	2.502	4.707	7.560	0.000	17.519
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.416	0.000	0.000	-0.582	-2.577	-8.054	0.379	0.135	0.646	2.263	0.000	-10.206
DEC	SEN CL	-1.367	0.000	0.000	-0.336	-0.641	1.251	1.580	2.732	5.301	7.906	0.000	16.426
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-9.166	0.000	0.000	-5.413	-12.121	-37.943	2.314	0.727	3.065	12.877	0.000	-45.679
TOT	SEN CL	10.589	0.000	0.000	-0.355	6.379	71.169	25.847	33.735	60.611	108.240	0.000	316.214
	LAT CL					0.723			29.287		0.000	0.000	30.010

Double Low-e -Tint Case DOE-B2.2D38c 5/15/2002 13:18:24 BDL RUN 1

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	18.70297	17	15	67.F	46.F	105.148	-9.659	11	6	26.F	21.F	-35.960	4566.	21.011
FEB	18.44822	7	15	71.F	48.F	112.898	-5.559	3	6	34.F	26.F	-27.917	3853.	18.650
MAR	20.77919	28	16	69.F	48.F	103.538	-5.635	5	4	31.F	24.F	-29.473	4160.	18.068
APR	26.31729	11	16	84.F	55.F	110.995	-1.425	7	5	46.F	44.F	-16.202	4181.	16.448
MAY	31.50233	31	16	99.F	61.F	122.148	-0.508	21	4	43.F	38.F	-16.000	4208.	17.072
JUN	39.48470	27	16	112.F	65.F	137.745	-0.001	15	4	57.F	42.F	-0.853	3905.	15.747
JUL	45.37960	25	16	109.F	68.F	137.644	0.000	0	0	0.F	0.F	0.000	4197.	15.932
AUG	44.70290	30	16	103.F	65.F	135.425	0.000	0	0	0.F	0.F	0.000	4216.	16.031
SEP	38.07270	20	16	99.F	60.F	133.555	0.000	0	0	0.F	0.F	0.000	3960.	16.399
OCT	29.67597	3	16	92.F	58.F	128.030	-0.588	23	6	47.F	37.F	-10.626	4381.	20.737
NOV	20.80369	25	15	66.F	46.F	107.335	-3.922	30	6	34.F	27.F	-23.837	4057.	21.019
DEC	19.14870	17	14	65.F	45.F	105.522	-8.183	13	6	29.F	21.F	-30.424	4489.	21.460
TOTAL	353.018						-35.480						50174.	
MAX						137.745						-35.960		21.460

Double Low-e -Tint Case DOE-B2.2D38c 5/15/2002 13:18:24 SDL RUN 1

REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TRY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
JAN	HEATNG	-2.606	0.000	0.000	-1.180	-2.734	-7.043	1.070	0.138	0.501	2.195	0.000	-9.659
	SEN CL	-1.620	0.000	0.000	-0.727	-0.791	1.232	5.320	2.875	4.139	6.275	0.000	18.703
	LAT CL					0.000			2.555		0.000	0.000	2.555
FEB	HEATNG	-1.287	0.000	0.000	-1.312	-1.678	-4.360	0.913	0.098	0.293	1.773	0.000	-5.559
	SEN CL	-1.090	0.000	0.000	-0.937	-0.556	2.246	5.566	2.509	3.251	7.459	0.000	18.448
	LAT CL					0.002			2.208		0.000	0.000	2.210
MAR	HEATNG	-1.222	0.000	0.000	-1.398	-1.720	-4.498	0.997	0.108	0.260	1.838	0.000	-5.635
	SEN CL	-1.198	0.000	0.000	-1.139	-0.590	2.666	6.543	2.779	3.333	8.385	0.000	20.779
	LAT CL					0.000			2.440		0.000	0.000	2.440
APR	HEATNG	-0.074	0.000	0.000	-0.732	-0.556	-1.559	0.449	0.044	0.103	0.900	0.000	-1.425
	SEN CL	0.072	0.000	0.000	-1.456	0.072	4.386	7.422	2.969	3.427	9.425	0.000	26.317
	LAT CL					0.000			2.557		0.000	0.000	2.557
MAY	HEATNG	-0.058	0.000	0.000	-0.140	-0.241	-0.671	0.182	0.017	0.038	0.364	0.000	-0.508
	SEN CL	1.234	0.000	0.000	-1.010	0.538	6.071	8.111	3.001	3.440	10.117	0.000	31.502
	LAT CL					0.000			2.557		0.000	0.000	2.557
JUN	HEATNG	0.002	0.000	0.000	0.000	-0.003	-0.008	0.001	0.000	0.000	0.005	0.000	-0.001
	SEN CL	3.477	0.000	0.000	-0.042	1.979	10.203	8.151	2.750	3.166	9.801	0.000	39.485
	LAT CL					0.045			2.324		0.000	0.000	2.369
JUL	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.531	0.000	0.000	0.917	2.613	12.173	8.223	3.013	3.438	10.471	0.000	45.380
	LAT CL					0.286			2.557		0.000	0.000	2.843
AUG	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	4.144	0.000	0.000	1.526	2.386	11.532	8.089	3.023	3.512	10.491	0.000	44.703
	LAT CL					0.341			2.557		0.000	0.000	2.898
SEP	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	SEN CL	2.852	0.000	0.000	1.528	1.377	8.598	7.854	2.741	3.335	9.788	0.000	38.073
	LAT CL					0.047			2.324		0.000	0.000	2.371
OCT	HEATNG	-0.083	0.000	0.000	0.157	-0.414	-1.187	0.200	0.027	0.076	0.637	0.000	-0.588
	SEN CL	0.266	0.000	0.000	0.929	-0.076	4.247	7.515	2.990	3.963	9.841	0.000	29.676
	LAT CL					0.005			2.557		0.000	0.000	2.561
NOV	HEATNG	-1.097	0.000	0.000	0.075	-1.564	-4.212	0.750	0.090	0.289	1.747	0.000	-3.922
	SEN CL	-1.037	0.000	0.000	0.071	-0.568	2.316	6.071	2.522	3.639	7.789	0.000	20.804
	LAT CL					0.000			2.208		0.000	0.000	2.208
DEC	HEATNG	-2.313	0.000	0.000	-0.560	-2.485	-6.544	0.965	0.125	0.481	2.149	0.000	-8.183
	SEN CL	-1.486	0.000	0.000	-0.362	-0.733	1.461	5.292	2.751	4.172	8.053	0.000	19.149
	LAT CL					0.000			2.440		0.000	0.000	2.440
TOT	HEATNG	-8.737	0.000	0.000	-5.091	-11.395	-30.083	5.527	0.648	2.041	11.610	0.000	-35.480
	SEN CL	10.146	0.000	0.000	-0.701	5.653	67.131	84.156	33.923	42.814	105.895	0.000	353.017
	LAT CL					0.727			29.285		0.000	0.000	30.012

Double Selective-Clear Case DOE-B2.2D38c 2/23/2002 19:55:29 BDL RUN 9

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELECTRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
	- - - COOLING					- - -	- - - HEATING					- - -	- - - ELEC	- - -
JAN	18.87639	17	15	67.F	46.F	104.498	-9.170	11	6	26.F	21.F	-34.598	4413.	20.719
FEB	18.79035	7	15	71.F	48.F	108.764	-5.222	3	6	34.F	26.F	-26.668	3767.	17.256
MAR	21.40116	21	15	70.F	46.F	101.968	-5.259	5	4	31.F	24.F	-28.164	4100.	16.587
APR	27.26424	22	15	89.F	58.F	113.882	-1.265	7	5	46.F	44.F	-15.226	4137.	15.609
MAY	32.39587	31	16	99.F	61.F	123.370	-0.442	21	4	43.F	38.F	-14.962	4175.	15.214
JUN	40.22881	27	16	112.F	65.F	138.974	-0.001	15	4	57.F	42.F	-0.446	3879.	15.141
JUL	45.97872	24	16	110.F	65.F	137.729	0.000	0	0	0.F	0.F	0.000	4173.	15.303
AUG	45.24823	30	16	103.F	65.F	135.170	0.000	0	0	0.F	0.F	0.000	4178.	15.331
SEP	38.53229	20	16	99.F	60.F	132.532	0.000	0	0	0.F	0.F	0.000	3894.	15.440
OCT	30.19282	3	16	92.F	58.F	126.257	-0.499	23	6	47.F	37.F	-9.744	4257.	20.284
NOV	21.22040	8	15	71.F	50.F	108.619	-3.604	30	6	34.F	27.F	-22.636	3956.	20.732
DEC	19.33142	5	15	74.F	49.F	105.040	-7.721	13	6	29.F	21.F	-29.091	4364.	21.430
TOTAL	359.461						-33.180						49294.	
MAX						138.974						-34.598		21.430

Double Selective-Clear Case DOE-B2.2D38c 2/23/2002 19:55:29 BDL RUN 9

REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.593	0.000	0.000	-1.175	-2.720	-6.714	1.273	0.137	0.439	2.183	0.000	-9.170
JAN	SEN CL	-1.636	0.000	0.000	-0.734	-0.605	0.607	6.568	2.877	3.705	8.294	0.000	18.876
	LAT CL					0.000			2.554		0.000	0.000	2.554
	HEATNG	-1.272	0.000	0.000	-1.305	-1.658	-4.144	1.073	0.096	0.245	1.743	0.000	-5.222
FEB	SEN CL	-1.107	0.000	0.000	-0.945	-0.576	1.505	6.886	2.513	3.016	7.496	0.000	18.790
	LAT CL					0.002			2.208		0.000	0.000	2.211
	HEATNG	-1.209	0.000	0.000	-1.384	-1.697	-4.270	1.172	0.106	0.220	1.803	0.000	-5.259
MAR	SEN CL	-1.213	0.000	0.000	-1.156	-0.613	1.888	8.106	2.784	3.177	8.428	0.000	21.401
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.079	0.000	0.000	-0.707	-0.541	-1.448	0.518	0.042	0.090	0.860	0.000	-1.265
APR	SEN CL	0.077	0.000	0.000	-1.483	0.057	3.699	9.172	2.974	3.297	9.472	0.000	27.264
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.060	0.000	0.000	-0.130	-0.228	-0.610	0.201	0.016	0.033	0.336	0.000	-0.442
MAY	SEN CL	1.238	0.000	0.000	-1.021	0.526	5.152	10.007	3.005	3.338	10.152	0.000	32.396
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.002	0.000	0.000	0.000	-0.002	-0.006	0.001	0.000	0.000	0.004	0.000	-0.001
JUN	SEN CL	3.481	0.000	0.000	-0.042	1.979	9.139	10.031	2.752	3.081	9.808	0.000	40.229
	LAT CL					0.046			2.324		0.000	0.000	2.370
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.535	0.000	0.000	0.918	2.613	10.938	10.122	3.015	3.359	10.479	0.000	45.979
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.148	0.000	0.000	1.527	2.386	10.318	9.959	3.026	3.387	10.498	0.000	45.248
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	2.854	0.000	0.000	1.529	1.377	7.445	9.669	2.743	3.120	9.795	0.000	38.532
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.088	0.000	0.000	0.135	-0.383	-1.045	0.213	0.024	0.063	0.582	0.000	-0.499
OCT	SEN CL	0.270	0.000	0.000	0.951	-0.107	3.333	9.271	2.996	3.575	9.904	0.000	30.193
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.081	0.000	0.000	0.073	-1.532	-3.951	0.860	0.087	0.246	1.696	0.000	-3.604
NOV	SEN CL	-1.055	0.000	0.000	0.073	-0.599	1.562	7.512	2.528	3.353	7.847	0.000	21.220
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.289	0.000	0.000	-0.556	-2.464	-6.215	1.136	0.122	0.424	2.121	0.000	-7.721
DEC	SEN CL	-1.513	0.000	0.000	-0.367	-0.754	0.759	6.539	2.756	3.824	8.088	0.000	19.331
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-8.668	0.000	0.000	-5.048	-11.225	-28.404	6.447	0.629	1.760	11.329	0.000	-33.181
TOT	SEN CL	10.078	0.000	0.000	-0.750	5.484	56.345	103.842	33.968	40.232	110.250	0.000	359.449
	LAT CL					0.727			29.284		0.000	0.000	30.011

Double Selective-Tint Case DOE-B2.2D38c 2/23/2002 19:57:41 BDL RUN 9

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	17.27135	17	15	67.F	46.F	97.121	-9.635	11	6	26.F	21.F	-35.207	4595.	21.051
FEB	16.87724	7	15	71.F	48.F	104.829	-5.610	3	6	34.F	26.F	-27.508	3873.	18.880
MAR	18.90850	28	16	69.F	48.F	96.955	-5.702	4	5	32.F	25.F	-28.984	4179.	18.345
APR	24.11311	11	16	84.F	55.F	103.703	-1.474	7	5	46.F	44.F	-16.009	4199.	16.598
MAY	29.02975	31	16	99.F	61.F	114.842	-0.528	21	4	43.F	38.F	-15.750	4223.	17.430
JUN	36.77029	27	16	112.F	65.F	129.871	-0.001	15	4	57.F	42.F	-0.832	3917.	15.952
JUL	42.55326	25	16	109.F	68.F	130.147	0.000	0	0	0.F	0.F	0.000	4210.	16.157
AUG	41.96617	30	16	103.F	65.F	127.990	0.000	0	0	0.F	0.F	0.000	4234.	16.214
SEP	35.57670	20	16	99.F	60.F	125.927	0.000	0	0	0.F	0.F	0.000	3984.	16.553
OCT	27.50073	3	16	92.F	58.F	120.388	-0.586	23	6	47.F	37.F	-10.458	4410.	20.799
NOV	19.09302	25	15	66.F	46.F	99.392	-3.934	30	6	34.F	27.F	-23.387	4078.	21.058
DEC	17.69517	17	14	65.F	45.F	98.100	-8.150	13	6	29.F	21.F	-29.840	4510.	21.464
TOTAL	327.355						-35.620						50412.	
MAX						130.147						-35.207		21.464

Double Selective-Tint Case DOE-B2.2D38c 2/23/2002 19:57:41 BDL RUN 9
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-2.655	0.000	0.000	-1.196	-2.768	-6.773	0.860	0.139	0.522	2.235	0.000	-9.635
JAN	SEN CL	-1.574	0.000	0.000	-0.713	-0.757	1.111	3.872	2.875	4.215	8.242	0.000	17.271
	LAT CL					0.000			2.556		0.000	0.000	2.556
	HEATNG	-1.323	0.000	0.000	-1.342	-1.708	-4.207	0.740	0.100	0.308	1.822	0.000	-5.610
FEB	SEN CL	-1.055	0.000	0.000	-0.908	-0.527	2.077	4.061	2.509	3.303	7.417	0.000	16.877
	LAT CL					0.002			2.208		0.000	0.000	2.210
	HEATNG	-1.253	0.000	0.000	-1.434	-1.747	-4.337	0.796	0.111	0.274	1.886	0.000	-5.702
MAR	SEN CL	-1.169	0.000	0.000	-1.105	-0.563	2.445	4.796	2.779	3.382	8.344	0.000	18.909
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.074	0.000	0.000	-0.764	-0.569	-1.520	0.357	0.046	0.112	0.936	0.000	-1.474
APR	SEN CL	0.072	0.000	0.000	-1.426	0.085	4.053	5.486	2.969	3.479	9.396	0.000	24.113
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.057	0.000	0.000	-0.149	-0.252	-0.665	0.151	0.019	0.041	0.385	0.000	-0.528
MAY	SEN CL	1.235	0.000	0.000	-1.002	0.549	5.647	6.006	3.002	3.489	10.103	0.000	29.030
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.002	0.000	0.000	0.000	-0.003	-0.008	0.001	0.000	0.000	0.005	0.000	-0.001
JUN	SEN CL	3.480	0.000	0.000	-0.042	1.979	9.540	6.049	2.752	3.205	9.807	0.000	36.770
	LAT CL					0.045			2.324		0.000	0.000	2.369
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	4.535	0.000	0.000	0.918	2.613	11.411	6.104	3.015	3.478	10.479	0.000	42.553
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	4.148	0.000	0.000	1.527	2.386	10.805	6.006	3.026	3.571	10.498	0.000	41.966
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	2.854	0.000	0.000	1.529	1.377	8.033	5.830	2.743	3.414	9.795	0.000	35.577
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.083	0.000	0.000	0.163	-0.423	-1.157	0.155	0.028	0.080	0.652	0.000	-0.586
OCT	SEN CL	0.266	0.000	0.000	0.924	-0.067	3.932	5.565	2.992	4.056	9.834	0.000	27.501
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.128	0.000	0.000	0.077	-1.595	-4.085	0.605	0.092	0.302	1.797	0.000	-3.934
NOV	SEN CL	-1.008	0.000	0.000	0.069	-0.537	2.158	4.446	2.522	3.697	7.745	0.000	19.093
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-2.348	0.000	0.000	-0.569	-2.506	-6.288	0.762	0.126	0.490	2.182	0.000	-8.150
DEC	SEN CL	-1.454	0.000	0.000	-0.354	-0.712	1.332	3.871	2.752	4.233	8.027	0.000	17.695
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-8.919	0.000	0.000	-5.214	-11.569	-29.038	4.429	0.662	2.128	11.900	0.000	-35.620
TOT	SEN CL	10.329	0.000	0.000	-0.584	5.827	62.543	62.093	33.935	43.522	109.679	0.000	327.345
	LAT CL					0.727			29.286		0.000	0.000	30.013

8" Concrete - No Insulation DOE-B2.2D38c 5/15/2002 16:05:59 BDL RUN 17

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - - - - - - - C O O L I N G - - - - - - - -						- - - - - - - - H E A T I N G - - - - - - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	15.73955	30	16	65.F	43.F	104.080	-19.331	11	6	26.F	21.F	-73.486	4417.	20.945
FEB	18.14963	27	15	71.F	49.F	117.022	-9.203	3	6	34.F	26.F	-51.206	3751.	18.066
MAR	21.18935	29	15	72.F	51.F	111.814	-8.874	5	6	33.F	25.F	-54.720	4068.	17.615
APR	34.39325	22	15	89.F	58.F	143.815	-1.381	7	5	46.F	44.F	-26.923	4086.	15.139
MAY	45.85268	31	16	99.F	61.F	158.903	-0.642	21	4	43.F	38.F	-29.128	4127.	16.632
JUN	64.21641	27	16	112.F	65.F	191.020	0.000	0	0	0.F	0.F	0.000	3840.	14.616
JUL	74.61727	26	16	106.F	65.F	188.227	0.000	0	0	0.F	0.F	0.000	4123.	14.778
AUG	72.00595	30	16	103.F	65.F	179.609	0.000	0	0	0.F	0.F	0.000	4129.	14.820
SEP	58.71231	20	16	99.F	60.F	170.936	0.000	0	0	0.F	0.F	0.000	3856.	14.937
OCT	38.12623	3	16	92.F	58.F	155.995	-0.918	23	6	47.F	37.F	-21.421	4230.	20.635
NOV	21.33185	8	15	71.F	50.F	116.715	-7.547	30	7	33.F	27.F	-47.960	3955.	20.751
DEC	16.50246	5	15	74.F	49.F	106.726	-16.735	13	6	29.F	21.F	-60.785	4374.	21.453
TOTAL	480.837						-64.631						48955.	
MAX						191.020						-73.486		21.453

8" Concrete - No Insulation DOE-B2.2D38c 5/15/2002 16:05:59 BDL RUN 17

REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

	(UNITS=MBTU)	WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-14.280	0.000	0.000	-1.206	-2.923	-9.176	3.033	0.393	0.747	4.082	0.000	-19.331
JAN	SEN CL	-3.993	0.000	0.000	-0.529	-0.601	0.622	9.089	2.512	2.992	5.647	0.000	15.740
	LAT CL					0.000			2.237		0.000	0.000	2.237
	HEATNG	-5.994	0.000	0.000	-1.160	-1.649	-5.144	1.966	0.123	0.266	2.390	0.000	-9.203
FEB	SEN CL	-2.953	0.000	0.000	-0.886	-0.585	1.013	10.349	2.394	2.618	6.198	0.000	18.150
	LAT CL					0.002			2.154		0.000	0.000	2.156
	HEATNG	-5.559	0.000	0.000	-1.187	-1.670	-5.231	2.087	0.123	0.200	2.363	0.000	-8.874
MAR	SEN CL	-3.196	0.000	0.000	-1.122	-0.640	1.301	12.260	2.668	2.767	7.151	0.000	21.189
	LAT CL					0.000			2.393		0.000	0.000	2.393
	HEATNG	-0.619	0.000	0.000	-0.402	-0.419	-1.385	0.616	0.022	0.044	0.763	0.000	-1.381
APR	SEN CL	3.690	0.000	0.000	-1.569	-0.065	3.429	14.349	2.884	2.868	8.826	0.000	34.393
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.393	0.000	0.000	-0.078	-0.107	-0.603	0.278	0.009	0.016	0.316	0.000	-0.642
MAY	SEN CL	10.093	0.000	0.000	-0.969	0.484	5.550	15.475	2.905	2.888	9.427	0.000	45.853
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUN	SEN CL	21.292	0.000	0.000	-0.038	1.976	11.059	15.485	2.657	2.658	9.127	0.000	64.216
	LAT CL					0.046			2.324		0.000	0.000	2.371
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	26.633	0.000	0.000	0.834	2.613	13.396	15.623	2.907	2.881	9.731	0.000	74.617
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	24.676	0.000	0.000	1.388	2.386	12.585	15.374	2.922	2.920	9.755	0.000	72.006
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	17.807	0.000	0.000	1.390	1.377	8.761	14.947	2.642	2.684	9.104	0.000	58.712
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.597	0.000	0.000	0.119	-0.328	-1.109	0.285	0.019	0.057	0.636	0.000	-0.918
OCT	SEN CL	4.696	0.000	0.000	0.869	-0.162	3.190	14.391	2.894	3.144	9.105	0.000	38.126
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-5.459	0.000	0.000	0.065	-1.506	-4.857	1.605	0.090	0.260	2.255	0.000	-7.547
NOV	SEN CL	-2.494	0.000	0.000	0.068	-0.626	1.015	11.346	2.435	2.958	6.630	0.000	21.332
	LAT CL					0.000			2.188		0.000	0.000	2.188
	HEATNG	-12.436	0.000	0.000	-0.550	-2.600	-8.351	2.504	0.314	0.699	3.688	0.000	-16.735
DEC	SEN CL	-3.978	0.000	0.000	-0.289	-0.618	0.626	9.365	2.460	3.138	5.799	0.000	16.502
	LAT CL					0.000			2.200		0.000	0.000	2.200
	HEATNG	-45.339	0.000	0.000	-4.399	-11.282	-35.857	12.374	1.092	2.288	16.492	0.000	-64.631
TOT	SEN CL	92.272	0.000	0.000	-0.873	5.540	62.546	158.052	32.279	34.518	96.502	0.000	480.836
	LAT CL					0.728			28.603		0.000	0.000	29.330

8" Concrete -IN w/ 1" Polyurethane Insulation DOE-B2.2D38c 5/15/2002 16:15:01 BDL RUN 19

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

MONTH	COOLING ENERGY (MBTU)	COOLING TIME OF MAX DY	COOLING TIME OF MAX HR	COOLING DRY-BULB TEMP	COOLING WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	HEATING TIME OF MAX DY	HEATING TIME OF MAX HR	HEATING DRY-BULB TEMP	HEATING WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	19.94030	17	15	67.F	46.F	114.640	-9.844	11	6	26.F	21.F	-40.366	4417.	20.945
FEB	21.15212	27	15	71.F	49.F	121.095	-4.691	3	6	34.F	26.F	-28.778	3751.	18.066
MAR	24.45844	21	15	70.F	46.F	113.397	-4.522	4	6	33.F	26.F	-30.514	4068.	17.615
APR	33.53021	22	15	89.F	58.F	130.592	-0.613	7	5	46.F	44.F	-13.805	4086.	15.139
MAY	41.07848	31	16	99.F	61.F	141.549	-0.200	21	4	43.F	38.F	-11.406	4127.	16.632
JUN	52.23958	27	16	112.F	65.F	162.448	0.000	0	0	0.F	0.F	0.000	3840.	14.616
JUL	59.33377	25	16	109.F	68.F	160.774	0.000	0	0	0.F	0.F	0.000	4123.	14.778
AUG	57.98480	30	16	103.F	65.F	156.711	0.000	0	0	0.F	0.F	0.000	4129.	14.820
SEP	49.26938	20	16	99.F	60.F	152.718	0.000	0	0	0.F	0.F	0.000	3856.	14.937
OCT	37.02509	3	16	92.F	58.F	144.102	-0.264	15	5	47.F	35.F	-7.471	4230.	20.635
NOV	24.30637	8	15	71.F	50.F	120.775	-3.237	30	6	34.F	27.F	-24.262	3955.	20.751
DEC	20.63749	5	15	74.F	49.F	114.474	-8.228	23	6	29.F	26.F	-33.644	4374.	21.453
TOTAL	440.956						-31.597						48955.	
MAX						162.448						-40.366		21.453

8" Concrete -IN w/ 1" Polyurethane Insulation DOE-B2.2D38c 5/15/2002 16:15:01 BDL RUN 19
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.691	0.000	0.000	-1.092	-2.647	-8.720	2.600	0.163	0.473	3.070	0.000	-9.844
JAN	SEN CL	-2.186	0.000	0.000	-0.735	-0.877	-0.394	10.709	2.825	3.364	7.234	0.000	19.940
	LAT CL					0.000			2.546		0.000	0.000	2.546
	HEATNG	-1.602	0.000	0.000	-1.132	-1.502	-4.953	1.950	0.109	0.220	2.221	0.000	-4.691
FEB	SEN CL	-1.323	0.000	0.000	-1.021	-0.732	0.550	11.576	2.484	2.727	6.890	0.000	21.152
	LAT CL					0.003			2.208		0.000	0.000	2.211
	HEATNG	-1.454	0.000	0.000	-1.181	-1.535	-5.070	2.169	0.117	0.172	2.259	0.000	-4.522
MAR	SEN CL	-1.412	0.000	0.000	-1.251	-0.775	0.874	13.563	2.762	2.850	7.847	0.000	24.458
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.070	0.000	0.000	-0.399	-0.340	-1.146	0.597	0.032	0.041	0.673	0.000	-0.613
APR	SEN CL	0.876	0.000	0.000	-1.699	-0.143	3.311	15.829	2.959	2.913	9.485	0.000	33.530
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.028	0.000	0.000	-0.065	-0.135	-0.455	0.214	0.010	0.013	0.247	0.000	-0.200
MAY	SEN CL	2.896	0.000	0.000	-1.039	0.432	5.714	17.066	2.991	2.932	10.087	0.000	41.078
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUN	SEN CL	6.420	0.000	0.000	-0.042	1.976	11.760	16.991	2.741	2.697	9.696	0.000	52.240
	LAT CL					0.046			2.324		0.000	0.000	2.371
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	8.217	0.000	0.000	0.877	2.613	14.272	17.135	2.990	2.920	10.308	0.000	59.334
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	7.543	0.000	0.000	1.461	2.386	13.392	16.869	3.013	2.963	10.357	0.000	57.985
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	5.591	0.000	0.000	1.464	1.377	9.341	16.401	2.720	2.723	9.652	0.000	49.269
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.093	0.000	0.000	0.068	-0.208	-0.722	0.198	0.019	0.030	0.445	0.000	-0.264
OCT	SEN CL	1.387	0.000	0.000	0.974	-0.282	2.950	15.902	2.961	3.231	9.883	0.000	37.025
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-1.338	0.000	0.000	0.058	-1.299	-4.404	1.402	0.094	0.213	2.035	0.000	-3.237
NOV	SEN CL	-1.102	0.000	0.000	0.084	-0.833	0.335	12.817	2.511	3.093	7.403	0.000	24.306
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-3.224	0.000	0.000	-0.504	-2.371	-7.952	2.271	0.146	0.470	2.935	0.000	-8.228
DEC	SEN CL	-1.920	0.000	0.000	-0.378	-0.847	-0.268	10.746	2.708	3.479	7.118	0.000	20.638
	LAT CL					0.000			2.438		0.000	0.000	2.438
	HEATNG	-11.498	0.000	0.000	-4.248	-10.037	-33.422	11.400	0.691	1.631	13.886	0.000	-31.597
TOT	SEN CL	24.987	0.000	0.000	-1.306	4.295	61.836	175.604	33.684	35.893	105.960	0.000	440.954
	LAT CL					0.728			29.271		0.000	0.000	30.000

8" Concrete -IN w/ 3" Polyurethane Insulation DOE-B2.2D38c 5/15/2002 16:13:35 BDL RUN 19

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	21.40861	17	15	67.F	46.F	119.228	-7.592	11	6	26.F	21.F	-32.860	4417.	20.945
FEB	22.16426	7	15	71.F	48.F	123.731	-3.627	3	6	34.F	26.F	-23.848	3751.	18.066
MAR	25.56131	21	15	70.F	46.F	116.036	-3.512	4	6	33.F	26.F	-25.429	4068.	17.615
APR	33.51142	22	15	89.F	58.F	128.249	-0.499	7	5	46.F	44.F	-11.708	4086.	15.139
MAY	40.02917	31	16	99.F	61.F	138.369	-0.154	21	4	43.F	38.F	-10.074	4127.	16.632
JUN	49.27246	27	16	112.F	65.F	155.842	0.000	0	0	0.F	0.F	0.000	3840.	14.616
JUL	55.41064	25	16	109.F	68.F	154.388	0.000	0	0	0.F	0.F	0.000	4123.	14.778
AUG	54.43688	30	16	103.F	65.F	151.868	0.000	0	0	0.F	0.F	0.000	4129.	14.820
SEP	46.77864	20	16	99.F	60.F	149.076	0.000	0	0	0.F	0.F	0.000	3856.	14.937
OCT	36.83477	3	15	92.F	60.F	142.463	-0.177	15	5	47.F	35.F	-6.348	4230.	20.635
NOV	25.29877	8	15	71.F	50.F	123.282	-2.331	30	6	34.F	27.F	-19.429	3955.	20.751
DEC	21.98342	5	15	74.F	49.F	118.012	-6.221	23	6	29.F	26.F	-28.525	4374.	21.453
TOTAL	432.690						-24.115						46955.	
MAX						155.842						-32.860		21.453

8" Concrete -IN w/ 3" Polyurethane Insulation DOE-B2.2D38c 5/15/2002 16:13:35 BDL RUN 19
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-1.490	0.000	0.000	-1.071	-2.542	-8.526	2.473	0.159	0.433	2.972	0.000	-7.593
JAN	SEN CL	-1.005	0.000	0.000	-0.784	-0.982	-0.736	11.154	2.851	3.429	7.481	0.000	21.409
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.635	0.000	0.000	-1.100	-1.425	-4.755	1.857	0.109	0.204	2.117	0.000	-3.627
FEB	SEN CL	-0.612	0.000	0.000	-1.086	-0.809	0.280	11.999	2.504	2.760	7.129	0.000	22.164
	LAT CL					0.003			2.208		0.000	0.000	2.211
	HEATNG	-0.575	0.000	0.000	-1.157	-1.463	-4.881	2.108	0.119	0.162	2.175	0.000	-3.512
MAR	SEN CL	-0.643	0.000	0.000	-1.311	-0.847	0.615	14.004	2.783	2.874	8.086	0.000	25.561
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.021	0.000	0.000	-0.392	-0.320	-1.076	0.596	0.033	0.040	0.641	0.000	-0.499
APR	SEN CL	0.346	0.000	0.000	-1.738	-0.164	3.271	16.227	2.960	2.924	9.664	0.000	33.511
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.004	0.000	0.000	-0.062	-0.124	-0.419	0.203	0.010	0.012	0.229	0.000	-0.154
MAY	SEN CL	1.200	0.000	0.000	-1.060	0.422	5.759	17.494	3.015	2.943	10.257	0.000	40.029
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUN	SEN CL	2.678	0.000	0.000	-0.044	1.976	11.941	17.405	2.764	2.707	9.845	0.000	49.272
	LAT CL					0.046			2.324		0.000	0.000	2.371
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	3.452	0.000	0.000	0.890	2.613	14.503	17.553	3.012	2.930	10.457	0.000	55.411
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	3.161	0.000	0.000	1.483	2.386	13.604	17.278	3.037	2.975	10.513	0.000	54.437
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	2.354	0.000	0.000	1.487	1.377	9.494	16.798	2.741	2.734	9.794	0.000	46.779
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.029	0.000	0.000	0.051	-0.175	-0.614	0.172	0.017	0.021	0.380	0.000	-0.177
OCT	SEN CL	0.578	0.000	0.000	1.006	-0.315	2.881	16.324	3.005	3.255	10.099	0.000	36.835
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-0.507	0.000	0.000	0.054	-1.203	-4.121	1.281	0.091	0.191	1.884	0.000	-2.331
NOV	SEN CL	-0.515	0.000	0.000	0.091	-0.929	-0.005	13.285	2.536	3.139	7.698	0.000	25.299
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-1.282	0.000	0.000	-0.487	-2.271	-7.739	2.153	0.146	0.426	2.833	0.000	-6.221
DEC	SEN CL	-0.889	0.000	0.000	-0.407	-0.947	-0.610	11.188	2.730	3.553	7.367	0.000	21.963
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-4.543	0.000	0.000	-4.165	-9.523	-32.131	10.844	0.684	1.489	13.231	0.000	-24.114
TOT	SEN CL	10.105	0.000	0.000	-1.474	3.781	60.997	180.709	33.957	36.225	108.392	0.000	432.694
	LAT CL					0.729			29.285		0.000	0.000	30.013

2 x 6 Wall w/ R-19 Batt Insulation | DOE-B2.2D38c 5/15/2002 14:52:13 BDL RUN 2

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	24.33939	17	15	67.F	46.F	141.452	-11.779	11	6	26.F	21.F	-46.292	4417.	20.945
FEB	25.07398	7	15	71.F	48.F	148.968	-6.723	3	6	34.F	26.F	-37.597	3751.	18.066
MAR	28.92152	21	15	70.F	46.F	137.281	-6.843	5	4	31.F	24.F	-39.280	4068.	17.615
APR	36.24575	11	16	84.F	55.F	148.132	-1.899	7	5	46.F	44.F	-22.960	4086.	15.139
MAY	42.85892	31	16	99.F	61.F	159.415	-0.732	21	4	43.F	38.F	-23.806	4127.	16.632
JUN	52.76579	27	16	112.F	65.F	178.115	-0.017	15	4	57.F	42.F	-5.163	3840.	14.616
JUL	59.51493	24	16	110.F	65.F	176.845	0.000	0	0	0.F	0.F	0.000	4123.	14.778
AUG	58.34148	30	16	103.F	65.F	175.042	0.000	0	0	0.F	0.F	0.000	4129.	14.820
SEP	49.86419	20	16	99.F	60.F	173.390	-0.005	14	5	62.F	50.F	-1.205	3856.	14.937
OCT	39.18632	3	15	92.F	60.F	165.424	-1.190	15	5	47.F	35.F	-17.728	4230.	20.635
NOV	28.01285	8	15	71.F	50.F	141.840	-5.310	30	6	34.F	27.F	-33.419	3955.	20.751
DEC	24.86409	17	15	67.F	45.F	139.592	-10.217	23	6	29.F	26.F	-40.883	4374.	21.453
TOTAL	469.989						-44.714						48955.	
MAX						178.115						-46.292		21.453

2 x 6 Wall w/ R-19 Batt Insulation DOE-B2.2D38c 5/15/2002 14:52:13 BDL RUN 2

REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-4.123	0.000	0.000	-1.093	-2.637	-9.123	1.854	0.096	0.390	2.857	0.000	-11.779
JAN	SEN CL	0.380	0.000	0.000	-0.770	-0.888	-0.104	11.746	2.916	3.475	7.584	0.000	24.339
	LAT CL					0.000			2.551		0.000	0.000	2.551
	HEATNG	-2.457	0.000	0.000	-1.183	-1.592	-5.571	1.573	0.066	0.193	2.247	0.000	-6.723
FEB	SEN CL	1.089	0.000	0.000	-1.014	-0.642	1.115	12.244	2.544	2.767	6.970	0.000	25.074
	LAT CL					0.003			2.208		0.000	0.000	2.211
	HEATNG	-2.513	0.000	0.000	-1.247	-1.631	-5.744	1.745	0.071	0.155	2.320	0.000	-6.843
MAR	SEN CL	1.380	0.000	0.000	-1.233	-0.679	1.507	14.359	2.822	2.876	7.890	0.000	28.921
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.840	0.000	0.000	-0.643	-0.550	-2.046	0.878	0.033	0.063	1.207	0.000	-1.899
APR	SEN CL	2.542	0.000	0.000	-1.495	0.066	4.250	15.915	2.982	2.903	9.083	0.000	36.246
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.393	0.000	0.000	-0.143	-0.249	-0.935	0.389	0.014	0.025	0.559	0.000	-0.732
MAY	SEN CL	3.896	0.000	0.000	-0.981	0.546	6.272	17.293	3.008	2.929	9.896	0.000	42.859
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.017	0.000	0.000	0.000	-0.012	-0.047	0.017	0.001	0.001	0.040	0.000	-0.017
JUN	SEN CL	6.269	0.000	0.000	-0.041	1.988	11.975	17.362	2.754	2.703	9.756	0.000	52.766
	LAT CL					0.041			2.324		0.000	0.000	2.365
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	7.634	0.000	0.000	0.896	2.613	14.449	17.535	3.014	2.931	10.443	0.000	59.515
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	7.167	0.000	0.000	1.491	2.386	13.576	17.254	3.029	2.972	10.467	0.000	58.341
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	-0.007	0.000	0.000	0.000	-0.004	-0.020	0.004	0.000	0.000	0.023	0.000	-0.005
SEP	SEN CL	5.526	0.000	0.000	1.493	1.382	9.468	16.770	2.740	2.734	9.751	0.000	49.864
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.790	0.000	0.000	0.201	-0.487	-1.821	0.538	0.025	0.071	1.074	0.000	-1.190
OCT	SEN CL	2.749	0.000	0.000	0.860	-0.003	4.064	15.934	2.995	3.208	9.378	0.000	39.186
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-2.412	0.000	0.000	0.070	-1.505	-5.391	1.395	0.062	0.199	2.271	0.000	-5.310
NOV	SEN CL	1.241	0.000	0.000	0.073	-0.627	1.246	13.138	2.556	3.121	7.265	0.000	28.013
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-3.809	0.000	0.000	-0.519	-2.401	-8.454	1.710	0.087	0.379	2.791	0.000	-10.217
DEC	SEN CL	0.545	0.000	0.000	-0.382	-0.817	0.122	11.613	2.789	3.601	7.392	0.000	24.864
	LAT CL					0.000			2.438		0.000	0.000	2.438
	HEATNG	-17.360	0.000	0.000	-4.559	-11.067	-39.152	10.103	0.455	1.476	15.390	0.000	-44.714
TOT	SEN CL	40.417	0.000	0.000	-1.103	5.326	67.941	181.164	34.150	36.220	105.869	0.000	469.984
	LAT CL					0.723			29.277		0.000	0.000	30.000

2 x 6 Wall w/ R-19 Batt & 3" Polyurethane Insulation DOE-B2.2D38c 5/15/2002 15:04:19 BDL RUN 5

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV THY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	25.00483	17	15	67.F	46.F	136.901	-9.892	11	6	26.F	21.F	-39.290	4379.	20.680
FEB	25.29187	7	15	71.F	48.F	142.104	-5.712	3	6	34.F	26.F	-31.509	3750.	17.049
MAR	29.09051	21	15	70.F	46.F	132.994	-5.789	5	4	31.F	24.F	-33.341	4092.	16.265
APR	35.61718	11	16	84.F	55.F	143.079	-1.638	7	5	46.F	44.F	-19.537	4133.	15.401
MAY	41.31628	31	16	99.F	61.F	151.875	-0.608	21	4	43.F	38.F	-20.023	4172.	15.136
JUN	49.68076	27	16	112.F	65.F	168.493	-0.015	15	4	57.F	42.F	-4.235	3877.	15.136
JUL	55.66999	24	16	110.F	65.F	167.191	0.000	0	0	0.F	0.F	0.000	4171.	15.136
AUG	54.77036	30	16	103.F	65.F	165.997	0.000	0	0	0.F	0.F	0.000	4175.	15.144
SEP	47.20256	20	16	99.F	60.F	164.279	-0.005	14	4	61.F	49.F	-1.228	3888.	15.220
OCT	38.33568	3	15	92.F	60.F	158.274	-0.947	15	5	47.F	35.F	-14.486	4238.	20.223
NOV	28.13471	8	15	71.F	50.F	138.345	-4.331	30	6	34.F	27.F	-27.559	3933.	20.530
DEC	25.40862	5	15	74.F	49.F	134.762	-8.501	23	6	29.F	26.F	-34.711	4333.	21.398
TOTAL	455.523						-37.437						49141.	
MAX						168.493						-39.290		21.398

2 x 6 Wall w/ R-19 Batt & 3" Polyurethane Insulation DOE-B2.2D38c 5/15/2002 15:04:19 BDL RUN 5
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-1.437	0.000	0.000	-1.099	-2.609	-9.158	1.823	0.141	0.393	2.054	0.000	-9.892
JAN	SEN CL	0.012	0.000	0.000	-0.786	-0.916	-0.187	12.036	2.854	3.638	8.354	0.000	25.005
	LAT CL					0.000			2.556		0.000	0.000	2.556
	HEATNG	-0.835	0.000	0.000	-1.196	-1.575	-5.586	1.548	0.100	0.216	1.615	0.000	-5.712
FEB	SEN CL	0.311	0.000	0.000	-1.027	-0.659	1.073	12.533	2.493	3.002	7.566	0.000	25.292
	LAT CL					0.003			2.208		0.000	0.000	2.211
	HEATNG	-0.851	0.000	0.000	-1.263	-1.618	-5.777	1.739	0.109	0.193	1.680	0.000	-5.789
MAR	SEN CL	0.416	0.000	0.000	-1.245	-0.691	1.486	14.670	2.764	3.200	8.491	0.000	29.090
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-0.270	0.000	0.000	-0.662	-0.545	-2.058	0.879	0.049	0.068	0.880	0.000	-1.638
APR	SEN CL	0.909	0.000	0.000	-1.501	0.061	4.290	16.234	2.946	3.295	9.384	0.000	35.617
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.126	0.000	0.000	-0.143	-0.243	-0.931	0.376	0.021	0.037	0.401	0.000	-0.608
MAY	SEN CL	1.446	0.000	0.000	-0.995	0.541	6.336	17.643	2.981	3.343	10.022	0.000	41.316
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.005	0.000	0.000	0.000	-0.011	-0.046	0.016	0.001	0.002	0.028	0.000	-0.015
JUN	SEN CL	2.358	0.000	0.000	-0.042	1.988	12.127	17.694	2.735	3.094	9.726	0.000	49.681
	LAT CL					0.042			2.324		0.000	0.000	2.366
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	2.880	0.000	0.000	0.906	2.613	14.634	17.868	2.995	3.363	10.410	0.000	55.670
	LAT CL					0.286			2.557		0.000	0.000	2.843
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	2.701	0.000	0.000	1.508	2.386	13.749	17.582	3.009	3.400	10.436	0.000	54.770
	LAT CL					0.341			2.557		0.000	0.000	2.898
	HEATNG	-0.003	0.000	0.000	0.000	-0.005	-0.025	0.005	0.000	0.001	0.021	0.000	-0.005
SEP	SEN CL	2.088	0.000	0.000	1.510	1.383	9.595	17.088	2.723	3.106	9.710	0.000	47.203
	LAT CL					0.047			2.324		0.000	0.000	2.371
	HEATNG	-0.256	0.000	0.000	0.178	-0.461	-1.747	0.485	0.036	0.084	0.734	0.000	-0.947
OCT	SEN CL	0.995	0.000	0.000	0.895	-0.030	4.019	16.299	2.965	3.505	9.686	0.000	38.336
	LAT CL					0.005			2.557		0.000	0.000	2.561
	HEATNG	-0.825	0.000	0.000	0.069	-1.477	-5.365	1.337	0.093	0.225	1.612	0.000	-4.331
NOV	SEN CL	0.378	0.000	0.000	0.076	-0.655	1.167	13.472	2.507	3.314	7.875	0.000	28.135
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-1.327	0.000	0.000	-0.520	-2.369	-8.464	1.665	0.128	0.388	1.998	0.000	-8.501
DEC	SEN CL	0.086	0.000	0.000	-0.392	-0.849	0.025	11.912	2.730	3.753	8.143	0.000	25.409
	LAT CL					0.000			2.440		0.000	0.000	2.440
	HEATNG	-5.934	0.000	0.000	-4.635	-10.914	-39.156	9.873	0.679	1.627	11.022	0.000	-37.437
TOT	SEN CL	14.579	0.000	0.000	-1.091	5.172	68.312	165.033	33.701	40.014	109.797	0.000	455.519
	LAT CL					0.724			29.286		0.000	0.000	30.010

No Plenum Bldg w/ Built-up Roof & No Insulation DOE-B2.2D38c 5/17/2002 6:35:49 BDL RUN 16

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	20.94894	17	15	67.F	46.F	147.538	-25.600	11	6	26.F	21.F	-89.509	4358.	20.747
FEB	24.37581	7	15	71.F	48.F	165.118	-14.739	3	6	34.F	26.F	-75.618	3724.	16.748
MAR	29.40782	21	15	70.F	46.F	159.581	-14.794	3	6	33.F	26.F	-76.800	4053.	16.245
APR	42.44852	22	15	89.F	58.F	183.863	-4.402	7	5	46.F	44.F	-43.456	4079.	14.948
MAY	53.54037	31	16	99.F	61.F	207.956	-2.379	21	4	43.F	38.F	-46.414	4122.	14.944
JUN	71.81473	27	16	112.F	65.F	241.728	-0.203	15	4	57.F	42.F	-14.733	3838.	14.551
JUL	82.41620	24	16	110.F	65.F	237.310	-0.016	4	4	68.F	63.F	-2.005	4121.	14.609
AUG	79.19059	1	16	106.F	69.F	228.035	-0.057	16	5	66.F	49.F	-3.950	4124.	14.634
SEP	64.40586	10	15	100.F	64.F	220.038	-0.373	14	5	62.F	50.F	-10.399	3849.	14.754
OCT	44.51343	3	15	92.F	60.F	202.811	-4.436	23	6	47.F	37.F	-39.256	4198.	20.327
NOV	27.54115	8	15	71.F	50.F	153.569	-13.380	30	6	34.F	27.F	-69.943	3922.	20.526
DEC	21.70061	5	15	74.F	49.F	145.789	-23.039	13	6	29.F	21.F	-80.495	4328.	21.407
TOTAL	562.304						-103.417						48715.	
MAX						241.728						-89.509		21.407

No Plenum Bldg w/ Built-up Roof & No Insulation DOE-B2.2D38c 5/17/2002 6:35:49 BDL RUN 16
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TRY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.590	-13.180	0.000	-1.122	-3.800	-12.483	3.676	0.304	0.807	3.790	0.000	-25.600
JAN	SEN CL	-1.933	-1.849	0.000	-0.765	-0.879	0.324	14.086	2.632	2.778	6.555	0.000	20.949
	LAT CL					0.000			2.461		0.000	0.000	2.461
	HEATNG	-1.707	-8.472	0.000	-1.140	-2.261	-7.465	2.894	0.178	0.419	2.815	0.000	-14.739
FEB	SEN CL	-1.405	-0.216	0.000	-1.084	-0.705	1.584	15.138	2.367	2.373	6.324	0.000	24.376
	LAT CL					0.003			2.185		0.000	0.000	2.188
	HEATNG	-1.615	-8.599	0.000	-1.199	-2.312	-7.672	3.184	0.178	0.360	2.862	0.000	-14.794
MAR	SEN CL	-1.561	0.748	0.000	-1.312	-0.755	2.067	17.800	2.646	2.509	7.266	0.000	29.408
	LAT CL					0.000			2.430		0.000	0.000	2.430
	HEATNG	-0.101	-3.576	0.000	-0.416	-0.727	-2.550	1.322	0.067	0.169	1.410	0.000	-4.402
APR	SEN CL	0.074	3.699	0.000	-1.750	0.085	5.420	20.584	2.871	2.680	8.786	0.000	42.448
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.018	-2.328	0.000	-0.076	-0.341	-1.231	0.644	0.036	0.110	0.788	0.000	-2.379
MAY	SEN CL	1.492	6.530	0.000	-1.065	0.736	8.224	22.403	2.910	2.733	9.576	0.000	53.540
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.031	-0.305	0.000	0.000	-0.017	-0.072	0.036	0.005	0.022	0.098	0.000	-0.203
JUN	SEN CL	4.481	11.486	0.000	-0.044	2.641	15.741	22.619	2.685	2.586	9.619	0.000	71.815
	LAT CL					0.052			2.324		0.000	0.000	2.376
	HEATNG	0.001	-0.034	0.000	0.000	0.000	-0.001	0.001	0.001	0.005	0.010	0.000	-0.016
JUL	SEN CL	5.885	14.215	0.000	0.906	3.470	18.997	22.846	2.936	2.825	10.337	0.000	82.416
	LAT CL					0.378			2.557		0.000	0.000	2.935
	HEATNG	0.007	-0.103	0.000	0.000	-0.001	-0.006	0.003	0.002	0.013	0.029	0.000	-0.057
AUG	SEN CL	5.373	12.652	0.000	1.509	3.168	17.844	22.493	2.954	2.845	10.351	0.000	79.191
	LAT CL					0.453			2.557		0.000	0.000	3.010
	HEATNG	0.105	-0.675	0.000	0.000	-0.026	-0.138	0.074	0.010	0.056	0.222	0.000	-0.373
SEP	SEN CL	3.597	8.386	0.000	1.512	1.855	12.560	21.798	2.663	2.570	9.464	0.000	64.406
	LAT CL					0.062			2.324		0.000	0.000	2.386
	HEATNG	-0.023	-4.118	0.000	0.103	-0.616	-2.223	0.815	0.065	0.200	1.362	0.000	-4.436
OCT	SEN CL	0.246	2.767	0.000	0.973	-0.035	5.163	20.640	2.880	2.882	8.999	0.000	44.514
	LAT CL					0.006			2.555		0.000	0.000	2.561
	HEATNG	-1.453	-8.625	0.000	0.061	-2.053	-6.988	2.337	0.158	0.444	2.737	0.000	-13.380
NOV	SEN CL	-1.338	-0.382	0.000	0.085	-0.778	1.528	16.620	2.397	2.687	6.723	0.000	27.541
	LAT CL					0.000			2.195		0.000	0.000	2.195
	HEATNG	-3.148	-12.358	0.000	-0.521	-3.426	-11.481	3.188	0.268	0.818	3.622	0.000	-23.039
DEC	SEN CL	-1.811	-1.836	0.000	-0.389	-0.846	0.505	14.148	2.535	2.925	6.470	0.000	21.701
	LAT CL					0.000			2.368		0.000	0.000	2.368
	HEATNG	-11.475	-62.373	0.000	-4.311	-15.581	-52.311	18.175	1.272	3.442	19.744	0.000	-103.417
TOT	SEN CL	13.099	56.202	0.000	-1.425	7.957	89.956	231.175	32.474	32.393	100.471	0.000	562.304
	LAT CL					0.954			29.068		0.000	0.000	30.022

No Plenum Bldg w/ Built-up Roof & R-30 Insulation DOE-B2.2D38c 5/17/2002 6:32:23 BDL RUN 14

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	23.27106	17	15	67.F	46.F	144.841	-15.191	11	6	26.F	21.F	-59.609	4358.	20.747
FEB	25.29781	27	15	71.F	49.F	154.737	-8.032	3	6	34.F	26.F	-45.655	3724.	16.748
MAR	29.60545	21	15	70.F	46.F	145.168	-7.964	5	4	31.F	24.F	-47.628	4053.	16.245
APR	40.39510	22	15	89.F	58.F	164.669	-1.674	7	5	46.F	44.F	-25.096	4079.	14.948
MAY	49.29275	31	16	99.F	61.F	179.008	-0.705	21	4	43.F	38.F	-25.917	4122.	14.944
JUN	63.44515	27	16	112.F	65.F	205.280	-0.010	15	4	57.F	42.F	-3.177	3838.	14.551
JUL	71.85831	24	16	110.F	65.F	202.184	0.000	0	0	0.F	0.F	0.000	4121.	14.609
AUG	69.90040	30	16	103.F	65.F	197.651	0.000	0	0	0.F	0.F	0.000	4124.	14.634
SEP	58.65170	20	16	99.F	60.F	192.554	-0.003	14	4	61.F	49.F	-0.704	3849.	14.754
OCT	43.28669	3	15	92.F	60.F	181.669	-1.325	23	6	47.F	37.F	-19.436	4198.	20.327
NOV	28.64333	8	15	71.F	50.F	150.832	-6.558	30	6	34.F	27.F	-41.141	3922.	20.526
DEC	23.97447	5	15	74.F	49.F	144.210	-13.255	23	6	29.F	26.F	-50.902	4328.	21.407
TOTAL	527.622						-54.717						48715.	
MAX						205.280						-59.609		21.407

No Plenum Bldg w/ Built-up Roof & Rigid Insulation DOE-B2.2D38c 5/17/2002 6:32:23 BDL RUN 14
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.457	-2.118	0.000	-1.122	-3.661	-12.296	3.241	0.203	0.595	3.426	0.000	-15.191
JAN	SEN CL	-2.142	-0.611	0.000	-0.765	-1.018	-0.029	14.888	2.790	3.055	7.103	0.000	23.271
	LAT CL					0.000			2.521		0.000	0.000	2.521
	HEATNG	-1.648	-1.324	0.000	-1.140	-2.161	-7.324	2.586	0.120	0.285	2.572	0.000	-8.032
FEB	SEN CL	-1.507	-0.247	0.000	-1.084	-0.806	1.362	15.818	2.474	2.558	6.729	0.000	25.298
	LAT CL					0.003			2.206		0.000	0.000	2.209
	HEATNG	-1.568	-1.352	0.000	-1.199	-2.221	-7.562	2.898	0.131	0.254	2.655	0.000	-7.964
MAR	SEN CL	-1.651	-0.073	0.000	-1.312	-0.845	1.880	18.519	2.747	2.688	7.653	0.000	29.605
	LAT CL					0.000			2.439		0.000	0.000	2.439
	HEATNG	-0.134	-0.470	0.000	-0.416	-0.654	-2.334	1.085	0.042	0.079	1.128	0.000	-1.674
APR	SEN CL	0.106	0.486	0.000	-1.750	0.011	5.243	21.273	2.952	2.824	9.250	0.000	40.395
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.073	-0.250	0.000	-0.076	-0.278	-1.000	0.431	0.018	0.038	0.485	0.000	-0.705
MAY	SEN CL	1.604	0.992	0.000	-1.065	0.672	8.089	23.092	2.986	2.858	10.065	0.000	49.293
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.008	-0.015	0.000	0.000	-0.007	-0.030	0.008	0.000	0.002	0.023	0.000	-0.010
JUN	SEN CL	4.566	2.003	0.000	-0.044	2.631	15.913	23.115	2.740	2.654	9.867	0.000	63.445
	LAT CL					0.058			2.324		0.000	0.000	2.382
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	5.966	2.535	0.000	0.906	3.470	19.255	23.319	2.994	2.883	10.532	0.000	71.856
	LAT CL					0.380			2.557		0.000	0.000	2.937
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.453	2.240	0.000	1.509	3.168	18.081	22.961	3.012	2.911	10.566	0.000	69.900
	LAT CL					0.453			2.557		0.000	0.000	3.010
	HEATNG	0.004	-0.013	0.000	0.000	-0.003	-0.013	0.003	0.000	0.003	0.016	0.000	-0.003
SEP	SEN CL	3.748	1.395	0.000	1.512	1.832	12.605	22.321	2.723	2.672	9.844	0.000	58.652
	LAT CL					0.063			2.324		0.000	0.000	2.387
	HEATNG	-0.092	-0.525	0.000	0.103	-0.532	-1.962	0.556	0.032	0.089	1.006	0.000	-1.325
OCT	SEN CL	0.319	0.275	0.000	0.973	-0.119	4.941	21.341	2.969	3.049	9.540	0.000	43.287
	LAT CL					0.006			2.557		0.000	0.000	2.563
	HEATNG	-1.405	-1.352	0.000	0.061	-1.958	-6.834	2.028	0.106	0.300	2.496	0.000	-6.558
NOV	SEN CL	-1.424	-0.283	0.000	0.085	-0.872	1.300	17.320	2.498	2.887	7.132	0.000	26.643
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-3.062	-1.987	0.000	-0.521	-3.311	-11.328	2.862	0.180	0.601	3.311	0.000	-13.255
DEC	SEN CL	-1.965	-0.589	0.000	-0.389	-0.962	0.202	14.831	2.677	3.208	6.960	0.000	23.974
	LAT CL					0.000			2.415		0.000	0.000	2.415
	HEATNG	-11.426	-9.404	0.000	-4.311	-14.786	-50.682	15.697	0.832	2.245	17.118	0.000	-54.717
TOT	SEN CL	13.073	8.123	0.000	-1.425	7.163	88.841	238.798	33.560	34.246	105.243	0.000	527.622
	LAT CL					0.963			29.219		0.000	0.000	30.182

No Plenmum Bldg w/ Built-up Roof & R-18 Rigid Insulation DOE-B2.2D38c 5/17/2002 6:30:43 BDL RUN 12

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - - C O O L I N G - - -						- - - H E A T I N G - - -						- - - E L E C - - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	22.57377	17	15	67.F	46.F	142.856	-15.712	11	6	26.F	21.F	-62.159	4358.	20.747
FEB	24.79665	27	15	71.F	49.F	153.588	-8.257	3	6	34.F	26.F	-47.910	3724.	16.748
MAR	29.12593	21	15	70.F	46.F	144.114	-8.161	5	6	33.F	25.F	-49.837	4053.	16.245
APR	40.36423	22	15	89.F	58.F	165.495	-1.701	7	5	46.F	44.F	-26.299	4079.	14.948
MAY	49.54602	31	16	99.F	61.F	180.903	-0.718	21	4	43.F	38.F	-27.211	4122.	14.944
JUN	64.22652	27	16	112.F	65.F	207.537	-0.011	15	4	57.F	42.F	-2.736	3838.	14.551
JUL	72.87714	24	16	110.F	65.F	204.620	0.000	0	0	0.F	0.F	0.000	4121.	14.609
AUG	70.78497	30	16	103.F	65.F	200.065	0.000	0	0	0.F	0.F	0.000	4124.	14.634
SEP	59.18824	20	16	99.F	60.F	194.481	-0.005	30	6	63.F	44.F	-0.687	3849.	14.754
OCT	43.16307	3	15	92.F	60.F	181.971	-1.369	23	6	47.F	37.F	-20.591	4198.	20.327
NOV	28.13367	8	15	71.F	50.F	149.886	-6.793	30	6	34.F	27.F	-43.217	3922.	20.526
DEC	23.30453	5	15	74.F	49.F	142.631	-13.736	13	6	29.F	21.F	-52.988	4328.	21.407
TOTAL	528.085						-56.461						46715.	
MAX						207.537						-62.159		21.407

No Plenmum Bldg w/ Built-up Roof & R-18 Rigid Insulation DOE-B2.2D38c 5/17/2002 6:30:43 BDL RUN 12
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.474	-2.834	0.000	-1.122	-3.673	-12.279	3.336	0.217	0.635	3.481	0.000	-15.712
JAN	SEN CL	-2.118	-1.073	0.000	-0.765	-1.007	-0.032	14.759	2.770	3.008	7.032	0.000	22.574
	LAT CL					0.000			2.513		0.000	0.000	2.513
	HEATNG	-1.650	-1.676	0.000	-1.140	-2.160	-7.284	2.639	0.125	0.305	2.584	0.000	-8.257
FEB	SEN CL	-1.501	-0.574	0.000	-1.084	-0.806	1.330	15.731	2.465	2.533	6.702	0.000	24.797
	LAT CL					0.003			2.205		0.000	0.000	2.208
	HEATNG	-1.567	-1.676	0.000	-1.199	-2.219	-7.510	2.945	0.137	0.271	2.658	0.000	-8.161
MAR	SEN CL	-1.648	-0.370	0.000	-1.312	-0.848	1.835	18.432	2.737	2.667	7.634	0.000	29.126
	LAT CL					0.000			2.437		0.000	0.000	2.437
	HEATNG	-0.137	-0.540	0.000	-0.416	-0.647	-2.287	1.096	0.042	0.082	1.105	0.000	-1.701
APR	SEN CL	0.110	0.569	0.000	-1.750	0.004	5.193	21.221	2.947	2.815	9.256	0.000	40.364
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.075	-0.277	0.000	-0.076	-0.274	-0.979	0.436	0.017	0.037	0.472	0.000	-0.718
MAY	SEN CL	1.604	1.341	0.000	-1.065	0.669	8.058	23.044	2.981	2.854	10.061	0.000	49.546
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.007	-0.018	0.000	0.000	-0.007	-0.026	0.007	0.000	0.003	0.022	0.000	-0.011
JUN	SEN CL	4.561	2.880	0.000	-0.044	2.630	15.889	23.073	2.736	2.648	9.853	0.000	64.226
	LAT CL					0.058			2.324		0.000	0.000	2.382
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	5.959	3.654	0.000	0.906	3.470	19.232	23.276	2.988	2.878	10.515	0.000	72.877
	LAT CL					0.380			2.557		0.000	0.000	2.937
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.446	3.222	0.000	1.509	3.168	18.059	22.919	3.007	2.906	10.549	0.000	70.785
	LAT CL					0.453			2.557		0.000	0.000	3.010
	HEATNG	0.004	-0.019	0.000	0.000	-0.003	-0.012	0.003	0.001	0.005	0.018	0.000	-0.005
SEP	SEN CL	3.744	2.021	0.000	1.512	1.832	12.589	22.280	2.718	2.666	9.826	0.000	59.188
	LAT CL					0.063			2.324		0.000	0.000	2.387
	HEATNG	-0.096	-0.609	0.000	0.103	-0.520	-1.903	0.557	0.032	0.092	0.975	0.000	-1.369
OCT	SEN CL	0.322	0.262	0.000	0.973	-0.131	4.879	21.301	2.963	3.041	9.554	0.000	43.163
	LAT CL					0.006			2.557		0.000	0.000	2.563
	HEATNG	-1.405	-1.705	0.000	0.061	-1.956	-6.768	2.075	0.110	0.316	2.498	0.000	-6.793
NOV	SEN CL	-1.421	-0.624	0.000	0.085	-0.874	1.260	17.237	2.489	2.866	7.115	0.000	28.134
	LAT CL					0.000			2.207		0.000	0.000	2.207
	HEATNG	-3.081	-2.666	0.000	-0.521	-3.324	-11.316	2.959	0.194	0.649	3.370	0.000	-13.736
DEC	SEN CL	-1.940	-1.021	0.000	-0.389	-0.948	0.204	14.702	2.658	3.154	6.885	0.000	23.305
	LAT CL					0.000			2.407		0.000	0.000	2.407
	HEATNG	-11.473	-12.019	0.000	-4.311	-14.782	-50.383	16.053	0.876	2.395	17.163	0.000	-56.461
TOT	SEN CL	13.117	10.287	0.000	-1.425	7.158	88.496	237.977	33.457	34.036	104.978	0.000	528.082
	LAT CL					0.963			29.200		0.000	0.000	30.163

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	23.35455	17	15	67.F	46.F	144.769	-14.950	11	6	26.F	21.F	-58.857	4358.	20.747
FEB	25.33955	27	15	71.F	49.F	154.500	-7.881	3	6	34.F	26.F	-44.864	3724.	16.748
MAR	29.62920	21	15	70.F	46.F	144.798	-7.810	5	4	31.F	24.F	-46.916	4053.	16.245
APR	40.35839	22	15	89.F	58.F	164.187	-1.621	7	5	46.F	44.F	-24.656	4079.	14.948
MAY	49.20040	31	16	99.F	61.F	178.265	-0.677	21	4	43.F	38.F	-25.393	4122.	14.944
JUN	63.23861	27	16	112.F	65.F	204.355	-0.009	15	4	57.F	42.F	-2.894	3838.	14.551
JUL	71.59263	24	16	110.F	65.F	201.286	0.000	0	0	0.F	0.F	0.000	4121.	14.609
AUG	69.66781	30	16	103.F	65.F	196.878	0.000	0	0	0.F	0.F	0.000	4124.	14.634
SEP	58.51401	20	16	99.F	60.F	191.891	-0.002	14	4	61.F	49.F	-0.599	3849.	14.754
OCT	43.27420	3	15	92.F	60.F	181.129	-1.265	23	6	47.F	37.F	-18.930	4198.	20.327
NOV	28.69015	8	15	71.F	50.F	150.756	-6.404	30	6	34.F	27.F	-40.380	3922.	20.526
DEC	24.05509	5	15	74.F	49.F	144.168	-13.029	23	6	29.F	26.F	-50.216	4328.	21.407
TOTAL	526.915						-53.647						48715.	
MAX						204.355						-58.857		21.407

No Plenum Bldg w/ Built-up Roof & R-49 Insulation DOE-B2.2D38c 5/17/2002 6:39:15 BDL RUN 18
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.451	-1.850	0.000	-1.122	-3.654	-12.281	3.227	0.196	0.582	3.404	0.000	-14.950
JAN	SEN CL	-2.149	-0.565	0.000	-0.765	-1.026	-0.048	14.911	2.797	3.070	7.130	0.000	23.355
	LAT CL					0.000			2.523		0.000	0.000	2.523
	HEATNG	-1.645	-1.152	0.000	-1.140	-2.156	-7.315	2.571	0.117	0.279	2.560	0.000	-7.881
FEB	SEN CL	-1.511	-0.238	0.000	-1.084	-0.811	1.351	15.842	2.478	2.566	6.745	0.000	25.340
	LAT CL					0.003			2.206		0.000	0.000	2.209
	HEATNG	-1.567	-1.176	0.000	-1.199	-2.218	-7.556	2.891	0.128	0.246	2.641	0.000	-7.810
MAR	SEN CL	-1.654	-0.085	0.000	-1.312	-0.849	1.872	18.536	2.751	2.697	7.671	0.000	29.629
	LAT CL					0.000			2.439		0.000	0.000	2.439
	HEATNG	-0.133	-0.397	0.000	-0.416	-0.646	-2.308	1.063	0.040	0.073	1.104	0.000	-1.621
APR	SEN CL	0.106	0.411	0.000	-1.750	0.004	5.219	21.306	2.955	2.831	9.278	0.000	40.358
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.075	-0.205	0.000	-0.076	-0.275	-0.991	0.426	0.016	0.033	0.469	0.000	-0.677
MAY	SEN CL	1.606	0.862	0.000	-1.065	0.670	8.081	23.108	2.989	2.865	10.085	0.000	49.200
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.008	-0.011	0.000	0.000	-0.007	-0.030	0.008	0.000	0.001	0.022	0.000	-0.009
JUN	SEN CL	4.567	1.770	0.000	-0.044	2.631	15.918	23.126	2.742	2.656	9.873	0.000	63.239
	LAT CL					0.058			2.324		0.000	0.000	2.382
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	5.968	2.242	0.000	0.906	3.470	19.261	23.330	2.995	2.884	10.536	0.000	71.593
	LAT CL					0.380			2.557		0.000	0.000	2.937
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.455	1.982	0.000	1.509	3.168	18.087	22.972	3.014	2.912	10.570	0.000	69.668
	LAT CL					0.453			2.557		0.000	0.000	3.010
	HEATNG	0.004	-0.005	0.000	0.000	-0.003	-0.012	0.003	0.000	0.001	0.010	0.000	-0.002
SEP	SEN CL	3.750	1.228	0.000	1.512	1.832	12.607	22.332	2.725	2.675	9.853	0.000	58.514
	LAT CL					0.063			2.324		0.000	0.000	2.387
	HEATNG	-0.093	-0.447	0.000	0.103	-0.529	-1.952	0.551	0.030	0.083	0.990	0.000	-1.265
OCT	SEN CL	0.320	0.226	0.000	0.973	-0.122	4.933	21.357	2.972	3.056	9.560	0.000	43.274
	LAT CL					0.006			2.557		0.000	0.000	2.563
	HEATNG	-1.403	-1.177	0.000	0.061	-1.955	-6.828	2.019	0.103	0.292	2.483	0.000	-6.404
NOV	SEN CL	-1.427	-0.270	0.000	0.085	-0.875	1.292	17.338	2.502	2.896	7.149	0.000	28.690
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-3.060	-1.733	0.000	-0.521	-3.308	-11.325	2.857	0.175	0.589	3.297	0.000	-13.029
DEC	SEN CL	-1.968	-0.547	0.000	-0.389	-0.965	0.196	14.844	2.684	3.221	6.979	0.000	24.055
	LAT CL					0.000			2.415		0.000	0.000	2.415
	HEATNG	-11.416	-8.152	0.000	-4.311	-14.750	-50.598	15.616	0.806	2.179	16.980	0.000	-53.647
TOT	SEN CL	13.063	7.015	0.000	-1.425	7.127	88.768	239.003	33.602	34.329	105.431	0.000	526.914
	LAT CL					0.963			29.222		0.000	0.000	30.185

No Plenmum Bldg w/ Built-up Roof & R-60 Insulation DOE-B2.2D38c 5/17/2002 6:27:55 BDL RUN 10

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	23.50695	17	15	67.F	46.F	144.644	-14.545	11	6	26.F	21.F	-57.565	4358.	20.747
FEB	25.41831	27	15	71.F	49.F	154.092	-7.628	3	6	34.F	26.F	-43.499	3724.	16.748
MAR	29.67809	21	15	70.F	46.F	144.162	-7.552	5	4	31.F	24.F	-45.689	4053.	16.245
APR	40.30154	22	15	89.F	58.F	163.358	-1.535	7	5	46.F	44.F	-23.902	4079.	14.948
MAY	49.04600	31	16	99.F	61.F	176.987	-0.634	21	4	43.F	38.F	-24.493	4122.	14.944
JUN	62.88425	27	16	112.F	65.F	202.765	-0.007	15	4	57.F	42.F	-2.567	3838.	14.551
JUL	71.13577	24	16	110.F	65.F	199.739	0.000	0	0	0.F	0.F	0.000	4121.	14.609
AUG	69.26812	30	16	103.F	65.F	195.546	0.000	0	0	0.F	0.F	0.000	4124.	14.634
SEP	58.27790	20	16	99.F	60.F	190.749	-0.001	14	4	61.F	49.F	-0.437	3849.	14.754
OCT	43.26017	3	15	92.F	60.F	180.198	-1.169	23	6	47.F	37.F	-18.059	4198.	20.327
NOV	28.77950	8	15	71.F	50.F	150.626	-6.147	30	6	34.F	27.F	-39.069	3922.	20.526
DEC	24.20257	5	15	74.F	49.F	144.096	-12.649	23	6	29.F	26.F	-49.037	4328.	21.407
TOTAL	525.759						-51.868						48715.	
MAX						202.765						-57.565		21.407

No Plenmum Bldg w/ Built-up Roof & R-60 Insulation DOE-B2.2D38c 5/17/2002 6:27:55 BDL RUN 10
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.445	-1.392	0.000	-1.122	-3.644	-12.269	3.209	0.187	0.558	3.372	0.000	-14.545
JAN	SEN CL	-2.159	-0.484	0.000	-0.765	-1.035	-0.067	14.943	2.809	3.095	7.169	0.000	23.507
	LAT CL					0.000			2.524		0.000	0.000	2.524
	HEATNG	-1.644	-0.858	0.000	-1.140	-2.151	-7.310	2.562	0.112	0.264	2.537	0.000	-7.628
FEB	SEN CL	-1.513	-0.221	0.000	-1.084	-0.815	1.343	15.866	2.485	2.582	6.775	0.000	25.418
	LAT CL					0.003			2.206		0.000	0.000	2.209
	HEATNG	-1.560	-0.874	0.000	-1.199	-2.208	-7.534	2.864	0.122	0.229	2.609	0.000	-7.552
MAR	SEN CL	-1.662	-0.105	0.000	-1.312	-0.858	1.848	18.581	2.760	2.716	7.711	0.000	29.678
	LAT CL					0.000			2.439		0.000	0.000	2.439
	HEATNG	-0.134	-0.279	0.000	-0.416	-0.640	-2.291	1.051	0.037	0.062	1.075	0.000	-1.535
APR	SEN CL	0.107	0.289	0.000	-1.750	-0.002	5.203	21.337	2.960	2.844	9.314	0.000	40.302
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	-0.077	-0.139	0.000	-0.076	-0.270	-0.977	0.417	0.014	0.025	0.449	0.000	-0.634
MAY	SEN CL	1.609	0.648	0.000	-1.065	0.665	8.072	23.137	2.993	2.875	10.113	0.000	49.046
	LAT CL					0.000			2.557		0.000	0.000	2.557
	HEATNG	0.006	-0.004	0.000	0.000	-0.006	-0.025	0.006	0.000	0.000	0.016	0.000	-0.007
JUN	SEN CL	4.571	1.369	0.000	-0.044	2.630	15.922	23.147	2.744	2.659	9.886	0.000	62.884
	LAT CL					0.059			2.324		0.000	0.000	2.383
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	5.972	1.740	0.000	0.906	3.470	19.272	23.349	2.997	2.887	10.544	0.000	71.136
	LAT CL					0.380			2.557		0.000	0.000	2.937
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.458	1.538	0.000	1.509	3.168	18.097	22.991	3.016	2.914	10.578	0.000	69.268
	LAT CL					0.453			2.557		0.000	0.000	3.010
	HEATNG	0.003	-0.002	0.000	0.000	-0.002	-0.009	0.002	0.000	0.000	0.007	0.000	-0.001
SEP	SEN CL	3.753	0.952	0.000	1.512	1.831	12.611	22.352	2.727	2.678	9.863	0.000	58.278
	LAT CL					0.063			2.324		0.000	0.000	2.387
	HEATNG	-0.100	-0.309	0.000	0.103	-0.519	-1.922	0.534	0.027	0.069	0.949	0.000	-1.169
OCT	SEN CL	0.326	0.137	0.000	0.973	-0.131	4.904	21.392	2.978	3.073	9.609	0.000	43.260
	LAT CL					0.006			2.557		0.000	0.000	2.563
	HEATNG	-1.398	-0.867	0.000	0.061	-1.946	-6.808	1.996	0.096	0.273	2.446	0.000	-6.147
NOV	SEN CL	-1.433	-0.256	0.000	0.085	-0.884	1.269	17.378	2.511	2.917	7.194	0.000	28.780
	LAT CL					0.000			2.208		0.000	0.000	2.208
	HEATNG	-3.053	-1.303	0.000	-0.521	-3.298	-11.308	2.845	0.165	0.567	3.258	0.000	-12.649
DEC	SEN CL	-1.978	-0.467	0.000	-0.389	-0.974	0.173	14.871	2.696	3.247	7.025	0.000	24.203
	LAT CL					0.000			2.418		0.000	0.000	2.418
	HEATNG	-11.403	-6.037	0.000	-4.311	-14.686	-50.454	15.486	0.762	2.048	16.718	0.000	-51.868
TOT	SEN CL	13.051	5.140	0.000	-1.425	7.063	88.646	239.343	33.673	34.486	105.782	0.000	525.759
	LAT CL					0.964			29.226		0.000	0.000	30.190

Application Minimum Compliance Building DOE-B2.2D38c 7/13/2002 15:53:42 BDL RUN 4

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	COOLING						HEATING						ELEC	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	24.81489	17	15	67.F	46.F	157.276	-12.848	11	6	26.F	21.F	-52.891	5288.	27.440
FEB	25.49204	7	15	71.F	48.F	164.033	-6.870	3	6	34.F	26.F	-39.046	4394.	22.768
MAR	28.92094	21	15	70.F	46.F	145.514	-6.923	5	4	31.F	24.F	-42.358	4674.	21.911
APR	38.52473	22	15	89.F	58.F	163.764	-1.475	7	5	46.F	44.F	-21.720	4633.	17.942
MAY	46.57907	31	16	99.F	61.F	175.283	-0.541	21	4	43.F	38.F	-21.673	4660.	20.537
JUN	59.62259	27	16	112.F	65.F	200.383	-0.001	15	4	57.F	42.F	-0.498	4335.	16.702
JUL	67.78851	25	16	109.F	68.F	199.360	0.000	0	0	0.F	0.F	0.000	4637.	16.918
AUG	66.38639	30	16	103.F	65.F	196.692	0.000	0	0	0.F	0.F	0.000	4676.	17.039
SEP	56.25151	20	16	99.F	60.F	191.689	0.000	0	0	0.F	0.F	0.000	4433.	17.674
OCT	42.72508	3	15	92.F	60.F	185.464	-0.626	15	5	47.F	35.F	-14.576	4952.	26.925
NOV	29.06356	8	14	72.F	50.F	160.188	-4.905	30	6	34.F	27.F	-33.887	4711.	27.349
DEC	25.50168	5	15	74.F	49.F	155.465	-10.851	23	6	29.F	26.F	-44.597	5252.	28.263
TOTAL	511.671						-45.040						56645.	
MAX						200.383						-52.891		28.263

Application Minimum Compliance Building DOE-B2.2D38c 7/13/2002 15:53:42 BDL RUN 4
REPORT- LS-F Building Monthly Load Components in MBTU WEATHER FILE- Las Vegas NV TRY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-3.359	0.000	0.000	-1.351	-3.171	-12.273	2.258	0.262	0.773	4.013	0.000	-12.848
JAN	SEN CL	-2.272	0.000	0.000	-0.802	-1.048	0.000	12.720	3.678	2.859	9.680	0.000	24.815
	LAT CL					0.000			3.373		0.000	0.000	3.373
	HEATNG	-1.636	0.000	0.000	-1.471	-1.900	-7.431	1.886	0.183	0.434	3.066	0.000	-6.870
FEB	SEN CL	-1.521	0.000	0.000	-1.067	-0.774	1.586	13.129	3.227	1.902	9.010	0.000	25.492
	LAT CL					0.003			2.913		0.000	0.000	2.916
	HEATNG	-1.565	0.000	0.000	-1.548	-1.930	-7.623	2.032	0.200	0.384	3.127	0.000	-6.923
MAR	SEN CL	-1.596	0.000	0.000	-1.317	-0.835	2.033	15.224	3.578	1.589	10.246	0.000	28.921
	LAT CL					0.000			3.220		0.000	0.000	3.220
	HEATNG	-0.140	0.000	0.000	-0.680	-0.567	-2.382	0.835	0.069	0.133	1.257	0.000	-1.475
APR	SEN CL	0.245	0.000	0.000	-1.790	-0.012	5.502	16.925	3.871	1.537	12.247	0.000	38.525
	LAT CL					0.000			3.373		0.000	0.000	3.373
	HEATNG	-0.082	0.000	0.000	-0.128	-0.237	-0.978	0.328	0.025	0.048	0.482	0.000	-0.541
MAY	SEN CL	1.817	0.000	0.000	-1.171	0.593	8.410	18.259	3.923	1.522	13.227	0.000	46.579
	LAT CL					0.000			3.373		0.000	0.000	3.373
	HEATNG	0.002	0.000	0.000	0.000	-0.002	-0.008	0.002	0.000	0.000	0.005	0.000	-0.001
JUN	SEN CL	4.777	0.000	0.000	-0.048	2.368	16.452	18.253	3.597	1.400	12.823	0.000	59.622
	LAT CL					0.055			3.066		0.000	0.000	3.121
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	6.190	0.000	0.000	1.035	3.128	19.867	18.443	3.941	1.489	13.695	0.000	67.788
	LAT CL					0.343			3.373		0.000	0.000	3.716
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.658	0.000	0.000	1.723	2.856	18.676	18.172	3.955	1.624	13.723	0.000	66.386
	LAT CL					0.408			3.373		0.000	0.000	3.781
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	3.866	0.000	0.000	1.725	1.649	13.060	17.842	3.584	1.723	12.802	0.000	56.251
	LAT CL					0.056			3.066		0.000	0.000	3.123
	HEATNG	-0.099	0.000	0.000	0.153	-0.413	-1.697	0.427	0.040	0.050	0.872	0.000	-0.626
OCT	SEN CL	0.357	0.000	0.000	1.072	-0.174	4.990	17.302	3.906	2.438	12.834	0.000	42.725
	LAT CL					0.006			3.373		0.000	0.000	3.379
	HEATNG	-1.378	0.000	0.000	0.084	-1.747	-7.002	1.616	0.163	0.421	2.936	0.000	-4.905
NOV	SEN CL	-1.472	0.000	0.000	0.082	-0.805	1.634	14.255	3.254	2.577	9.539	0.000	29.064
	LAT CL					0.000			2.913		0.000	0.000	2.913
	HEATNG	-2.960	0.000	0.000	-0.636	-2.875	-11.330	2.097	0.239	0.729	3.885	0.000	-10.851
DEC	SEN CL	-2.120	0.000	0.000	-0.405	-0.978	0.273	12.614	3.523	3.136	9.459	0.000	25.502
	LAT CL					0.000			3.220		0.000	0.000	3.220
	HEATNG	-11.217	0.000	0.000	-5.578	-12.840	-50.724	11.482	1.181	3.013	19.643	0.000	-45.040
TOT	SEN CL	13.929	0.000	0.000	-0.962	5.967	92.483	193.139	44.035	23.795	139.285	0.000	511.672
	LAT CL					0.871			38.635		0.000	0.000	39.506

Application Design Case DOE-B2.2D38c 10/13/2002 20:24:46 BDL RUN 8

REPORT- LS-D Building Monthly Loads Summary WEATHER FILE- Las Vegas NV TMY2

	- - C O O L I N G - -						- - H E A T I N G - -						- - E L E C - -	
MONTH	COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	14.40182	30	17	62.F	41.F	92.891	-12.281	11	6	26.F	21.F	-43.816	6360.	28.210
FEB	13.99637	7	17	68.F	47.F	98.257	-6.989	3	7	34.F	26.F	-34.260	5484.	27.419
MAR	15.74664	28	17	67.F	47.F	97.653	-7.111	4	5	32.F	25.F	-37.211	6001.	27.223
APR	23.39855	29	16	88.F	58.F	118.360	-1.573	7	6	46.F	44.F	-18.469	6029.	25.496
MAY	29.75179	31	16	99.F	61.F	130.474	-0.567	21	4	43.F	38.F	-17.442	6096.	26.937
JUN	40.68253	28	16	108.F	64.F	154.086	0.000	15	4	57.F	42.F	-0.002	5678.	24.772
JUL	47.99099	25	16	109.F	68.F	151.829	0.000	0	0	0.F	0.F	0.000	6086.	25.632
AUG	46.83909	19	16	105.F	65.F	146.760	0.000	0	0	0.F	0.F	0.000	6099.	25.300
SEP	37.52528	3	16	99.F	62.F	140.040	0.000	0	0	0.F	0.F	0.000	5713.	26.001
OCT	26.32132	3	16	92.F	58.F	126.684	-0.506	15	5	47.F	35.F	-11.806	6253.	28.118
NOV	15.62496	8	17	69.F	49.F	103.445	-4.768	30	7	33.F	27.F	-29.752	5640.	28.204
DEC	14.55578	5	16	71.F	48.F	99.817	-10.261	30	4	30.F	28.F	-37.590	6187.	28.364
TOTAL	326.835						-44.056						71627.	
MAX						154.086						-43.816		28.364

Application Design Case   DOE-B2.2D38c 10/13/2002 20:24:46 BDL RUN 8
REPORT- LS-F Building Monthly Load Components in MBTU   WEATHER FILE- Las Vegas NV TMY2

(UNITS=MBTU)		WALLS	ROOFS	INT SUR	UND SUR	INFIL	WIN CON	WIN SOL	OCCUP	LIGHTS	EQUIP	SOURCE	TOTAL
	HEATNG	-4.288	0.000	0.000	-1.516	-3.482	-9.440	0.388	0.280	1.228	4.551	0.000	-12.281
JAN	SEN CL	-1.972	0.000	0.000	-0.653	-0.737	-1.943	0.827	3.687	5.953	9.239	0.000	14.402
	LAT CL					0.000			3.373		0.000	0.000	3.373
	HEATNG	-2.373	0.000	0.000	-1.718	-2.161	-5.742	0.339	0.200	0.811	3.656	0.000	-6.989
FEB	SEN CL	-1.376	0.000	0.000	-0.840	-0.513	-0.978	0.832	3.234	5.132	8.505	0.000	13.996
	LAT CL					0.003			2.913		0.000	0.000	2.916
	HEATNG	-2.285	0.000	0.000	-1.836	-2.209	-5.932	0.354	0.221	0.825	3.751	0.000	-7.111
MAR	SEN CL	-1.530	0.000	0.000	-1.050	-0.556	-0.993	1.035	3.583	5.541	9.716	0.000	15.747
	LAT CL					0.000			3.220		0.000	0.000	3.220
	HEATNG	-0.292	0.000	0.000	-0.864	-0.661	-1.789	0.128	0.082	0.271	1.551	0.000	-1.573
APR	SEN CL	-0.048	0.000	0.000	-1.625	0.082	1.628	1.427	3.887	6.001	12.048	0.000	23.399
	LAT CL					0.000			3.373		0.000	0.000	3.373
	HEATNG	-0.151	0.000	0.000	-0.157	-0.282	-0.762	0.055	0.030	0.099	0.602	0.000	-0.567
MAY	SEN CL	1.441	0.000	0.000	-1.152	0.638	3.783	1.680	3.946	6.212	13.204	0.000	29.752
	LAT CL					0.000			3.373		0.000	0.000	3.373
	HEATNG	0.000	0.000	0.000	0.000	0.000	-0.001	0.000	0.000	0.000	0.001	0.000	0.000
JUN	SEN CL	4.481	0.000	0.000	-0.048	2.366	9.778	1.720	3.622	5.847	12.917	0.000	40.683
	LAT CL					0.055			3.066		0.000	0.000	3.122
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
JUL	SEN CL	5.918	0.000	0.000	1.043	3.128	12.162	1.713	3.968	6.266	13.792	0.000	47.991
	LAT CL					0.343			3.373		0.000	0.000	3.716
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AUG	SEN CL	5.369	0.000	0.000	1.736	2.856	11.172	1.572	3.983	6.333	13.819	0.000	46.839
	LAT CL					0.408			3.373		0.000	0.000	3.781
	HEATNG	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SEP	SEN CL	3.482	0.000	0.000	1.738	1.649	6.832	1.378	3.609	5.945	12.892	0.000	37.525
	LAT CL					0.056			3.066		0.000	0.000	3.123
	HEATNG	-0.165	0.000	0.000	0.148	-0.430	-1.197	0.035	0.040	0.135	0.928	0.000	-0.506
OCT	SEN CL	-0.077	0.000	0.000	1.087	-0.157	0.781	1.184	3.934	6.694	12.874	0.000	26.321
	LAT CL					0.006			3.373		0.000	0.000	3.379
	HEATNG	-1.990	0.000	0.000	0.095	-1.988	-5.410	0.234	0.175	0.660	3.436	0.000	-4.768
NOV	SEN CL	-1.428	0.000	0.000	0.071	-0.564	-1.113	0.858	3.266	5.409	9.126	0.000	15.625
	LAT CL					0.000			2.913		0.000	0.000	2.913
	HEATNG	-3.811	0.000	0.000	-0.711	-3.156	-8.656	0.335	0.249	1.095	4.394	0.000	-10.261
DEC	SEN CL	-1.883	0.000	0.000	-0.338	-0.697	-1.766	0.786	3.539	5.872	9.043	0.000	14.556
	LAT CL					0.000			3.220		0.000	0.000	3.220
	HEATNG	-15.356	0.000	0.000	-6.559	-14.371	-38.926	1.867	1.276	5.145	22.869	0.000	-44.055
TOT	SEN CL	12.375	0.000	0.000	-0.030	7.497	39.343	15.012	44.257	71.205	137.172	0.000	326.832
	LAT CL					0.871			38.635		0.000	0.000	39.506

APPENDIX C

COST AND PERFORMANCE DATA

Ground Source Heat Pump — FEMP Fiscal Year: 2002 — isc. Rate: 3.2% — DOE Region: West
Years of Analysis: 25 — .nalysis Sector: Commercial

Year	NON-ANNUAL RECURRING COSTS: Investment-Related Costs (e.g. 1st cost, replacement, residual): Description of Cost	Constant $	Discounted PV$	Operations-Related Costs (e.g. non-annual maintenance): Description of Cost	Constant $	Discounted PV$	ELECTRIC COSTS: Annual Recurring Electric Constant $	Electric Differential Escalation %	Discounted Electric w/Fuel Esc. PV$	NATURAL GAS COSTS: Annual Recurring Nat Gas Constant $	Nat Gas Differential Escalation %	Discounted Nat Gas w/Fuel Esc PV$	ANNUAL RECURRING COSTS: Annual Recurring (e.g. maintenance) Constant $	Discounted Recurring PV$	Year	TOTAL COSTS: Discounted Total Costs PV$	CUMULATIVE COSTS: Discounted Cumulative Costs PV$	CUMULATIVE SAVINGS: Discounted Cumulative Savings PV$	Payback: Discounted Payback yrs
0	First Cost	$165,542	$165,542	n/a	n/a	n/a	$4,744			$0			$1,426		0	$165,542	$165,542		
1		$0	$0		$0	$0	$4,744	-7.50%	$4,252	$0	-5.83%	$0	$1,426	$1,382	1	$5,634	$171,176	n/a	n/a
2		$0	$0		$0	$0	$4,744	-4.23%	$3,946	$0	3.83%	$0	$1,426	$1,339	2	$5,285	$176,461	n/a	n/a
3		$0	$0		$0	$0	$4,744	-4.21%	$3,663	$0	1.40%	$0	$1,426	$1,297	3	$4,960	$181,422	n/a	n/a
4		$0	$0		$0	$0	$4,744	-2.24%	$3,470	$0	0.35%	$0	$1,426	$1,257	4	$4,727	$186,149	n/a	n/a
5		$0	$0		$0	$0	$4,744	-0.66%	$3,340	$0	-0.69%	$0	$1,426	$1,218	5	$4,558	$190,707	n/a	n/a
6		$0	$0		$0	$0	$4,744	0.27%	$3,245	$0	-0.17%	$0	$1,426	$1,180	6	$4,425	$195,132	n/a	n/a
7		$0	$0		$0	$0	$4,744	0.31%	$3,154	$0	-0.52%	$0	$1,426	$1,144	7	$4,298	$199,430	n/a	n/a
8		$0	$0		$0	$0	$4,744	-0.13%	$3,052	$0	-1.05%	$0	$1,426	$1,108	8	$4,161	$203,591	n/a	n/a
9		$0	$0		$0	$0	$4,744	0.35%	$2,968	$0	-0.18%	$0	$1,426	$1,074	9	$4,042	$207,633	n/a	n/a
10		$0	$0		$0	$0	$4,744	-2.90%	$2,793	$0	0.71%	$0	$1,426	$1,041	10	$3,833	$211,466	n/a	n/a
11		$0	$0		$0	$0	$4,744	-1.00%	$2,679	$0	1.05%	$0	$1,426	$1,008	11	$3,687	$215,153	n/a	n/a
12		$0	$0		$0	$0	$4,744	-0.37%	$2,586	$0	0.35%	$0	$1,426	$977	12	$3,564	$218,717	n/a	n/a
13		$0	$0		$0	$0	$4,744	-0.14%	$2,503	$0	0.52%	$0	$1,426	$947	13	$3,450	$222,167	n/a	n/a
14		$0	$0		$0	$0	$4,744	0.18%	$2,430	$0	0.34%	$0	$1,426	$917	14	$3,347	$225,514	n/a	n/a
15	HF Replace	$43,620	$30,936		$0	$0	$4,744	0.14%	$2,357	$0	0.00%	$0	$1,426	$889	15	$34,182	$259,696	n/a	n/a
16		$0	$0		$0	$0	$4,744	-0.14%	$2,281	$0	0.17%	$0	$1,426	$861	16	$3,143	$262,839	n/a	n/a
17		$0	$0		$0	$0	$4,744	0.00%	$2,211	$0	0.51%	$0	$1,426	$835	17	$3,045	$265,884	n/a	n/a
18		$0	$0		$0	$0	$4,744	-0.18%	$2,138	$0	0.85%	$0	$1,426	$809	18	$2,947	$268,831	n/a	n/a
19		$0	$0		$0	$0	$4,744	-0.41%	$2,063	$0	0.68%	$0	$1,426	$784	19	$2,847	$271,678	n/a	n/a
20		$0	$0		$0	$0	$4,744	-0.37%	$1,992	$0	0.84%	$0	$1,426	$759	20	$2,751	$274,429	n/a	n/a
21		$0	$0		$0	$0	$4,744	-0.42%	$1,922	$0	0.67%	$0	$1,426	$736	21	$2,658	$277,087	n/a	n/a
22		$0	$0		$0	$0	$4,744	-0.42%	$1,855	$0	0.83%	$0	$1,426	$713	22	$2,568	$279,655	n/a	n/a
23		$0	$0		$0	$0	$4,744	-0.42%	$1,789	$0	0.66%	$0	$1,426	$691	23	$2,481	$282,135	n/a	n/a
24		$0	$0		$0	$0	$4,744	-0.42%	$1,727	$0	0.82%	$0	$1,426	$670	24	$2,396	$284,531	n/a	n/a
25	Residual	($16,540)	($7,526)		$0	$0	$4,744	-0.42%	$1,666	$0	0.65%	$0	$1,426	$649	25	($5,211)	$279,321	n/a	n/a
		$198,622	#####		$0	$0	$118,600		$66,082	$0		$0	$35,650	$24,287		$279,321	$279,321	n/a	n/a

Rooltop Multizone

FEMP Fiscal Year: 2002 isc. Rate: 3.2% DOE Region: West
Years of Analysis: 25 .alysis Sector: Commercial

	NON-ANNUAL RECURRING COSTS						ELECTRIC COSTS		
	Investment-Related Costs (e.g. 1st cost, replacement, residual)			Operations-Related Costs (e.g. non-annual maintenance)					
Year	Description of Cost	Constant $	Discounted PV$	Description of Cost	Constant $	Discounted PV$	Annual Recurring Electric Constant $	Electric Differential Escalation %	Discounted Electric w/Fuel Esc. PV$
0	First Cost	$170,836	$170,836	n/a	n/a	n/a	$8,100		
1		$0	$0		$0	$0	$8,100	-7.50%	$7,261
2		$0	$0		$0	$0	$8,100	-4.23%	$6,738
3		$0	$0		$0	$0	$8,100	-4.21%	$6,254
4		$0	$0		$0	$0	$8,100	-2.24%	$5,924
5		$0	$0		$0	$0	$8,100	-0.66%	$5,703
6		$0	$0		$0	$0	$8,100	0.27%	$5,541
7		$0	$0		$0	$0	$8,100	0.31%	$5,385
8		$0	$0		$0	$0	$8,100	-0.13%	$5,212
9		$0	$0		$0	$0	$8,100	0.35%	$5,068
10		$0	$0		$0	$0	$8,100	-2.90%	$4,768
11		$0	$0		$0	$0	$8,100	-1.00%	$4,574
12		$0	$0		$0	$0	$8,100	-0.37%	$4,416
13		$0	$0		$0	$0	$8,100	-0.14%	$4,273
14		$0	$0		$0	$0	$8,100	0.18%	$4,148
15	Replace	$170,836	$106,508		$0	$0	$8,100	0.14%	$4,025
16		$0	$0		$0	$0	$8,100	-0.14%	$3,895
17		$0	$0		$0	$0	$8,100	0.00%	$3,774
18		$0	$0		$0	$0	$8,100	-0.18%	$3,651
19		$0	$0		$0	$0	$8,100	-0.41%	$3,523
20		$0	$0		$0	$0	$8,100	-0.37%	$3,401
21		$0	$0		$0	$0	$8,100	-0.42%	$3,282
22		$0	$0		$0	$0	$8,100	-0.42%	$3,167
23		$0	$0		$0	$0	$8,100	-0.42%	$3,055
24		$0	$0		$0	$0	$8,100	-0.42%	$2,948
25	Residual	($56,945)	($25,910)		$0	$0	$8,100	-0.42%	$2,845
		$284,127	#####		$0	$0	$202,500		$112,829

	NATURAL GAS COSTS			ANNUAL RECURRING COSTS		TOTAL COSTS		CUMULATIVE COSTS	CUMULATIVE SAVINGS	Payback
Year	Annual Recurring Nat Gas Constant $	Nat Gas Differential Escalation %	Discounted Nat Gas w/Fuel Esc. PV$	Annual Recurring (e.g., maintenance) Constant $	Discounted Recurring PV$	Year	Discounted Total Costs PV$	Discounted Cumulative Costs PV$	Discounted Cumulative Savings PV$	Discounted Payback yrs
0	$3,765			$1,600		0	$170,836	$170,836	($5,294)	
1	$3,785	-5.83%	$3,454	$1,800	$1,744	1	$12,458	$183,294	($12,118)	
2	$3,785	3.83%	$3,415	$1,800	$1,690	2	$11,903	$195,197	($18,736)	
3	$3,785	1.40%	$3,414	$1,800	$1,638	3	$11,306	$206,503	($25,081)	
4	$3,785	0.35%	$3,320	$1,800	$1,587	4	$10,831	$217,334	($31,186)	
5	$3,785	-0.69%	$3,195	$1,800	$1,538	5	$10,435	$227,769	($37,062)	
6	$3,785	-0.17%	$3,090	$1,800	$1,490	6	$10,121	$237,890	($42,758)	
7	$3,785	-0.52%	$2,979	$1,800	$1,444	7	$9,808	$247,698	($48,268)	
8	$3,785	-1.05%	$2,856	$1,800	$1,399	8	$9,467	$257,165	($53,574)	
9	$3,785	-0.18%	$2,763	$1,800	$1,356	9	$9,186	$266,351	($58,718)	
10	$3,785	0.71%	$2,696	$1,800	$1,314	10	$8,778	$275,128	($63,662)	
11	$3,785	1.05%	$2,640	$1,800	$1,273	11	$8,487	$283,615	($68,462)	
12	$3,785	0.35%	$2,567	$1,800	$1,233	12	$8,216	$291,832	($73,115)	
13	$3,785	0.52%	$2,500	$1,800	$1,195	13	$7,969	$299,800	($77,634)	
14	$3,785	0.34%	$2,431	$1,800	$1,158	14	$7,738	$307,538	($82,024)	
15	$3,785	0.00%	$2,356	$1,800	$1,122	15	$114,012	$421,550	($161,854)	
16	$3,785	0.17%	$2,287	$1,800	$1,087	16	$7,269	$428,819	($165,980)	
17	$3,785	0.51%	$2,227	$1,800	$1,054	17	$7,055	$435,874	($169,930)	
18	$3,785	0.85%	$2,176	$1,800	$1,021	18	$6,848	$442,722	($173,891)	
19	$3,785	0.68%	$2,123	$1,800	$989	19	$6,635	$449,357	($177,679)	
20	$3,785	0.84%	$2,075	$1,800	$959	20	$6,434	$455,791	($181,362)	
21	$3,785	0.67%	$2,024	$1,800	$929	21	$6,234	$462,025	($184,938)	
22	$3,785	0.83%	$1,977	$1,800	$900	22	$6,044	$468,069	($188,415)	
23	$3,785	0.66%	$1,929	$1,800	$872	23	$5,856	$473,926	($191,790)	
24	$3,785	0.82%	$1,884	$1,800	$845	24	$5,677	$479,603	($195,071)	
25	$3,785	0.65%	$1,837	$1,800	$819	25	($20,409)	$459,194	($173,873)	
	$94,625		$64,274	$45,000	*$30,656*		*$459,194*	*$459,194*	*($173,873)*	*>25*

	Single Zone Rooftop								FEMP Fiscal Year:	2002	Isc. Rate:	3.2%	DOE Region:	West					
											Years of Analysis:	25	.nalysis Sector:	Commercial					
	NON-ANNUAL RECURRING COSTS						ELECTRIC COSTS			NATURAL GAS COSTS			ANNUAL RECURRING COSTS		TOTAL COSTS		CUMULATIVE COSTS	CUMULATIVE SAVINGS	Payback
	Investment-Related Costs (e.g. 1st cost, replacement, residual)			Operations-Related Costs (e.g. non-annual maintenance)			Annual Recurring Electric	Electric Differential Escalation	Discounted Electric w/Fuel Esc.	Annual Recurring Nat Gas	Nat Gas Differential Escalation	Discounted Nat Gas w/Fuel Esc.	Annual Recurring (e.g., maintenance)	Discounted Recurring		Discounted Total Costs	Discounted Cumulative Costs	Discounted Cumulative Savings	Discounted Payback
Year	Description of Cost	Constant $	Discounted PV $	Description of Cost	Constant $	Discounted PV $	Constant $	%	PV $	Constant $	%	PV $	Constant $	PV $	Year	PV $	PV $	PV $	yrs
0	First Cost	$96,634	$96,634	n/a	n/a	n/a	$3,622			$575			$6,500		0	$96,634	$96,634	$68,908	
1		$0	$0		$0	$0	$3,622	-7.50%	$3,247	$575	-5.83%	$525	$6,500	$6,298	1	$10,070	$106,704	$64,472	15.5
2		$0	$0		$0	$0	$3,622	-4.23%	$3,013	$575	3.83%	$528	$6,500	$6,103	2	$9,644	$116,348	$60,114	
3		$0	$0		$0	$0	$3,622	-4.21%	$2,797	$575	1.40%	$519	$6,500	$5,914	3	$9,229	$125,577	$55,845	
4		$0	$0		$0	$0	$3,622	-2.24%	$2,649	$575	0.35%	$504	$6,500	$5,731	4	$8,884	$134,461	$51,688	
5		$0	$0		$0	$0	$3,622	-0.66%	$2,550	$575	-0.69%	$485	$6,500	$5,553	5	$8,588	$143,049	$47,658	
6		$0	$0		$0	$0	$3,622	0.27%	$2,478	$575	-0.17%	$469	$6,500	$5,381	6	$8,328	$151,377	$43,756	
7		$0	$0		$0	$0	$3,622	0.31%	$2,408	$575	-0.52%	$453	$6,500	$5,214	7	$8,074	$159,451	$39,979	
8		$0	$0		$0	$0	$3,622	-0.13%	$2,330	$575	-1.05%	$434	$6,500	$5,052	8	$7,816	$167,268	$36,323	
9		$0	$0		$0	$0	$3,622	0.35%	$2,266	$575	-0.18%	$420	$6,500	$4,895	9	$7,581	$174,849	$32,784	
10		$0	$0		$0	$0	$3,622	-2.90%	$2,132	$575	0.71%	$410	$6,500	$4,744	10	$7,285	$182,134	$29,332	
11		$0	$0		$0	$0	$3,622	-1.00%	$2,045	$575	1.05%	$401	$6,500	$4,597	11	$7,043	$189,177	$25,976	
12		$0	$0		$0	$0	$3,622	-0.37%	$1,975	$575	0.35%	$390	$6,500	$4,454	12	$6,819	$195,996	$22,721	
13		$0	$0		$0	$0	$3,622	-0.14%	$1,911	$575	0.52%	$380	$6,500	$4,316	13	$6,607	$202,602	$19,564	
14		$0	$0		$0	$0	$3,622	0.18%	$1,855	$575	0.34%	$369	$6,500	$4,182	14	$6,406	$209,009	$16,505	
15	Replace	$96,634	$60,247		$0	$0	$3,622	0.14%	$1,800	$575	0.00%	$358	$6,500	$4,052	15	$66,457	$275,466	($15,770)	
16		$0	$0		$0	$0	$3,622	-0.14%	$1,742	$575	0.17%	$347	$6,500	$3,927	16	$6,016	$281,482	($18,643)	
17		$0	$0		$0	$0	$3,622	0.00%	$1,688	$575	0.51%	$338	$6,500	$3,805	17	$5,831	$287,313	($21,429)	
18		$0	$0		$0	$0	$3,622	-0.18%	$1,632	$575	0.85%	$331	$6,500	$3,687	18	$5,650	$292,963	($24,132)	
19		$0	$0		$0	$0	$3,622	-0.41%	$1,575	$575	0.68%	$323	$6,500	$3,573	19	$5,470	$298,433	($26,756)	
20		$0	$0		$0	$0	$3,622	-0.37%	$1,521	$575	0.84%	$315	$6,500	$3,462	20	$5,298	$303,731	($29,302)	
21		$0	$0		$0	$0	$3,622	-0.42%	$1,467	$575	0.67%	$307	$6,500	$3,355	21	$5,129	$308,861	($31,774)	
22		$0	$0		$0	$0	$3,622	-0.42%	$1,416	$575	0.83%	$300	$6,500	$3,251	22	$4,967	$313,828	($34,173)	
23		$0	$0		$0	$0	$3,622	-0.42%	$1,366	$575	0.66%	$293	$6,500	$3,150	23	$4,809	$318,637	($36,501)	
24		$0	$0		$0	$0	$3,622	-0.42%	$1,318	$575	0.82%	$286	$6,500	$3,052	24	$4,657	$323,293	($38,762)	
25	Residual	($64,423)	($29,312)		$0	$0	$3,622	-0.42%	$1,272	$575	0.65%	$279	$6,500	$2,957	25	($24,804)	$298,490	($19,169)	
		$128,845	#####		$0	$0	$90,550		$50,453	$14,375		$9,764	$162,500	*$110,784*		*$298,490*	*$298,490*	*($19,169)*	*15.5*

REPORT- ES-D Energy Cost Summary WEATHER FILE- Las Vegas NV TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
Electricity Rate 1	ELECTRICITY	EM1	76305. KWH	7213.	0.0945	YES
Fuel Rate 1	NATURAL-GAS	FM1	167. THERM	336.	2.0097	YES
Electricity Rate 2	ELECTRICITY	EM2	42225. KWH	4256.	0.1008	YES
Fuel Rate 2	NATURAL-GAS	FM2	0. THERM	0.	0.0000	YES
				11805.		

ENERGY COST/GROSS BLDG AREA: 0.89
ENERGY COST/NET BLDG AREA: 0.89

Application Design Building - GCHP   DOE-B2.2D38c 9/02/2002 8:41:45 BDL RUN 1

REPORT- BEPS Building Energy Performance   WEATHER FILE- Las Vegas NV TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM2 ELECTRICITY MBTU	0.0	0.0	0.0	2.7	122.0	0.0	0.0	19.3	0.0	0.0	0.0	0.0	144.1
EM1 ELECTRICITY MBTU	78.9	0.0	165.5	0.0	0.0	0.0	16.0	0.0	0.0	0.0	0.0	0.0	260.4
FM2 NATURAL-GAS MBTU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FM1 NATURAL-GAS MBTU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	16.7
MBTU	78.9	0.0	165.5	2.7	122.0	0.0	16.0	19.3	0.0	0.0	16.7	0.0	421.3

TOTAL SITE ENERGY 421.26 MBTU 31.9 KBTU/SQFT-YR GROSS-AREA 31.9 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 1230.33 MBTU 93.3 KBTU/SQFT-YR GROSS-AREA 93.3 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Application Design Building - GCHP DOE-B2.2D38c 9/02/2002 8:41:45 BDL RUN 1

REPORT- BEPU Building Utility Performance WEATHER FILE- Las Vegas NV TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM2 ELECTRICITY KWH	0.	0.	0.	801.	35758.	0.	0.	5666.	0.	0.	0.	0.	42225.
EM1 ELECTRICITY KWH	23127.	0.	48499.	0.	0.	0.	4678.	0.	0.	0.	0.	0.	76305.
FM2 NATURAL-GAS THERM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
FM1 NATURAL-GAS THERM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	167.	0.	167.

TOTAL ELECTRICITY 118530. KWH 8.985 KWH /SQFT-YR GROSS-AREA 8.985 KWH /SQFT-YR NET-AREA
TOTAL NATURAL-GAS 167. THERM 0.013 THERM /SQFT-YR GROSS-AREA 0.013 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.4
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Application Design Building - Rooftop Multi-zone   DOE-B2.2D38c   8/25/2002   17:47:56   BDL RUN 2

REPORT- ES-D Energy Cost Summary   WEATHER FILE- Las Vegas NV TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
Electricity Rate 1	ELECTRICITY	EM1	71622. KWH	6780.	0.0947	YES
Electricity Rate 2	ELECTRICITY	EM2	89181. KWH	8100.	0.0908	YES
Fuel Rate 1	NATURAL-GAS	FM1	167. THERM	336.	2.0097	YES
Fuel Rate 2	NATURAL-GAS	FM2	6593. THERM	3785.	0.5741	YES
				==========		
				19001.		

ENERGY COST/GROSS BLDG AREA: 1.44
ENERGY COST/NET BLDG AREA: 1.44

Application Design Building - Rooftop Multi-zone DOE-B2.2D38c 8/25/2002 17:47:56 BDL RUN 2

REPORT- BEPS Building Energy Performance WEATHER FILE- Las Vegas NV TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM2 ELECTRICITY													
MBTU	0.0	0.0	0.0	0.0	234.6	0.0	0.7	69.1	0.0	0.0	0.0	0.0	304.4
EM1 ELECTRICITY													
MBTU	78.9	0.0	165.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	244.4
FM2 NATURAL-GAS													
MBTU	0.0	0.0	0.0	659.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	659.3
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	16.7
MBTU	78.9	0.0	165.5	659.3	234.6	0.0	0.7	69.1	0.0	0.0	16.7	0.0	1224.8

TOTAL SITE ENERGY 1224.80 MBTU 92.8 KBTU/SQFT-YR GROSS-AREA 92.8 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 2322.43 MBTU 176.0 KBTU/SQFT-YR GROSS-AREA 176.0 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Application Design Building - Rooftop Multi-zone   DOE-B2.2D38c   8/25/2002   17:47:56 BDL RUN 2

REPORT- BEPU Building Utility Performance   WEATHER FILE- Las Vegas   NV TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM2 ELECTRICITY KWH	0.	0.	0.	0.	68737.	0.	198.	20246.	0.	0.	0.	0.	89181.
EM1 ELECTRICITY KWH	23122.	0.	48499.	0.	0.	0.	0.	0.	0.	0.	0.	0.	71622.
FM2 NATURAL-GAS THERM	0.	0.	0.	6593.	0.	0.	0.	0.	0.	0.	0.	0.	6593.
FM1 NATURAL-GAS THERM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	167.	0.	167.

TOTAL ELECTRICITY   160803. KWH   12.189 KWH   /SQFT-YR GROSS-AREA   12.189 KWH   /SQFT-YR NET-AREA
TOTAL NATURAL-GAS   6760. THERM   0.512 THERM   /SQFT-YR GROSS-AREA   0.512 THERM   /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.0
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

REPORT- ES-D Energy Cost Summary WEATHER FILE- Las Vegas NV TMY2

UTILITY-RATE	RESOURCE	METERS	METERED ENERGY UNITS/YR	TOTAL CHARGE ($)	VIRTUAL RATE ($/UNIT)	RATE USED ALL YEAR?
Electricity Rate 1	ELECTRICITY	EM1	71627. KWH	6781.	0.0947	YES
Electricity Rate 2	ELECTRICITY	EM2	36449. KWH	3622.	0.0994	YES
Fuel Rate 1	NATURAL-GAS	FM1	167. THERM	336.	2.0097	YES
Fuel Rate 2	NATURAL-GAS	FM2	1001. THERM	575.	0.5741	YES
				==========		
				11314.		

ENERGY COST/GROSS BLDG AREA: 0.86
ENERGY COST/NET BLDG AREA: 0.86

Application Design Building - Single-Zone DOE-B2.2D38c 10/13/2002 20:24:46 BDL RUN 8

REPORT- BEPS Building Energy Performance WEATHER FILE- Las Vegas NV TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM2 ELECTRICITY													
MBTU	0.0	0.0	0.0	0.0	93.4	0.0	3.4	27.6	0.0	0.0	0.0	0.0	124.4
EM1 ELECTRICITY													
MBTU	78.9	0.0	165.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	244.5
FM2 NATURAL-GAS													
MBTU	0.0	0.0	0.0	37.3	0.0	0.0	62.8	0.0	0.0	0.0	0.0	0.0	100.1
FM1 NATURAL-GAS													
MBTU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	16.7
MBTU	78.9	0.0	165.5	37.3	93.4	0.0	66.2	27.6	0.0	0.0	16.7	0.0	485.7

TOTAL SITE ENERGY 485.68 MBTU 36.8 KBTU/SQFT-YR GROSS-AREA 36.8 KBTU/SQFT-YR NET-AREA
TOTAL SOURCE ENERGY 1223.40 MBTU 92.7 KBTU/SQFT-YR GROSS-AREA 92.7 KBTU/SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 19.1
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

Application Design Building - Single-Zone DOE-B2.2D38c 10/13/2002 20:24:46 BDL RUN 8

REPORT- BEPU Building Utility Performance WEATHER FILE- Las Vegas NV TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM2 ELECTRICITY KWH	0.	0.	0.	0.	27361.	0.	990.	8098.	0.	0.	0.	0.	36449.
EM1 ELECTRICITY KWH	23127.	0.	48499.	0.	0.	0.	0.	0.	0.	0.	0.	0.	71627.
FM2 NATURAL-GAS THERM	0.	0.	0.	373.	0.	0.	628.	0.	0.	0.	0.	0.	1001.
FM1 NATURAL-GAS THERM	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	167.	0.	167.

TOTAL ELECTRICITY 108076. KWH 8.192 KWH /SQFT-YR GROSS-AREA 8.192 KWH /SQFT-YR NET-AREA
TOTAL NATURAL-GAS 1168. THERM 0.089 THERM /SQFT-YR GROSS-AREA 0.089 THERM /SQFT-YR NET-AREA

PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 19.1
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

APPENDIX D

GLHEPRO LONG TERM DESIGN DATA

Application Minimum Compliance Case Ground-loop Data

rinted from GLHEPRO -- Output file

\ctive borehole length, ft	=390.9
Borehole Radius, in	=2.165
Borehole spacing, ft	=263.9
Borehole Geometry	: RECTANGULAR CONFIGURATION
	: 42 : 6 x 7, rectangle
Soil Type currently used	:
Thermal conductivity of the ground, Btu/(hr•ft•°F)	=0.9100
Volumetric heat capacity of Ground, Btu/(°F•ft^3)	=26.99
Volumetric heat capacity of fluid, Btu/(°F•ft^3)	=62.40
Undisturbed ground temperature, °F	=69.00
Borehole thermal resistance, °F/(Btu/(hr•ft))	=0.2400
Fluid type currently entered	: 100.00% Pure Water
Mass flow rate of the fluid, gal/min	=42.25
Density of the fluid, lb/ft^3	=62.43
Heat Pump Selected	: ClimateMaster Genesis 036

GLHE Monthly Loads

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	000000.00	000000.00	000000.00	000000.00
February	000000.00	000000.00	000000.00	000000.00
March	000000.00	000000.00	000000.00	000000.00
April	000000.00	000000.00	000000.00	000000.00
May	000000.00	000000.00	000000.00	000000.00
June	000000.00	000000.00	000000.00	000000.00
July	000000.00	000000.00	000000.00	000000.00
August	000000.00	000000.00	000000.00	000000.00
September	000000.00	000000.00	000000.00	000000.00
October	000000.00	000000.00	000000.00	000000.00
November	000000.00	000000.00	000000.00	000000.00
December	000000.00	000000.00	000000.00	000000.00

Heat Pump Monthly Loads

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	012848.00	027371.00	000052.90	000157.30
February	006870.00	027703.00	000039.00	000164.00
March	006923.00	031361.00	000042.40	000145.50
April	001475.00	041082.00	000021.70	000163.80
May	000541.00	049136.00	000021.70	000175.30
June	000001.00	061993.00	000000.50	000200.40
July	000000.00	070632.00	000000.00	000199.40
August	000000.00	069284.00	000000.00	000196.70
September	000000.00	058623.00	000000.00	000191.70
October	000626.00	045286.00	000014.60	000185.50
November	004905.00	031272.00	000033.90	000160.20
December	010851.00	027942.00	000044.60	000155.50

Results

Borehole Information

Each Borehole Depth, ft = 390.87
Total Borehole Depth, ft = 16416.54
Distance between borhole centers, ft = 022.00

Average Temperature

Maximum Average Temperature, °F = 089.73 at month 298
Minimum Average Temperature, °F = 068.36 at month 01

Peak temperature

Maximum Peak Temperature, °F = 089.92 at month 298
Minimum Peak Temperature, °F = 068.27 at month 01

Monthly loads

Month	Heating(Btu)	Cooling(Btu)	Peak Heating(Btu/hr)	Peak Cooling(Btu/hr)
January	12848000.000	27371000.000	52900.000	157300.000
February	6870000.000	27703000.000	39000.000	164000.000
March	6923000.000	31361000.000	42400.000	145500.000
April	1475000.000	41082000.000	21700.000	163800.000
May	541000.000	49136000.000	21700.000	175300.000
June	1000.000	61993000.000	500.000	200400.000
July	.000	70632000.000	.000	199400.000
August	.000	69284000.000	.000	196700.000
September	.000	58623000.000	.000	191700.000
October	626000.000	45286000.000	14600.000	185500.000
November	4905000.000	31272000.000	33900.000	160200.000
December	10851000.000	27942000.000	44600.000	155500.000

Note : EWT = Entering water temperature to heat pump(s)
ExWT = Exiting water temperature from heat pump(s)

Time (months)	Q (Btu/hr•ft)	Power (kW-hr)	Tf (F)	Average ExWT (F)	Average EWT (F)	Minimum EWT (F)	Maximum EWT (F)
1	-1.66	1085.81	69.00	69.64	68.36	68.27	68.55
2	-2.29	698.69	70.48	71.37	69.59	69.50	69.78
3	-2.40	734.78	71.18	72.11	70.25	70.15	70.41
4	-3.75	475.28	71.43	72.89	69.98	69.87	70.13
5	-4.42	491.03	72.78	74.49	71.06	70.94	71.22
6	-5.81	576.51	73.63	75.88	71.37	71.25	71.54
7	-6.41	659.31	75.14	77.63	72.66	72.66	72.81
8	-6.29	648.59	76.02	78.46	73.58	73.58	73.73
9	-5.50	549.80	76.28	78.41	74.14	74.14	74.30
10	-4.07	464.24	75.90	77.48	74.32	74.22	74.51
11	-2.61	601.45	74.88	75.89	73.87	73.78	74.05
12	-1.84	946.61	73.70	74.41	72.99	72.90	73.18
13	-1.66	1069.60	73.03	73.68	72.39	72.30	72.58
14	-2.29	694.51	72.84	73.73	71.95	71.86	72.14
15	-2.40	731.14	73.41	74.34	72.48	72.38	72.64
16	-3.75	476.47	73.58	75.03	72.12	72.02	72.28
17	-4.42	493.50	74.86	76.57	73.14	73.02	73.30
18	-5.81	580.07	75.65	77.91	73.39	73.27	73.56
19	-6.41	663.53	77.13	79.62	74.65	74.65	74.80
20	-6.29	652.91	78.01	80.45	75.56	75.56	75.72
21	-5.50	553.57	78.28	80.41	76.14	76.14	76.30
22	-4.07	466.78	77.91	79.49	76.32	76.22	76.51
23	-2.61	600.30	76.88	77.89	75.87	75.77	76.04
24	-1.84	941.26	75.67	76.38	74.96	74.87	75.15
25	-1.66	1062.90	74.95	75.59	74.31	74.21	74.50
26	-2.29	691.67	74.69	75.58	73.80	73.71	73.99
27	-2.40	728.69	75.17	76.10	74.24	74.14	74.40
28	-3.75	477.64	75.26	76.72	73.80	73.70	73.96
29	-4.42	495.64	76.48	78.20	74.76	74.65	74.93
30	-5.81	583.07	77.22	79.48	74.97	74.84	75.13
31	-6.41	667.06	78.67	81.16	76.18	76.18	76.34
32	-6.29	656.45	79.52	81.96	77.08	77.08	77.23
33	-5.50	556.61	79.78	81.92	77.65	77.65	77.81
34	-4.07	468.87	79.41	80.99	77.83	77.73	78.02
35	-2.61	599.68	78.39	79.40	77.38	77.29	77.56
36	-1.84	937.55	77.18	77.89	76.47	76.38	76.66
37	-1.66	1058.09	76.45	77.09	75.80	75.71	76.00
38	-2.29	689.67	76.17	77.06	75.28	75.19	75.47
39	-2.40	726.95	76.62	77.55	75.69	75.59	75.85
40	-3.76	478.78	76.66	78.12	75.21	75.10	75.37
41	-4.43	497.59	77.85	79.57	76.13	76.01	76.29
42	-5.82	585.79	78.56	80.82	76.30	76.18	76.47
43	-6.42	670.25	79.98	82.48	77.49	77.49	77.65
44	-6.30	659.64	80.81	83.26	78.37	78.37	78.52
45	-5.51	559.33	81.06	83.20	78.92	78.92	79.08

46	-4.08	470.75	80.68	82.26	79.10	78.99	79.28
47	-2.61	599.33	79.65	80.66	78.64	78.55	78.82
48	-1.84	934.74	78.44	79.15	77.72	77.64	77.91
49	-1.66	1054.38	77.70	78.34	77.06	76.96	77.25
50	-2.29	688.18	77.41	78.30	76.52	76.43	76.71
51	-2.40	725.66	77.85	78.78	76.91	76.82	77.08
52	-3.76	479.86	77.87	79.33	76.42	76.31	76.57
53	-4.43	499.40	79.04	80.76	77.32	77.20	77.48
54	-5.82	588.28	79.73	81.99	77.47	77.34	77.64
55	-6.42	673.17	81.13	83.62	78.64	78.64	78.79
56	-6.30	662.55	81.94	84.39	79.50	79.50	79.65
57	-5.51	561.82	82.18	84.31	80.04	80.04	80.20
58	-4.08	472.48	81.79	83.37	80.20	80.10	80.39
59	-2.61	599.15	80.75	81.76	79.74	79.64	79.92
60	-1.84	932.48	79.53	80.25	78.82	78.73	79.01
61	-1.66	1051.36	78.79	79.43	78.15	78.06	78.34
62	-2.30	687.01	78.50	79.39	77.61	77.52	77.80
63	-2.40	724.66	78.93	79.86	78.00	77.90	78.16
64	-3.76	480.92	78.95	80.41	77.49	77.38	77.65
65	-4.43	501.10	80.10	81.82	78.38	78.26	78.54
66	-5.82	590.61	80.77	83.03	78.51	78.39	78.68
67	-6.42	675.90	82.16	84.65	79.67	79.67	79.82
68	-6.30	665.27	82.95	85.40	80.51	80.51	80.66
69	-5.51	564.12	83.17	85.31	81.03	81.03	81.19
70	-4.08	474.08	82.77	84.35	81.18	81.08	81.37
71	-2.61	599.08	81.71	82.73	80.70	80.61	80.88
72	-1.84	930.67	80.48	81.20	79.77	79.68	79.96
73	-1.66	1048.94	79.72	80.37	79.08	78.99	79.28
74	-2.30	686.12	79.42	80.31	78.53	78.44	78.72
75	-2.40	723.94	79.84	80.77	78.90	78.81	79.06
76	-3.76	481.86	79.84	81.30	78.38	78.28	78.54
77	-4.43	502.57	80.98	82.70	79.26	79.14	79.42
78	-5.82	592.62	81.64	83.90	79.38	79.25	79.55
79	-6.43	678.26	83.02	85.51	80.52	80.52	80.68
80	-6.30	667.62	83.80	86.25	81.35	81.35	81.51
81	-5.51	566.12	84.01	86.15	81.87	81.87	82.03
82	-4.08	475.49	83.60	85.18	82.01	81.91	82.20
83	-2.61	599.10	82.54	83.55	81.53	81.43	81.71
84	-1.84	929.22	81.30	82.02	80.59	80.50	80.78
85	-1.66	1046.95	80.54	81.19	79.90	79.81	80.10
86	-2.30	685.41	80.24	81.13	79.35	79.26	79.54
87	-2.40	723.36	80.66	81.59	79.72	79.63	79.88
88	-3.76	482.77	80.66	82.12	79.20	79.10	79.36
89	-4.43	503.99	81.80	83.52	80.08	79.96	80.24
90	-5.83	594.56	82.46	84.72	80.20	80.07	80.36
91	-6.43	680.55	83.83	86.32	81.33	81.33	81.49
92	-6.31	669.91	84.61	87.05	82.16	82.16	82.31
93	-5.52	568.07	84.81	86.95	82.66	82.66	82.83
94	-4.08	476.86	84.38	85.97	82.80	82.69	82.98
95	-2.61	599.17	83.32	84.33	82.30	82.21	82.48
96	-1.84	927.96	82.07	82.78	81.36	81.27	81.54
97	-1.66	1045.21	81.30	81.94	80.66	80.57	80.85
98	-2.30	684.83	80.99	81.88	80.10	80.00	80.29
99	-2.40	722.91	81.40	82.33	80.46	80.37	80.63
100	-3.76	483.63	81.39	82.85	79.93	79.83	80.09
101	-4.44	505.29	82.53	84.25	80.80	80.68	80.97
102	-5.83	596.32	83.18	85.44	80.91	80.79	81.08
103	-6.43	682.61	84.54	87.04	82.04	82.04	82.20
104	-6.31	671.96	85.31	87.76	82.86	82.86	83.01
105	-5.52	569.82	85.50	87.64	83.36	83.36	83.52
106	-4.08	478.11	85.07	86.66	83.49	83.38	83.67
107	-2.61	599.28	84.00	85.02	82.99	82.89	83.17
108	-1.84	926.92	82.75	83.46	82.03	81.95	82.22
109	-1.66	1043.74	81.97	82.62	81.33	81.24	81.53
110	-2.30	684.36	81.66	82.55	80.77	80.68	80.96
111	-2.40	722.56	82.06	83.00	81.13	81.03	81.29
112	-3.76	484.44	82.06	83.52	80.60	80.49	80.76
113	-4.44	506.52	83.19	84.91	81.47	81.35	81.63
114	-5.83	597.98	83.84	86.10	81.58	81.45	81.75
115	-6.43	684.57	85.20	87.70	82.71	82.71	82.86
116	-6.31	673.93	85.97	88.42	83.52	83.52	83.67
117	-5.52	571.50	86.16	88.30	84.02	84.02	84.18
118	-4.09	479.31	85.72	87.31	84.14	84.03	84.32
119	-2.61	599.42	84.65	85.66	83.63	83.54	83.81
120	-1.84	926.00	83.39	84.10	82.67	82.59	82.86
121	-1.66	1042.44	82.61	83.25	81.96	81.87	82.16
122	-2.30	683.96	82.28	83.18	81.39	81.30	81.58

123	-2.40	722.28	82.69	83.62	81.75	81.66	81.91
124	-3.76	485.22	82.68	84.14	81.21	81.11	81.37
125	-4.44	507.67	83.80	85.52	82.08	81.96	82.24
126	-5.83	599.53	84.45	86.71	82.18	82.06	82.35
127	-6.43	686.39	85.80	88.30	83.31	83.31	83.46
128	-6.31	675.75	86.57	89.02	84.12	84.12	84.27
129	-5.52	573.05	86.75	88.89	84.61	84.61	84.77
130	-4.09	480.42	86.31	87.90	84.73	84.62	84.91
131	-2.61	599.58	85.23	86.24	84.21	84.12	84.39
132	1.81	925.23	83.96	84.68	83.25	83.16	83.44
133	-1.66	1041.32	83.18	83.82	82.54	82.44	82.73
134	-2.30	683.64	82.85	83.74	81.96	81.87	82.15
135	-2.41	722.06	83.25	84.18	82.32	82.22	82.48
136	-3.76	485.95	83.24	84.70	81.77	81.67	81.93
137	-4.44	508.74	84.36	86.08	82.63	82.51	82.80
138	-5.83	600.97	85.00	87.26	82.73	82.61	82.90
139	-6.44	688.07	86.35	88.85	83.85	83.85	84.01
140	-6.31	677.43	87.11	89.56	84.66	84.66	84.81
141	-5.52	574.48	87.29	89.43	85.15	85.15	85.31
142	-4.09	481.45	86.85	88.43	85.26	85.16	85.44
143	-2.62	599.76	85.76	86.77	84.74	84.65	84.92
144	-1.84	924.57	84.49	85.21	83.78	83.69	83.97
145	-1.66	1040.35	83.70	84.35	83.06	82.97	83.26
146	-2.30	683.38	83.37	84.26	82.48	82.39	82.67
147	-2.41	721.89	83.76	84.70	82.83	82.73	82.99
148	-3.77	486.63	83.75	85.21	82.29	82.18	82.44
149	-4.44	509.74	84.87	86.59	83.14	83.02	83.30
150	-5.83	602.31	85.50	87.77	83.24	83.11	83.41
151	-6.44	689.64	86.85	89.35	84.35	84.35	84.51
152	-6.32	679.00	87.61	90.06	85.16	85.16	85.31
153	-5.52	575.82	87.79	89.93	85.64	85.64	85.80
154	-4.09	482.42	87.34	88.93	85.75	85.65	85.94
155	-2.62	599.95	86.25	87.26	85.23	85.14	85.41
156	-1.84	923.99	84.98	85.69	84.26	84.17	84.45
157	-1.66	1039.49	84.18	84.83	83.54	83.45	83.74
158	-2.30	683.17	83.85	84.74	82.96	82.87	83.15
159	-2.41	721.77	84.24	85.17	83.31	83.21	83.47
160	-3.77	487.29	84.22	85.68	82.76	82.65	82.92
161	-4.44	510.68	85.33	87.06	83.61	83.49	83.77
162	-5.84	603.57	85.97	88.23	83.70	83.58	83.87
163	-6.44	691.12	87.32	89.82	84.82	84.82	84.97
164	-6.32	680.47	88.07	90.52	85.62	85.62	85.77
165	-5.53	577.08	88.24	90.39	86.10	86.10	86.26
166	-4.09	483.33	87.79	89.38	86.21	86.10	86.39
167	-2.62	600.14	86.70	87.71	85.68	85.59	85.86
168	-1.84	923.50	85.42	86.14	84.71	84.62	84.90
169	-1.66	1038.74	84.63	85.27	83.99	83.89	84.18
170	-2.30	682.99	84.29	85.18	83.40	83.31	83.59
171	-2.41	721.67	84.68	85.61	83.75	83.65	83.91
172	-3.77	487.90	84.66	86.12	83.19	83.09	83.35
173	-4.44	511.57	85.77	87.49	84.05	83.93	84.21
174	-5.84	604.75	86.40	88.67	84.14	84.01	84.30
175	-6.44	692.50	87.75	90.25	85.25	85.25	85.40
176	-6.32	681.85	88.50	90.95	86.04	86.04	86.20
177	-5.53	578.26	88.67	90.81	86.52	86.52	86.69
178	-4.09	484.18	88.22	89.81	86.63	86.53	86.81
179	-2.62	600.34	87.12	88.14	86.10	86.01	86.28
180	-1.84	923.06	85.84	86.56	85.13	85.04	85.32
181	-1.66	1038.07	85.05	85.69	84.40	84.31	84.60
182	-2.30	682.85	84.70	85.60	83.81	83.72	84.00
183	-2.41	721.61	85.09	86.02	84.16	84.06	84.32
184	-3.77	488.49	85.06	86.53	83.60	83.50	83.76
185	-4.44	512.41	86.18	87.90	84.45	84.33	84.61
186	-5.84	605.87	86.81	89.07	84.54	84.41	84.71
187	-6.44	693.81	88.15	90.65	85.65	85.65	85.80
188	-6.32	683.16	88.90	91.35	86.44	86.44	86.60
189	-5.53	579.37	89.07	91.21	86.92	86.92	87.08
190	-4.09	485.00	88.61	90.20	87.02	86.92	87.21
191	-2.62	600.54	87.51	88.53	86.50	86.40	86.68
192	-1.84	922.68	86.23	86.95	85.52	85.43	85.71
193	-1.66	1037.46	85.43	86.08	84.79	84.70	84.99
194	-2.30	682.73	85.09	85.98	84.20	84.11	84.39
195	-2.41	721.56	85.47	86.41	84.54	84.44	84.70
196	-3.77	489.05	85.45	86.91	83.98	83.88	84.14
197	-4.44	513.21	86.56	88.28	84.83	84.71	84.99
198	-5.84	606.93	87.18	89.45	84.92	84.79	85.09
199	-6.44	695.05	88.53	91.03	86.03	86.03	86.18

200	-6.32	684.40	89.27	91.73	86.82	86.82	86.97
201	-5.53	580.43	89.44	91.59	87.29	87.29	87.46
202	-4.09	485.77	88.98	90.57	87.40	87.29	87.58
203	-2.62	600.74	87.88	88.90	86.87	86.77	87.05
204	-1.84	922.34	86.60	87.32	85.89	85.80	86.08
205	-1.66	1036.92	85.80	86.44	85.16	85.06	85.35
206	-2.30	682.63	85.45	86.35	84.56	84.47	84.75
207	-2.41	721.54	85.84	86.77	84.90	84.80	85.06
208	-3.77	489.59	85.81	87.27	84.34	84.24	84.50
209	-4.44	513.97	86.91	88.64	85.19	85.07	85.35
210	-5.84	607.93	87.54	89.81	85.27	85.15	85.44
211	-6.44	696.24	88.88	91.38	86.38	86.38	86.53
212	-6.32	685.52	89.63	92.08	87.17	87.17	87.32
213	-5.53	581.44	89.79	91.94	87.65	87.65	87.81
214	-4.09	486.50	89.33	90.92	87.75	87.64	87.93
215	-2.62	600.94	88.23	89.25	87.21	87.12	87.39
216	-1.84	922.04	86.95	87.66	86.23	86.14	86.42
217	-1.66	1036.44	86.14	86.79	85.50	85.41	85.69
218	-2.30	682.56	85.80	86.69	84.90	84.81	85.09
219	-2.41	721.52	86.18	87.11	85.24	85.14	85.40
220	-3.77	490.11	86.14	87.61	84.68	84.58	84.84
221	-4.45	514.69	87.25	88.98	85.52	85.41	85.69
222	-5.84	608.89	87.87	90.14	85.61	85.48	85.78
223	-6.44	697.35	89.21	91.71	86.71	86.71	86.87
224	-6.32	686.64	89.96	92.41	87.50	87.50	87.66
225	-5.53	582.39	90.12	92.27	87.97	87.97	88.14
226	-4.09	487.20	89.66	91.25	88.07	87.97	88.26
227	-2.62	601.14	88.56	89.57	87.54	87.45	87.72
228	-1.84	921.78	87.27	87.99	86.56	86.47	86.74
229	-1.66	1036.00	86.46	87.11	85.82	85.73	86.02
230	-2.30	682.50	86.12	87.01	85.22	85.13	85.41
231	-2.41	721.53	86.49	87.43	85.56	85.46	85.72
232	-3.77	490.60	86.46	87.93	85.00	84.89	85.16
233	-4.45	515.38	87.57	89.29	85.84	85.72	86.00
234	-5.84	609.80	88.19	90.46	85.92	85.80	86.09
235	-6.45	698.36	89.53	92.03	87.03	87.03	87.18
236	-6.33	687.70	90.27	92.73	87.82	87.82	87.97
237	-5.53	583.30	90.43	92.58	88.29	88.29	88.45
238	-4.09	487.87	89.97	91.56	88.38	88.28	88.57
239	-2.62	601.33	88.87	89.88	87.85	87.76	88.03
240	-1.84	921.54	87.58	88.29	86.86	86.78	87.05
241	-1.66	1035.59	86.77	87.41	86.13	86.03	86.32
242	-2.30	682.45	86.42	87.31	85.53	85.44	85.72
243	-2.41	721.54	86.80	87.73	85.86	85.77	86.03
244	-3.77	491.07	86.76	88.23	85.30	85.20	85.46
245	-4.45	516.04	87.87	89.59	86.14	86.02	86.30
246	-5.84	610.67	88.49	90.76	86.22	86.10	86.39
247	-6.45	699.38	89.83	92.33	87.32	87.32	87.48
248	-6.33	688.72	90.57	93.02	88.11	88.11	88.27
249	-5.53	584.18	90.73	92.88	88.58	88.58	88.75
250	-4.10	488.51	90.27	91.86	88.68	88.57	88.86
251	-2.62	601.53	89.16	90.18	88.14	88.05	88.32
252	-1.84	921.33	87.87	88.59	87.16	87.07	87.35
253	-1.66	1035.23	87.06	87.71	86.42	86.33	86.61
254	-2.30	682.41	86.71	87.60	85.82	85.73	86.01
255	-2.41	721.56	87.09	88.02	86.15	86.06	86.31
256	-3.77	491.53	87.05	88.52	85.59	85.48	85.75
257	-4.45	516.67	88.16	89.88	86.43	86.31	86.59
258	-5.84	611.51	88.78	91.05	86.51	86.38	86.68
259	-6.45	700.37	90.11	92.61	87.61	87.61	87.76
260	-6.33	689.70	90.85	93.31	88.40	88.40	88.55
261	-5.53	585.02	91.01	93.16	88.87	88.87	89.03
262	-4.10	489.13	90.55	92.14	88.96	88.86	89.14
263	-2.62	601.73	89.44	90.46	88.42	88.33	88.60
264	-1.84	921.14	88.15	88.86	87.43	87.35	87.62
265	-1.66	1034.89	87.34	87.98	86.70	86.60	86.89
266	-2.30	682.39	86.99	87.88	86.09	86.00	86.29
267	-2.41	721.59	87.36	88.30	86.43	86.33	86.59
268	-3.77	491.97	87.33	88.79	85.86	85.76	86.02
269	-4.45	517.29	88.43	90.16	86.70	86.58	86.86
270	-5.84	612.32	89.05	91.32	86.78	86.65	86.95
271	-6.45	701.31	90.38	92.89	87.88	87.88	88.04
272	-6.33	690.65	91.12	93.58	88.67	88.67	88.82
273	-5.53	585.77	91.28	93.43	89.14	89.14	89.30
274	-4.10	489.72	90.82	92.41	89.23	89.12	89.41
275	-2.62	601.92	89.71	90.72	88.69	88.60	88.87
276	-1.84	920.97	88.42	89.13	87.70	87.61	87.89

277	-1.66	1034.58	87.61	88.25	86.96	86.87	87.16
278	-2.30	682.37	87.25	88.15	86.36	86.27	86.55
279	-2.41	721.63	87.63	88.56	86.69	86.59	86.85
280	-3.77	492.40	87.59	89.05	86.13	86.02	86.28
281	-4.45	517.88	88.69	90.42	86.96	86.84	87.13
282	-5.85	613.10	89.31	91.58	87.04	86.91	87.21
283	-6.45	702.22	90.64	93.15	88.14	88.14	88.30
284	-6.33	691.56	91.38	93.84	88.93	88.93	89.08
285	-5.54	586.55	91.54	93.69	89.39	89.39	89.56
286	-4.10	490.30	91.06	92.67	89.49	89.38	89.67
287	-2.62	602.11	89.96	90.98	88.95	88.85	89.13
288	-1.84	920.82	88.67	89.39	87.96	87.87	88.15
289	-1.66	1034.30	87.86	88.50	87.22	87.12	87.41
290	-2.30	682.37	87.51	88.40	86.61	86.52	86.80
291	-2.41	721.67	87.88	88.82	86.94	86.85	87.11
292	-3.77	492.81	87.84	89.31	86.38	86.27	86.54
293	-4.45	518.45	88.94	90.67	87.22	87.10	87.38
294	-5.85	613.85	89.56	91.83	87.29	87.16	87.46
295	-6.45	703.10	90.89	93.40	88.39	88.39	88.54
296	-6.33	692.43	91.63	94.09	89.17	89.17	89.33
297	-5.54	587.30	91.79	93.94	89.64	89.64	89.80
298	-4.10	490.85	91.32	92.91	89.73	89.63	89.92
299	-2.62	602.30	90.21	91.23	89.19	89.10	89.37
300	-1.84	920.68	88.92	89.63	88.20	88.11	88.39

Application Design Case Ground-loop Data

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```
Active borehole length, ft                                -231.5
Borehole Radius, in                                       -2.165
Borehole spacing, ft                                      -263.9
Borehole Geometry                                         : RECTANGULAR CONFIGURATION
                                                          : 42 : 6 x 7, rectangle
Soil Type currently used                                  :
Thermal conductivity of the ground, Btu/(hr*ft*°F)        -0.9100
Volumetric heat capacity of Ground, Btu/(°F*ft^3)         -26.99
Volumetric heat capacity of fluid, Btu/(°F*ft^3)          -62.40
Undisturbed ground temperature, °F                        -69.00
Borehole thermal resistance, °F/(Btu/(hr*ft))             -0.2400
Fluid type currently entered                              : Pure Water
Mass flow rate of the fluid, gal/min                      -32.62
Density of the fluid, lb/ft^3                             -62.40
Heat Pump Selected                                        : ClimateMaster Genesis 036
```

GLHE Monthly Loads

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	000000.00	000000.00	000000.00	000000.00
February	000000.00	000000.00	000000.00	000000.00
March	000000.00	000000.00	000000.00	000000.00
April	000000.00	000000.00	000000.00	000000.00
May	000000.00	000000.00	000000.00	000000.00
June	000000.00	000000.00	000000.00	000000.00
July	000000.00	000000.00	000000.00	000000.00
August	000000.00	000000.00	000000.00	000000.00
September	000000.00	000000.00	000000.00	000000.00
October	000000.00	000000.00	000000.00	000000.00
November	000000.00	000000.00	000000.00	000000.00
December	000000.00	000000.00	000000.00	000000.00

Heat Pump Monthly Loads

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	012281.00	016958.00	000043.80	000092.90
February	006989.00	016207.00	000034.30	000098.30
March	007111.00	018187.00	000037.20	000097.70
April	001573.00	025956.00	000018.50	000118.40
May	000567.00	032309.00	000017.40	000130.50
June	000000.00	043053.00	000002.00	000154.10
July	000000.00	050834.00	000000.00	000151.80
August	000000.00	049737.00	000000.00	000146.80
September	000000.00	039896.00	000000.00	000140.00
October	000506.00	028882.00	000011.80	000126.70
November	004768.00	017833.00	000029.80	000103.40
December	010261.00	016996.00	000037.60	000099.80

Results

Borehole Information

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Each Borehole Depth, ft =   1350.98
Total Borehole Depth, ft =   56741.16
Distance between borhole centers, ft =   022.00
```

Average Temperature

Maximum Average Temperature, °F = 072.14 at month 299
Minimum Average Temperature, °F = 067.80 at month 06

Peak temperature

Maximum Peak Temperature, °F = 069.98 at month 299
Minimum Peak Temperature, °F = 067.84 at month 07

Monthly loads

Month	Heating(Btu)	Cooling(Btu)	Peak Heating(Btu/hr)	Peak Cooling(Btu/hr)
January	12281000.000	16958000.000	43800.000	92900.000
February	6989000.000	16207000.000	34300.000	98300.000
March	7111000.000	18187000.000	37200.000	97700.000
April	1573000.000	25956000.000	18500.000	118400.000
May	567000.000	32309000.000	17400.000	130500.000
June	.000	43053000.000	2000.000	154100.000
July	.000	50834000.000	.000	151800.000
August	.000	49737000.000	.000	146800.000
September	.000	39896000.000	.000	140000.000
October	506000.000	28882000.000	11800.000	126700.000
November	4768000.000	17833000.000	29800.000	103400.000
December	10261000.000	16996000.000	37600.000	99800.000

Note : EWT = Entering water temperature to heat pump(s)
ExWT = Exiting water temperature from heat pump(s)

Time (months)	Q (Btu/hr*ft)	Power (kW-hr)	Tf (F)	Average ExWT (F)	Average EWT (F)	Minimum EWT (F)	Maximum EWT (F)
1	-.22	951.83	69.00	69.38	68.62	69.71	66.51
2	-.33	602.18	69.19	69.76	68.62	69.69	66.52
3	-.35	628.17	69.31	69.91	68.71	69.84	66.64
4	-.67	341.44	69.34	70.51	68.17	69.40	66.00
5	-.84	334.69	69.64	71.10	68.19	69.62	65.92
6	-1.17	396.56	69.83	71.85	67.80	69.38	65.36
7	-1.33	468.27	70.15	72.47	67.84	67.84	65.68
8	-1.30	458.45	70.36	72.62	68.09	68.09	66.02
9	-1.08	368.12	70.39	72.27	68.51	68.51	66.32
10	-.75	299.49	70.24	71.54	68.94	70.15	66.65
11	-.39	472.43	69.97	70.65	69.29	70.36	67.14
12	-.26	819.25	69.67	70.11	69.22	70.25	66.98
13	-.22	949.49	69.54	69.92	69.17	70.26	67.05
14	-.33	601.46	69.51	70.08	68.94	70.00	66.83
15	-.35	627.49	69 61	70.21	69.01	70.15	66.94
16	-.67	341.43	69.63	70.80	68.46	69.70	66.29
17	-.84	334.84	69.93	71.38	68.48	69.91	66.21
18	-1.17	396.82	70.10	72.13	68.08	69.66	65.64
19	-1.33	468.58	70.43	72.74	68.11	68.11	65.95
20	-1.30	458.75	70.63	72.89	68.36	68.36	66.29
21	-1.08	368.37	70.66	72.53	68.78	68.78	66.59
22	-.75	299.62	70.50	71.80	69.20	70.41	66.92
23	-.39	472.07	70.23	70.91	69.55	70.62	67.40
24	-.26	818.37	69.92	70.37	69.48	70.50	67.23
25	-.22	948.45	69.79	70.17	69.41	70.50	67.30
26	-.33	600.91	69.75	70.32	69.18	70.24	67.07
27	-.35	626.95	69.84	70.44	69.24	70.38	67.17
28	-.67	341.43	69.86	71.03	68.70	69.93	66.53
29	-.84	334.96	70.16	71.62	68.71	70.14	66.44
30	-1.17	397.05	70.34	72.37	68.31	69.90	65.88
31	-1.33	468.86	70.67	72.99	68.36	68.36	66.20
32	-1.30	459.04	70.88	73.14	68.61	68.61	66.54
33	-1.08	368.61	70.91	72.79	69.03	69.03	66.84
34	-.75	299.75	70.75	72.05	69.45	70.66	67.17
35	-.39	471.74	70.48	71.16	69.80	70.86	67.64
36	-.26	817.55	70.16	70.60	69.72	70.74	67.47
37	-.22	947.48	70.02	70.40	69.64	70.73	67.53
38	-.33	600.41	69.97	70.54	69.40	70.46	67.29
39	-.35	626.46	70.06	70.66	69.46	70.60	67.39
40	-.67	341.43	70.07	71.24	68.90	70.14	66.73
41	-.84	335.07	70.37	71.82	68.91	70.34	66.65
42	-1.17	397.25	70.54	72.56	68.51	70.10	66.07
43	-1.33	469.09	70.86	73.18	68.55	68.55	66.39
44	-1.30	459.25	71.06	73.33	68.80	68.80	66.73

45	-1.08	368.78	71.09	72.97	69.21	69.21	67.02
46	-.75	299.84	70.93	72.23	69.63	70.84	67.34
47	-.39	471.51	70.65	71.33	69.97	71.04	67.81
48	-.26	816.96	70.33	70.77	69.89	70.91	67.64
49	-.22	946.77	70.19	70.57	69.81	70.90	67.70
50	-.33	600.03	70.14	70.71	69.57	70.63	67.46
51	-.35	626.07	70.23	70.83	69.63	70.77	67.56
52	-.67	341.43	70.25	71.42	69.08	70.32	66.91
53	-.84	335.18	70.55	72.01	69.10	70.53	66.83
54	-1.17	397.44	70.73	72.76	68.71	70.29	66.27
55	-1.33	469.33	71.06	73.38	68.75	68.75	66.59
56	-1.30	459.49	71.27	73.53	69.00	69.00	66.94
57	-1.08	368.98	71.30	73.18	69.42	69.42	67.23
58	-.75	299.95	71.14	72.43	69.84	71.04	67.55
59	-.39	471.24	70.85	71.54	70.17	71.24	68.02
60	-.26	816.29	70.53	70.97	70.09	71.11	67.84
61	-.22	945.96	70.39	70.76	70.01	71.10	67.89
62	-.33	599.60	70.33	70.90	69.76	70.83	67.65
63	-.35	625.66	70.42	71.02	69.82	70.96	67.75
64	-.67	341.44	70.44	71.61	69.27	70.50	67.10
65	-.84	335.28	70.73	72.19	69.28	70.71	67.01
66	-1.17	397.62	70.91	72.94	68.88	70.47	66.45
67	-1.33	469.54	71.24	73.56	68.92	68.92	66.77
68	-1.30	459.70	71.44	73.71	69.18	69.18	67.11
69	-1.08	369.14	71.47	73.35	69.59	69.59	67.40
70	-.75	300.04	71.30	72.60	70.00	71.21	67.72
71	-.39	471.03	71.02	71.70	70.34	71.40	68.18
72	-.26	815.75	70.69	71.14	70.25	71.28	68.00
73	-.22	945.30	70.54	70.92	70.17	71.26	68.05
74	-.33	599.26	70.49	71.06	69.92	70.98	67.81
75	-.35	625.32	70.57	71.17	69.97	71.11	67.90
76	-.67	341.44	70.59	71.76	69.42	70.65	67.25
77	-.84	335.36	70.88	72.34	69.43	70.86	67.16
78	-1.17	397.78	71.06	73.09	69.03	70.62	66.59
79	-1.33	469.71	71.39	73.70	69.07	69.07	66.91
80	-1.30	459.87	71.59	73.85	69.32	69.32	67.25
81	-1.08	369.28	71.61	73.49	69.73	69.73	67.54
82	-.75	300.11	71.44	72.74	70.14	71.35	67.86
83	-.39	470.85	71.16	71.84	70.48	71.54	68.32
84	-.26	815.29	70.83	71.27	70.38	71.41	68.14
85	-.22	944.75	70.68	71.06	70.30	71.39	68.19
86	-.33	598.96	70.62	71.19	70.05	71.12	67.94
87	-.35	625.03	70.70	71.30	70.10	71.24	68.03
88	-.67	341.45	70.72	71.89	69.55	70.78	67.38
89	-.84	335.44	71.01	72.47	69.56	70.99	67.29
90	-1.17	397.91	71.19	73.21	69.16	70.74	66.72
91	-1.33	469.86	71.51	73.83	69.20	69.20	67.04
92	-1.30	460.02	71.71	73.97	69.44	69.44	67.38
93	-1.08	369.40	71.73	73.61	69.85	69.85	67.67
94	-.75	300.18	71.56	72.86	70.26	71.47	67.98
95	-.39	470.69	71.28	71.96	70.60	71.66	68.44
96	-.26	814.88	70.95	71.40	70.51	71.54	68.26
97	-.22	944.24	70.80	71.18	70.43	71.52	68.31
98	-.33	598.69	70.75	71.32	70.18	71.24	68.07
99	-.35	624.75	70.84	71.44	70.24	71.38	68.17
100	-.67	341.45	70.86	72.03	69.69	70.92	67.52
101	-.84	335.52	71.15	72.61	69.70	71.13	67.43
102	-1.17	398.05	71.33	73.35	69.30	70.89	66.86
103	-1.33	470.04	71.65	73.97	69.34	69.34	67.18
104	-1.30	460.20	71.85	74.12	69.59	69.59	67.52
105	-1.08	369.55	71.87	73.75	70.00	70.00	67.81
106	-.75	300.26	71.71	73.01	70.41	71.62	68.12
107	-.39	470.52	71.42	72.10	70.74	71.80	68.58
108	-.26	814.42	71.09	71.53	70.65	71.67	68.40
109	-.22	943.68	70.94	71.32	70.56	71.66	68.45
110	-.33	598.39	70.89	71.45	70.32	71.38	68.21
111	-.35	624.46	70.97	71.57	70.37	71.51	68.30
112	-.67	341.46	70.99	72.16	69.82	71.05	67.65
113	-.84	335.60	71.28	72.74	69.83	71.26	67.56
114	-1.17	398.19	71.46	73.49	69.43	71.02	66.99
115	-1.33	470.20	71.78	74.10	69.47	69.47	67.31
116	-1.30	460.35	71.98	74.25	69.72	69.72	67.65
117	-1.08	369.68	72.00	73.88	70.12	70.12	67.93
118	-.75	300.33	71.83	73.13	70.53	71.74	68.25
119	-.39	470.36	71.54	72.23	70.86	71.93	68.71
120	-.26	814.02	71.21	71.66	70.77	71.80	68.52
121	-.22	943.19	71.06	71.44	70.69	71.78	68.57

122	-.33	598.13	71.01	71.58	70.44	71.50	68.33
123	-.35	624.20	71.09	71.69	70.49	71.63	68.42
124	-.67	341.47	71.11	72.28	69.94	71.17	67.77
125	-.84	335.67	71.40	72.86	69.95	71.38	67.68
126	-1.17	398.31	71.58	73.60	69.55	71.14	67.11
127	-1.33	470.34	71.90	74.22	69.59	69.59	67.43
128	-1.30	460.50	72.10	74.36	69.83	69.83	67.76
129	-1.08	369.79	72.12	73.99	70.24	70.24	68.05
130	-.75	300.39	71.95	73.25	70.65	71.86	68.36
131	-.39	470.22	71.66	72.34	70.98	72.04	68.82
132	-.26	813.65	71.33	71.77	70.88	71.91	68.64
133	-.22	942.74	71.17	71.55	70.80	71.89	68.68
134	-.33	597.90	71.12	71.69	70.55	71.61	68.44
135	-.35	623.97	71.20	71.80	70.60	71.74	68.53
136	-.67	341.48	71.22	72.39	70.05	71.28	67.88
137	-.84	335.73	71.51	72.96	70.06	71.49	67.79
138	-1.17	398.43	71.68	73.71	69.66	71.24	67.22
139	-1.33	470.48	72.01	74.32	69.69	69.69	67.53
140	-1.30	460.63	72.20	74.47	69.94	69.94	67.87
141	-1.08	369.90	72.22	74.10	70.34	70.34	68.15
142	-.75	300.45	72.05	73.35	70.75	71.96	68.46
143	-.39	470.09	71.76	72.44	71.08	72.15	68.92
144	-.26	813.32	71.43	71.87	70.98	72.01	68.74
145	-.22	942.33	71.28	71.65	70.90	71.99	68.78
146	-.33	597.68	71.22	71.79	70.65	71.71	68.54
147	-.35	623.75	71.30	71.90	70.70	71.84	68.63
148	-.67	341.48	71.32	72.49	70.15	71.38	67.98
149	-.84	335.79	71.61	73.06	70.16	71.59	67.89
150	-1.17	398.53	71.78	73.81	69.75	71.34	67.31
151	-1.33	470.60	72.10	74.42	69.79	69.79	67.63
152	-1.30	460.75	72.30	74.56	70.03	70.03	67.96
153	-1.08	370.00	72.32	74.20	70.44	70.44	68.25
154	-.75	300.50	72.14	73.44	70.84	72.05	68.56
155	-.39	469.97	71.85	72.54	71.17	72.24	69.02
156	-.26	813.01	71.52	71.96	71.08	72.11	68.83
157	-.22	941.96	71.37	71.75	70.99	72.08	68.88
158	-.33	597.48	71.31	71.88	70.74	71.81	68.63
159	-.35	623.56	71.39	71.99	70.79	71.93	68.72
160	-.67	341.49	71.41	72.58	70.24	71.47	68.07
161	-.84	335.85	71.70	73.16	70.25	71.68	67.98
162	-1.17	398.63	71.88	73.90	69.85	71.44	67.41
163	-1.33	470.72	72.20	74.52	69.89	69.89	67.73
164	-1.30	460.87	72.40	74.66	70.13	70.13	68.06
165	-1.08	370.10	72.42	74.30	70.54	70.54	68.35
166	-.75	300.56	72.25	73.55	70.95	72.16	68.66
167	-.39	469.84	71.96	72.64	71.28	72.35	69.12
168	-.26	812.66	71.63	72.07	71.19	72.21	68.94
169	-.22	941.53	71.48	71.86	71.10	72.19	68.98
170	-.33	597.26	71.42	71.99	70.85	71.91	68.74
171	-.35	623.33	71.50	72.10	70.90	72.04	68.83
172	-.67	341.50	71.52	72.69	70.35	71.58	68.18
173	-.84	335.91	71.81	73.26	70.36	71.79	68.09
174	-1.17	398.75	71.98	74.01	69.96	71.54	67.52
175	-1.33	470.86	72.31	74.62	69.99	69.99	67.83
176	-1.30	461.00	72.50	74.77	70.24	70.24	68.17
177	-1.08	370.21	72.52	74.40	70.64	70.64	68.46
178	-.75	300.62	72.35	73.65	71.05	72.26	68.77
179	-.39	469.71	72.06	72.75	71.38	72.45	69.23
180	-.26	812.33	71.73	72.17	71.29	72.32	69.04
181	-.22	941.13	71.58	71.96	71.20	72.29	69.08
182	-.33	597.04	71.52	72.09	70.95	72.02	68.84
183	-.35	623.12	71.60	72.20	71.00	72.14	68.93
184	-.67	341.51	71.62	72.79	70.45	71.68	68.27
185	-.84	335.97	71.91	73.36	70.45	71.88	68.19
186	-1.17	398.85	72.08	74.11	70.05	71.64	67.61
187	-1.33	470.98	72.40	74.72	70.09	70.09	67.93
188	-1.30	461.13	72.60	74.87	70.33	70.33	68.27
189	-1.08	370.31	72.62	74.50	70.74	70.74	68.55
190	-.75	300.68	72.45	73.75	71.15	72.36	68.86
191	-.39	469.60	72.16	72.84	71.48	72.55	69.32
192	-.26	812.03	71.83	72.27	71.38	72.41	69.14
193	-.22	940.76	71.67	72.05	71.30	72.39	69.18
194	-.33	596.85	71.61	72.18	71.05	72.11	68.93
195	-.35	622.93	71.70	72.29	71.10	72.24	69.02
196	-.67	341.52	71.71	72.88	70.54	71.77	68.37
197	-.84	336.03	72.00	73.46	70.55	71.98	68.28
198	-1.17	398.95	72.17	74.20	70.15	71.73	67.71

199	-1.33	471.10	72.50	74.81	70.18	70.18	68.02
200	-1.30	461.24	72.69	74.96	70.43	70.43	68.36
201	-1.08	370.40	72.71	74.59	70.83	70.83	68.64
202	-.75	300.73	72.54	73.84	71.24	72.45	68.95
203	-.39	469.49	72.25	72.93	71.57	72.64	69.41
204	-.26	811.74	71.92	72.36	71.47	72.50	69.23
205	-.22	940.41	71.76	72.14	71.39	72.48	69.27
206	-.33	596.66	71.70	72.27	71.13	72.20	69.02
207	-.35	622.75	71.78	72.38	71.18	72.32	69.11
208	-.67	341.53	71.80	72.97	70.63	71.86	68.46
209	-.84	336.09	72.09	73.54	70.63	72.06	68.37
210	-1.17	399.05	72.26	74.29	70.23	71.82	67.79
211	-1.33	471.21	72.58	74.90	70.27	70.27	68.11
212	-1.30	461.35	72.78	75.04	70.51	70.51	68.44
213	-1.08	370.49	72.80	74.68	70.92	70.92	68.73
214	-.75	300.78	72.62	73.92	71.32	72.53	69.04
215	-.39	469.39	72.33	73.02	71.65	72.72	69.50
216	-.26	811.48	72.00	72.44	71.56	72.59	69.31
217	-.22	940.08	71.85	72.22	71.47	72.56	69.35
218	-.33	596.49	71.79	72.35	71.22	72.28	69.11
219	-.35	622.57	71.87	72.47	71.27	72.41	69.19
220	-.67	341.53	71.88	73.05	70.71	71.94	68.54
221	-.84	336.14	72.17	73.62	70.72	72.15	68.45
222	-1.17	399.14	72.34	74.37	70.31	71.90	67.87
223	-1.33	471.32	72.66	74.98	70.35	70.35	68.19
224	-1.30	461.46	72.86	75.12	70.59	70.59	68.52
225	-1.08	370.58	72.88	74.76	71.00	71.00	68.81
226	-.75	300.83	72.71	74.01	71.41	72.62	69.12
227	-.39	469.29	72.41	73.10	71.73	72.80	69.58
228	-.26	811.22	72.08	72.52	71.64	72.67	69.39
229	-.22	939.77	71.93	72.30	71.55	72.64	69.43
230	-.33	596.33	71.87	72.43	71.30	72.36	69.19
231	-.35	622.41	71.94	72.54	71.35	72.49	69.27
232	-.67	341.54	71.96	73.13	70.79	72.02	68.62
233	-.84	336.19	72.25	73.70	70.79	72.22	68.53
234	-1.17	399.22	72.42	74.45	70.39	71.98	67.95
235	-1.33	471.42	72.74	75.06	70.42	70.42	68.27
236	-1.30	461.56	72.94	75.20	70.67	70.67	68.60
237	-1.08	370.66	72.95	74.83	71.07	71.07	68.89
238	-.75	300.88	72.78	74.08	71.48	72.69	69.19
239	-.39	469.20	72.49	73.17	71.81	72.88	69.65
240	-.26	810.98	72.16	72.60	71.71	72.74	69.47
241	-.22	939.48	72.00	72.38	71.62	72.72	69.51
242	-.33	596.17	71.94	72.51	71.37	72.44	69.26
243	-.35	622.26	72.02	72.62	71.42	72.56	69.35
244	-.67	341.55	72.03	73.20	70.86	72.10	68.69
245	-.84	336.24	72.32	73.78	70.87	72.30	68.60
246	-1.17	399.30	72.49	74.52	70.47	72.05	68.03
247	-1.33	471.51	72.81	75.13	70.50	70.50	68.34
248	-1.30	461.65	73.01	75.28	70.74	70.74	68.67
249	-1.08	370.74	73.03	74.91	71.15	71.15	68.96
250	-.75	300.92	72.85	74.15	71.55	72.76	69.27
251	-.39	469.11	72.56	73.24	71.88	72.95	69.72
252	-.26	810.76	72.23	72.67	71.78	72.81	69.54
253	-.22	939.20	72.07	72.45	71.70	72.79	69.58
254	-.33	596.03	72.01	72.58	71.44	72.51	69.33
255	-.35	622.12	72.09	72.69	71.49	72.63	69.42
256	-.67	341.56	72.10	73.27	70.93	72.17	68.76
257	-.84	336.28	72.39	73.85	70.94	72.37	68.67
258	-1.17	399.38	72.56	74.59	70.54	72.12	68.10
259	-1.33	471.60	72.88	75.20	70.57	70.57	68.41
260	-1.30	461.74	73.08	75.34	70.81	70.81	68.74
261	-1.08	370.81	73.10	74.97	71.22	71.22	69.03
262	-.75	300.96	72.92	74.22	71.62	72.83	69.34
263	-.39	469.03	72.63	73.31	71.95	73.02	69.79
264	-.26	810.54	72.30	72.74	71.85	72.88	69.61
265	-.22	938.94	72.14	72.52	71.76	72.86	69.65
266	-.33	595.89	72.08	72.65	71.51	72.57	69.40
267	-.35	621.98	72.16	72.76	71.56	72.70	69.49
268	-.67	341.57	72.17	73.34	71.00	72.23	68.83
269	-.84	336.33	72.46	73.91	71.01	72.44	68.74
270	-1.17	399.46	72.63	74.66	70.60	72.19	68.16
271	-1.33	471.69	72.95	75.27	70.63	70.63	68.47
272	-1.30	461.83	73.14	75.41	70.88	70.88	68.81
273	-1.08	370.88	73.16	75.04	71.28	71.28	69.09
274	-.75	301.01	72.99	74.29	71.69	72.90	69.40
275	-.39	468.96	72.70	73.38	72.02	73.08	69.86

276	-.26	810.34	72.36	72.81	71.92	72.95	69.67
277	-.22	938.68	72.21	72.58	71.83	72.92	69.71
278	-.33	595.75	72.14	72.71	71.58	72.64	69.46
279	-.35	621.85	72.22	72.82	71.62	72.76	69.55
280	-.67	341.57	72.23	73.40	71.06	72.30	68.89
281	-.84	336.37	72.52	73.98	71.07	72.50	68.80
282	-1.17	399.53	72.69	74.72	70.67	72.25	68.23
283	-1.33	471.78	73.02	75.33	70.70	70.70	68.54
284	-1.30	461.91	73.21	75.47	70.94	70.94	68.87
285	-1.08	370.95	73.23	75.10	71.35	71.35	69.16
286	-.75	301.04	73.05	74.35	71.75	72.96	69.46
287	-.39	468.88	72.76	73.44	72.08	73.15	69.92
288	-.26	810.14	72.42	72.87	71.98	73.01	69.73
289	-.22	938.44	72.27	72.65	71.89	72.98	69.77
290	-.33	595.63	72.21	72.78	71.64	72.70	69.53
291	-.35	621.72	72.29	72.88	71.69	72.83	69.61
292	-.67	341.58	72.30	73.47	71.13	72.36	68.95
293	-.84	336.41	72.59	74.04	71.13	72.56	68.86
294	-1.17	399.60	72.76	74.78	70.73	72.31	68.29
295	-1.33	471.86	73.08	75.39	70.76	70.76	68.60
296	-1.30	461.99	73.27	75.54	71.00	71.00	68.93
297	-1.08	371.01	73.29	75.17	71.41	71.41	69.22
298	-.75	301.08	73.11	74.41	71.81	73.02	69.52
299	-.39	468.81	72.82	73.50	72.14	73.21	69.98
300	-.26	809.95	72.48	72.93	72.04	73.07	69.79

Application Design Case (70°F Ground Temperature) Ground-loop Data

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\ctive borehole length, ft                             =231.5
3orehole Radius, in                                    =2.165
3orehole spacing, ft                                   =263.9
3orehole Geometry                                      : RECTANGULAR CONFIGURATION
                                                       : 42 : 6 x 7, rectangle
3oil Type currently used                               :
Thermal conductivity of the ground, Btu/(hr•ft•°F)     =0.9100
/olumetric heat capacity of Ground, Btu/(°F•ft^3)      =26.99
/olumetric heat capacity of fluid, Btu/(°F•ft^3)       =62.40
Undisturbed ground temperature, °F                     =69.00
3orehole thermal resistance, °F/(Btu/(hr•ft))          =0.2400
Fluid type currently entered                           : Pure Water
Mass flow rate of the fluid, gal/min                   =32.62
Density of the fluid, lb/ft^3                          =62.40
Heat Pump Selected                                     : ClimateMaster Genesis 036
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GLHE Monthly Loads

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	000000.00	000000.00	000000.00	000000.00
February	000000.00	000000.00	000000.00	000000.00
March	000000.00	000000.00	000000.00	000000.00
April	000000.00	000000.00	000000.00	000000.00
May	000000.00	000000.00	000000.00	000000.00
June	000000.00	000000.00	000000.00	000000.00
July	000000.00	000000.00	000000.00	000000.00
August	000000.00	000000.00	000000.00	000000.00
September	000000.00	000000.00	000000.00	000000.00
October	000000.00	000000.00	000000.00	000000.00
November	000000.00	000000.00	000000.00	000000.00
December	000000.00	000000.00	000000.00	000000.00

Heat Pump Monthly Loads

Month	Total Heating 1000 Btu	Total Cooling 1000 Btu	Peak Heating 1000 Btu/Hr	Peak Cooling 1000 Btu/Hr
January	012281.00	016958.00	000043.80	000092.90
February	006989.00	016207.00	000034.30	000098.30
March	007111.00	018187.00	000037.20	000097.70
April	001573.00	025956.00	000018.50	000118.40
May	000567.00	032309.00	000017.40	000130.50
June	000000.00	043053.00	000002.00	000154.10
July	000000.00	050834.00	000000.00	000151.80
August	000000.00	049737.00	000000.00	000146.80
September	000000.00	039896.00	000000.00	000140.00
October	000506.00	028882.00	000011.80	000126.70
November	004768.00	017833.00	000029.80	000103.40
December	010261.00	016996.00	000037.60	000099.80

Results

Borehole Information

Each Borehole Depth, ft = 231.48
Total Borehole Depth, ft = 9722.16
Distance between borhole centers, ft = 022.00

Average Temperature

Maximum Average Temperature, °F = 088.84 at month 297
Minimum Average Temperature, °F = 068.62 at month 01

Peak temperature

Maximum Peak Temperature, °F = 089.93 at month 297
Minimum Peak Temperature, °F = 068.09 at month 01

Monthly loads

Month	Heating(Btu)	Cooling(Btu)	Peak Heating(Btu/hr)	Peak Cooling(Btu/hr)
January	12281000.000	16958000.000	43800.000	92900.000
February	6989000.000	16207000.000	34300.000	98300.000
March	7111000.000	18187000.000	37200.000	97700.000
April	1573000.000	25956000.000	18500.000	118400.000
May	567000.000	32309000.000	17400.000	130500.000
June	.000	43053000.000	2000.000	154100.000
July	.000	50834000.000	.000	151800.000
August	.000	49737000.000	.000	146800.000
September	.000	39896000.000	.000	140000.000
October	506000.000	28882000.000	11800.000	126700.000
November	4768000.000	17833000.000	29800.000	103400.000
December	10261000.000	16996000.000	37600.000	99800.000

Note : EWT = Entering water temperature to heat pump(s)
ExWT = Exiting water temperature from heat pump(s)

Time (months)	Q (Btu/hr•ft)	Power (kW-hr)	Tf (F)	Average ExWT (F)	Average EWT (F)	Minimum EWT (F)	Maximum EWT (F)
1	-1.27	951.83	69.00	69.38	68.62	68.09	69.67
2	-1.91	600.03	70.14	70.71	69.57	69.05	70.61
3	-2.01	624.80	70.81	71.41	70.21	69.65	71.23
4	-3.93	341.46	71.02	72.19	69.85	69.24	70.92
5	-4.88	336.57	72.83	74.28	71.37	70.67	72.49
6	-6.81	400.95	73.93	75.95	71.90	71.12	73.10
7	-7.79	475.93	75.93	78.25	73.61	73.61	74.68
8	-7.62	467.67	77.19	79.46	74.92	74.92	75.94
9	-6.32	375.95	77.44	79.32	75.55	75.55	76.64
10	-4.37	303.52	76.62	77.92	75.32	74.72	76.45
11	-2.29	466.33	75.13	75.81	74.44	73.92	75.51
12	-1.49	807.15	73.40	73.84	72.96	72.45	74.07
13	-1.27	936.79	72.70	73.08	72.33	71.79	73.37
14	-1.91	595.03	72.51	73.07	71.94	71.41	72.98
15	-2.01	620.16	73.08	73.68	72.48	71.91	73.50
16	-3.93	341.72	73.22	74.39	72.05	71.44	73.12
17	-4.89	338.12	74.98	76.43	73.52	72.81	74.64
18	-6.82	403.58	76.02	78.05	73.99	73.21	75.20
19	-7.79	479.19	77.97	80.29	75.65	75.65	76.72
20	-7.63	470.96	79.18	81.45	76.91	76.91	77.93
21	-6.32	378.60	79.39	81.27	77.51	77.51	78.59
22	-4.38	305.09	78.54	79.84	77.23	76.64	78.37
23	-2.29	464.60	77.00	77.69	76.32	75.80	77.39
24	-1.49	801.86	75.24	75.69	74.80	74.29	75.91
25	-1.26	930.21	74.51	74.89	74.14	73.60	75.18
26	-1.91	591.62	74.28	74.85	73.72	73.19	74.76
27	-2.01	616.92	74.83	75.43	74.23	73.67	75.25
28	-3.93	342.09	74.93	76.10	73.76	73.15	74.83
29	-4.89	339.49	76.65	78.10	75.19	74.48	76.31
30	-6.82	405.79	77.65	79.68	75.61	74.83	76.82
31	-7.80	481.91	79.55	81.87	77.23	77.23	78.30
32	-7.63	473.66	80.71	82.99	78.44	78.44	79.46
33	-6.33	380.76	80.88	82.76	79.00	79.00	80.08
34	-4.38	306.39	80.00	81.30	78.69	78.10	79.83
35	-2.29	463.46	78.44	79.13	77.76	77.24	78.83
36	-1.49	798.08	76.67	77.11	76.22	75.72	77.34
37	-1.26	925.43	75.92	76.30	75.54	75.00	76.59
38	-1.91	589.17	75.67	76.24	75.10	74.58	76.15
39	-2.01	614.61	76.19	76.79	75.60	75.03	76.62
40	-3.93	342.49	76.27	77.44	75.10	74.49	76.18
41	-4.89	340.66	77.96	79.42	76.51	75.80	77.63
42	-6.82	407.66	78.94	80.97	76.91	76.13	78.12
43	-7.80	484.24	80.83	83.15	78.51	78.51	79.58
44	-7.64	476.04	81.99	84.26	79.71	79.71	80.74

45	-6.33	382.70	82.15	84.04	80.27	80.27	81.35
46	-4.38	307.60	81.27	82.57	79.96	79.36	81.09
47	-2.29	462.59	79.70	80.38	79.02	78.49	80.09
48	-1.49	795.00	77.91	78.35	77.47	76.96	78.58
49	-1.26	921.55	77.14	77.51	76.76	76.22	77.81
50	-1.91	587.21	76.87	77.43	76.30	75.77	77.34
51	-2.01	612.79	77.36	77.96	76.76	76.20	77.79
52	-3.94	342.91	77.41	78.59	76.24	75.63	77.32
53	-4.89	341.73	79.08	80.54	77.62	76.92	78.74
54	-6.83	409.32	80.03	82.07	78.00	77.22	79.21
55	-7.81	486.28	81.90	84.23	79.58	79.58	80.65
56	-7.64	478.08	83.04	85.31	80.76	80.76	81.79
57	-6.33	384.33	83.18	85.07	81.29	81.29	82.38
58	-4.38	308.62	82.27	83.58	80.97	80.37	82.10
59	-2.29	461.98	80.69	81.37	80.01	79.48	81.08
60	-1.49	792.75	78.88	79.32	78.43	77.92	79.55
61	-1.26	918.68	78.09	78.46	77.71	77.17	78.76
62	-1.91	585.78	77.80	78.37	77.23	76.70	78.27
63	-2.01	611.45	78.28	78.88	77.68	77.11	78.70
64	-3.94	343.28	78.31	79.48	77.14	76.53	78.21
65	-4.90	342.61	79.96	81.42	78.51	77.80	79.63
66	-6.83	410.69	80.90	82.94	78.87	78.09	80.08
67	-7.81	487.96	82.76	85.08	80.43	80.43	81.50
68	-7.64	479.76	83.88	86.15	81.60	81.60	82.63
69	-6.34	385.69	84.01	85.89	82.12	82.12	83.21
70	-4.38	309.47	83.09	84.39	81.78	81.18	82.92
71	-2.29	461.55	81.49	82.17	80.81	80.28	81.88
72	-1.49	791.00	79.66	80.11	79.22	78.71	80.33
73	-1.26	916.44	78.86	79.24	78.49	77.95	79.53
74	-1.91	584.67	78.56	79.13	77.99	77.47	79.04
75	-2.01	610.41	79.03	79.63	78.43	77.86	79.45
76	-3.94	343.62	79.06	80.23	77.88	77.27	78.96
77	-4.90	343.39	80.70	82.16	79.24	78.54	80.37
78	-6.83	411.88	81.64	83.67	79.60	78.82	80.81
79	-7.81	489.44	83.49	85.82	81.16	81.16	82.24
80	-7.65	481.28	84.61	86.89	82.34	82.34	83.36
81	-6.34	386.93	84.75	86.63	82.86	82.86	83.95
82	-4.38	310.27	83.83	85.14	82.52	81.92	83.66
83	-2.29	461.19	82.24	82.92	81.55	81.02	82.62
84	-1.49	789.42	80.41	80.85	79.97	79.46	81.08
85	-1.26	914.38	79.60	79.98	79.23	78.69	80.28
86	-1.91	583.65	79.30	79.86	78.73	78.20	79.77
87	-2.01	609.47	79.76	80.36	79.16	78.59	80.18
88	-3.94	343.98	79.78	80.95	78.60	77.99	79.68
89	-4.90	344.15	81.41	82.87	79.95	79.25	81.08
90	-6.83	413.05	82.34	84.37	80.31	79.52	81.51
91	-7.81	490.88	84.18	86.51	81.86	81.86	82.93
92	-7.65	482.72	85.30	87.58	83.02	83.02	84.05
93	-6.34	388.10	85.43	87.31	83.54	83.54	84.62
94	-4.39	311.02	84.50	85.81	83.20	82.59	84.33
95	-2.29	460.90	82.90	83.58	82.22	81.69	83.29
96	-1.49	788.10	81.06	81.51	80.62	80.11	81.73
97	-1.26	912.65	80.25	80.62	79.87	79.33	80.92
98	-1.91	582.81	79.94	80.50	79.37	78.84	80.41
99	-2.01	608.69	80.39	80.99	79.79	79.22	80.82
100	-3.94	344.31	80.40	81.57	79.23	78.62	80.30
101	-4.90	344.84	82.03	83.49	80.57	79.87	81.70
102	-6.83	414.10	82.95	84.99	80.92	80.13	82.13
103	-7.82	492.17	84.79	87.12	82.47	82.47	83.54
104	-7.65	484.02	85.90	88.18	83.62	83.62	84.65
105	-6.34	389.14	86.02	87.91	84.13	84.13	85.22
106	-4.39	311.69	85.09	86.40	83.78	83.18	84.92
107	-2.29	460.67	83.48	84.17	82.80	82.27	83.87
108	-1.49	786.98	81.64	82.08	81.20	80.69	82.31
109	-1.26	911.18	80.82	81.20	80.45	79.90	81.50
110	-1.91	582.10	80.50	81.07	79.93	79.40	80.98
111	-2.01	608.03	80.95	81.55	80.35	79.78	81.38
112	-3.94	344.62	80.96	82.13	79.78	79.17	80.86
113	-4.90	345.47	82.58	84.04	81.12	80.41	82.25
114	-6.84	415.04	83.50	85.53	81.46	80.68	82.67
115	-7.82	493.33	85.33	87.66	83.01	83.01	84.08
116	-7.65	485.19	86.44	88.72	84.16	84.16	85.19
117	-6.34	390.09	86.55	88.44	84.66	84.66	85.75
118	-4.39	312.30	85.62	86.92	84.31	83.71	85.45
119	-2.29	460.49	84.00	84.69	83.32	82.79	84.39
120	-1.49	786.01	82.16	82.60	81.71	81.20	82.83
121	-1.26	909.91	81.33	81.71	80.96	80.41	82.01

122	-1.91	581.49	81.01	81.57	80.44	79.91	81.48
123	-2.02	607.47	81.45	82.05	80.85	80.29	81.88
124	-3.94	344.92	81.45	82.63	80.28	79.67	81.36
125	-4.90	346.05	83.08	84.54	81.62	80.91	82.74
126	-6.84	415.91	83.99	86.02	81.95	81.17	83.16
127	-7.82	494.40	85.82	88.15	83.49	83.49	84.56
128	-7.65	486.26	86.92	89.20	84.64	84.64	85.67
129	-6.35	390.95	87.03	88.92	85.14	85.14	86.23
130	-4.39	312.86	86.09	87.40	84.78	84.18	85.92
131	-2.29	460.35	84.47	85.16	83.79	83.26	84.86
132	-1.49	785.17	82.62	83.07	82.18	81.67	83.29
133	-1.26	908.79	81.79	82.17	81.42	80.88	82.47
134	-1.91	580.95	81.46	82.03	80.90	80.37	81.94
135	-2.02	606.98	81.91	82.51	81.31	80.74	82.33
136	-3.94	345.19	81.91	83.08	80.73	80.12	81.81
137	-4.90	346.58	83.53	84.99	82.06	81.36	83.19
138	-6.84	416.71	84.43	86.47	82.40	81.61	83.61
139	-7.82	495.38	86.26	88.59	83.93	83.93	85.01
140	-7.66	487.25	87.36	89.64	85.08	85.08	86.11
141	-6.35	391.75	87.47	89.36	85.58	85.58	86.66
142	-4.39	313.39	86.52	87.83	85.22	84.62	86.35
143	-2.29	460.23	84.90	85.59	84.22	83.69	85.29
144	-1.49	784.43	83.05	83.49	82.61	82.09	83.72
145	-1.26	907.80	82.22	82.59	81.84	81.30	82.89
146	-1.91	580.49	81.88	82.45	81.31	80.79	82.36
147	-2.02	606.55	82.32	82.92	81.72	81.16	82.75
148	-3.94	345.46	82.32	83.49	81.14	80.53	82.22
149	-4.91	347.08	83.94	85.40	82.47	81.77	83.60
150	-6.84	417.45	84.84	86.88	82.80	82.02	84.01
151	-7.82	496.29	86.66	88.99	84.34	84.34	85.41
152	-7.66	488.17	87.76	90.04	85.48	85.48	86.51
153	-6.35	392.49	87.86	89.75	85.97	85.97	87.06
154	-4.39	313.86	86.91	88.22	85.61	85.00	86.74
155	-2.29	460.14	85.29	85.97	84.60	84.07	85.67
156	-1.49	783.79	83.42	83.87	82.98	82.47	84.10
157	-1.26	906.95	82.59	82.96	82.21	81.67	83.26
158	-1.91	580.09	82.25	82.82	81.68	81.15	82.73
159	-2.02	606.19	82.69	83.29	82.09	81.52	83.11
160	-3.94	345.69	82.68	83.85	81.50	80.89	82.58
161	-4.91	347.52	84.29	85.75	82.83	82.12	83.96
162	-6.84	418.10	85.20	87.23	83.16	82.37	84.37
163	-7.82	497.10	87.02	89.35	84.69	84.69	85.76
164	-7.66	488.98	88.11	90.39	85.83	85.83	86.86
165	-6.35	393.15	88.21	90.10	86.32	86.32	87.41
166	-4.39	314.29	87.26	88.57	85.95	85.35	87.09
167	-2.29	460.06	85.63	86.31	84.95	84.42	86.02
168	-1.49	783.22	83.77	84.21	83.32	82.81	84.44
169	-1.26	906.19	82.93	83.30	82.55	82.01	83.60
170	-1.91	579.73	82.59	83.16	82.02	81.49	83.07
171	-2.02	605.87	83.02	83.62	82.42	81.85	83.45
172	-3.94	345.92	83.01	84.19	81.84	81.23	82.92
173	-4.91	347.94	84.63	86.09	83.16	82.46	84.29
174	-6.84	418.72	85.53	87.56	83.49	82.70	84.70
175	-7.82	497.86	87.35	89.68	85.02	85.02	86.09
176	-7.66	489.74	88.44	90.72	86.16	86.16	87.19
177	-6.35	393.76	88.54	90.43	86.65	86.65	87.73
178	-4.39	314.70	87.58	88.89	86.28	85.68	87.41
179	-2.29	460.00	85.95	86.64	85.27	84.74	86.34
180	-1.49	782.71	84.09	84.53	83.64	83.13	84.76
181	-1.26	905.50	83.24	83.62	82.87	82.33	83.92
182	-1.91	579.41	82.90	83.47	82.33	81.81	83.38
183	-2.02	605.58	83.33	83.93	82.73	82.17	83.76
184	-3.94	346.13	83.32	84.50	82.15	81.54	83.23
185	-4.91	348.33	84.94	86.40	83.47	82.77	84.60
186	-6.84	419.30	85.84	87.87	83.80	83.01	85.01
187	-7.83	498.57	87.65	89.98	85.32	85.32	86.40
188	-7.66	490.46	88.74	91.02	86.46	86.46	87.49
189	-6.35	394.34	88.84	90.73	86.95	86.95	88.04
190	-4.39	315.08	87.88	89.19	86.57	85.97	87.71
191	2.30	459.95	86.25	86.93	85.56	85.03	86.64
192	-1.49	782.26	84.38	84.82	83.94	83.42	85.05
193	-1.26	904.88	83.53	83.91	83.16	82.61	84.21
194	-1.91	579.13	83.19	83.76	82.62	82.09	83.67
195	-2.02	605.33	83.62	84.22	83.02	82.45	84.05
196	-3.95	346.33	83.61	84.78	82.43	81.82	83.51
197	-4.91	348.69	85.22	86.68	83.75	83.04	84.88
198	-6.84	419.83	86.11	88.15	84.08	83.29	85.29

199	-7.83	499.22	87.93	90.26	85.60	85.60	86.67
200	-7.66	491.11	89.02	91.30	86.74	86.74	87.77
201	-6.35	394.87	89.11	91.01	87.22	87.22	88.31
202	-4.39	315.43	88.16	89.46	86.85	86.25	87.99
203	-2.30	459.91	86.52	87.20	85.84	85.31	86.91
204	-1.49	781.85	84.65	85.09	84.21	83.69	85.32
205	-1.26	904.32	83.80	84.18	83.43	82.88	84.48
206	-1.91	578.88	83.46	84.02	82.89	82.36	83.93
207	-2.02	605.10	83.88	84.48	83.28	82.72	84.31
208	-3.95	346.52	83.87	85.04	82.70	82.08	83.77
209	-4.91	349.03	85.48	86.94	84.02	83.31	85.14
210	-6.85	420.33	86.38	88.41	84.34	83.55	85.55
211	-7.83	499.84	88.19	90.52	85.86	85.86	86.94
212	-7.66	491.73	89.28	91.56	87.00	87.00	88.03
213	-6.35	395.37	89.37	91.26	87.48	87.48	88.57
214	-4.39	315.76	88.41	89.72	87.11	86.50	88.24
215	-2.30	459.88	86.78	87.46	86.09	85.56	87.16
216	-1.49	781.47	84.90	85.35	84.46	83.95	85.58
217	-1.26	903.80	84.05	84.43	83.68	83.14	84.73
218	-1.91	578.64	83.71	84.28	83.14	82.61	84.19
219	-2.02	604.89	84.13	84.73	83.53	82.97	84.56
220	-3.95	346.71	84.12	85.29	82.94	82.33	84.02
221	-4.91	349.36	85.73	87.19	84.27	83.56	85.39
222	-6.85	420.80	86.62	88.66	84.58	83.80	85.80
223	-7.83	500.43	88.44	90.77	86.11	86.11	87.18
224	-7.66	492.33	89.52	91.81	87.24	87.24	88.27
225	-6.35	395.85	89.62	91.51	87.72	87.72	88.81
226	-4.40	316.08	88.66	89.97	87.35	86.75	88.49
227	-2.30	459.86	87.02	87.70	86.33	85.80	87.41
228	-1.49	781.12	85.14	85.59	84.70	84.19	85.82
229	-1.26	903.32	84.29	84.67	83.92	83.38	84.97
230	-1.91	578.42	83.95	84.51	83.38	82.85	84.42
231	-2.02	604.69	84.37	84.97	83.77	83.20	84.80
232	-3.95	346.88	84.35	85.53	83.18	82.57	84.26
233	-4.91	349.67	85.96	87.42	84.50	83.79	85.63
234	-6.85	421.25	86.85	88.89	84.82	84.03	86.03
235	-7.83	500.98	88.67	91.00	86.34	86.34	87.41
236	-7.67	492.87	89.75	92.03	87.47	87.47	88.50
237	-6.36	396.29	89.84	91.73	87.95	87.95	89.04
238	-4.40	316.37	88.87	90.18	87.56	86.96	88.70
239	-2.30	459.84	87.23	87.91	86.55	86.01	87.62
240	-1.49	780.82	85.35	85.79	84.91	84.40	86.02
241	-1.26	902.91	84.50	84.87	84.12	83.58	85.17
242	-1.91	578.24	84.15	84.72	83.58	83.05	84.63
243	-2.02	604.53	84.57	85.17	83.97	83.40	85.00
244	-3.95	347.03	84.55	85.73	83.38	82.77	84.46
245	-4.91	349.93	86.16	87.62	84.70	83.99	85.82
246	-6.85	421.64	87.05	89.09	85.01	84.23	86.23
247	-7.83	501.45	88.87	91.20	86.53	86.53	87.61
248	-7.67	493.35	89.95	92.23	87.66	87.66	88.69
249	-6.36	396.68	90.03	91.93	88.14	88.14	89.23
250	-4.40	316.63	89.07	90.38	87.76	87.16	88.90
251	-2.30	459.82	87.42	88.11	86.74	86.21	87.81
252	-1.49	780.55	85.54	85.99	85.10	84.59	86.22
253	-1.26	902.54	84.69	85.07	84.32	83.77	85.37
254	-1.91	578.08	84.34	84.91	83.77	83.24	84.82
255	-2.02	604.38	84.76	85.36	84.16	83.60	85.19
256	-3.95	347.18	84.75	85.92	83.57	82.96	84.65
257	-4.91	350.18	86.35	87.81	84.89	84.18	86.01
258	-6.85	422.01	87.24	89.28	85.20	84.42	86.42
259	-7.83	501.91	89.05	91.39	86.72	86.72	87.80
260	-7.67	493.81	90.13	92.42	87.85	87.85	88.88
261	-6.36	397.05	90.22	92.11	88.33	88.33	89.42
262	-4.40	316.88	89.26	90.56	87.95	87.34	89.08
263	-2.30	459.81	87.61	88.29	86.93	86.39	88.00
264	-1.49	780.29	85.73	86.17	85.29	84.77	86.40
265	-1.26	902.18	84.87	85.25	84.50	83.96	85.55
266	-1.91	577.92	84.52	85.09	83.95	83.43	85.00
267	-2.02	604.25	84.95	85.55	84.35	83.78	85.37
268	-3.95	347.32	84.93	86.10	83.75	83.14	84.83
269	-4.91	350.43	86.53	87.99	85.07	84.36	86.20
270	-6.85	422.37	87.42	89.46	85.38	84.60	86.60
271	-7.83	502.35	89.23	91.57	86.90	86.90	87.98
272	-7.67	494.26	90.31	92.60	88.03	88.03	89.06
273	-6.36	397.41	90.40	92.29	88.51	88.51	89.60
274	-4.40	317.11	89.43	90.74	88.12	87.52	89.26
275	-2.30	459.80	87.79	88.47	87.10	86.57	88.18

276	-1.49	780.06	85.91	86.35	85.46	84.95	86.58
277	-1.26	901.85	85.05	85.42	84.67	84.13	85.73
278	-1.91	577.77	84.70	85.27	84.13	83.60	85.18
279	-2.02	604.12	85.12	85.72	84.52	83.95	85.55
280	-3.95	347.46	85.10	86.28	83.93	83.31	85.00
281	-4.91	350.66	86.70	88.17	85.24	84.53	86.37
282	-6.85	422.71	87.60	89.64	85.56	84.77	86.77
283	-7.83	502.77	89.41	91.74	87.07	87.07	88.15
284	-7.67	494.64	90.49	92.77	88.20	88.20	89.23
285	-6.36	397.75	90.57	92.46	88.68	88.68	89.77
286	-4.40	317.35	89.60	90.91	88.29	87.69	89.43
287	-2.30	459.79	87.96	88.64	87.27	86.74	88.35
288	-1.49	779.83	86.07	86.52	85.63	85.12	86.75
289	-1.26	901.54	85.22	85.59	84.84	84.30	85.90
290	-1.91	577.64	84.87	85.43	84.30	83.77	85.34
291	-2.02	604.00	85.29	85.89	84.69	84.12	85.72
292	-3.95	347.59	85.27	86.44	84.09	83.48	85.17
293	-4.91	350.89	86.87	88.33	85.41	84.70	86.53
294	-6.85	423.05	87.76	89.80	85.72	84.93	86.93
295	-7.83	503.18	89.57	91.90	87.24	87.24	88.31
296	-7.67	495.04	90.65	92.93	88.37	88.37	89.40
297	-6.36	398.08	90.74	92.63	88.84	88.84	89.93
298	-4.40	317.57	89.77	91.08	88.46	87.85	89.59
299	-2.30	459.79	88.12	88.80	87.43	86.90	88.51
300	-1.49	779.62	86.23	86.68	85.79	85.28	86.91

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