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NATIONAL ORANGE SHOW FACILITIES
FEASIBILITY STUDY
SAN BERNARDINO, CALIFORNIA

November 1981

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A
GEOTHERMAL RETROFIT STUDY
FOR THE
NATIONAL ORANGE SHOW FACILITIES
IN
SAN BERNARDINO, CALIFORNIA

PREPARED FOR
FOR
OREGON INSTITUTE OF TECHNOLOGY
IN
KLAMATH FALLS, OREGON

BY
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NOVEMBER 17, 1981

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SUMMARY

The purpose of this study was to determine the cost and feasibility of retrofitting the National Orange Show Facilities to use geothermal heat instead of natural gas for heating. Because of the limited usage of the smaller facilities the study was limited to the conversion of the six major buildings: Domed, Hobby, Citrus, Auditorium, Restaurant and Commercial.

There were several basic problems associated with trying to develop a cost effective design. A major problem is that most of the buildings are used on a very limited bases. This drastically reduced the amount of savings that could be used to amortize the retrofit cost. Another problem is that the buildings are spread over a large area and so the below grade piping costs were high. Finally, all of the buildings except for the Auditorium have direct gas fired heaters that would require all new terminal heating systems.

In order to limit the retrofit cost, the retrofit system was designed to handle less than the peak load. This seemed appropriate because the facility might not even be in operation when a peak load condition occurred. Also, the existing systems could be used to supplement the geothermal system if necessary. The following summary shows the calculated and design peak loads:

HEATING LOADS

<u>BUILDING</u>	<u>CALCULATED PEAK LOAD</u>	<u>RETROFIT DESIGN PEAK LOAD</u>
	BTUH	BTUH
DOMED	449,000	300,000
HOBBY	1,676,000	1,200,000
CITRUS	1,261,000	900,000
AUDITORIUM	1,193,000	900,000
RESTAURANT	1,116,000	800,000
COMMERCIAL	<u>2,013,000</u>	<u>1,500,000</u>
TOTAL	7,708,000	5,600,000

Because of the high ceilings, a downdraft type of revolving fan/coil unit was used in the Domed, Hobby, and Commercial buildings. Horizontal blow fan/coil unit heaters were used in the Citrus Building. Hot water coils were installed in the existing Restaurant systems to replace the existing duct heaters. The Auditorium has an existing hot water heating system and only required a connection to the existing hot water distribution system.

Cost of the proposed retrofit is as follows:

System 1 - - - - -	\$171,500
Domed, Hobby & Citrus	
System 2 - - - - -	\$143,200
Auditorium, Restaurant & Commercial	
TOTAL	<u>\$314,700</u>

Based on a 20 year study period the present value of the anticipated savings was \$186,000. This did not compare favorably with the \$314,000 cost of the retrofit. If just the Restaurant were retrofitted, a retrofit cost of \$45,500 would result in a present value savings of \$52,000. As a demonstration project the Restaurant retrofit would appear to be very promising.

	<u>Page</u>
I. INTRODUCTION	1-1
II. FACILITIES STUDY	2-1
GENERAL	2-1
BUILDING DESCRIPTIONS	2-3
General	2-3
Domed Building	2-3
Hobby Building	2-6
Citrus Building	2-7
Auditorium	2-8
Restaurant	2-9
Commercial Building	2-10
HEATING REQUIREMENTS	2-11
General	2-11
Gas Usage	2-11
Peak Heating Loads	2-13
III. PRELIMINARY DESIGN	3-1
GENERAL	3-1
SYSTEM DESIGN	3-2
General	3-2
Sequence of Operation	3-3
EQUIPMENT AND MATERIALS SELECTION	3-8
Heat Exchangers	3-8
Pipe	3-8
Terminal Heating Units	3-8
Pumps	3-9

IV. ECONOMIC STUDY	4-1
GENERAL	4-1
RETROFIT COST	4-1
NET OPERATING AND MAINTENANCE COSTS	4-2
Gas Versus Geothermal Costs	4-2
Electrical and Maintenance Costs	4-3
V. CONCLUSIONS AND RECOMMENDATIONS	5-1
VI. APPENDIX A - Facility Usage	
APPENDIX B - Weather Data & Heating Calculations	
APPENDIX C - Gas Usage	
APPENDIX D - Economic Calculations	

LIST OF FIGURES

	<u>Page</u>
2-1 Site Map	2-2
2-2 Building Configurations	2-4
2-3 Building Usage	2-5
2-4 Gas Usage By Building	2-12
3-1 Routing of Below Grade Piping	3-4
3-2 Mill Street System Schematic	3-5
3-3 Arrowhead Avenue System Schematic	3-7
3-4 Downdraft Rotating Heater	3-10

LIST OF TABLE

	<u>Page</u>
2-1 Heating Loads	2-14

INTRODUCTION

The purpose of this study was to determine the cost and feasibility of retrofitting the National Orange Show Facilities to use geothermal heat instead of natural gas. This study is a part of a much larger geothermal study involving the development of a heating district for a number of facilities in the area around the National Orange Show site.

In order to determine the probable quantity of geothermal water required for this facility the various buildings on the site were studied to determine their individual requirements. This portion of the study is discussed in Chapter 2, "Facilities Study." Chapter 3, "Preliminary Design" describes the various design considerations and costs as well as the reasons for the design selected. The economics of the project are discussed in Chapter 4 with the final conclusions and recommendations being presented in Chapter 5.

During the course of this study an unexpected problem arose when an airplane crashed into the Auditorium Building and severely damaged the building. The final status of the Auditorium has not yet been determined, so for the purpose of this study the Auditorium was assumed to be repairable or would be replaced. It was also assumed that in either case heating would be provided by a hot water system.

FACILITIES STUDY

GENERAL

The facilities located on the National Orange Show grounds are fairly typical of a large county fairground. These facilities consist of the following buildings: Domed, Hobby Citrus, Swing Auditorium, Restaurant, Commercial, Art Gallery and Administration. In addition there are the North and South Stands for the Stadium, restroom buildings and storage sheds. The location of the various elements can be seen in the site plan of Figure 2-1.

Because of the cost of retrofitting the buildings for geothermal heat the small buildings and those with small loads were not included in the analysis. The buildings that were not evaluated for the geothermal retrofit were: Stadium Stands, Administration, Art Gallery and restrooms.

Two site visits were made to gather information on the facilities and their usage. Inspection of the facilities along with the review of available drawings provided the data for establishing peak heating loads and annual gas consumption. The actual grounds and the surrounding area were also inspected to try and determine the most appropriate routing for the hot water lines.

NATIONAL ORANGE SHOW

Figure 2-1

BUILDING DESCRIPTIONS

General

A brief description of the physical characteristics and usage for each building is contained in this section.

Figure 2-2 provides a convenient reference for the size and shape of each of the buildings being evaluated. In addition, the bar graph contained in Figure 2-3 shows the hours of usage for each facility on a monthly basis. The usage data was obtained from the monthly events calendar published by the Orange Show. Actual usage will vary from year to year depending on the actual events that are booked.

Domed Building

Area of this building is approximately 12,000 ft² and it is 122 feet in diameter and 38 feet high. The perimeter wall is five feet high and constructed of concrete block. The roof is a geodetic dome type of structure constructed of aluminum and has about one inch of cellulose insulation sprayed on the inside surface. Around the bottom edge of the roof there are translucent fiberglass panels in place of the aluminum panels. An opening in the top of the dome is open to the outside. The floor of the structure is concrete.

The Domed Building is used mainly for wedding receptions and small shows such as the antique doll show. Occasionally dances and various meetings are held in the building. It is most frequently used on Saturdays starting in the day time and con-

AREA = 11,844 ft²

DOME BUILDING

AREA = 42,900 ft²

HOBBY SHOW

AREA = 24,480 ft²

CITRUS BUILDING

AREA = 41,520 ft²

COMMERCIAL BUILDING

AREA = 10,614 ft²

LARGE DINING ROOM

AREA = 3,264 ft²

SMALL DINING ROOM

AREA = 43,200 ft²

AUDITORIUM

BUILDING CONFIGURATIONS

FIGURE 2-2

BUILDING USAGE

HRS./MO.

HOURS
PER
MONTH

2-5

FIGURE 2-3

tinuing into the evening hours. Except for the eleven days of the Orange Show it is typically used about once a week. Total usage during the heating season was estimated at 245 hours.

Heating is accomplished by four gas furnaces spaced around the perimeter of the building. The heating system uses all outside air. Cooling is accomplished with four split systems. The fan/coil units are inside the building near the discharge grilles for the furnaces. No outside air is supplied to the fan/coil units. Each of the four furnaces is rated at 245,000 BTUH output for a total of 980,000 BTUH.

Hobby Building

Area of this building is approximately 42,900 ft² and it is 143 feet wide, 300 feet long and 39 feet tall. The building is a quonset type structure with a bare metal roof and a ridge ventilator that is open to the outside. The walls are also metal, but have a ten foot high interior facing of $\frac{1}{4}$ " thick wood paneling around the entire perimeter of the building. The floor is concrete and the building is not insulated.

The Hobby Building is used for exhibits only during the Orange Show and has a total heating season usage estimated at 132 hours.

Heating is accomplished with gas space heaters and radiant heat-

ers supported from the ceiling. Heating is normally provided by the space heaters with the radiant heaters being used only in very cold weather. Equipment ratings are as follows:

10 - unit heaters, 200,000 BTUH output.

2 - unit heaters, 20,000 BTUH output.

16 - radiant heaters, 50,000 BTUH output.

Total output 2,840,000 BTUH.

No cooling is provided for the building.

Citrus Building

Area of this building is 24,480 ft² and it is 180 feet long, 136 feet wide and 44 feet tall. The building is a quonset type structure with ten foot high metal siding walls and a roof with a suspended ceiling of acoustic tile. Although the walls are not insulated, about one half of the walls are covered with 1/4" plywood. The floor is concrete.

The Citrus building is used for receptions and dances which sometimes require only one half of the building. It is also used for various shows and sales including gun shows, energy shows, ski-wear sales and stereo sales. Except for the dances most of these events usually begin in the day time and end in the early evening hours. The Citrus Building is typically used about once a week and has a total heating season usage estimated at 480 hours.

Heating is basically accomplished with six gas space heaters located along the side of the room. Equipment ratings are as follows:

4 - unit heaters, 100,000 BTUH output.

2 - unit heaters, 400,000 BTUH output.

Total Output 1,200,000 BTUH.

Originally the four, 100,000 BTUH heaters were installed and found to be inadequate. The two 400,000 BTUH heaters were added later. A gas radiant heater is located at the west entrance. Cooling in the building is provided by evaporative coolers.

Auditorium

The area of the building is 43,200 ft², and it is 180 feet wide, 240 feet long, and 68 feet tall. The building is a metal frame structure with an open ridge metal roof and metal siding. Insulation consists of 1" urethane on the roof and fiberglass batts attached to the inside of the walls. The floor is concrete.

The Auditorium is used for various concerts, shows and closed circuit television events. It is sometimes used during the week, but the events largely occur during the weekend and in the evening hours. The building was badly damaged by an airplane crash during the course of this study and its future has not been resolved.

Heating is accomplished by a boiler using hot water and 23 hot water unit heaters spaced around the perimeter. The boiler is rated at 2,400,000 BTUH output, cooling is provided by evaporative cooling units.

Restaurant

The Restaurant has a large dining room and small dining room. The area of the large dining room is 10,614 ft². It is 58 feet wide, 183 feet long, and 18 feet high. The area of the small dining room is 3264 ft², it is 51 feet wide, 64 feet long, and 18 feet high. Both the large dining room and small dining room are structurally very similar with the main difference being that the large dining room has a stage at one end. The rooms are essentially metal siding with a covering of wall board or acoustic tile. A 30 inch high concrete wall is located beneath the large window areas in the dining rooms. Ceilings in both rooms consist of plaster with an acoustical tile covering. The floors are concrete and the large dining room is carpeted. Vinyl tile covers the floor in the small dining room.

Heating is accomplished by duct furnaces. Each dining room has its own air handler. Air conditioning is also provided and the coils are in the ducts downstream of the duct heaters. The small dining room operates on all outside air. Heating season usage is estimated to be 855 hours.

Commerical Building

The area of this building is 41,520 ft². It is 173 feet wide, 240 feet long, and 40 feet tall. The building is a quonset type structure of metal construction with 17 feet high side walls consisting of 10 feet of cement block and 7 feet of sheet metal. There is no insulation in the building and it has a concrete floor. A ridge ventilator runs the length of the building.

The Commercial Building is used mainly for shows and sales that take place sporadically during the year. The events include gun shows, motorcycle shows, leather sales, and swap meets. Lengths of the events vary from one evening up to two weeks. Because of a large show the December usage was very high.

Heating is accomplished with twelve small gas unit heaters. These heaters are suspended from the roof along both sides of the building. No cooling is provided for the building.

HEATING REQUIREMENTS

General

Prior to developing a design or performing an economic analysis, it was necessary to determine the anticipated gas usage for each building as well as the peak heating load. After the initial investigation of all of the buildings it was decided that only the six main buildings would be evaluated for the geothermal retrofit. The remaining structures had minimal usage. There is also some gas usage by portable booths during certain events but this use also seemed to be small enough to ignore. For purposes of this study all of the gas usage was assigned to the six main buildings - Domed, Hobby, Citrus, Auditorium, Restaurant and Commercial.

Gas Usage

The gas usage of the facility was obtained from the utility bills. Both the Restaurant and the Commercial Building have submetering and the monthly gas usage was obtained from the records that are maintained by the Orange Show personnel. With this information the remaining usage was assigned to the other four building. The calculations are located in Appendix C and a chart of the monthly gas usage is contained in Figure 2-4.

GAS USAGE BY BUILDING

FIGURE 2-4

Peak Heating Loads

Based on weather data and the type of construction the peak design loads were determined for each building. Since all of the buildings already have existing heating systems, there seemed to be no need to design for the few really cold hours that occur during a year. First, because the buildings are used only intermittantly, they may not even be in operation when the unusually cold period occurs. Secondly, if necessary the existing gas systems could supplement the geothermal heat.

The one exception was the coils for the Restaurant. Since the coils would be installed in place of the existing duct heaters they would have to be designed for the peak load. Calculations for the peak heating loads are contained in Appendix C and a summary of the results is located in Table 2-1.

TABLE 2-1

HEATING LOADS

<u>BUILDING</u>	<u>CALCULATED PEAK LOAD</u> BTUH	<u>RETROFIT DESIGN PEAK LOAD</u> BTUH
DOMED	449,000	300,000
HOBBY	1,676,000	1,200,000
CITRUS	1,261,000	900,000
AUDITORIUM	1,193,000	900,000
RESTAURANT	1,116,000	800,000
COMMERCIAL	<u>2,013,000</u>	<u>1,500,000</u>
TOTAL	7,708,000	5,600,000

PRELIMINARY DESIGN

GENERAL

Retrofitting the facilities at the National Orange Show so that they could be heated with geothermal fluids presented several problems. One of the most significant problems was the lack of information regarding the geothermal source. The existing well is producing water at a temperature of 145°F. This water is a mixture flowing from various producing layers and contains both hot and cold water. While it does insure that the water will be at least 145°F, the dilution problem prevents the accurate assessment of the actual temperature and mineral content of the final water source to be used when a new well is drilled.

The other problems dealt with the facility itself. Because of the size of the grounds, the buildings are spread over a large area. This requires extensive underground piping runs. Also, except for the Auditorium the existing systems are gas fired which requires that all new terminal heating equipment be installed. An additional problem is the limited usage of the facilities. The limited gas usage relative to the peak load requirements makes it difficult to design a cost effective system.

Still another problem was the disposal of the geothermal fluids. Generally the spent fluids are returned to the producing zone through an injection well. Again, because of the limited usage it would be difficult to justify the expense.

As a result, it was decided to return the used fluid to the geothermal main. The small reduction in temperature that would normally occur should not create any significant problem downstream. This is certainly true for the line going along Arrowhead Avenue. The main going along Mill Street could have a problem on weekends. If the college had only a minimal load and the Orange Show had a large load connected to the Mill Street main, a substantial drop in temperature would be experienced by the geothermal fluids going to the college. Prior to starting on the final design, this problem should be reviewed. If it appears to be a problem at the time, the discharge line for the geothermal fluid will have to be connected to the Arrowhead Avenue main.

SYSTEM DESIGN

General

A number of different approaches were investigated. It was finally decided to group the building into two groups as

shown in Figure 3-1. This would allow the Dome, Hobby and Citrus building to be supplied through a geothermal connection on Mill Street and the Auditorium, Commercial and Restaurant buildings to be supplied from Arrowhead Avenue.

A schematic of the Mill Street system is contained in Figure 3-2 and the Arrowhead Avenue system in Figure 3-3. Special emphasis was given to reducing the system cost since operating hours were relatively short. Because of the summer time need for hot water for the restaurant, provisions were included to preheat the domestic hot water.

Sequence of Operation

The Mill Street schematic is shown in Figure 3-2 and the sequence of operations is as follows:

1. If any building calls for heating, pump (P7) will start.
2. If the Domed Bldg. is calling for heat, pump (P12) will start.*
3. If either the Hobby or Citrus Building calls for heat, pump (P9) will start as well as pump(s) (P10) and/or (P11).
4. Two stage thermostats will be used and if pump (P7) cannot provide sufficient heating it will stop and pump (P8) will start.

NATIONAL ORANGE SHOW

Figure 3-1

MILL STREET SYSTEM SCHEMATIC

FIGURE 3-2

5. As long as the buildings are in the heating mode the pumps will operate continuously and three-way valves will be used to control temperature.
6. When no further heating is required all pumps will stop.
*If only the Domed Building is operating, pump (P9) will not be required because at the reduced flow rate through the heat exchanger the pressure drop will be less than 1 psi.

The Arrowhead Avenue schematic is shown in Figure 3-3 and the sequence of operations is as follows:

1. If the temperature of the preheat tank drops to 135°F, pumps (P4) and (P2) will start.
2. When the temperature in the preheat tank reaches 145°F the pumps will stop.
3. If either dining room requires heating, both pumps (P2) and (P3) will start.
4. If either the Auditorium or the Commercial building require heating, pumps (P1) and (P5) will start. Pump (P2) will stop if it was operating.
5. Pumps (P6) and/or (P13) will start if their respective building is in a heating mode.
6. As long as the buildings are in a heating mode the appropriate pumps will operate continuously and three-way valves will be used to control space temperature.

ARROWHEAD AVENUE SYSTEM SCHEMATIC

FIGURE 3-3

7. When no further heating is required all pumps will stop.

EQUIPMENT AND MATERIALS SELECTION

Heat Exchangers

Plate heat exchangers were used because of their corrosion resistance, ease of cleaning, good heat transfer characteristics and lower cost. Because of these characteristics plate heat exchangers have almost become the standard for geothermal applications.

Pipe

All piping below grade will be preinsulated fiber glass reinforced plastic. Above grade the piping should be steel in order to provide the necessary durability. The steel piping used on the geothermal side of the system shall be Fusecoated to prevent corrosion. All of the steel pipe shall be insulated and suitably jacketed where specified.

Terminal Heating Units

The only building having a hot water system is the Auditorium. The existing fan/coil units would remain and the new hot water distribution system would simply by-pass the existing boiler.

Both air handler systems in the Restaurant would be fitted with hot water coils in place of the existing duct furnaces.

Because of the high roofs and the large areas of coverage, revolving unit heaters would be used in the Domed, Hobby and Commercial Buildings. These downdraft type of heaters would help to reduce the normal stratification that occurs with high ceilings. An example of this heater is shown in Figure 3-4.

The Citrus Building has a relatively low, finished ceiling (23 ft). This made the revolving unit heaters less attractive. Instead hot water unit heaters were placed in each corner of the room and the middle of each side.

Pumps

Because of the limited operating time per year the pump life should be extended. The type of pumps selected for this project are units designed for domestic hot water service. They operate at 3600 RPM, are bronze fitted and have mechanical seals.

high level circulators

WINTER OPERATION

Heat from radiators, floor type heaters, horizontal discharge unit heaters or by many plant processes, often is lost in the truss area and through the roof and upper walls.

Wing High Level Circulators draw in this hot air and distribute it downward to the floor in constantly changing directions. Large areas are covered with comfortable warmth. Machines, columns or stacked material cannot block the air flow. Air at the working level is kept gently on the move so no hot or cold spots can develop.

II. SUMMER/WINTER OPERATION

This arrangement will enable HLC's to serve a dual purpose. The prime function is to deliver warm re-circulated air for space heating during the winter. In the summer the unit will distribute fresh, unheated outside air (filtered if required) to working areas utilizing highly effective Wing Revolving Discharges.

Summer ventilation is provided by incorporating a fresh air intake with a motorized damper as well as a mixing box with motorized recirculating dampers. The dampers are operated by a summer-winter switch.

The Wing Fan delivers air efficiently at high velocities against high static pressures. An optional fan safety guard can be supplied when required.

The motor is mounted above the fan to prevent fouling by dirt and interference with the entering air.

DOWNDRAFT ROTATING HEATER

FIGURE 3-4

ECONOMIC STUDY

GENERAL

The purpose of the economic study was to determine the economic impact of converting the Orange Show facilities from gas to geothermal energy. In the design portion of this report the problem of developing a cost effective system was discussed. The limited hours of operation were cited as a major problem.

RETROFIT COST

Every effort was made to make the design as inexpensive as possible in keeping with a moderate level of operating and maintenance costs. The detailed cost estimate is contained in Appendix D. Although the estimates are somewhat rough their accuracy is felt to be adequate for the level of overall information available. The estimated costs are as follows:

System 1 - Includes the Domed, Hobby and Citrus Buildings.	\$171,500
System 2 - Includes the Auditorium, Restaurant and Commercial Buildings,	\$143,200
Total Retrofit Cost	<u>\$314,700</u>

Because of the relatively high number of hours of operation the Restaurant was believed to have the best chance of recovering the cost of the geothermal retrofit. The cost of the Restaurant retrofit is \$45,500. This included large enough piping to allow the addition of the Auditorium and Commercial Building at a later date.

The main expense was the below grade piping that amounts to approximately 34% of the total cost.

NET OPERATING AND MAINTENANCE COSTS

Gas Versus Geothermal Cost

Future energy costs were based on the data obtained from the California Energy Commission Staff Report entitled, "California Energy Prices 1980-2000." During the past year the Orange Show facility used approximately 40,000 therms. Not all of the gas usage can be replaced with geotherm heat. It is not practical to retrofit some of the small buildings and isolated uses. Also the kitchen in the Restaurant will continue to use gas for food preparation and some water heating. Based on our investigation it was estimated the 80% of the gas could be replaced with geothermal heat.

The cost of geothermal therms has not been determined since not even the temperature of the fluid is known at this time. Based on discussions with the San Bernardino Water Department the cost of geothermal therms was estimated to be 80% of the cost of a gas therm.

Another factor is that the geothermal therms are directly attributable to the load whereas the gas therms are only 75% assignable to the heating process because of combustion and stand-by losses.

Calculations for the savings in energy cost achieved by converting to geothermal are contained in Appendix D. These calculations were based on a twenty year period starting in 1983. Present values were computed using a 10% discount factor. The present value of the savings would be \$186,000. This does not compare favorably with the retrofit cost of \$314,000. Savings for the Restaurant alone were \$52,000. This does compare favorably with the \$45,500 cost of the required retrofit. This retrofit cost could be lowered even more if no provisions were to be made for future expansion and if the relatively small discharge could be routed into Warm Creek.

Electrical and Maintenance Costs

Because of the gross assumptions that had to be made in the economic analysis, the additional refinement resulting from the estimation of the electrical energy and maintenance costs did not seem justified at this time.

CONCLUSIONS AND RECOMMENDATIONS

The conclusion comes as no surprise as it was recognized as a major problem during the design phase. The limited hours of usage and the high cost of retrofitting prevents the energy savings from justifying the change. As previously stated, the fact that most of the buildings have gas heating units rather than hot water and the long pipe runs make the retrofit cost quite high. A \$374,000 retrofit would only provide a present value savings of \$186,000 based on a twenty year period.

If a demonstration program were desired, the best option would be to retrofit only the Restaurant. It is used quite frequently, has a domestic hot water load and would be relatively close to the geothermal main along Arrowhead Avenue. A retrofit cost of \$45,500 should result in a present value savings of approximately \$52,000. The cost of the retrofit could be reduced somewhat more depending on the final design criteria.

APPENDIX B

WEATHER DATA & HEATING CALCULATIONS

NORTON AFB/SAN BERNARDINO CALIFORNIA

Tempera- ture Range	NOVEMBER					DECEMBER					JANUARY					FEBRUARY					MARCH					APRIL					ANNUAL TOTAL										
	Obsn Hour Co			Total Obsn	R C W B	Obsn Hour Co			Total Obsn	R C W B	Obsn Hour Co			Total Obsn	R C W B	Obsn Hour Co			Total Obsn	R C W B	Obsn Hour Co			Total Obsn	R C W B	Obsn Hour Co			Total Obsn	R C W B											
	01	09	17			01	09	17			01	09	17			01	09	17			01	09	17			01	09	17			01	09	17								
	10	16	24			10	16	24			10	16	24			10	16	24			10	16	24			10	16	24			10	16	24								
110/114																															0	0	0	69							
105/109																															10	0	10	70							
100/104																															51	2	53	69							
95/99																		0		0	63			2		2	65			168	14	182	68								
90/94		2		2	59							0		0	66		0		0	62			0		0	61		7	1	8	60	0	247	52	299	66					
85/89	0	5	0	5	58		0		0	56		1		1	62		2		2	59			3	0	3	58		18	2	20	59	2	249	102	353	65					
80/84	0	15	1	16	57		3	C	3	55		5	0	5	57		6	1	7	57			11	1	12	56		0	24	6	30	58	11	260	152	423	63				
75/79	0	28	3	31	55		11	C	11	53		1	12	2	15	54		14	2	16	54			21	4	25	55		0	28	11	39	57	44	285	212	541	61			
70/74	0	35	8	43	53		28	1	29	51		0	21	3	24	52		24	6	30	53			35	9	44	54		2	30	16	48	56	116	321	291	728	59			
65/69	1	45	16	62	52		0	38	6	44	50		0	32	7	39	50		0	26	11	47	51		1	36	17	54	52		4	34	24	62	54	241	349	334	924	57	
60/64	6	52	34	92	51		1	44	14	59	49		2	45	17	64	49		3	46	26	75	50		3	49	29	81	51		7	35	36	78	53	374	366	404	1144	54	
55/59	31	37	59	127	50		7	53	32	93	48		7	55	33	95	47		15	47	49	111	50		10	49	56	115	49		41	35	59	135	51	514	315	449	1278	51	
50/54	58	17	64	139	47		24	42	59	125	45		29	45	59	133	46		49	34	62	145	47		67	34	77	178	47		75	22	54	151	48	520	202	425	1147	47	
45/49	67	3	37	107	42		50	19	68	137	42		51	23	58	132	42		55	12	43	110	43		80	7	37	124	44		67	6	24	97	44	444	72	276	792	43	
40/44	51	1	15	67	38		76	8	45	129	38		60	8	41	109	37		57	2	18	77	39		60	1	14	75	39		35	1	7	43	40	354	21	142	517	38	
35/39	22	0	3	25	34		63	1	18	82	34		54	1	20	75	34		32	0	5	37	34		22		2	24	35		9		0	9	36	203	2	48	253	34	
30/34	4	0	1	5	30		23	0	3	26	29		37	0	7	44	29		12		1	13	30		5		0	5	30		0		0	33	82	0	12	94	29		
25/29	0			0	25		3		0	3	26		7		0	7	25		1		0	1	25		0			0	26								11		0	11	25
20/24							0		0	23			0		0	19																			0		0	22			

STATE				WINTER DESIGN DATA HEATING				DEGREE DAYS	SUMMER DESIGN DATA AIR CONDITIONING										SUMMER CRITERIA DATA AIR CONDITIONING				
	LOCATION			Dry Bulb					Dry Bulb							Wet Bulb			Dry Bulb		Wet Bulb		
	Station	Lat	Long	Elev	99%	97.5%	Prvg Wind		Mean Speed	Heating	1% MCWB	Mean Daily Range			Prvg Wind	5% MCWB	1%	2.5%	5%	≥ 93°F	≥ 80°F	≥ 73°F	≥ 67°F
												°	°	°									
			feet	°	°	dir	knots	annual	°	°	°	°	°	dir	°	°	°	°	°	hrs	hrs	hrs	hrs
CALIFORNIA (CONT)			N	W																			
Imperial Beach NF/Ream Fld			32 34	117 07	23	40	41	E	6	1839	78 70	76 69	10	W	74 68	71 70	69	4	34	6	426		
Klamath AFS			41 34	124 05	804	31	33	E	5	4445	68 60	65 59	15	NW	63 58	62 60	59	0	3	0	1		
Kramer			34 55	117 55	2315	20	22	WNW	3	3077	104 67	102 67	35	WSW	99 66	70 69	67	504	1505	6	216		
Lemoore NAS/Reeves Field			36 20	119 57	237	25	28	W	3	2579	105 71	102 70	37	NNE	100 69	73 71	70	519	1577	40	555		
Letterman Army Hospital			37 48	122 27	20	38	40	W	5	3080	74 63	71 62	12	W	69 61	64 62	61	0	12	0	8		
Livermore			37 42	121 57	500	24	27	WNW	4	3035	100 69	97 68	35	NW	93 67	71 70	68	169	863	8	318		
Long Beach			33 45	118 14	12	41	43	E	4	1819	83 68	80 68	15	WSW	77 67	70 69	68	7	99	3	291		
Long Beach/Daugherty Field			33 49	118 09	30	38	40	NW	4	1606	89 69	85 69	23	WNW	82 68	71 70	69	19	299	12	438		
Los Alamitos NAS			33 47	118 03	35	37	39	NE	4	1482	89 69	85 68	23	SW	82 68	71 70	69	20	288	13	475		
Los Angeles City Office			34 03	118 14	270	37	40	NW	4	1245	93 70	89 70	19	NW	86 69	72 71	70	38	581	23	586		
Los Angeles IAP			33 56	118 24	97	41	43	E	4	1819	83 68	80 68	15	WSW	77 67	70 69	68	7	99	3	291		
March AFB/Riverside			33 53	117 15	1533	29	32	N	4	2162	100 68	98 68	34	NW	95 67	72 71	70	269	1132	23	431		
Mare Island NAVSHIPYD			38 05	122 16	25	30	32	N	4	3311	89 68	84 66	33	SE	80 65	72 69	67	10	184	22	171		
Mather AFB/Sacramento			38 34	121 18	96	29	31	ESE	4	2600	101 69	98 69	35	W	96 68	71 70	69	259	1052	12	376		
McClellan AFB/Sacramento			38 40	121 24	76	29	31	NNW	4	2566	102 70	99 69	35	SW	96 68	72 70	69	299	1124	16	413		
McPherson Peak			34 53	119 48	5763	19	22	N	18	5200	89 59	86 59	18	S	84 58	63 61	60	3	345	0	0		
Merced use Castle AFB																							
Mill Valley AFS			37 55	122 35	2600	26	28	N	5	3400	97 65	94 65	40	W	91 64	68 67	65	107	701	3	72		
Miramar NAS/Mitscher Field			32 52	117 08	477	39	41	E	5	1532	89 68	85 68	22	W	82 68	71 70	69	18	340	13	472		
Moffett Field NAS			37 25	122 03	34	34	36	SE	4	2511	85 66	81 65	23	NNW	77 64	68 67	65	3	117	1	85		
Mojave			35 02	118 11	2735	22	26	WNW	5	3012	105 67	102 67	35	WSW	100 66	70 69	67	499	1649	6	216		
Montague/Siskiyou Co Aprt			41 46	122 28	2648	11	16	N	6	5474	97 65	94 65	40	NW	91 64	68 67	65	107	701	3	72		
Monterey FWC			36 36	121 52	162	35	38	SE	4	3556	75 63	71 61	17	NW	68 61	64 62	61	1	18	0	6		
Monterey/Presidio			36 36	121 54	100	35	38	SE	4	3556	75 63	71 61	17	NW	68 61	64 62	61	1	18	0	6		
Mt Diablo			37 53	121 55	3849	24	28	N	10	4600	90 60	87 60	18	S	85 59	62 61	60	8	454	0	0		
Mt Disappointment			34 18	118 02	5900	19	21	NW	15	5200	86 62	84 60	18	SE	82 59	65 63	62	0	293	0	0		
Mt Laguna AFS			32 53	116 25	6199	18	20	NW	17	5445	84 62	82 60	18	SE	80 59	65 63	62	0	163	2	10		
Mt Martell ANG			37 49	122 04	2022	30	33	N	5	2809	96 68	92 67	26	WSW	89 66	69 68	67	74	676	0	155		
Mt Pinos			34 48	119 08	8831	5	8	NW	20	7800	80 52	77 51	20	W	75 50	55 53	52	0	32	0	0		
Muroc NAS use Edwards AFB																							
North Highlands ANGB			38 38	121 25	76	29	31	NNW	4	2566	102 70	99 69	35	SW	96 68	72 70	69	299	1124	16	413		
Norton AFB/San Bernardino			34 06	117 14	1156	31	33	E	3	1978	102 70	99 69	37	W	96 68	74 72	71	345	1206	60	648		
Oakland Army Base			37 49	122 19	5	34	36	E	5	2909	85 64	80 63	24	WNW	75 62	66 64	63	5	92	0	14		

NORTON AFB/SAN BERNARDINO CALIFORNIA

LAT 34 06N LONG 117 14W ELEV 1156 FT

MEAN FREQUENCY OF OCCURRENCE OF DRY BULB TEMPERATURE (DEGREES F) WITH MEAN COINCIDENT WET BULB TEMPERATURE (DEGREES F) FOR EACH DRY BULB TEMPERATURE RANGE

Tempera- ture Range	MAY					JUNE					JULY					AUGUST					SEPTEMBER					OCTOBER						
	Obsn Hour Gp			Total Obsn	R C W B	Obsn Hour Gp			Total Obsn	R C W B	Obsn Hour Gp			Total Obsn	R C W B	Obsn Hour Gp			Total Obsn	R C W B	Obsn Hour Gp			Total Obsn	R C W B							
	01	09	17			01	09	17			01	09	17			01	09	17			01	09	17			01	09	17				
	10	10	10			10	10	10			10	10	10			10	10	10			10	10	10			10	10	10				
	00	16	24			00	16	24			00	16	24			00	16	24			00	16	24			00	16	24				
110/114						0	0	0	66							0	0	72			0	0	71									
105/109						1		1	67			4	0	4	69	3		3	71		2	0	2	71								
100/104		1		1	66	4		4	68		15	1	16	70		18	1	19	71		11	0	11	69		2		2	66			
95/99		3	0	3	64	19	1	20	66		48	6	54	69		54	5	59	70		30	2	32	67		12	0	12	63			
90/94		10	1	11	63	31	6	37	66		0	68	17	85	67		60	17	77	69		43	8	51	66		26	2	28	62		
85/89	0	22	3	25	62	32	14	46	65		1	49	31	81	66		1	46	29	76	68	0	43	17	60	65		28	6	34	61	
80/84	0	31	9	40	61	1	33	20	54	64	3	31	37	71	65		5	32	42	79	66	2	35	25	62	64	0	34	10	44	59	
75/79	1	36	15	52	60	3	31	26	60	63	13	19	47	79	64		16	18	51	85	65	8	28	34	70	63	2	39	17	58	59	
70/74	3	39	24	66	58	8	29	38	75	61	35	9	57	101	63		45	11	58	114	64	19	23	44	86	62	4	37	27	68	58	
65/69	6	39	36	81	57	20	29	48	97	59	74	3	38	115	61		82	4	35	121	61	41	18	53	112	60	12	35	43	90	57	
60/64	19	38	60	117	55	65	23	52	140	57	71	1	13	85	58		73	1	9	83	58	81	7	45	133	57	43	25	69	137	55	
55/59	99	22	71	192	53	104	8	32	144	54	41		1	42	54		24		0	24	54	60	1	10	71	53	75	8	46	129	52	
50/54	82	6	24	112	49	33	0	3	36	50	9			9	49		2		0	2	50	24		2	26	45	68	2	21	91	47	
45/49	31	1	4	36	45	5		0	5	45											4		0	4	45	34	1	5	40	43		
40/44	6		1	7	41	1			1	42											0			0	42	8		1	9	38		
35/39	0			0	34																							1	0	1	33	
30/34																													1		1	30

[illegible]

Sosok & Associates

JOB NO. 166
PROJECT Orange School

DATE 9 Nov 81
SHEET 2 OF 2
BY LB

"L"-FACTOR CALCULATIONS

OPAQUE SURFACES	COOLING				U_c	L_c
	CLTD					
	TABLE VALUE	L&M CORR.	COLOR CORR.	TEMP. CORR.		
COMMERCIAL						
WALL (1)						
WALL (2)						
ROOF						
GLASS						
16.0 IN. GLASS						
N. E. SURFACE						
WALL (1)						
GLASS (1)						
WALL (2)						
WALL - WIND						
GLASS (2)						
GLASS (3)						
WALL (4)						
ROOF						

HEATING		
U_H	ΔT_H	I_H
0.69	44	32.4
0.38	44	16.2
0.72	44	34.7
1.1	44	40.4
0.41	44	18.0
0.83	44	36.5
0.37	44	16.3
0.81	44	35.6
1.1	44	48.4
0.37	44	16.3
0.27	44	11.9

DESIGN CONDITIONS			
COOLING		HEATING	
OUTSIDE	DB	WB	85 DB
INSIDE	DB	WB	31 DB
ΔT	DB		44 DB
DAILY RANGE	DB		DB
LATITUDE	N		

CORRECTION FACTORS	
CORR. FOR AV. OSA TEMP.	
CORR. FOR INDOOR TEMP.	
NET TEMP. CORR. FACTOR	
LAT. & MONTH CORR. FACTOR	
COLOR CORR. FACTOR	

TIME OF MAX. COOLING LOAD	MONTH	HOUR

NOTES:

[illegible][illegible]

"L"-FACTOR CALCULATIONS

DESIGN CONDITIONS				
COOLING			HEATING	
OUTSIDE	DB	WB	75 DB	WB
INSIDE	DB	WB	81 DB	WB
ΔT	DB		44 DB	
DAILY RANGE	DB		DB	
LATITUDE	N			

CORRECTION FACTORS	
CORR. FOR AV. OSA TEMP.	
CORR. FOR INDOOR TEMP.	
NET TEMP. CORR. FACTOR	
LAT. & MONTH CORR. FACTOR	
COLOR CORR. FACTOR	

TIME OF MAX. COOLING LOAD	MONTH	HOURL

NOTES:

[illegible][illegible][illegible][illegible]

DATE 9/16/91
 SHEET 2 OF 3
 BY LB

ROOM LOADS

JOB NO. 1660

PROJECT DR. A. J. S. Hall

ROOM NO.					<u>LG. DINING HALL</u>		<u>SM. DINING HALL</u>	
ROOM FUNCTION			<u>COMMERCIAL</u>					
DIMENSIONS - LxWxH (FT)			<u>130 x 123 x 4</u>					
AREA (FT ²)								
VOLUME (FT ³)								
COOLING LOAD	EXP	"L"	UNITS	BTUH	UNITS	BTUH	UNITS	BTUH
OUTSIDE WALLS								
GLASS								
CEILING OR ROOF								
SUB - TOTAL		X	X		X		X	
PEOPLE								
LIGHTS								
EQUIPMENT								
TOTAL SENSIBLE LOAD			X		X		X	
PEOPLE								1
TOTAL LATENT LOAD			X		X		X	
HEATING LOAD		"L"	AREA	BTUH	AREA	BTUH	AREA	BTUH
OUTSIDE WALL (1)	30.2	14.2	11.0	8260	251,104	915	14,412	132.5
" (2)	16.2	16.3	11.3	7562	123,261	7129	47,726	1401
GLASS (1)	46.1	20.5	11.4	5760	27,878	2928	15,801	741
CEILING OR ROOF	34.7	11.9	34.5	45,360	1,437,912	10,004	110,307	3264
PARTITION WALL		35.6				30.3	12,405	
WALL (3)		16.5				28.0	40,74	
TOTAL HEATING LOAD			X	1,340,155	X	31,3104	X	162,225

GLASS (2)

DATE 9/16/81
 SHEET 1 OF 3
 BY LB

ROOM LOADS

JOB NO. 1161

PROJECT ORANGE SHOW

ROOM NO.									
ROOM FUNCTION			<u>HOBBY SHOP</u>		<u>CUTLER BUILDING</u>		<u>ORANGE BUILDING</u>		
DIMENSIONS - LxWxH (FT)			<u>300x143x39</u>		<u>143x130x22</u>				
AREA (FT ²)									
VOLUME (FT ³)									
COOLING LOAD	EXP	"L"	UNITS	BTUH	UNITS	BTUH	UNITS	BTUH	
OUTSIDE WALLS									
GLASS									
CEILING OR ROOF									
SUB - TOTAL		X	X		X		X		
PEOPLE									
LIGHTS									
EQUIPMENT									
TOTAL SENSIBLE LOAD			X		X		X		
PEOPLE									
TOTAL LATENT LOAD			X		X		X		
HEATING LOAD		"L"	AREA	BTUH	AREA	BTUH	AREA	BTUH	
OUTSIDE WALL ①	24.9	30.1	30.3	8860	210,614	6320	142,232	916	58,054
" WALL ②	30.1	16.3	50.1	5248	159,470	5400	88,020	767	38,810
GLASS						414	22,020		
CEILING OR ROOF	32.0	12.8	5.2	57760	1,054,720	22,020	270,304	14344	71,380
PARTITION	24.7						82,793		
WALL ④	30.1					3325	100,023		
TOTAL HEATING LOAD			X	2,234,804	X	771,470	X	171,454	

APPENDIX C

GAS USAGE

SOSOKA & ASSOCIATES

2882 Myrtle Avenue
(213) 595-7387

Long Beach, California
90806

PROJECT NO. 166

DESCRIPTION Orange Show

Peak Design Loads

BY N.S.

DATE 10/3/81

Calculated Peak Loads - Outside 31°F , Inside 75°F

	Trans. Load BTUH	OSA Load - BTUH (2)	cm/ft
DOME	171,000	394,000	10
HOBBY	(2) 2,235,000	714,000	5
CITRUS	771,000	814,000	10
AUDITORIUM	(1) 500,000	1,000,000	10
RESTAURANTS	480,000	734,000	20
COMMERCIAL	1,840,000	690,000	5

Referring to The Norton AFB weather data that during the 8AM to Midnight period there are only 62 hrs below 40°F . Since all of the buildings except the restaurant will still have their existing system as back-ups, the new retrofits should be designed for a minimum of 40°F instead of 31°F . The one exception is the restaurant where the new coils will have to be designed for 31°F .

Based on the above comments the new design loads will be as follows:

	TOTAL LOAD - BTUH	(4) FINAL DESIGN LOAD BTUH
DOME	449,000	300,000
HOBBY	1,686,000	1,200,000
CITRUS	1,261,000	900,000
AUDITORIUM	1,193,000	900,000
RESTAURANTS	1,116,000	800,000
COMMERCIAL	2,013,000	1,500,000
Total		5,600,000

(1) Because of internal loads - lights, people, etc - it would seem reasonable to reduce the design loads by 25%.

(3) Design for use only in May OSA = 50°F min.

(2) Max. design occupancy and cm/person as shown.

(1) Estimated

SOSOKA & ASSOCIATES

2889 Myrtle Avenue
(213) 595-7387

Long Beach, California
90806

PROJECT NO. 166

DESCRIPTION Orange Show

Gas Usage

BY V. S.

DATE 9/19/81

Gas Usage + Therms

Metered

Calculated

①

see sheet 2

Metered

Total

Dome

Hobby

Citrus

And

Restau

Comm.

Month

1980

June

1,839

80

0

160

226

1,241

132

July

1,481

130

260

389

781

121

Aug

1,726

160

200

303

493

630

Sept

1,774

100

200

283

868

323

Oct

1,824

100

200

337

1,055

130

Nov

4,156

322

704

985

1,126

1020

Dec

8,156

218

1088

673

2,196

3981

1981

Jan

3,995

148

0

2317

1,185

345

Feb

4,332

641

781

1366

1,397

147

Mar

3,924

139

1966

208

1,384

227

April

2,461

144

432

624

926

335

May *

4,135

253

886

206

886

1,272

333

40,001

2375

886

4497

5597

13,924

7724

Allocation

Remaining Gas

18,353 Therms.

Building Area

122

12,000

43,000

24,000

43,000

Air Factor

0.10

0.35

0.20

0.35

Hours of Oper.

Nov

74

27/34

0/0

28/38

19/26

Dec

99

22/22

0/0

57/57

20/2

Jan

53

9/17

0/0

0/0

44/33

Feb

87

39/45

0/0

24/28

24/28

Mar

105

12/11

0/0

88/89

5/05

Apr

15

4/27

0/0

6/1

5/33

May

320

80/25

80/25

80/25

80/25

* Orange Show month

① Dome Thru Oct Allocated on an arbitrary 1:2:3

relationship for Dome, Citrus & And.

SHEET 1 OF 1

SOSOKA & ASSOCIATES

2689 Myrtle Avenue
(213) 595-7387

Long Beach, California
90806

PROJECT NO. 166

DESCRIPTION Orange Show

Gas Usage

BY J.S.

DATE 9/19/81

Building

Month	Dome				Hobby				Citrus				Aud.				XALL
	AF	OF	X	AX	AF	OF	X	AX	AF	OF	X	AX	AF	OF	X	AX	
80 Nov	0.1	36	36	0.16	35	0	0	0	0.2	38	76	0.35	0.35	26	107	0.49	219
Dec	0.22	22		0.11				0	0.57	114		0.55	0.2	70		0.34	206
81 Jan	0.17	17		0.06				0	0	0		0	0.83	291		0.94	308
Feb	0.45	45		0.23				0	0.18	54	0.28		0.28	98		0.49	199
Mar	0.11	11		0.06				0	0.84	168	0.85		0.05	18		0.09	197
Apr	0.27	27		0.12				0	0.4	80	0.36		0.33	114		0.52	223
May	0.1	25	25	0.10	35	25	88	0.35	0.22	95	50	0.20	0.35	25	88	0.35	251

AF = Area Factor

OF = Operating Time Factor

X = (AF)(OF)(1000)

AX = Averaging Factor based on the $\frac{X_B}{X_{B-ALL}}$ all four Bldgs

X_B = Factor for building

X_{B-ALL} = Total of X's for all four building

Month	Remaining Gas Therms/mo	Gas Allocation				Therms / Month			
		Dome		Hobby		Citrus		Aud.	
		AX		AX		AX		AX	
80 Nov	2010	0.16	322	0	0	0.35	704	0.49	985
Dec	1979	0.11	218		0	0.55	1088	0.34	673
81 Jan	2465	0.06	148		0	0	0	0.94	2317
Feb	2788	0.23	641		0	0.28	781	0.49	1366
Mar	2313	0.06	139		0	0.85	1966	0.09	208
Apr	1200	0.12	144	0	0	0.36	432	0.52	624
May	2580	0.10	253	0.35	886	0.20	506	0.35	886

APPENDIX D

ECONOMIC CALCULATIONS

SOSOKA & ASSOCIATES2882 Myrtle Avenue
(213) 595-7387Long Beach, California
90806PROJECT NO. 166DESCRIPTION Orange Show Geothermal
Cost EstimatesBY J.S. DATE 11/13/81DOME D BLDG.

- 1- Fan/Coil Unit Heater - 300,000 BTUH
@ 160°F Ent. Water, 30°F AT, 20 GPM
Wing Model 38 (2 HP)

\$ 3,100

Installation
Unit

500

Piping 150' of 1 1/2" ϕ @ \$8/ft. (No. Ins.)

1,200

Below Grade Piping - Preinsulated FRP

80' of 2" ϕ @ \$26/ft.

2,100

Electrical Ser. Fan/Coil Unit.

400

- 1- Hot Water Pump - 20 GPM @ 15 psi (P-12)

800

Installation and electrical
Controls and Misc.

400

800

Total

\$ 9,300

HOBBY BLDG.

- 6- Fan/Coil Unit Heaters - 200,000 BTUH/each
@ 160°F Ent. Water, 30°F AT, 13 gpm
Wing Model 33 (1 HP)

\$ 15,000

Installation

Units

3,000

Piping 1200' of 2 1/2" ϕ @ \$13/ft (N.I.)

15,600

Electrical Ser. Fan/Coil - 600' @ \$4/ft + Misc

3,000

- 1- Hot Water Pump - 80 GPM @ 10 psi (P-10)

900

Installation and electrical

400

Controls & Misc

1,500

\$ 39,400

SOSOKA & ASSOCIATES2889 Myrtle Avenue
(213) 695-7387Long Beach, California
90806PROJECT NO. 166DESCRIPTION Orange Show Geothermal
Cost EstimateBY J.S. DATE 11/13/81CITRUS BLDG

6- Fan/Coil Unit Heaters - 150,000 BTUH/ea.
@ 160°F Ent. Water, 30°F AT, 10 GPM
Reznor Model UHHR-094A (1/2 HP)

\$ 9,000

Installation
UnitsPiping 1000' of 2 1/2" ϕ @ \$13/ft (No. Insul.)

2,000

Electrical 600' @ \$4/ft + Misc.

13,000

3,000

1- Hot Water Pump - 80 GPM @ 5 gpi. (P-11)

700

Installation and electrical

400

Bel. Grade Piping - Pre-insulated

160' of 2 1/2" ϕ @ \$28/ft

4,500

Above Grade in Hobby Bldg - Insulated

400' of 2 1/2" ϕ @ \$15/ft

6,000

Controls and Misc.

1,500

Total

\$ 40,100

PRIMARY LOOP

1- Expansion Tank

\$ 300

1- Hot Water Pump, 160 GPM @ 15 gpi (P-9)

1,200

Installation and electrical

900

Total

\$ 2,400

GEOHERMAL SYSTEM

1- Heat Exchanger - Alfa Laval P-31 (HX-2)

\$ 5,000

3" Piping - Insulated

Bel. Grd. 100' @ \$28/ft

2,800

In Hobby Bldg. 400' @ \$17/ft

6,800

1- Hot Water Pump - 20 GPM @ 5 gpi. (P-8)

600

1- " " " - 160 GPM @ 15 gpi. (P-7)

1,200

Electrical for pumps

800

Controls and Misc.

2,000

\$ 19,200

SOSOKA & ASSOCIATES2689 Myrtle Avenue
(213) 595-7387Long Beach, California
90808PROJECT NO. 166DESCRIPTION Orange Show Geothermal
Cost EstimatorBY J. S.DATE 11/13/81DOMED/HOBBY/CITRUS BLDGS SYSTEM COST.

Basic Cost

Domed

\$ 9,300

Hobby

39,400

Citrus

40,100

Primary Loop

2,400

Geothermal

19,200

Total

\$ 110,400

Contractor O.H. & Profit 20%

22,100

Contingency 10%

11,000

Total Cost

\$ 143,500

Inflation 1 year @ 10%

14,000

Design, Inspection & Project Management 10%

14,000

Total System Cost

\$ 171,500

SOSOKA & ASSOCIATES2889 Myrtle Avenue
(213) 595-7387Long Beach, California
90806PROJECT NO. 166DESCRIPTION Orange Show Geothermal
Cost EstimatorBY J. S. DATE 11/13/81AUDITORIUMPiping - 2 1/2" ϕ

Bel. Grd. 130' @ \$28/st

B. Bldg (NT) 100' @ \$13/st

Valves, Controls and Misc.

Total

\$ 3,600

2,300

1,000

\$ 6,900

COMMERCIAL

6- Fan/Coil Unit Heaters - 400,000 BTUH/ea.

@ 140°F Ext. water, 30°F AT, 16 GPM

Wing Model 36 (1 1/2 HP)

Installation

Piping 1200' of 2 1/2" (NT) @ \$13/st

Electrical - 600 St @ \$4/st + Misc.

1- Hot Water Pump - 100 GPM @ 10 psi.

Installation and electrical
Controls and Misc.

\$ 17,000

3,000

13,000

3,000

1,000

400

1,200

\$ 38,600

RESTAURANT

2- Coils

Installation

1- Storage Tank

1- Hot Water Pump - 20 GPM @ 10 psi (P-4)

1- " " - 53 GPM @ 15 psi (P-3)

Installation & Electrical

Controls and Misc.

Piping Bel. Grade - 30' of 2 1/2" ϕ @ \$28/st" " Abr. Grade (Fns) 260' of 2" ϕ @ \$12/st.

\$ 2,400

2,000

800

700

800

1,000

1,500

800

3,100

\$ 13,100

SOSOKA & ASSOCIATES2889 Myrtle Avenue
(213) 595-7387Long Beach, California
90806PROJECT NO. 166DESCRIPTION Orange Show Geothermal
Cost EstimatesBY J.S.DATE 11/13/81PRIMARY LOOP

1- Hot Water Pump - 233 GPM @ 10 psi (P-5)	\$ 1,700
Installation and Electrical	600
Piping Bel. Grd. 270' of 4" @ \$32/ft	8,600
Controls and Misc.	600
Expansion Tank	800
Total	<u>\$ 12,300</u>

GEOTHERMAL LOOP

1- Heat Exchanger - Alfa-Laval P-31 (HX-1)	6,000
1- Hot Water Pump - 233 GPM @ 15 psi	1,700
1- " " " - 73 " @ 5 psi	900
Piping Bel. Grade 310' of 4" @ \$32/ft	9,900
Housing for Heat Exchanger & Pumps	1,000
Pump Installation and Electrical	800
Controls and Misc.	600
Total	<u>20,900</u>

AUDITORIUM/COMMERCIAL/RESTAURANT SYSTEM COST.

Basic Cost	
Auditorium	\$ 6,900
Commercial	38,600
Restaurant	13,100
Primary Loop	12,300
Geothermal Loop	<u>20,900</u>
	\$ 91,800
Contractor O.H. & Profit 20%	18,400
Contingency 10%	<u>9,200</u>
Total Cost	119,400
Inflation 1 yr @ 10%	11,900
Design, Inspection & Project Management 10%	<u>11,900</u>
Total System Cost	\$143,200

SOSOKA & ASSOCIATES2569 Myrtle Avenue
(213) 585-7387Long Beach, California
90806PROJECT NO. 166DESCRIPTION Orange Show Geothermal
Cost Estimator

BY

J.S.DATE 11/13/81

Total Project Cost
Dwelling / Hobby / C. Trus
And / Commercial / Restaurant
Total

\$ 171,500
143,200
\$ 314,700

RESTAURANT ONLY.

Restaurant System
Geothermal Loop

\$ 13,100

1- Heat Exchanger

3,000

Piping Bel. Grade - 4' - 310' @ \$32/ft.

9,900

Installation & Misc. & Exg. Tank

800

1- Hot water Pump - 73 GPM @ 15 psi.

1,200

Installation and Electrical

400

Housing

800

\$ 29,200

Contractor O.H. & Profit 20%

5,800

Contingency 10%

2,900

Total Cost

\$ 37,900

Inflation 1 yr @ 10%

38

Design, Inspection & Project Management 10%

3,800

Total System Cost.

\$ 45,500

SOSOKA & ASSOCIATES

8502 Myrtle Avenue
(213) 635-7387

Long Beach, California
90808

PROJECT NO. 1166

DESCRIPTION Orange Shale
Savings

BY J. S.

DATE 10/6/81

Year	Cost \$/10 ⁶ BTU	Pres. Worth \$ (10% D.F.)
1983	4.46	4.46
84	5.08	4.59
85	5.69	4.70
86	6.78	5.09
87	8.05	5.50
88	9.50	5.90
89	11.16	6.30
1990	13.11	6.73
91	15.36	7.17
92	18.04	7.65
93	19.62	7.56
94	21.31	7.47
95	23.16	7.38
96	25.19	7.30
97	27.34	7.20
98	29.74	7.12
99	32.29	7.03
2000	35.06	6.93
2001	37.68	6.78
2002	40.51	6.62

Total Gas Consumption
≈ 40,000 Therms/Year
Estimate of amount of gas
to be replaced with
geothermal. = 80%

Amount of gas replaced
(40,000 Therms) (80%)
= 32,000 Therms/Year

Assuming geothermal
therms cost 80% of gas
Therms. Also geothermal
therms are 75% of gas
therms because no
conversion is necessary in
furnace of heater.

129.38 or \$12.94/Therm for 20 yr. period

$$\text{Savings} = \left\{ (40,000 \text{ Therms}) \left(\frac{80\%}{\text{Therm}} \right) \left(\frac{\$12.94}{\text{Therm}} \right) (20\%) \right\} + \left\{ (32,000 \text{ Therms}) (25\%) \left(\frac{\$12.94}{\text{Therm}} \right) \right\} = \$103,500$$

Total Pres. Value of Savings = \$186,300

* Savings are estimated to be 15-25%

** From CEC Staff Report.

SOSOKA & ASSOCIATES2889 Myrtle Avenue
(213) 895-7387Long Beach, California
90806PROJECT NO. 166
DESCRIPTION Orange Show
Cost Estimator

BY

J. S.

DATE

10/6/81Restaurant Only - Energy Savings

Yearly Energy Usage $\approx$ 14,000 Therms.
4000 Therms attributable to
cooking and supplementary
space & DHW heating
Net Available for Geo. $\frac{4000}{10,000}$ Therms

25% saved because no conversion
process required

$(\$12.94)(10,000)(412.94) =$ \$ 32,350
Savings due to Geo. cost = 80% of
gas cost.

$(7,500 \text{ Therms})(\$12.94)(20\%) =$ $\frac{19,410}{51,760}$

Present Value of 20 year Savings $\approx$ \$54,000