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Marlin

CHAMBER OF COMMERCE

DOE/R6/10987--11

AT
DE-FG46-79 R6 10987

FINAL REPORT

GEOTHERMALLY HEATED
CHAMBER OF COMMERCE OFFICES
AT
MARLIN, TEXAS

MASTER

July 31, 1981

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FINAL REPORT

GEOTHERMALLY HEATED
CHAMBER OF COMMERCE OFFICES
AT
MARLIN, TEXAS

Under:

US DOE Small-Scale Appropriate Energy
Technology Grants Program
Grant No. DE-FG46-79R610987

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Submitted to:

U.S. Department of Energy
Region VI Office
2626 West Mockingbird Lane
Dallas, Texas 75235

July 31, 1981

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JWJ

MARLIN — For Industry - Health - Retirement

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1.0

PROJECT INFORMATION

Title: Geothermally Heated Chamber of
Commerce Offices at Marlin, Texas

Location: Marlin Chamber of Commerce
245 Coleman Street
Marlin, Texas 76661

Energy Source: City of Marlin Geothermal Well
Drilled in 1893
3,400 Feet Deep
20 GPM Artesian Flow at 118°F

Delivered Heat: 40,000 BTU/Hour

Grantee: Marlin Chamber of Commerce

Geothermal
Consulting Engineers: Radian Corporation, Austin, Texas

System Installation:

- City of Marlin
- Orand's Refrigeration
- L. Jefferson Plumbing
- LaBarbera Welding
- Susan Wardlow Sign Painting

Cost-Share Funding:

- US Department of Energy - 76%
- Chamber of Commerce and } - 24%
- City of Marlin

Cost: \$15,134

Contact: Jacquelyn W. Johnson, Manager
(817) 883-2171

2.0 PROJECT SUMMARY

2.1 Purpose

The primary purpose of this project is to demonstrate the use of an existing, low temperature, geothermal resource to heat the Chamber of Commerce offices (Figure 1) in Marlin, Texas.

A secondary purpose is to attract new industries and businesses to Marlin via this alternate energy show-piece demonstration of a simple and practical application of Texas' low temperature geothermal resource.

2.2 Geothermal Resource

Long before the term "geothermal" came into wide use throughout the world, the city of Marlin had a "hot mineral water well" drilled in 1893. This well has been flowing--via artesian pressure--ever since and is located in a wellhouse adjacent to the Marlin Chamber of Commerce offices as shown in Figure 2.

These well waters, however, were not suited for a municipal water source as they contain around 10,000 parts per million of dissolved minerals and a respectable amount of hydrogen sulfide gas which gives a distinct "rotten eggs" odor.

The geothermal water is produced from the Glen Rose aquifer some 3,400 feet below ground level. During its heyday, the well has produced as much as 170 gallons per minute (gpm) at 147°F for use at various health spas in town. Currently, the well is allowed to produce only about 20 gpm to supply a public drinking fountain and one remaining spa nearby. As with any geothermal well, lower production rates yield lower water temperatures and this is seen today with a well water temperature of about 118°F.

Figure 1. Marlin Chamber of Commerce Offices

Figure 2. Geothermal Wellhouse

2.3

System Overview

Figure 3 shows a simplified overview of the geothermal heating system installed at the Marlin Chamber of Commerce offices.

Figure 3. Geothermal Heating System Overview

Hot water will continue to flow to the spa's cooling and holding tank as it has over the years. However, the water is first passed through a plate heat exchanger located inside the wellhouse. This heat exchanger is necessary to isolate the corrosive geothermal water from the rest of the system. Inside the heat exchanger, heat from the geothermal water is transferred to a circuit of regular drinking water which is connected by pipes to a new air coil installed in the existing electric furnace/air conditioner on the Chamber's office roof

Thus, the geothermal water heat is used to heat the

air coil in the electric furnace. When the furnace blower forces cool return-air over this hot air coil, the cool air is heated and passed on to the Chamber offices. This is the same process as is done when air is passed over the hot electric coils of the furnace. Naturally, the electric furnace controls have been modified so that the electric coils do not come on unless extremely cold weather arrives.

2.4 Benefits

Many benefits to the Chamber of Commerce, the City of Marlin, the State of Texas and the federal government have resulted from this project.

First, through this program the U.S. Department of Energy has helped put in place the first modern, working geothermal demonstration project in Texas whereby the Chamber of Commerce can reduce their winter electricity expenditures by around ninety percent via this alternate energy source.

Second, the first step at building a Central Texas infrastructure capable of installing such a system has taken place.

Third, Marlin has been exploring ways to use their geothermal resource for years for they know this resource application can mean new business entries as conventional energy costs soar. This demonstration project will allow potential newcomers to see a real, operating geothermal system and visualize what it can do for them.

Fourth, through newspaper and television coverage

plus the distribution of two Project Fact Sheets--included in the Appendix--the project has been able to sow seeds in a large segment of Texas with accurate information about the use of Texas' geothermal resources.

3.0

SYSTEM DESCRIPTION

3.1

Approach

Figure 4 shows an as-built schematic drawing of the geothermal heating system for the Marlin Chamber of Commerce offices.

The unique and essential aspect of using the existing, corrosive geothermal water was to employ a plate heat exchanger to isolate the majority of the system from the corrosive water. Corrosion by the geothermal water is caused by certain chemical species in the water usually listed as the pH, chlorides, sulfates, and gases such as hydrogen sulfide, carbon dioxide and ammonia. In order to protect the heat exchanger from corrosion, 316 stainless steel plates, which provided good service in this particular water, were specified.

Geothermal heat is transferred to the secondary loop as shown in Figure 4. The purpose of this circulating loop is to pump a hot water/antifreeze mixture from the heat exchanger to the air coil installed in the existing Model ECH8-46-593-1L Lennox electric furnace/air conditioner on the roof. Cooled water from the air coil is pumped back to the heat exchanger for reheating. Antifreeze keeps the secondary loop water from freezing during winter periods when the system is not in operation.

Control of the system is much like that of a home gas-fired furnace in that the thermostat turns on the circulation pump first and the blower is delayed so that the roof-top air coil is completely heated before the furnace blower starts moving the air. Otherwise, if the pump and fan were turned on simultaneously, cool air would be blown within the building for the first minute.

NOTES:

1. ALL PIPING IS 1 1/4" SCH 80 PVC.

2. BALL VALVES ARE CHEMTROL PVC TRUE UNION BALL VALVES WITH VITON OR EPDM O-RINGS.

3. CHECK VALVE IS CHEMTROL PVC TRUE UNION BALL CHECK VALVE.

4. AIR VENTS ARE HOFFMAN NO. 791.

5. PUMP IS BELL & GOSSETT MODEL 60-11-S.

6. PLATE HEAT EXCHANGER IS TRANTER MODEL UX-016-UJ-12 WITH 316 SS PLATES.

7. HEATING COIL IS 18" x 18" TRANE 4-ROW TYPE "W" SERIES 56.

8. 3/4" THICK RIGID URETHANE INSULATION WITH WHITE PVC ALL SERVICE JACKET APPLIED TO ALL SECONDARY PIPING.

9. THERMOSTAT IS TWO STAGE HEATING, ONE STAGE COOLING.

CONTRACT NO. 212-004-01		RADIAN CORPORATION P.O. BOX 9948/AUSTIN, TEXAS/78768	
APPROVALS	DATE	MARLIN CHAMBER OF COMMERCE GEOTHERMAL HEATING SYSTEM: AS BUILT SCHEMATIC	
DRAWN <i>Scott Robinson</i>	7/81		
CHECKED <i>7/24/81</i>	11/61		
FIGURE 4		SIZE	CODE IDENT NO.
		DRAWING NO. 70B2212	
		SCALE ~	SHEET 1 OF 1

3.1.1 Plate Heat Exchanger

Plate heat exchangers (HX) are essential to properly designed geothermal heating systems--especially when using low temperature geothermal resources. The installed Tranter unit is shown on the wellhouse slab floor in Figure 5. These units have many advantages over their shell-and-tube HX counterparts.

- For a given situation, plate HX are smaller and cheaper than shell-and-tube HX.
- They are easy to disassemble and clean when fouling (scaling) occurs on the plates.
- The HX plates can be made from any flat sheet stock that can be shaped by stamping. Such selectability means that the metal least affected by corrosion can be used.
- Better heat transfer is made via the large area of the plates than with shell-and-tube HX and more plates can be added to accommodate system expansion.

One difference between the two HX's may represent a plate HX disadvantage. A plate HX typically requires more water pressure, and thus a larger pump, than shell-and-tube HX although the increased pressure is not great.

3.1.2 Secondary Loop

A 30%/70% mixture of propylene glycol and water is pumped around the secondary loop by a 0.25 HP pump at the rate of 8.5 gpm. This concentration of 30 percent glycol (antifreeze agent) will protect the water loop from freezing down to 0°F.

As shown in Figures 6 and 7, the Schedule 80 PVC, 1.25 inch plastic piping connects the circulation pump and plate

HX in the wellhouse with the air coil unit in the roof-top furnace. Rigid, 0.75 inch, urethane with an all weather PVC jacket insulates the entire secondary loop from unreasonable heat loss.

Various auxillary components are also installed in the secondary loop to provide for necessary filling, draining, operation and maintenance. These components include a strainer (also used for fill and drain); an expansion tank for air release and volume changes due to water temperature changes; three air vents to aid filling operations; ball valves to isolate the pump for changeout or the plate HX for cleaning; and thermometer wells whereby the supply and return line temperatures can be determined during operation.

3.1.3 Air Coil

A four-row, 18-inch-square, Trane air heating coil was designed for this system and can deliver 40,000 BTU per hour by passing the heated water/glycol through its finned tubing. Hot water entering the unit is passed, in turn, through each of the four rows before being returned to the plate HX so that maximum heat energy can be extracted from the water.

The Trane air coil was installed in the return-air duct at the roof-top furnace/AC unit as shown in Figure 8. As the furnace blower draws air from the Chamber offices, it is heated by passing through the air coil and is then blown on to the air outlets in the offices.

3.1.4 Controls

A two-stage Honeywell thermostat was installed to operate both the geothermal and electric heating systems.

Figure 5. Tranter Plate Heat Exchanger in Wellhouse

Figure 6. Secondary Loop Piping Rising from Wellhouse to Office Roof

Figure 7. Secondary Loop Piping Continuing on to Roof Furnace

Figure 8. Secondary Loop Piping Connections to Air Cool in Furnace

When the room temperature drops and causes the thermostat to call for heat, the first stage turns on the geothermal heating system by energizing the circulation pump in the wellhouse. About sixty seconds later the furnace blower is activated and hot air is moved throughout the office space.

In the event that the outside temperature and wind are so severe that the geothermal system cannot achieve the desired internal air temperature, the office temperature will continue to drop. When it drops an additional two degrees, the thermostat second stage turns on the regular furnace electric heating coils and the total heat input to the offices will double since the geothermal system remains on during the second stage. Both systems will be terminated when the desired room temperature is obtained.

3.1.5 Instrumentation

Four temperature and two pressure gauges are used to display the important operating parameters of this geothermal heating system.

Temperature gauges measure the supply and return temperatures of the HX primary (geothermal) side and the secondary (water/glycol) side.

Heat exchanger fouling can be determined by measuring the pressure loss of the geothermal water as it passes through the primary side. The pressure loss can be determined by measuring the inlet and outlet pressures. Thus, if the primary side passageways foul due to scaling, the outlet pressure will decrease. This technique allows fouling to be detected and cleaning operations begun. Cleaning is necessary because fouling interferes with the HX ability to transfer heat from the geothermal water to the secondary loop water/glycol.

3.2

Major Component Specifications

Major Component	Manufacturer	Type/Model
• Heat Exchanger	Tranter	Plate Type UX-016-UJ-12 316 Stainless Steel Plates
• Air Coil	Trane	4R56W, 4-Row, 18" x 18", 40,000 BTU/Hr.
• Circulation Pump	Bell & Gossett	60-11-S, 1/4 HP, 115 VAC
• Piping	Celanese	1-1/4", Sch 80, PVC Type 1, Grade 1
• Piping Insulation	Southwest Insulators	Rigid Urethane with PVC Jacket (K=0.14)
• Thermostat	Honeywell	Two Stage, LR1620

3.3

Geothermal Water Disposal

No special disposal of the utilized geothermal water is required after system use since it continues to be passed on to the spa holding tank some 125 feet away as shown in Figure 9.

During peak heating demand by the Chamber offices,

the geothermal water passed on to the spa will be cooler by less than 5°F. This slightly cooler water will not alter its usefulness to the spa since their water is first cooled in their cooling/holding tank.

The underground pipe that transports the water to the spa tank corrodes and leaks from time-to-time. A special 1.5 inch (ID) polymer concrete (PC) pipe has been furnished (free of charge) by DOE Brookhaven National Laboratory to replace the underground pipe and it is anticipated that this PC pipe will be immune to corrosion. Once installed, the PC pipe will provide a field demonstration of this new product in a real life geothermal environment.

Figure 9. Spa Cooling and Holding Tank

4.0

LESSONS LEARNED

Through the bid package process, the Marlin Chamber of Commerce experienced considerable difficulty and delay in locating a mechanical contractor willing to install the system hardware at a fair price in-line with the estimate provided by their Geothermal Consulting Engineers. Many contractors were invited to bid via two separate solicitations using two different bid package formats.

As a result of the first package, two bids were received that represented unsatisfactory, inflated costs. Solicitation No. 2 resulted in a local contractor who was willing to install the system--but not to procure the materials. Since a local contractor was a highly desirable objective and his labor price was in accordance with the engineers' estimates, the Chamber selected the contractor and ordered the materials directly.

Even though the geothermal system is considered to be a simple, straightforward design, considerable construction frustration was realized nonetheless. A lesson in insufficient infrastructure was learned.

5.0 SYSTEM PERFORMANCE

5.1 Test

An operational system test was conducted in July, 1981 in order to obtain some data prior to the termination of the grant period. Obviously, fall and winter months will provide the most relevant data. However, warm office temperatures do not preclude nor invalidate a system test.

The geothermal heating system was activated after disabling the air conditioner and allowing the offices to start raising their temperatures due to outside ambient air temperature.

The following measurements were made:

- Return air inlet - 84°F
- Exhaust air outlet - 100°F
- Effective rise - 16°F

A temperature rise of 16°F is commendable considering an inlet of 84°F. Based on these data, engineering calculations show that during winter operations, the inlet temperature will be near 70°F and the exhaust will be between 93-95°F.

5.2 Operation and Maintenance

The system should require little continuing oversight during operation as the well flows continuously through the heat exchanger primary side all year long. The secondary loop circulation pump is the only component that cycles on and off.

Prior to the start of each heating season, however, five inspection and maintenance activities should be accomplished.

1. Expansion Tank: This reservoir is a two gallon, plastic tank on top of the roof furnace. The water/glycol level in the tank should be checked and filled to the top.

2. Strainer: The strainer is located in the well-house, below the circulation pump and in line to the pump inlet. The mesh screen inside collects debris and is to be cleaned by opening the exhaust valve and "blowing down" (discharging at a high rate) about one to two pints of water/glycol into a container.

3. Antifreeze: The propylene glycol does not last indefinitely. It is a good idea to check its condition for it may have to be replaced at two to three year intervals. Dow Chemical will analyze a sample at no charge and recommend what action is necessary. Therefore, each year when the strainer is blown down, that exhausted water sample should be sent to Dow for analysis.

4. Circulation Pump: Oil should be added to each of the two cups.

5. Plate Heat Exchanger: At the end of the first heating season, the heat exchanger should be opened and the plates examined for fouling. Any fouling deposits can be removed by scrubbing the plates on a flat surface using a laundry brush with detergent and water. The results of the first year's experience can be used to estimate whether it is necessary to inspect and clean annually. Additionally, the pressure loss across the primary side can be calibrated by comparison to the actual fouling.

APPENDIX

Marlin

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Celeste Kotter
President

Jacquelyn W. Johnson
Manager

MARLIN CHAMBER OF COMMERCE GEOTHERMAL PROJECT FACT SHEET NUMBER 1

PURPOSE

To demonstrate the technical feasibility of using energy for space heating.

SITE

The Marlin Chamber of Commerce offices.

METHOD

The geothermal fluid from a city well drilled in 1893 will be utilized. This geothermal well water (from the old well behind the Chamber of Commerce offices) will pass through a heat exchanger on its way to the mineral bath spa. The geothermal fluid gives up some of its heat to a secondary water loop. The secondary loop transports the heated water to a hot water coil in the return air duct of the existing commercial electric furnace. The air thus heated by the secondary loop replaces heat that is presently supplied by electricity.

SYSTEM SCHEMATIC

PROJECT
DIRECTOR

Ms. Celeste Kotter
President, Marlin Chamber of Commerce

CONSULTANTS

Radian Corporation, Austin: Geothermal Heating
system engineering design, installation, and
technology transfer.

TIMETABLE
ESTIMATE

	<u>Start</u>	<u>Complete</u>
System Design	12/79	1/80
Site Preparation	1/80	2/80
System Construction	2/80	4/80
Final Report	5/80	7/80

CONTRIBUTORS

• U.S. Department of Energy, Region VI	\$11,433
• Marlin Chamber of Commerce	<u>3,701</u>
Total:	\$15,134

FOR MORE
INFORMATION

Contact the Marlin Chamber of Commerce. As the
project progresses, updated fact sheets will be
available.

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MARLIN CHAMBER OF COMMERCE GEOTHERMAL PROJECT

FACT SHEET NUMBER 2

FREQUENTLY
ASKED QUESTIONS
WITH ANSWERS

- Q. *How extensive is the geothermal resource area and how is the water heated?*
- A. The geothermal water is obtained from a deep aquifer which was tapped in 1893. The aquifer is heated by circulation through the Mexia-Talco-Luling fault zone. This renewable geothermal resource presently supplies 20 gpm at 120°F to a public drinking fountain and a spa, but has produced artesian flow at flow rates as high as 170 gpm and temperatures of 147°F. It extends over a large area of Central Texas at varying temperatures.
- Q. *Who is funding the geothermal project?*
- A. In April, 1979, the Chamber of Commerce submitted a proposal to the U.S. Department of Energy (DOE) under the Region VI Small-Scale Appropriate Energy Technology Grants Program. The total funding provided by DOE is \$11,433. The Chamber is cost-sharing by providing an additional \$3,701 for a total of \$15,134.
- Q. *How will corrosion be controlled?*
- A. Corrosion of metal is best solved by selecting those metals that are most resistant to certain constituents in the geothermal water. The heat exchanger material will be selected on the basis of tests conducted on similar well water. Because the temperature is relatively low, plastic piping can be used throughout the system since plastics are not degraded by the corrosive geothermal fluids.
- Q. *How will the use of the present Chamber office electric heating unit be decreased?*
- A. The geothermal heating system will be controlled by an additional thermostat. The set point of the geothermal thermostat will be higher than the electric furnace

thermostat. Thus, when the office temperature decreases, the geothermal thermostat will sense this first and turn on the system. After the fluid has warmed the hot water coil, only the electric furnace blower will turn on. On unusually cold days, the geothermal heating system may not be able to keep the office temperature to the desired point. In this case, the normal electric furnace thermostat will energize the furnace and the necessary extra heat will be added.

FOR MORE
INFORMATION

Contact Marlin Chamber of Commerce. As the project progresses, updated fact sheets will be available.