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GEOTHERMAL HEAT PUMPS: Technology Outreach, Design Assistance, and Training

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KEY WORDS

geothermal design assistance, geothermal engineering training, geothermal heat pumps, ground source heat pumps, HVAC, heating, cooling

PROJECT BACKGROUND AND STATUS

Ground source heat pumps are one of the nation's fastest growing businesses in terms of increased sales of equipment as reported by geothermal heat pump manufactures. One reason for the fast growth of geothermal heat pumps (GHP's) used in the residential and commercial heating, cooling and water heating market is they have demonstrated that this technology can cut costs significantly by saving energy and reducing maintenance.

Identifying projects in the federal government sector and assisting with design information, with design review or trouble-shooting of projects has been implemented this past year. More of this activity is continuing and an example of the project is shown in the research results.

PROJECT OBJECTIVES

Project objectives are to identify and develop GHP projects at DOD, HUD, Postal Service and other facilities, to provide limited design, engineering, and installation assistance to these agencies personnel, utilities, A&E's and contractors on a project by project basis. Also technical training is to be conducted for selected situations.

TECHNICAL OBJECTIVES

- Technology Outreach - to identify and develop GHP projects at DOD, HUD, Postal Service and other facilities
- Technical Assistance - provide the federal sector and limited commercial entities access to experts in the geothermal heat pump field
- Technical Training -present "the state of the art" overview of geothermal technology

Expected Outcomes

Increased number of federal and commercial projects involving GHP technology through:

- identification of projects which will be viable for demonstration of the benefits,
- direct assistance to designers which will produce a cost competitive outcomes, and

- technical training so more people have the ability to perpetuate the design process.

APPROACH

A consultant (Deepak Kenkeremath) in the Washington DC area was hired to act as an outreach contact to establish viable projects within DOD and HUD. In addition, other persons aware of GHP needs in the federal sector will contact us upon identification of a project that could benefit from technical support.

With respect to technical assistance, the approach is to be available to assist in the design of appropriate federal GHP project(s) or utilities, A&E's and contractors on a project by project basis upon approval by the project officer. A team of experienced persons was organized to provide expertise in the area required by the project.

The approach for the training portion of the project is to use an experienced team of instructors to teach the topics which are needed for a particular project. The topics could include design and/or installation.

RESEARCH RESULTS

Several projects were served by this project, these include:

- preliminary support on the Statue of Liberty project,
- Austin School district, review of specifications for the Navy,
- design of a Texaco convenience store, and
- other lesser projects.

A significant project which was completed and shown in more detail was the analysis and design of a geothermal heat pump system in Building 93 at the Anacostia Naval Station located in Washington, DC. A summary of the design study and changes recommended are as follows:

1. Reduce the winter entering water temperature (EWT) from 43°F to 38°F. The lower temperature will reduce ground heat exchanger length by 30 % and still provide sufficient heating capacity and heat pump heating efficiency.

2. Increase the thermal conductivity of the ground from 0.96 to 1.08 Btu/hr-ft-°F. The bore hole test report indicated soil and rock materials that have higher thermal conductivity than was assumed.

3. Peak load for heating was changed to January (1) and for cooling in July (7).

4. The following shows the original design in comparison to results from the above changes:

   Original 50 bores, 200 feet deep or 10,000 feet
   Redesign 36 bores, 190 feet deep or 6,840 feet

   A significant lower cost should be realized. The software design package called GLHEPRO was use to determine the borehole field design.

5. Heat pumps should be selected close to the loads in the conditioned space which provides better comfort and performance along with lower costs. Costs for 29 heat pumps were based upon 2 ton units or 58 total tons versus 33 tons required according to the heat pump schedule.

6. A potential for reducing operating and first cost can be achieved by placing individual pumps (circulators) at the heat pumps and have the primary pump in the mechanical room down sized to accommodate only the loses to and from the heat exchanger field.

7. Only basic controls are needed for this project and considerable cost reduction should be realized by specifying individual digital programmable thermostats rather than any centralized system.

8. Replacing welded steel pipe with groove lock pipe systems should reduce overall costs. This has been done on even much larger projects.

9. If domestic hot water in the range of 125 to 130 °F is sufficient then considerations of 100% use of heat pumps for water heating will reduce costs.

10. Suggest water-to-water heat pump replacing the water-to-air make-up-air heat pump or use a heat (energy) wheel.

11. Possibly eliminate the hot water storage tank from the costs when considering the HVAC costs. It is a $6340 item and not found on the drawings.

A summary of recommendations and their associated cost reductions are shown in the following table:

Building Systems: 221 HVAC

		Original Costs				Revised Costs		
		Costs	Mark-up	Total		Costs	Mark-up	Total
Geothermal Wells	10,000 ft, U-bends & grout	$10,450	1.295	$13,533	6840 ft, U-bends & grout	$3,231	1.295	$4,184
	drilling services	$18,500	1.466	$27,121	drilling services	$17,000	1.466	$24,922
Field Piping	pipe & fittings	$10,000	1.295	$12,950	pipe & fittings	$4,296	1.295	$5,563
	installation	$6,000	1.466	$8,796	installation	$4,320	1.466	$6,333
Heat Pumps	29 units all 2 tons	$37,700	1.295	$48,822	29 units, actual size cost estimate	$24,650	1.295	$31,922
Controls	controls	$15,000	1.401	$21,015	controls	$6,200	1.401	$8,686
	installation	$12,000	1.586	$19,032	installation	$9,300	1.586	$14,750
Hot Water Storage	tank	$5,720	1.295	$7,407	not on drawing, assume 400 gal gas heater takes its place			
	installation	$620	1.466	$909				
			SUBTOT	$159,585			SUBTOT	$96,360
Remaining System Costs: not Revised				$97,377				$97,377
221 HVAC Total Costs				$256,962				$193,737

Cost Savings = Original - Revised = $63,224 a 25% SAVINGS

Note: Other savings are possible but need to be verified,e.g. the internal pipe. With rules of thumb given by Victaulic representatives the material costs would be increased by 10%, but the installation costs reduced by 30%.

			Original				Revised
Pipe	$1,0873	1.295	$14,081	10172*1.10 = **	$11,189.2	1.295	$14,490
Installation	$4,036	1.466	$5,902	4026*0.70 =	$2,563.4	1.466	$3,758
			$19,983				$18,248

** solder cost not included

FUTURE PLANS

Outreach activities are continuing by the consultant and others knowledgeable of the GHP needs in DOD, HUD and Postal Service. Small and significant projects will be processed as information is made available to our technical assistance group. Information gained from these experiences will be developed into case study items and used in publications and technical training sessions.

INDUSTRY INTEREST AND TECHNOLOGY TRANSFER

Industry interest is on the increase, even above that which occurred a year earlier. Cost effective results are being recognized by the federal government and private industry. We have been called after teleconferences about the architect and engineers manual developed by funding from DOE, DOD and GHPC. We have had inquiries from government and industry about who is available to help with design and installation of GHP projects.

REFERENCES

Copies of the A&E Notebooks entitled "Geothermal Heat Pump System Design Training for: Architect and Engineers" are available from the International Ground Source Heat Pump Association. Contact IGSHPA for cost information.