GEOHERMAL DIRECT-HEAT UTILIZATION ASSISTANCE

QUARTERLY REPORT

PERIOD JULY THROUGH SEPTEMBER 1993

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By
GEO-HEAT Center
Oregon Institute of Technology
Klamath Falls, OR 97601

MASTER

**FEDERAL ASSISTANCE PROGRAM
QUARTERLY PROJECT PROGRESS REPORT**

GEOHERMAL DIRECT-HEAT UTILIZATION ASSISTANCE

GRANT NO. DE-FG07-90ID 13040

Reporting Period: JULY - SEPTEMBER 1993

Paul Lienau, Project Director

**Geo-Heat Center
Oregon Institute of Technology
Klamath Falls, OR 97601**

1.0 Project Summary: July - September 1993

- 1.1 Technical Assistance. GHC staff provided assistance to 93 requests from 26 states. A breakdown of the requests according to application are: space and district heating (13), geothermal heat pumps (25), greenhouses (2), aquaculture (1), industrial (4), electric power (2), resource/well (18), equipment (12), resort/spas (4) and general (12).
- 1.2 R & D Activities. Progress is reported on: 1) Evaluation of Lineshaft Turbine Pump Problems, 2) Compilation of Data on Low-Temperature Resources, and 3) Geothermal Heat Pump Performance Evaluation.
- 1.3 Technology Transfer. Vol. 15, No. 1 of the GHC Quarterly Bulletin was sent to 1719 U.S. and 296 foreign subscribers, a chapter on Geothermal Energy Utilization is being prepared for the 1995 ASHRAE Applications Handbook, two presentations and one tour were conducted. There were 32 volumes added to the geothermal library and publications sent to 33 requests.
- 1.4 Geothermal Progress Monitor. Progress reports include: 1) Klamath Basin Earthquakes, September 20, 1993, 2) Newberry Geothermal Pilot Project EIS Update, 3) Geothermal Dehydration Plant Being Built at Empire, Nevada, 4) Geothermal Alligator Farm, 5) Carrier Corp. Introduces Water-Source Heat Pump, 6) High Marks for GSHP in Midwest Survey, 7) Boston Edison Breaks Ground with Geothermal Project, and 8) Center Earns Award.
- 1.5 GHC staff that worked on the project during fourth quarter included: P. Lienau 41%, G. Culver 73%, K. Rafferty 74%, Donna Gibson 71%, and J. Lund donated 40 hours to the project.

2.0 Technical Assistance

The Geo-Heat Center provides technical assistance including: data and information on low-temperature (4 to 150°C) resources, space and district heating, geothermal heat pumps, greenhouses, aquaculture, industrial processes and other items. Project assistance is provided to individuals, developers, and consultants of geothermal direct heat applications by means of referrals through state energy offices, DOE/Geothermal Division, and direct contact. The assistance could include preliminary feasibility studies, review of direct use project plans, assist in project material and equipment selection, analysis solutions of operating problems, and information on resources and utilization.

Geo-Heat Center staff provided technical assistance to the following during July - September 1993:

	<u>Name</u>	<u>Nature</u>
2.1	Elon Yuruit 3861 Avenida Del Sol Studio, City, CA 91604	Resort/Spa. Provided information and re-sources/hot spring data on a number of re-sort areas that Mr. Yuruit is interested in purchasing. Discussed the Symes Hotel Hot Springs in Montana. Provided water chemistry and general geology information over the phone. Also discussed greenhouse heating methods and cost estimates on unit heaters (7-1-93).
2.2	Rick Sterling Idaho Water Resources Boise, ID	Equipment. Called to inform the GHC of a pump failure at the College of S. Idaho, Twin Falls occurred in April 93 (installed in 1992). Contacted Don Butner, Maintenance Supervisor at CSI to discuss the pump. The pump is an American, 3-stage, 11-H-110 with zinkless bronze bearings. The pump bearings failed; however, column bearings made of the same material appeared to be ok (7-1-93).
2.3	Lisa Powell 210 N. 6th Street Grand Forks, ND 58203	General. Provided general information on low-temp resources and applications for a research project (7-1-93).
2.4	Gordon McKay McKay Drilling Reno, NV	Equipment. Reported that they have had a few pump problems in district heating systems in the Reno area. All the problems have been bearings in the pump, which was not considered a real problem (7-1-93).
2.5	Kent Colahan Supt. Geo. Systems K. Falls, OR 97601	Well. Requested a measurement of shut-in pressure and pressure testing of DeGroots well. When pressure tested--noted small flows in fill around cement casing. Appears well is leaking--solution will be between owner and driller (7-6-92).
2.6	Louis Templeton City of Susanville Susanville, CA	Equipment. Discussed geothermal well pump failure. Pump operated satisfactorily for 18 months; after a power failure, pump could not be started or turned with a wrench. After inspection, it appeared that a black flaky material settled into the 0.010 clearance between the impeller skirts and bowls, and bound the pump (7-6-93).
2.7	Dan Palin Consulting Engr. 1200 Tulip Lane Missoula, MT	Space Heating. Discussed using geothermal heating systems suitable for 120 - 130°F water for the Symes Hotel in Camas, Montana (7-7-93).

- 2.8 Earnest Palmer
Basin Transit Serv.
1130 Adams Street
K. Falls, OR 97601
District Heating. Basin Transit Service (BTS) is considering to use the city geothermal district heating system for a snow melt system. Provided a preliminary feasibility study which included design, equipment needed and cost estimates (7-8-93).
- 2.9 Bob Stayton
Surprise Valley
Schools
Surprise Valley, CA
Space Heating. Requested a discussion with All Weather Construction, Co. on geothermal modifications to the school. Discussed with Tony Tipton AWC, Co., plate & frame heat exchangers used to isolate school heating system from geothermal fluids, provided manufacturers, reasonable approach and ΔT s, materials selection, approximate size, etc. (7-11-93).
- 2.10 Rich Kishi
CEC
1516 9th Street
Sacramento, CA 95814
GHP. Discussed comparison of a ground-water heat pump system with a boiler/chiller system. Included an explanation of data and calculation of COP for the system (7-12-93).
- 2.11 Darrell Jackson
P.O. Box 1184
Yreka, CA 96097
GHP. Discussed results of a well test for a geothermal heat pump system for a school. Included capacity and sizing of the pipeline. Recommended a continuity of design as an important aspect of groundwater projects (7-12-93).
- 2.12 John Haldeman
15007 Hiddenwood
Houston, TX 77070
Equipment. Explained direct-use geothermal systems and heat exchangers for isolation corrosion vs. scaling (7-12-93).
- 2.13 C. J. Gustafson
P.O. Box 1606
Dolan Springs, AZ
86411
GHP. Provided information on geothermal heat pumps and referred to IGSHA for training and certification programs for installers (7-14-93).
- 2.14 VIP Realty
K. Falls, OR
Well. Requested geothermal well log of home for sale at 330 Pacific Terrace. Made copy of log and delivered to VIP (7-14-93).
- 2.15 Alfred ?
Esalen Institute
Big Sur, CA
Space Heating. Discussed possibility of funding space heating project. Wanted to know about CEC and other possibilities. Suggested Monterey library for listing of philanthropic groups (7-15-93).
- 2.16 Henry Dietz
Surprise Valley Sch.
Surprise Valley, CA
Space Heating. Requested names of experienced contractors to install heat exchangers. Provided names of two contractors (7-15-93).

- 2.17 Wes Fremeyer
Rt. 1, Box 4
Oakland, IA 51560
GHP. Discussed geothermal heat pumps and whether or not they work in all parts of country. Also discussed the advantages and limitations of the slinky and sent information on heat pump technology (7-16-93).
- 2.18 Ralph F. Fleischman
1016 Clay Avenue
Pelham Manor, NY
10803
GHP. Referred to IGSHPA for design considerations of slinky loops and offered cautions on: 1) reliability and energy efficiency are influenced by the quality of the installation (loop contractor should be IGSHPA certified), and 2) slinky installations are very sensitive to backfill procedures (7-19-93).
- 2.19 Jim Kuwada
5601 Sierra Avenue
Richmond, CA 94805
Equipment. Provided lists of suppliers for heating and cooling coil and heat exchangers (7-21-93).
- 2.20 Rick Sterling
IDWR
Boise, ID
GHP. Requested information on heat pump well permitting in other states. Idaho is "thinking" of a separate permit procedure, fees, construction, etc., for GHPs. Most states permit as water wells (7-21-93).
- 2.21 Forest Mest
VIP Real Estate
K. Falls, OR
Wells. Requested well logs for Old Fort Road area. Sent seven geothermal well logs (7-21-93).
- 2.22 Thomas Allison
Reno, NV
GHP. Requested installation instructions for a ground-coupled heat pump installation. Recommended he order Ground and Water Source Heat Pumps by S. Kavanaugh, University of Alabama (7-21-93).
- 2.23 Emily Barry
Rt. 1, Box 748
Doswell, VA 23047
GHP. Provided information on GSHPs from Water Source Heat Pump Handbook by R. Donald Dexheimer and sent a package of material on GCHPs (7-21-93).
- 2.24 Brian Brown
Fort Klamath, OR
Space Heating. Discussed Fairhaven School heating system control layout for geothermal system (7-22-93).
- 2.25 Melanie Wagner
1007 McKinley St.
West Bend, WI 53095
General. Provided materials for a paper on geothermal energy. Informed that geothermal energy is the most environmentally benign energy source with virtually no emissions of any kind associated with use in direct heat applications and in properly designed electric power generation (7-22-93).

- 2.26 Frank Hahn
5304 Jamiewood Ct.
Carmichael, CA 95608
Space Heating. Discussed Esalen Institute geothermal heating project over the phone (7-22-93).
- 2.27 Steve Molienaar
3103 Westview Road NW
Wellmar, MN 56201
GHP. Explained operation of a geothermal heat pump in terms of Carnot cycle and thermodynamics and sent material on the technology (7-22-93).
- 2.28 Dr. Crasain
ORMAT
Sparks, NV
Electric Power. Discussed geophysical work and pipeline at Clearlake. Referred to Mark Dellinger on pipeline development (7-26-93).
- 2.29 Lou Ellyn Kelly
SOCO
296 Main Street
K. Falls, OR 97601
District Heating. Conducted a preliminary review of the Winema Hotel's heating system and its potential for connection to the city geothermal district heating system. Retrofit costs were estimated at \$68,000 and recommended modifications for hot water operation were made. The geothermal rate for most customers has been approximately 50% of their past costs (7-27-93).
- 2.30 Mr. Swetland
Union Manor
K. Falls, OR
Space Heating. Discussed heating system for Union Manor, well depths nearby, etc. Trying to decide whether or not to go with natural gas or drill injection well (7-27-93).
- 2.31 John Braumbeck
Business Dev. Spec.
Fort Peck Reservation,
Montana
Greenhouses. The Reservation wants to develop a 160° to 270°F geothermal resource. Discussed greenhouses--temp requirements, types of heating systems, marketing, etc. Binary power might be possible with higher temperatures (7-28-93).
- 2.32 Gordon Ash
Cedarville, CA
General. Requested general information on Surprise Valley geothermal resources. Mr. Ash is Economic Development Director for Modoc County and is trying to get people interested in Surprise Valley resource (7-30-93).
- 2.33 Rudy Hatcher
Hatcher Engr. &
Constr., Inc.
P.O. Box 3611
Boise, ID 83703
General. Discussed low-temp projects and potential in western U.S. Installed a GSHP system for the Corp of Engineers. Looking for work on geothermal projects in western U.S. (7-30-93).

- 2.34 Randy Kessler
Duracell
GHP. Provided information on GHP installations--Portland Commonwealth Building, Yakima Co. Jail, Junction City High School, Albany General Hospital, Oklahoma State Capitol, Galt House in Louisville, KY. Also, provided contact names for above projects (7-30-93).
- 2.35 Evelyn Roeloffs
USGS
Vancouver, WA
Resource. Discussed water level and temp changes of geothermal wells in the Klamath Basin that have been noted. "Connection with future earthquakes??" (8-2-93).
- 2.36 Bart Ryder
Boulder Hot Springs
Montana
Equipment. Discussed pump and heat exchanger problems associated with geothermal space heating system (8-2-93).
- 2.37 Ted Rogers
1211 West Hill Drive
Evansville, IN 47720
GHP. Discussed geothermal heat pump as a replacement for an air-source heat pump. Sent package of information on GHPs (8-3-93).
- 2.38 Mary Lundt
Seattle Metro
Seattle, WA
District Heating. Discussed marketing effluent in Seattle. Requested a copy of K. Falls geothermal district heating marketing plan (8-4-93).
- 2.39 Chris Benson
Arkansas Energy Ofc.
1 State Capitol Mall
Little Rock, AR 72201
General. Provided guidebook, GHC Bulletins, publications listing and described technical assistance program (8-5-93).
- 2.40 Lynn McLarty
Meridian Corp.
4300 King Street
Alexandria, VA 22302
General. Provided estimates of direct-heat applications growth rate based on historical data. Estimated savings from direct-use projects at about \$189 million per year (8-5-93).
- 2.41 Betty Whitlock
Warm Springs Park
459 N. Main
SLC, UT 84103
Pool. Discussed rebuilding park with geothermal spas and pools--wanted any information available. Sent feasibility study on Children's Museum, and space and pool heating chapters from Guidebook (8-9-93).
- 2.42 Tom Van Lieu
Idaho Power
Boise, ID 83707
GHP. Discussed GHP open system for a 53-home subdivision. Also, discussed impact on injection well temperature (8-11-93).
- 2.43 John Sass
USGS
2255 N. Genimi Dr.
Flagstaff, AZ 86001
General. Requested a loan of slides on direct heat applications--drilling, K. Falls district heating, Idaho greenhouses, etc. (8-11-93).

- 2.44 Dr. Birol Kilgis
Heatway
3131 W. Chestnut
Expressway
Springfield, MO 65802
GHP. Discussed geothermal heat pumps technology, anti-corrosion and iron bacteria. Sent research report from Hackett/Lehr on iron bacteria (8-12-93).
- 2.45 Ed Henderson
RTW Engineers
1600 Stout Street
Denver, CO 80202
Resorts/Spas. Requested list of major spa/resort operators in the U.S. Developed geothermal heating system for the Glenwood Hot Springs Hotel using a custom designed hot spring heat exchanger (8-12-93).
- 2.46 Ken Whiteside
P.O. Box 34
Rico, CO 81332
Resource. Requested maps and resource data--primarily mining drill holes. Wants to use geothermal fluids for a radiant floor heating system (8-12-93).
- 2.47 Marilyn Nemzer
Geo. Edu. Office
664 Hilary Drive
Tiburon, CA 94920
General. Requested information on direct use development in Canada. Called Edison, Canada--no development resource too deep. Most of development is with GHP in the Ontario area (8-13-93).
- 2.48 Gordon Bloomquist
WSEO
P.O. Box 43105
Olympia, WA 98504
GHP. Provided an article on Large Tonnage Groundwater Systems--Yakima County Jail (8-13-93).
- 2.49 Joel Renner
INEL
Idaho Falls, ID
Well. Requested a review of cost estimates for the Boise injection well project. Submitted comments on environment assessments, design and establishment of well, design of wellhouse, pump, controls, etc., and collection pipeline (8-13-93).
- 2.50 Dennis Trexler
UNLV
Reno, NV
Industrial. Investigating sewage sludge sterilization with geothermal energy. Discussed sterilization of mushroom growing medium at Vale, OR--facilities process, and New Zealand process (8-13-93).
- 2.51 Rick Chase
1868 Lawrence
K. Falls, OR
Equipment. Geothermal heated driveway is heaving. Inspection resulted in determination of corrosion from the outside--recommended using polybutylene for replacement (8-13-93).
- 2.52 Stephanie Vajovich
P.O. Box 205
Ennis, MT 59729
Resource. Reviewed gravity and audiomagnetic telluric reports--major feature is an E-W wrench fault 1600 ft N of Ennis H.S. and intercepted by N-E faults where up-flow plume spreads thermal water below gravel 300 to 600 ft S and at least 5000 ft N. Identified well depth and temp, and bedrock of wells drilled in plume.

Plume does not extend 1 mile S to Sportsman Lodge--recommend using 500 ft well for GHP. Sent report and GHP papers (8-18-93).

2.53 Jim Haberman
Pacific Power
920 S.W. Sixth St.
Portland, OR 97204

GHP. A groundwater heat pump was proposed at Yreka High School. Informed Pacific Power that the GHC made recommendations concerning well drilling and testing, and also, at a later date, an alternate system design to accommodate the reduced flow along the pump and piping requirements. Explained the GHC's technical assistance program and offered similar assistance for other groundwater systems if it becomes necessary (8-23-93).

2.54 Debby Brown
411 Pacific Terrace
K. Falls, OR

Well. Attempted to log well, but could not get probe down between pipes. Measured static water level at 40 ft 9 in. (8-25-93).

2.55 Phil Rose
429 Pacific Terrace
K. Falls, OR

Well. Logged well with total depth of 194 ft. Temp. 63.2°C @ 175 ft to 64.1°C @ 50 ft, obviously circulating. Sent letter (8-25-93).

2.56 Owen Johnson
106 Ruste Road
Barneveld, WI 53507

GHP. Discussed both open and closed loop technologies applied to geothermal heat pumps. Sent papers describing technologies, list of manufacturers and recommended contacting utility for incentive program (8-25-93).

2.57 Dennis Trexler
UNLV
Reno, NV

Industrial. A new vegetable dehydrator near Gerloch will be discharging effluent of 600 to 700 gpm at 160°F. Proposes to use effluent for greenhousing and soil warming. Requested information on dryer coil design (8-25-93).

2.58 Nancy Rader
Boston, MA

GHP. A consulting firm is doing DSM study for Boston Edison. Discussed GHP in terms of winter peak vs. summer peak benefit (8-25-93).

2.59 Donald Yamada
USGAO
301 Howard Street
San Francisco, CA
94105

General. Mr. Yamada is preparing a report to Congress on direct uses. Requested databases for direct use and geothermal heat pumps, the new low-temp resource database for Utah, last three Direct Heat Utilization Assistance quarterly reports and CEC database on financial assistance to direct use projects (8-25-93).

- 2.60 Doug Wescott
2949 Seattle Avenue
Bonanza, OR 97623
Electric Power. Discussed proposed circulation of liquid nitrogen in ground to generate electric power. Explained geothermal binary technology (8-25-93).
- 2.61 Ilene Kerr
Kerr Aquafarms
60556 County Rd. E
Center, CO 81125
Aquaculture. Discussed Kerr Aquafarms which consists of a 13-acre pond, 6 half-acre separate ponds and 2 one-acre raceways raising tilapia, channel catfish and large mouth bass. The facility has been in operation for 17 years and is supplied by a free flowing geothermal well producing 1500 gpm at 97°F (8-26-93).
- 2.62 Tak Yoshida
Portland, OR
Resort/Spa. Reviewed geophysical report prepared by Geosciences from Japan on potential for geothermal near Carson Hot Springs near the Columbia River. Two sites are being considered: 1) property (need to purchase) near Carson H.S. which would require a pipeline crossing the Wind River, and 2) drilling 3000 ft on Mr. Yoshida's property. Discussed costs of pipeline and problems related to Wind River crossing. The project consists of space heating approximately 72,000 ft² and supplying spas and swimming pools (8-26-93).
- 2.63 Stefanie Colvin
UURI
SLC, UT
GHP. Requested case studies on commercial, retail, schools, etc., and utility programs. Several examples were sent with geographic data, rebate information and operating description (8-26-93).
- 2.64 Judy Alexander
Alaska Energy Office
Juneau, AK
GHP. Discussed geothermal heat pump technology and recommended Ground and Water Source Heat Pumps handbook by Steve Kavanaugh (8-26-93).
- 2.65 H. C. Fruitt
P.O. Box 1859
Pagosa Springs, CO
81147
Equipment. Discussed brazed plate-heat exchanger report and resource management. Sent copy of K. Falls Resource Management Act (8-26-93).
- 2.66 Chad Corol
K. Falls, OR
Space Heating. Discussed design of geothermal heating system for home--forced air wall units vs. central forced air. Central system is more expensive (8-30-93).

- 2.67 Jim Andrews
Thermal Pipe Co.
Portland, OR
Equipment. Discussed possible direct use projects in western U.S. Installing pre-insulated ductile iron pipe for city of K. Falls district heating system extension to the Ross Ragland Theatre (8-30-93).
- 2.68 Evelyn Roeloffs
USGS
5400 MacArthur Blvd.
Vancouver, WA 98661
Resource. Provided water level records believed to be associated with earthquakes (9-1-93).
- 2.69 Bob ?
Henley area
K. Falls, OR
GHP. Discussed GHP options--DX vs. open systems vs. closed loop. Suggested closed loop because existing well has iron bacteria. He is working with United Mechanical and Thomas Sheet Metal on the project (9-1-93).
- 2.70 Dr. Chandrasekharam
Department of Earth
Sciences
Indian Inst. of Tech.
Powai, Bombay
400 076 India
District Heating. Requested information on geothermal district heating systems. Sent report of review of U.S. Geothermal District Heating Systems, GHC Bulletins and reference list (9-4-93).
- 2.71 Russ Dunn
K. Falls, OR
Equipment. Discussed backfill with pea gravel as a substitute for pumice in the pipe installation extension for Ross Ragland Theatre from city geothermal district heating system. Insulation will not be as effective (9-9-93).
- 2.72 Rick Chase
1868 Lawrence
K. Falls, OR
Snow Melt. Provided key characteristics of modern radiant slab system:
• Polybutylene or polyethylene piping
• Glycol circulating fluid
• Continuous piping loops
• Piping embedded in slab (min. 2 in. cover)
• 6 to 12 in. centers (9-10-93).
- 2.73 Dick Hansen
1043 S. Garfield
Denver, CO 80209
General. Provided disk containing HEATTOOLS in Lotus 123/Quattro Pro format (9-10-93).
- 2.74 Vonna Kirk
19515 S. Sprague Rd.
Oregon City, OR 97045
Well. Well of depth 80 - 100 ft always "ice cold." About mid-July, warmed up. Had her measure temperature with candy thermometer--122°F. Referred to DOGAMI and informed Volcano Watch (Evelyn Roeloffs, USGS) (9-13-93).

- 2.75 Don Yamada
USGAO
San Francisco, CA
Well. Requested costs of drilling direct-use wells, 275 to 3030 ft, a max. and min. cost. Gathered information on well costs over last 3 - 5 years in western U.S. and sent same (9-13-93).
- 2.76 Paul Ramoundos
605 Chapman Street
Hillside, NJ 07205
GHP. Discussed installation and operation of different types of geothermal heat pumps. Provided list of manufacturers and address of heat pump association in the northeast (9-14-93).
- 2.77 Don Brown
LASL
Los Alamos, NM
Industrial. Requested information on U.S. TEOR. Told him I did not think geothermal fluids were being used for TEOR. Referred to Jane Negus de Wys and Oil & Gas Journal, April 1990 (9-14-93).
- 2.78 Bill Clark
Geothermal Energy
Systems Tech, Comm.
Society of Mechanical
Engineers
General. Answered questionnaire on research needs to make technology more cost effective. Gene Culver volunteered to review proposals and serve as committee member (9-15-93).
- 2.79 Dale Burgett
Burgett Floral
Animas, NM
Greenhouses. Discussed problems with BLM --they want to measure enthalpy at each 6 wellheads and out of greenhouses for royalty charges. BLM wants vortex shedding meters at a cost of tens of thousands dollars. Discussed possible options over the phone (9-17-93).
- 2.80 Harold Heaton
600 Hillside
K. Falls, OR
Well. Drilled well to a TD of 525 ft in 1992. Has 400 ft of DHE, SWL is about 200 ft. The well does not heat the house; it cools down when loaded. Looked up several wells nearby--all good, one next door heats 3 large houses. Drilled lower portion with mud rotary. Suspect mud invasion. Recommend bailing and rawhiding; if it doesn't work, deepen 25 ft (9-17-93).
- 2.81 Bill Christofferson
2773 Graham Road
Belvedere, IL 61008
GHP. Discussed GHPs, both open systems and closed loop; sent information (9-17-93).
- 2.82 Stephen Longchamps
87 Vincent Drive
Newington, CT 06111
GHP. Sent package of information on GHPs (9-20-93).

- 2.83 Johnna Polson
1965 Manzanita
K. Falls, OR
Well. Want to drill a geothermal well and requested information on nearby wells. Data on 8 wells includes depths of 125 to 415 ft and temperatures of 198 to 200°F. Recommended a cable tool rig be specified and provided names of two contractors (9-20-93).
- 2.84 Louis Templeton
City
Susanville, CA
Equipment. Susan 1 rebuilt pump lasted about 1/2 hr., will not turn when in well, but can turn by hand laying down. Has rubber pump bearings, which swell in hot water. Also, column hard to get apart; recommend using Texaco Thread Tex, local pump people use it in hot wells (9-21-93).
- 2.85 Stanley Ericsson
P.O. Box 841
Mobile, AL 36526
GHP. Discussed "slinky" vs. vertical ground loop and manufacturers. Suggested he contact IGSHPA for loop contractors (9-21-93).
- 2.86 George Priest
DOGAMI
Portland, OR
Well. Discussed Kirk well near Oregon City that heated up (9-22-93).
- 2.87 Betty Holmes
605 Hill Avenue
K. Falls, OR
Equipment. Discussed problems with CPVC expanding and breaking. Recommended at least two 4 ft expansion loops with loops left open (covered) so pipe can move (9-22-93).
- 2.88 Sothmore Moran
Univ. of Washington
Seattle, WA
Well. Discussed well behavior before and after the earthquake. Also, to get info on hot water wells (9-22-93).
- 2.89 Jim Dewey
USGS
National Earthquake
Center
Golden, CO
Well. Met to discuss geothermal well behavior relative to earthquake and damage to buildings (9-22-93).
- 2.90 David Farnsworth
Portland, OR
Well. Installed an EMT seismic device between OIT geothermal wells 5 & 6. Provided K. Basin fault map and well hydrographs (9-23-93).
- 2.91 Ron Huebert, Supt.
Modoc Joint Unified
School District
906 W. Fourth Street
Alturas, CA 96101
District Heating. Discussed bids for building district heating system primarily for school buildings (9-28-93).
- 2.92 Clayton Gillespie
239 W. Lake Circle
Madison, AL 35758
GHP. Sent information package on GHP (9-30-93).

- 2.93 Ron Stryer General. Discussed project opportunities
Strategic Resources for companies with hydrologic experience.
Group Provided reference listing and Bulletins
1611 116th Avenue (9-30-93).
Bellevue, WA 98004

3.0 R & D Activities.

The direct use research and development program objectives are to aid the industry in resource and technical development problems. To investigate and analyze methods or approaches of reducing costs of developing, designing and operating low-temperature geothermal projects.

During the current reporting period work involved: 1) Evaluation of Lineshaft Vertical Turbine Pump Problems, 2) Compilation of Data on Low-Temperature Resources, and 3) Geothermal Heat Pump Performance Evaluation.

3.1 Evaluation of Lineshaft Vertical Turbine Pump Problems.

This project relies on reports of pump failures in the field. The April - June 1993 progress report documents specific pump failures for: 1) Susanville District Heating System - Susan No. 1 Well, 2) Modoc High School - Well No. AL-1, 3) College of Southern Idaho - well pump, and 4) Paisley, OR - well pump in terms of pump description, symptoms, inspection and conclusions.

On September 21, 1993, it was reported that the Susan-1 rebuilt pump lasted about 1/2 hour. The pump shaft would not turn in the well with a 75 horsepower motor; however, after it was pulled and laying on the ground, it could be turned by hand. The pump has rubber bearings, which may have swelled in the hot water causing the pump to seize. The bearings in the pump were replaced with bronze and has been operating satisfactorily for about two weeks.

3.2 Compilation of the Data on Low-Temperature Resources.

State geothermal resource assessment teams for ten states are compiling and updating their low-temperature (20° to 150°C) geothermal resource inventories. Each state is preparing a comprehensive digital database in tabular format and a resource map at a scale of 1:1,000,000. The compilations will include resources, many of which have potential to supply district heating systems for collocated cities as well as greenhouses, aquaculture, industrial and other process applications.

The State Teams, under subcontract to OIT and with guidance from UURI, are reviewing drilling records and other information to identify new resources and verify temperatures and flow rates of springs and wells which may have changed substantially since the previous statewide geothermal resource inventory. The databases

are being organized into tables linked by common data fields, using the preliminary database from the Utah Geological Survey as a model for uniformity in presentation. Information to be contained in the tables include:

Location Information

<u>Field Name</u>	<u>Field Contents</u>
Record Id:	Unique assigned identifier
Source name/owner:	Name of spring of well owner
County:	Two-letter county code
Latitude:	In decimal degrees
Longitude:	In decimal degrees
Cadastral location:	Section, township, range
UTM coordinates:	

Descriptive Information

Type of source:	Well or spring
Temperature:	In degrees celsius
Depth:	Well depth in meters
Status:	Pumped or flowing
Flow rate:	In liters per minute
Water level:	Depth in meters to potentiometric surface, negative if above ground
Reference:	Source of data

Water Chemistry

Conductance:	In microsiemens
pH:	In pH units.
Major cations:	In milligrams per liter
Major anions:	In milligrams per liter
TDS:	in milligrams per liter
Charge balance:	in meq/L, cations/anions
Stable isotopes:	$\delta^{18}\text{O}$ and $\delta^2\text{H}$

The status of the State Teams inventories in terms of the number of well and thermal spring records entered into the databases to date and compared with those of 1982 are given below:

<u>State</u>	<u>Agency</u>	<u>Data Entries</u>	
		<u>1993</u>	<u>1982</u>
California	Division of Mines & Geology	551	486
Colorado	Colorado Geological Survey	170	120
Idaho	Idaho Water Res. Research Institute	N/A	900
Montana	Bureau of Mines & Geology	327	96
New Mexico	S.W. Technology Dev. Inst.	700	N/A
Arizona	" "	N/A	N/A
Nevada	Bureau of Mines & Geology	N/A	796
Oregon	Dept. of Geology & Mineral Industries	2,500	609
Utah	Utah Geological Survey	572	209
Washington	Division of Geology & Earth Science	971	338

3.3 Geothermal Heat Pump Performance Evaluation.

The geothermal heat pump system is one of the promising new energy technologies that has shown rapid increase in usage over the past ten years in the United States. The intention of this study is to evaluate the actual energy benefits of geothermal heat pump systems.

The results of the study comes from a comparison of 217 monitored and theoretical studies across the U.S. that attempt to compare geothermal heat pump systems with competing technologies.

The study attempts to accurately portray the GHP energy savings opportunities (kWh) and from energy savings project an economic analysis. It evaluates the ability of GHP systems to reduce utility peaking power loads (kW). Information is being collected and interpreted on utility marketing and incentive programs, benefits to utilities, barriers to market entry and number of GHP installations in service areas.

The preliminary conclusions that can be drawn from the energy comparative survey is that GHP technology is effective in saving energy over all other electrical heating systems, typically on the order of 15 to 35% over air-source systems and 25 to 60% on electrical systems. The savings for a residential system in \$/year over an air-source heat pump system was typically found to be in the range of \$200 to \$350/yr (electrical costs calculated at \$0.075/kWh).

Compared to non-electric heating systems, the GHP was found to save significant energy costs over liquefied petroleum gas (LPG) systems, but have very small to no savings over natural gas systems. GHP systems had a dollar savings per year over LPG systems on the order of \$498 to \$731 per year or 35% to 58%.

Due to additional cost of the ground loop, in most cases the economic payback of the system requires an incentive to be attractive and in some cases there is no economic justification.

Based on contact with nearly 60 utilities, they see GHPs as a peak reducing demand-side management (DSM) tool and many offer incentives of some kind. Incentive programs offered to customer could include: rebates of \$125 to \$500 per ton of installed capacity, low-cost loans, discounts on electric rates for GHP systems, and in some cases install ground loops. The main barrier to market entry of GHPs are higher initial costs (\$800 to \$1000/ton) due to incremental cost of the ground loop. A lack of an infrastructive of loop installers, dealers and experienced contractors is another problem.

The report will be presented in eight sections as follows:

- I - National Energy Concept of GHP Systems
- II - Residential Monitoring of Systems
- III - Residential Energy Usage
- IV - Power Peaking Analysis

- V - School Systems
- VI - Commercial Systems
- VII - Economic Analysis
- VIII - Utility Programs for GHPs

Each section will contain three subsections:

- A. Summary - A comparison of the savings by all case studies related to that section topic.
- B. Examples - Two to four of the best examples of the case studies related to that topic are included to demonstrate the level of analysis that was involved.
- C. List of Case Studies - The list includes a synopsis of pertinent conclusions drawn by each case study evaluated in this section.

A draft of the report for reviewing agencies should be available by the end of November 1993.

4.0 Technology Transfer.

The Geo-Heat Center prepares and publishes information and educational materials on direct heat applications that includes: a quarterly Bulletin, technical papers, computer programs and progress monitor activities. In addition, resources of a technical library and tours of geothermal facilities in the Klamath Falls area are made available.

4.1 Geo-Heat Center Quarterly Bulletins. Bulletin Vol. 15, No. 1 was distributed in August to 1719 U.S. and 296 foreign subscribers. Articles featured in the Bulletin included:

- "Alturas - The Development of a Blind Resource" by Gene Culver
- "Marketing the Klamath Falls Geothermal District Heating System" by Kevin Rafferty
- "Brazed Plate Heat Exchangers for Geothermal Applications" by Kevin Rafferty
- "Review of Histogrammic Aspects of Geothermal Energy in the Mediterranean and Mesoamerican Areas Prior to the Modern Age" by Raffaele Cataldi
- "Low-Temperature Resource Assessment Program Update" by Paul Lienau and Howard Ross
- "Geothermal Pipeline - Progress and Development Update from the Geothermal Progress Monitor"

4.2 Technical Papers, Presentations and Tours.

- 1. Technical Paper. Preparing a chapter for the 1995 ASHRAE Handbook of Applications titled: Geothermal Energy Utilization.

2. Presentation. A meeting was held at the Utah Geological Survey with the State Teams participants, Low-Temperature Program, to coordinate presentation of the databases and establish priority criteria for 5 to 10 resource areas for detailed studies (July 8-10, 1993).
 3. Presentation. "Geothermal Energy in the United States" to 20 students from Mouran Institute, Tokyo, Japan (8-13-93).
 4. Tour. Discussion held with Mr. Tak Yoshida, Portland, Oregon, on development of resource and 72,000 ft² hotel and spa facility at the confluence of the Wind and Columbia River. Toured OIT geothermal system, and pipe installation downtown Klamath Falls (9-30-93).
- 4.3 Geothermal Library. Twenty-two volumes were added to the library during the fourth quarter. Work continued with the computerized library system with 2760 entries of the library in the program.
- 4.4 Information Dissemination. The GHC provided the following individuals with publications:

<u>Name</u>	<u>No.</u> <u>Publications</u>	<u>Nature</u>
<u>7/1/93</u>		
Paul McKee Fernley, NV 89408	2	GHP
Klint Krouse Ft. Wayne, IN 46801	2	GHP
Tom Harrison Cincinnati, OH 45255	2	GHP
<u>7/7/93</u>		
Russell Reed Winnfield, LA 71483-1260	5	GHP Other
Ruben Castillo Winnfield, LA 71483-1260	5	Other
<u>7/14/93</u>		
C. J. Gustafson Dolan Springs, AZ 86441	5	GHP
<u>7/15/93</u>		
Steve Molienaar Willmer, MN 56201	2	GHP

7/19/93

Ralph F. Fleischman
Pelham Manor, NY 10803

2

GHP

7/20/93

Wes Fremeyer
Oakland, IA 51560

2

GHP

7/21/93

Emily Barry
Doswell, VA 23047

2

GHP

7/22/93

Melanie Wagner
West Bend, WI 53095

8

Other

7/27/93

Richard Hatch
Condon, OR 97823

3

GHP

Joel Birman
S. Pasadena, CA 91030

7

GHP
Other

7/30/93

Ted Rogers
Evansville, IN 47720

3

GHP

8/2/93

Ben Lunis
Ashton, ID 83420

1

Other

Ray Miller
Cincinnati, OH 45207-4111

3

GHP

8/11/93

Marilyn Ayers
Oak Ridge, TN 37831-6070

3

Other

Tom Van Lieu
Boise, ID 83707

5

GDH

C. J. Gustafson
Dolan Springs, CO 86441

6

Greenhouses
GHP

8/16/93

Betty Whitlock
Salt Lake City, UT 84103

1

GHP

8/18/93

Joe Birman S. Pasadena, CA 91030	42	Other
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Dr. Birol Kilkis Springfield, MO 65802	6	Other
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8/23/93

Owen Johnson Barneveld, WI 53507	2	GHP
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9/15/93

Mihaly Szoes Hungary	4	Other
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Dr. Belhamel Algeria	3	Other
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Paul Ramoundos Hillside, NJ 07205	2	GHP
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9/21/93

Stephen Longchamps Newington, CT 06111	2	GHP
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9/28/93

Monte Somervell Woodbrine, NJ 08270	2	GHP
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9/30/93

Clayton Gillespie Madison, AL 35758	2	GHP
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Ron Stryer Bellevue, WA 98004	3	Other
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Stanley Ericsson Daphne, AL 36526	2	GHP
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Tom Felmley Rico, CO 81332	6	Other GDH
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David Wheeler Glenshaw, PA 15116	3	GHP
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5.0 Geothermal Progress Monitor

5.1 Klamath Basin Earthquakes, September 20, 1993.

Two moderate earthquakes occurred approximately 30 km northwest (122.1°W and 42.3°N) of Klamath Falls, Oregon, on the evening of September 20th. These two were measured at M 5.9 and M 6.0 by the University of Washington and occurred at an approximate depth of 20 km. (The USGS National Earthquake Information Center in Golden, Colorado, reported the magnitude at 5.4 and 5.2 at depths of 10 km.) Numerous after-shocks measuring between M 2.8 and M 4.3, occurring in the same general vicinity, were felt in the area through September 24th. The earthquakes were felt in Salem (300 km north) and in Redding, California (150 km south). One person was killed by falling rocks on highway US 97, approximately 25 km north of town, and one person died of a heart attack, probably induced by the events. Over 100 buildings were damaged by the quakes, several serious enough to be closed to public use. The water levels of geothermal wells in the area, which number over 500, were affected to some degree.

Figure 1. Plot from University of Washington Geophysics Program based on data from combined USGS northern California and Washington-Oregon seismic networks.

5.2 Newberry Geothermal Pilot Project EIS Update

Since the last EIS Update, the EIS team has been working with the USFS, BLM and BPA, as well as with CE Exploration and Eugene Water & Electric Board, to further refine and develop alternatives for the project. Transmission line routes and access roads have now been defined, along with alternative drill pad sites. In addition, the team is analyzing possible effects from the proposed project.

Work is also under way on the baseline studies. The field surveys are completed, along with the reports on geothermal hydrology, vegetation, cultural/archaeological resources and wildlife. Air quality studies are in progress, including one which will predict the approximate height and density of the steam plume from the cooling towers (and other activities, such as well testing) during various seasons and weather conditions. This air quality study is taking longer than originally expected. The analysis of visual impacts has also been delayed because it depends on the outcome of the plume predictions. When these two reports are completed, the draft EIS (DEIS) can be completed. Publication of the DEIS is expected later this year.

5.3 Geothermal Dehydration Plant Being Built at Empire, Nevada.

Integrated Ingredient's new state-of-the-art plant will feature the processing and year-round storage of dehydrated onion and garlic products. Clean and environmentally safe geothermal resources will be utilized to produce the heat required for dehydration.

The recent expansion of the Burns Philp's North American spice operations are due to the acquisition of Durkee-French. This acquisition has generated a huge increase in their requirements for dehydrated onion and garlic, two of the largest purchased spices in North America.

The new facility will enable the company to produce its current industrial and consumer requirements at a considerable cost savings instead of purchasing garlic and onion externally.

Mr. Andrew Turnbull, Managing Director/CEO, said "This new facility forms part of Burns Philp's strategy to direct-source as many herbs and spices as possible and brings it one step closer to being a full service supplier."

Burns Philp Food, Inc. is well-known to the food industry, under the Integrated Ingredient's marketing umbrella as Spice Islands and Durkee-French brands for spices, herbs, seasoning and blends. Other brands within Burns Philp Food, Inc. include Fleischmann's Yeast, Fleischmann's Vinegar, Dromedary Products, Blue Ribbon Spices, Pure Culture Products and Mauri Laboratories. For information, contact Linda Garcia-Lum at (510) 748-6362.

5.4 Geothermal Alligator Farm

An alligator and catfish farm using geothermal waters is being developed in the Raft River area of Cassia County, Idaho. Mr. Garland Larson plans to raise thousands of alligators and to eventually produce 6 million pounds of processed catfish per year.

The alligators will be raised for meat and skins. It is expected that carcasses of farm animals and chemical high-protein fodder will be used to feed the alligators. A hatchling alligator will take about 2 years to reach a 6 ft length.

Most of the meat will be shipped to southern states at first; but, Mr. Larson hopes people in Idaho will also take a liking to it. (Source: Aquaculture News, September 1993).

5.5 Carrier Corp. Introduces Water-Source Heat Pump

Carrier Corp. is making a splash with water-source heat pumps.

The 50YS "WeatherMaker" GT Water-Source Comfort System uses heat from the earth and groundwater to heat and cool homes more cost effectively than conventional systems, according to the manufacturer.

While the exact amount of energy savings varies with climate, home, and current comfort system, a typical homeowner can expect to save up to 60% to 70% on heating and 30% to 40% on cooling, the company says.

"Carrier is entering this market to allow dealers to respond to increasing demand from homeowners for this environmentally sound, highly efficient option for heating and cooling," says John Manning, senior product manager for residential water-source systems.

Manning points to a recent study by the Electric Power Research Institute showing a high degree of customer satisfaction with water-source systems compared to conventional systems. The federal Environmental Protection Agency also has acknowledged the benefits of ground-source technology.

With water-source system, part of the heat used to warm the home is free. Two-thirds of the energy comes naturally from the ground. The homeowner pays only for the energy used to move and enhance this natural heat, according to Carrier.

Optional water heater

A water heater is optional with this system.

In summer, heat extracted in the cooling process goes directly into the home's water tank, providing "free" hot water with the added benefit of improving overall system efficiency, the company says.

All piping is underground; condensing equipment is tucked away in the closet, attic, or basement, for quiet, unobtrusive operation.

Because the system is installed indoors, the compressor and other components are protected from the elements. The earth's stable temperature and the elimination of the need for defrost cycles translates into stable system operation, according to Carrier.

The WeatherMaker GT achieves an EER of up to 15, and a COP heating rating of up to 4. Some utilities offer incentives for installing geothermal systems, including Niagara Mohawk in upstate New York, which offers a \$900/ton rebate.

"Since most home systems are three to four tons, this amounts to a \$2,700 to \$3,600 rebate--enough to pay for installing the loop in the ground," Manning notes.

Carrier water-source system dealers are trained and certified to install the WeatherMaker GT by the International Ground Source Heat Pump Association (IGSHPA).

5.6 High Marks to GSHP in Midwest Survey

Ninety-five percent of those responding to a recent survey said their ground-source heat pump (GSHP) met or exceeded their expectations.

The survey was conducted last spring through local electric cooperatives, in the Associated Electric Cooperative system in Missouri and southeast Iowa. The survey was conducted by National Rural Electric Cooperative Association (NRECA) Market Research, Lincoln, Nebraska.

In addition, 94% of the respondents said they would install a GSHP again, and 99% said they would recommend one to a friend.

"The findings are fairly consistent, maybe even a bit higher than the ground-source heat pump customer satisfaction we've found in other co-op areas around the country," said Dennis Hein, NRECA project director.

"The ground-source system simply gets the highest marks from the customer of any heating and cooling system I've seen."

The survey was sent to 301 households where GSHP systems have been rebated by cooperatives from 1986 through 1992. Among the results:

- Respondents rated GSHPs an average 9.5 on a 10-point scale in providing summer air conditioning, and an average 8.7 in providing winter cooling.
- Eighty-two percent of the respondents said GSHPs were the same or quieter than other HVAC systems; 17% said they were noisier.
- Eighty-six percent said operating cost savings met or exceeded expectations; 9% said they did not save as much as expected.
- Eighty-one percent said GSHPs produce the same or better heating than their old system; 17% said they produced worse heating.
- Eighty-seven percent said they were satisfied or very satisfied with their GSHP; 12% said they were dissatisfied or only somewhat satisfied.

Respondents also were asked to list desirable and nondesirable features. Low operating costs (29%) and high efficiency (20%) were the most desirable. Not enough heat output (10%), noise (8%), and high first cost (6%), were the least desirable.

Eighty-six percent of respondents said their GSHP had a desuperheater water heater, 46% used no backup heating, and 28% used electric resistance backup. Half were installed in new homes and 26% replaced electric systems, and 24% replaced gas or wood systems.

Fifty-three percent learned about GSHPs from their electric cooperative, 24% from friends or relatives, and 9% from ads.

For more information, contact Associated Electric Cooperative, 2814 S. Golden, P.O. Box 754, Springfield, MO 65801. (Source: Air-Conditioning, Heating and Refrigeration News, September 6, 1993).

5.7 Boston Edison Breaks New Ground with Geothermal Project

A large, energy-efficient geothermal heat pump system is being installed in a new Boston housing complex thanks to an innovative marketing program administered by Boston Edison. The advanced geothermal system, which will use three 1500-ft standing-column wells, will provide heating, cooling, and water heating for the 123-unit St. Cecilia's House elderly housing development being built for the Archdiocese of Boston.

Through the utility's Energy Crafted Home (ECH) demand-side management program, the archdiocese will receive approximately \$178,000 in incentives to apply to the cost of the geothermal system and other new-construction shell measures such as increased insulation and high-efficiency windows and lighting.

The ECH program was developed by Boston Edison and other New England utilities to encourage energy efficiency in new construction. The program offers training and cash incentives to builders, architects, and engineers who design and build houses that meet ECH standards.

"The program goes significantly above code in terms of envelope tightness, insulation levels, and appliance efficiency," says Jim Sugden, residential HVAC product manager at Boston Edison. "We also promote high-efficiency heat pumps in the program, especially geothermal heat pumps. As a result of these efficiency measures, ECH construction produces an energy savings of 40 - 50% compared to standard code-built construction."

Boston Edison first proposed the geothermal system to the Archdiocese as a way to qualify St. Cecilia's House for additional incentives under the ECH program by using a high-efficiency electrotechnology. The utility then brought in experts to explain geothermal installation and operating principles to the project's architect-engineers, who were unfamiliar with the technology.

The geothermal installation is a reversible water-to-water "two-pipe" hydronic system that will carry either heated or chilled water through the building--heated in winter, chilled in summer. Each room will be equipped with a fan coil that will blow conditioned air off the pipe surface into the living space. The system will use two ClimateMaster 40-ton water-to-water heat pump "stacks", providing 80 tons of capacity in all. The system will also provide domestic hot water--a major energy use in elderly housing facilities.

A notable feature of the installation is the use of standing column wells. In typical geothermal applications, water-source heat pumps are connected to buried plastic pipes filled with circulating antifreeze. These closed pipes serve as heat exchangers, absorbing heat from the earth in the winter and rejecting heat in the summer.

With a standing-column well, in contrast, the ground coupling is achieved via a vertical column of water under atmospheric pressure. Well water is supplied to the heat pump's water-refrigerant heat exchanger and returned to the well through open pipes. The water conditioned by the heat pump circulates through the living space in a closed loop.

The standing column well configuration offers several advantages, according to Carl Orio, president of Water and Energy Systems and a consultant to Boston Edison. "A standing-column well uses about 60% less borehole than a closed loop/closed pipe system--about 60 linear feet of borehole per ton instead of 150 linear feet per ton. Moreover, standing-column wells allow us to use standard well-drilling techniques to achieve deeper holes--1500 ft is common--so we get 25 tons per hole. That's how we can get by with only three wells in this installation, instead of forty or so wells."

Construction of St. Cecilia's House will begin this fall and is scheduled for completion in spring 1994.

For more information contact Jim Sugden, Boston Edison, (617) 424-2943, or Carl Orio, Water and Energy Systems (603) 362-4666. (Source: EPRI Heat Pump New Exchange, October 1993)

5.8 Center Earns Award

The OIT Geo-Heat Center has received a special achievement award from the Geothermal Resources Council (GRC).

The award recognizes the Center's efforts in developing "practical, hands-on", cost effective techniques for harnessing geothermal resources, location and development research and "economic and practical assistance" to those interested in geothermal direct-use.

In presenting the award, Gerald Hutterer representing the GRC, noted that the OIT Geo-Heat Center staff "has become internationally recognized as the leading source of information regarding direct use topics."

Geo-Heat Center staff members include Gene Culver, Paul Lienau, John Lund, Kevin Rafferty and Bob Rogers.

Paul Lienau accepted the award and accompanying plaque on behalf of the Center at the Council's annual meeting in early October.

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