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Quarterly Report

ENERGY PROGRAMS

at The Johns Hopkins University Applied Physics Laboratory

JANUARY—MARCH 1981

THE JOHNS HOPKINS UNIVERSITY • APPLIED PHYSICS LABORATORY

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THE JOHNS HOPKINS UNIVERSITY ■ APPLIED PHYSICS LABORATORY
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FOREWORD

The Applied Physics Laboratory issues the Quarterly Report series to provide the defense establishment and the scientific community with current awareness of selected APL activities. At present, the Quarterly consists of the following volumes:

<u>Programs</u>	<u>Report Designators</u>
<u>Department of Defense Programs</u>	
Research and Development	RQR
Exploratory Development for Missile Propulsion	DQR
<u>Civil Programs</u>	
Energy	EQR
Biomedical Research, Development, and Engineering (Annual Report)	MQR

The nomenclature for the APL Quarterly Report is as follows. The designation for Quarterly Report, "QR," is preceded in each case by a letter that indicates the volume's program area. After the "QR," a virgule is followed by a year indicator (e.g., "77-") and a number from 1 to 4 to specify the calendar quarter.

The format is flexibly designed so that most technical articles can be presented on a single sheet of paper. Each article is given a section number (e.g., §24), which applies to the current Quarterly only. Each article is keyed to its major program area (e.g., Research and Exploratory Development), its technical instruction (e.g., Amorphous Semiconductors), its budget code (e.g., A3), the Laboratory Group or Groups that performed the work (e.g., BBE), and the agency that supported it (e.g., SEA-62R).

Certain Laboratory programs, including some that report a portion of their activities through the Quarterly Report, use document series other than the QR to report the bulk of their activities. Those series are available only to individuals and organizations that are directly concerned with the specific programs involved.

Requests for Quarterly Reports should be directed to: Supervisor, Technical Publications Group, Applied Physics Laboratory, Johns Hopkins Road, Laurel, Maryland 20810.

PREFACE

The Johns Hopkins University Applied Physics Laboratory, under contracts with several agencies of the federal government, is engaged in developing energy resources, utilization concepts, and monitoring and storage methods. This Quarterly Report summarizes the work on the various tasks as of 31 March 1981.

The Energy Quarterly Report is divided into three sections. The first, Geothermal Energy Development Planning and Technical Assistance, supported by the Department of Energy/Division of Geothermal Energy (DOE/DGE), contains reports on the progress of geothermal-related tasks on which effort was concentrated during the quarter.

The second section, Siting of Critical Facilities, supported by the Nuclear Regulatory Commission (NRC) and in-house funds, contains reports on geologic investigations in western Connecticut and areas in adjacent New York, development of seismotectonic domains, and fracture permeability in siting hazardous waste repositories.

The third section, Energy Conservation and Storage Techniques, supported by the Argonne National Laboratory (ANL), reports on institutional barriers to landfill methane recovery and the need for state legislation.

THE
FEDERAL BUREAU OF INVESTIGATION
UNITED STATES DEPARTMENT OF JUSTICE
WASHINGTON, D. C. 20535

TO : DIRECTOR, FBI (100-442101)
FROM : SAC, NEW YORK (100-100000) (P)
SUBJECT: [Illegible]

RE: [Illegible]
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TABLE OF CONTENTS

GEOTHERMAL ENERGY DEVELOPMENT PLANNING AND TECHNICAL ASSISTANCE

DEVELOPMENT OF GEOTHERMAL ENERGY IN THE EASTERN U.S.

§17	Geothermal Technical Assistance	9
§18	Geothermal Market Study: Georgia	13
§19	Economics of Geothermal Energy Application	15
§20	Aid to State and Local Governments	17
§21	Overview - Geothermal Energy Development in the Eastern United States	19
§22	Comments on Limited Tasks	23

SITING OF CRITICAL FACILITIES

NEOTECTONIC INVESTIGATION

§23	Geologic Investigations in Western Connecticut and Adjacent New York	27
-----	---	----

EARTHQUAKE HAZARDS MITIGATION PROGRAM

§24	Development of Seismotectonic Domains	29
§25	Fracture Permeability Considerations in Siting Hazardous Waste Repositories	31

ENERGY CONVERSION AND STORAGE TECHNIQUES

UTILIZATION OF LANDFILL METHANE

§26	Institutional Barriers to Landfill Methane Recovery and the Need for State Legislation	33
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THE HISTORY OF THE UNITED STATES

OF THE UNITED STATES OF AMERICA
FROM 1776 TO 1876

BY
JAMES M. SMITH
OF THE
UNITED STATES ARMY
AND
OF THE
UNITED STATES NAVY

NEW YORK
PUBLISHED BY
J. B. LIPPINCOTT & CO.

1876

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UNITED STATES NAVY

GEOHERMAL ENERGY DEVELOPMENT PLANNING § 17 AND TECHNICAL ASSISTANCE

**Development of Geothermal Energy in the Eastern
U. S. ZJ7CQO**

Support: DOE/DGE

**R. von Briesen, J. E. Tillman, F. C. Paddison,
and C. S. Leffel, Jr.**

January-March 1981

GEOHERMAL TECHNICAL ASSISTANCE

APL has been designated by the Department of Energy's Division of Geothermal Energy (DOE/DGE) as a center for technical assistance (TA) for the application of geothermal energy. Normally constrained to a maximum of 100 hours for each request, APL assistance is in the form of preliminary feasibility, engineering, or economic studies and is not a substitute for detailed design, which is the province of the consulting engineering community. APL efforts can include the following:

1. Counsel on known information concerning geothermal resources and DOE programs in a particular area;
2. Preliminary estimates of the hydrologic properties of geothermal resources as functions of time and usage;
3. Advice on recovering geothermal energy in a specific case (e.g., an engineering feasibility study);
4. Estimates of the life-cycle cost of applying geothermal energy in a specific case;
5. Advice on the legal, institutional, and other requirements for the application of geothermal energy;
6. Advice on available federal geothermal opportunities or other federal programs that relate to the use of geothermal energy; and
7. Counsel on available financial assistance and details and mechanics of the geothermal loan guarantee program.

DISCUSSION

The TA program provided by DOE through APL and other institutions has been helpful in determining the potential, the method of application, and the approximate cost of developing geothermal energy. It also informs DOE/DGE and the parties involved of the problems the potential user faces from a technical, financial risk, or management point of view.

In addition to stimulating interest in the application of geothermal energy through APL TA efforts, a part of this effort is subcontracted to local consulting engineers to expedite the development of an informed geothermal engineering infrastructure. Three of the TA tasks documented (geothermal energy at Ocean City, Md., vacuum distillation with a modest-temperature geothermal resource for ethanol production, and the application of geothermal energy at Dover AFB, Del.) are subcontractor efforts.

Technical assistance efforts for the towns of Berlin, Md., Forty Fort, Pa., Richmond and Indianapolis, Ind., Bellows Falls, Vt., and

Salisbury, Md., are awaiting awards of DOE/HUD grants to evaluate district heating and cooling (Ref. 1).

REFERENCE

1. Request for Cooperative Agreement Application No. 6500, "Access District Heating/Cooling Systems Potential in Community Development Block Grant Eligible Communities," Dep. Housing and Urban Dev. (Nov 1980).

TECHNICAL ASSISTANCE ON THE DELMARVA PENINSULA, OCEAN CITY, MD.

Requests for technical assistance that were outstanding as of 1 January 1981, are listed in Table 2 of Ref. 1. One of these requests was from Mayor Kelley of Ocean City, who is interested in applying geothermal heating to a proposed community center in the northern part of the city. As reported in Ref. 1, APL has attempted to subcontract this TA study to a private engineering company with recognized competence in geothermal energy. The difficulties mentioned in Ref. 2 have been solved and a subcontract was let to D'Appolonia Engineers, Inc., in Pittsburgh, Pa. (Ref. 2).

Under the subcontract with APL, D'Appolonia will perform the following tasks:

1. Discuss with Ocean City officials their plans for the community center;
2. Identify the possible uses for geothermal energy;
3. Define the hydrothermal geothermal resources using the best available information;
4. Perform a technical feasibility study matching the resource estimate to the energy demand;
5. Perform an economic analysis, including capital cost of the geothermal installation and an amortization schedule based on the savings of alternative energy sources, i.e., electricity, fuel oil, or propane; and
6. Provide a final report of the evaluation.

Work on the subcontract began on 30 March 1981, with a meeting of representatives of the Mayor's Office, APL, and D'Appolonia in Ocean City. D'Appolonia plans to use the enhanced GRITS computer program, developed by The Johns Hopkins University Center for Metropolitan Studies (Ref. 3), for the feasibility study.

REFERENCES

1. Section 14, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.
2. "APL Contract No. 601434-L" to D'Appolonia Consulting Engineers, Inc., JHU/APL Lett. AC-14957, 16 Mar 1981.
3. Section 17, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.

TECHNICAL ASSISTANCE REQUEST FROM DOVER AFB, DEL.

The Air Force has requested a TA study for the potential use of geothermal energy at Dover AFB. The study, contracted to the Solar Energetics Co. of Wilmington, Del., by APL, has been completed and will soon be published. It was reported in the last Quarterly (Ref. 1). The study covers the various possible uses of geo-

thermal energy at the base, such as airplane washing and space heating.

REFERENCE

1. Section 14, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.

GEOTHERMAL DISTILLATION OF ETHANOL

There are plans for expansion of ethanol production in both the eastern and western United States. High temperature geothermal resources are a most attractive candidate as the energy source in the distillation process. In the east, where geothermal resources are more modest in temperature, they still may play a significant role, replacing fossil fuel in the distillation process. Currently, large wet corn mills, which manufacture fructose (a corn syrup), use a vacuum process with temperatures of 125 to 145°F for the concentration of fructose. Similarly a vacuum process would allow the use of modest temperature geothermal water to distill ethanol from corn or other feed stocks. A subcontract (Ref. 1) has been signed with Carltech Associates of Columbia, Md., to review the literature pertinent to the use of vacuum distillation to prepare fuel-grade ethanol and to assess the technical feasibility for use of eastern geothermal energy as process heat for vacuum rectification.

The vacuum process will be analyzed for a planned ethanol plant at the Accomac Industrial Park, Parksley, Va.

REFERENCE

1. "APL Contract No. 601437-S" to Carltech Associates, JHU/APL Lett. AC-14962, 16 Mar 1981.

TECHNICAL ASSISTANCE, MCGUIRE AFB, N.J.

TA Report No. 6 (Ref. 1) has been completed and distributed. This report suggests a geothermal/heat pump system for using geothermal ground water at a 1000 ft depth (66°F) for space heating and cooling 200 of the 1452 housing units at McGuire AFB. Cost comparisons are made using projections of future costs of gas, coal, and electricity by DoD and industry (Westinghouse); also compared are the relative cost of the geothermal/heat pump system with the existing natural gas and planned coal conversion central heating systems. The report also shows the anticipated hydrological (drawdown) effects upon an existing water supply well by a geothermal production and reinjection well.

REFERENCE

1. F. K. Hill and R. von Briesen, "Technical Assistance Report No. 6, Geothermal Space Heating by McGuire Air Force Base, New Jersey," JHU/APL QM-80-190 (Dec 1980).

ANALYSIS OF GEOTHERMAL ENERGY AT CHARLESTON AFB, S.C.

On 26 February 1981, representatives of APL visited Charleston AFB, S.C. The purpose of the visit was to provide the Deputy Base Chief Civil Engineer with information on what APL has done regarding the DOE Geothermal TA Program relating to DoD installations and spe-

cifically what might be covered in a TA study for Charleston AFB. The contact between APL and Charleston AFB was initiated by personnel at Tyndall AFB and Scott AFB.

A tour of the base was taken with emphasis placed on the main energy users. The base is laid out similarly to Dover AFB and McGuire AFB. The major exceptions are that the on-base housing units are heated with individual natural gas furnaces and cooled with individual split-system air conditioners. Also the base uses 100 psi steam from No. 6 fuel oil to heat the industrial areas. The main steam plant is shut down in the summer months. Any area that needs heat has its own separate boiler. Because of the low number of heating degree-days (2000) and the low cost of electricity (3.3¢/kWh), which the base purchases from the South Carolina Public Power Authority, the use of geothermal resources for Charleston AFB is not obvious. The civil engineering people agreed to discuss among themselves where the use of geothermal energy would be applicable, then request APL to do a TA study.

REFERENCE

1. "Information Geothermal Technical Assistance (TA) Visit to Charleston Air Force Base, South Carolina," JHU/APL QM-81-039 (Mar 1981).

RESERVOIR CONSERVATION WELL AT MONTEZUMA, N.Y.

Clinton Corn Products, a division of Standard Brands, operates a wet corn mill at Montezuma, N.Y. The mill manufactures fructose and associated products. The potential of modest-temperature geothermal water is of considerable interest in preheating boiler feed water and corn steep water (Ref. 1). DOE/DGE has entered into an agreement with the New York State Energy Research and Development Authority (NYSERDA) to drill a reservoir confirmation well on the property of the plant at Montezuma. A request for proposals was issued by NYSERDA (Ref. 2) to drill and test the well. Responses are currently being evaluated. The tests include an evaluation of the basement rock for hot dry rock in addition to a hydrothermal resource. The well is planned to be spudded in the next two months, and testing is to be completed before the end of the fiscal year.

REFERENCES

1. Section 28, Quarterly Report Jan-Mar 1980, JHU/APL EQR/80-1.
2. "Drill Test for Preliminary Geothermal Prospect Evaluation. Proposal, Instructions, and Conditions," NYSERDA ER-30-80.

REQUEST FOR TECHNICAL ASSISTANCE FROM BRISTOL MYERS, SYRACUSE, N.Y.

Bristol Myers Co. of Syracuse, N.Y., requested technical assistance in assessing geothermal energy for its Syracuse plant. F. C. Paddison visited the plant (Bristol Laboratories, Syracuse) on 3 February 1981 to provide a review of geothermal energy applications and the DOE programs, in particular those in the eastern United States and the New York State area. Reference 1 documents the visit. A brief tour of the plant led to suggestions being made to A.

Pascarella, Manager of Maintenance Engineering. The primary product in Syracuse is penicillin and a large hypodermic called Bems. Bristol Laboratories makes most of the world's penicillin.

The plant shows considerable potential for energy engineering. Total annual energy use is 1.6×10^{12} Btu. The largest energy use is in the fermentation tanks, where the penicillin spores grow in a constantly agitated solution. The tanks are quite large, and a 500 hp motor is required for agitation. The spores are mixed with water and nutrients and allowed to grow. No heat is added. After about 60 hours, the spores begin to multiply and produce heat. The process is aerobic, and air is injected in the material and refrigeration is used to control the vat temperatures for 150 hours, until the end of the process. The cooling is done with chilled water at 45°F using 1000 ton coolers; the return water is at 60°F.

APL SUGGESTIONS

1. There are many uses for 130°F water in the plant. It was suggested that the company follow the progress of the well at Montezuma.
2. Cooling of vats could be accomplished by combinations of plant input water — 1×10^6 gal/day. Company officials were not sure of the temperature range of the water but thought it was from 45 to 60°F. Syracuse is an area that was once a terminal moraine, covered with deep glacial till, and has an adequate supply of water available if additional ground water is required. Further, there is an aquifer under Syracuse where a cleft in the granite was formed similar to the finger lakes, but which now is filled with gravel. Personnel at Bristol will evaluate the groundwater. It was suggested that they should determine the temperatures and quantities available, even if wells must be

drilled and tested. Heat pumps could be used to lower the water temperature to 45°F all year to provide heat for other purposes (Ref. 2).

3. Finally the company was interested in obtaining natural gas from a geothermal well. Because there are low productivity wells nearby (i.e., Auburn), the company probably could, but it is probably better to have separate wells since quite a few low productivity wells will be needed to provide a sufficient flow of gas. Bristol has 50 acres. APL suggested that the company contact Mayor Lattimore for advice on prospecting for the natural gas.

REFERENCES

1. F. C. Paddison, "Visit to Bristol-Myers Co., Syracuse, N.Y.," JHU/APL QM-81-020 (3 Feb 1981).
2. "Forwarding Names and Addresses," JHU/APL Lett. CQO-2989, 4 Feb 1981.

USE OF 74°F SPRING WATER AT BERKLEY SPRINGS, W. VA.

On 25 March 1981, B. T. Leonard of West Virginia University met with representatives of APL and Gruy Corp. to discuss the use of 74°F spring water to heat a two-story building housing the Roman Baths and Senior Citizens Activity Center at the Berkley Springs, W. Va., State Park. There is currently 330 gal/min of spring water not being put to use. Suggestions were made relating to the desirability of water-to-air heat pumps for heating upper floors using the existing air distribution system. A separate water-to-water heat pump was suggested in the lower area of the building to increase the temperature of water for baths and space heating.

A list of water-referenced heat pumps that are commercially available was provided.

**GEOHERMAL ENERGY DEVELOPMENT PLANNING § 18
AND TECHNICAL ASSISTANCE**
Development of Geothermal Energy in the Eastern
U. S. ZJ7CQO
Support: DOE/DGE
C. S. Leffel, Jr.
January-March 1981

GEOHERMAL MARKET STUDY: GEORGIA

The definition of markets for geothermal energy has been made for the Atlantic Coastal Plain between New Jersey and North Carolina (Ref. 1). A technical assistance study for the Naval Submarine Base at King Bay in southeastern Georgia is discussed in Ref. 2. The present market study is designed to estimate the energy market in 32 counties along the coastal plain in Georgia. Emphasis is placed on industrial uses of energy.

SUMMARY

The area chosen for the Georgia Geothermal Energy Survey is shown in Fig. 1. This area is estimated to have temperatures at basement of 90 to 160°F; all 32 counties selected for the survey have an appreciable fraction of their areas inside the 90°F contour and at least parts of 19 counties lie within the 120°F contour. With the exception of the county containing Savannah (which has a population of 183,000), the population density is relatively low. In the selected area, only eight counties have a population in excess of 20,000 and there are only seven cities or towns (including Savannah) with a population of over 10,000. No attempt has been made to estimate domestic heating demand in this survey of this area of Georgia because the number of heating-degree days is 1500 to 1800, the average winter temperature is 58°F or greater, and (with the exception of Savannah) the population density is low.

In the area shown in Fig. 1, 163 industries were selected from the Georgia Manufacturing Directory issued by the Georgia Bureau of Industries. An attempt was made to select a sample that included representatives of all industries of significance in the area. While the possibility of applying the geothermal resource of the area was a consideration in the selection process, this was not an overriding factor. The Standard Industrial Code (SIC) used by most states to classify the end product of an industry does not reveal (unless one is familiar with all the processes involved in the production of that product) the detailed energy uses and temperatures that might be used.

The survey began with the preparation and mailing of a letter to the 163 selected companies informing them of the purpose and nature of the market survey and stating that the letter would be followed by a telephone call within several weeks (Ref. 3). Included in the letter was a brief description of the estimated Georgia geothermal resource and a drawing illustrating the industrial use of a moderate temperature hydrothermal resource. These letters were mailed in the latter part of February.

Fig. 1 Geothermal market survey area in Georgia; estimated temperatures at basement (from Ref. 1). (81-1/46)

The letter requests that the selected companies supply the following information:

1. The energy-consuming processes in the plant, particularly those using heat,
2. The required temperature for each process,
3. Type and quantity of fuel used for each process,
4. Type and quantity of fuel used for space heating, and
5. Seasonal variation in energy demand.

Of the 163 letters mailed, five were returned as nondeliverable by the Post Office. Two large industries replied that they did not wish to participate in the survey. The telephone survey of the remaining 157 companies began in March and is now essentially completed.

In general, the response to the telephone contacts has been cooperative. While the forms distributed to the APL telephone interviewers have not been collected and summarized, several conclusions can be drawn.

1. Industries, particularly the larger ones, are very aware of the energy problem and have, in some cases, performed their own studies of methods to reduce energy costs.
2. On the coastal plain of Georgia, the usual sources of energy are oil, natural gas, and electricity. For large energy users, natural gas is usually supplied on an interruptible schedule, which means that in the winter they must use oil, since residential heating has priority on natural gas consumption.
3. The use of steam as the transfer medium for process heat is very common. In those instances where the use of steam is necessary because of temperatures or mechanical limitations, the percentage of any hydrothermal contribution to the energy supply would be small because of the large amounts of energy

required for vaporization. Just how much the use of steam is the result of industry custom remains to be determined.

FUTURE PLANS

The results of the telephone survey will be collected and summarized. A relatively small number of companies will be selected for on-site visits, during which the details and requirements of energy consumption can be more carefully determined. From the results of the telephone survey and visits, classified according to industrial process, an attempt will be made (a) to summarize the industrial energy consump-

tion for the coastal plain of Georgia and (b) to estimate the energy contribution that geothermal energy could make.

REFERENCES

1. W. J. Toth, "Definition of Markets for Geothermal Energy in the Northern Atlantic Coastal Plain," JHU/APL GEMS-002 (QM-80-075) (May 1980).
2. Section 16, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.
3. Letter to Georgia Industries, JHU/APL CQO-2990, 5 Feb 1981.

GEOHERMAL ENERGY DEVELOPMENT PLANNING § 19 AND TECHNICAL ASSISTANCE

Development of Geothermal Energy in the Eastern

U. S. ZJ7CQO

Support: DOE/DGE

S. Kane and P. Kroll (Metro Center)

January-March 1981

ECONOMICS OF GEOTHERMAL ENERGY APPLICATION

During the first quarter of 1981, the GRITS computer program (Refs. 1 and 2), designed to aid in the preliminary economic assessments of potential geothermal projects, was enhanced and improved. This latest version of the program permits direct comparison of a geothermal heating system with an analogous fossil-fuel-only system. The modeling of the transmission system underwent substantial revision. In addition, all major cost components have been updated to current dollars.

DISCUSSION

Three types of changes have been incorporated in the GRITS computer program: additional operating modes were added, engineering formulas were revised and updated, and capital costs were updated to 1981 dollars. GRITS version 8 includes all of the changes listed previously in Ref. 3 in addition to a few others. This discussion will focus on the most important and most recent revisions of the model.

New Operating Modes. Two operating modes were added to the program. One allows the system size to be constrained to supply a specified demand. The other permits the simulation of a fossil-fuel-only system (no geothermal). Because each is a rather strong departure from the basic assumptions of earlier documented versions of GRITS, we list the combinations of scenarios that can be modeled by the new program, in the context of the familiar version.

1. Choice of Resource or Demand-Constrained System. In the past, GRITS could model any one of three possible types of demand system:

1. Industrial process heat,
2. Residential-commercial mix of space heating and domestic hot water heating, and
3. Residential space and domestic hot water heating alone, if commercial demand was zero.

The basic modeling assumption was that the system was resource-constrained. That is, given a specified geothermal resource, GRITS assumed that the developer could capture sufficient customers to use the resource completely, or in the case of industrial process heat, that the developer had a buyer for all he could supply. This assumed that potential demand was unlimited, and the resource would be used to capacity.

Although this situation is likely to occur in many cases, it would also be helpful to size the system to meet only a specified demand such as a new housing development, a commercial development, or a potential industrial user.

One new modification of the version 8 of GRITS is the addition of a demand-specified mode

of operation. (This is similar to but greatly exceeds in detail and flexibility the structure of the DSM model (Ref. 4), which version 8 of GRITS also supersedes.)

The new option, which permits the selection of operating GRITS in either a resource-constrained or demand-constrained mode, operates in conjunction with both residential-commercial and industrial scenarios. If the user chooses the resource-constrained mode, the program operates exactly as it did in the earlier versions, bringing enough demand on the system to use the resource fully. However, if the demand-constrained mode is selected, only enough of the resource necessary to supply the specified demand is used. GRITS determines the flow necessary in the final year to supply all demand. The specified flow function is then adjusted proportionally for each year of the simulation.

The earlier versions of GRITS already permitted specification of commercial demand. This new version allows the user to indicate the number of households to be placed on the system when GRITS is operating in the demand-constrained mode. It allows specification of the hourly industrial process heat during hours of operation in the industrial case of the demand-constrained mode. Because the residential demand is independent of the commercial demand in the demand-specified case, the user can model four possible scenarios in which the demand is prescribed:

1. Industrial,
2. Residential-commercial mix,
3. Residential alone, and
4. Commercial alone.

2. Special Fossil-Fuel-Only Mode (No Geothermal). Another special mode of operation has been added to GRITS. Often in evaluating the desirability of a geothermal heating system, a comparison with an analogous fossil-fuel-fired system is useful. GRITS now has the ability (in the demand-specified scenario only) to simulate a district heating (or process heating) system supplied by a fossil-fuel boiler.

If the user selects a fossil-fuel-only system, no geothermal capital cost components will be installed (wells, heat exchangers, upwell and reinjection pumps, and storage tank). The system will consist of a boiler large enough to supply the specified demand at the peak through a similar distribution system and hookup structure. The flow that will circulate through the boiler is based on the assumption that ΔT_0 is 30°F (Ref. 5) in the circulating water, from 180 to 150°F for the residential-commercial case, and 200 to 170°F in the industrial process heat case. Then $f = Q/(500 \times 30^\circ\text{F})$, where f is flow in gal/min and Q is peak heat flow in Btu/h. The flow, f , is reported in GRITS' results when a fossil-fuel-only scenario is run. If a transmission line is needed, pumping energy is calculated.

Capital Component Modifications. Three major component cost equations were updated: transmission system, well costs, and heat exchanger costs. GRITS is now set up to allow the user to configure (or test a variety of configurations of) the transmission system. The system layout is done externally by the user, so that he can take into account all the unique geographical and hydrological characteristics of the area. The input of GRITS is then indicated simply as the total length of all pipe segments classified according to the volume of flow passing through

them, where the flow is described in terms of the flow per well.

The well cost equation (Refs. 6 and 7) and heat exchanger cost equation (Ref. 8) have also been revised based on newer information.

For all internal capital cost component equations, a standard price updating system is used to account for inflation of earlier cost data.

FUTURE PLANS

Subsequent economic analysis will use this enhanced version of the GRITS computer program. An assessment of the potential for geothermal heating systems in the southeastern region of the United States will be conducted during the next quarter of 1981. As additional modeling needs and updates materialize, GRITS will continue to be extended to deal with them.

REFERENCES

1. W. Barron, P. Kroll, R. Weissbrod, and W. Toth, "GRITS: A Computer Program for the Economic Evaluation of Direct-Use Applications of Geothermal Energy," JHU/APL GEMS-008 (QM-80-077) (Jun 1980).
2. Section 18, Quarterly Report, Jul-Sep 1980, JHU/APL EQR/80-3.
3. Section 17, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.
4. P. Kroll, W. Barron, and W. Toth, "The Demand Specified Model for Direct Applications of Geothermal Energy: A User's Guide," JHU/APL QM-80-31 (Dec 1980).
5. R. von Briesen, "Hook-up and Water Meter Cost," JHU/APL QM-81-052 (Apr 1981).
6. K. Yu, "Geothermal Well Drilling Cost, Another Fit," JHU/APL QM-81-008 (Jan 1981).
7. J. F. Kunze et al., "Reservoir Development and Management," Chapter 3, Geothermal Resources Council Special Report No. 7, Direct Utilization of Geothermal Energy; A Technical Handbook, pp. 3-21 (1980).
8. R. von Briesen, personal correspondence, Feb 1981.

GEOHERMAL ENERGY DEVELOPMENT PLANNING § 20 AND TECHNICAL ASSISTANCE

**Development of Geothermal Energy in the Eastern
U. S. ZJ7CQO**

Support: DOE/DGE

**J. E. Tillman, C. S. Leffel, Jr., and F. C. Paddison
(APL) and J. Capper (Metro Center)**

January-March 1981

AID TO STATE AND LOCAL GOVERNMENTS

Resource assessment on the Atlantic Coastal Plain has identified broad regions with hydrothermal resources in the Delmarva Peninsula area of Delaware, Maryland, and Virginia. New Jersey and northern North Carolina have also been shown to possess areas with hydrothermal potential. This work, supported by DOE/DGE, has been done by VPI&SU, which is now extending its assessment efforts to the southern Atlantic Coastal States (Ref. 1).

A complementary assessment of the market for modest-temperature hydrothermal energy in the identified areas of New Jersey, Delaware, Maryland, Virginia, and North Carolina has been performed by APL (Ref. 2). This work is also being extended to the southern Atlantic Coastal areas as they are identified by resource assessment effort (Ref. 3).

As a result of DOE efforts, individuals and state agencies have become interested in the application of geothermal energy. Many requests have been received for technical assistance in assessing feasibility of geothermal energy (Ref. 4) and to assist in drafting legislation and developing rules and regulations for geothermal energy development and use. It has been suggested that a state team should be organized and initially partially funded by DOE/DGE to focus state, local, individual, and industrial efforts in developing geothermal energy. In addition the state team would organize and publish a how-to-do-it book on writing a state prospectus (Refs. 5 and 6). The National Conference of State Legislatures (NCSL) is supported by individual states and by DOE to formulate legislative issues relating to geothermal energy and groundwater heat pumps. The NCSL has organized workshops with appropriate state legislatures to address technical, legal, and institutional issues. APL assists, as requested, in technical support of the workshops. The following is a brief discussion of the status of formation of state teams, their progress in writing a state prospectus, and the results of legislative workshops.

DISCUSSION

State of Maryland. During the latter part of 1980, the Special Joint Committee on Energy of the Maryland General Assembly held several meetings to review (among other things) revisions in Maryland law that would assist in the development of geothermal energy. These meetings followed a study by the NCSL; a summary of the public meetings of this joint committee (which were attended by APL) is given in Ref. 7.

The proposed legislation discussed below was a consequence of the activities of the Special Joint Committee on Energy.

During the current session of the General Assembly, public hearings were held on four bills that concern geothermal energy. At the request of the Energy Administration of the State Department of Natural Resources, APL testified in support of those bills at public hearings held on 9 February (House Environmental Matters Committee), 11 February (Senate Economic Affairs Committee), 12 March (Senate Budget and Taxation Committee), and 13 March (House Environmental Matters Committee).

The four bills introduced were:

1. House Bill 651 - Senate Bill 348

This bill is an amendment to the Maryland Geothermal Resources Act of 1978 and, as written for the public hearing, extended to the Department of Natural Resources the authority to regulate well drilling and the reinjection of geothermal fluids, and declared geothermal resources to be the property of the State. The sponsors withdrew the ownership provision before the house committee hearing of 9 February, but the committee accepted the rest of the bill.

2. House Bill 652 - Senate Bill 347

This bill extends to the Board of Public Works the authority to sell, lease, or otherwise dispose of a geothermal resource located on lands owned by the State for a consideration determined to be adequate by the Board.

3. Joint House Resolution 26 - Joint Senate Resolution 9.

This resolution requests the Department of Natural Resources to review the issues of access and allocation of geothermal resources and specifies the allocation options to be examined.

4. House Bill 1264 - Senate Bill 832

This bill would create a Maryland Energy Supply and Conservation Authority explicitly empowered to offer financial assistance for energy projects and feasibility studies and to offer technical and management advice. Geothermal energy is one of the alternative sources that the Authority is to assist. Designed to be self-supporting after a few years, the Authority is assigned a permanent technical staff and empowered to issue bonds for financing alternative energy projects.

The APL testimony in support of this proposed legislation is documented in Refs. 8, 9, 10, and 11. The question of ownership of geothermal resources (which is left ambiguous in House Bill 651 and which interacts with Joint House Resolution 26) is discussed in Refs. 8 and 9.

As of the end of March, the fate of these bills in the General Assembly is unknown. However, it is known that House Bill 1264, which would have created an authority separate from any existing state agency, was amended before its introduction on the House and Senate floors. In its current amended form, the bill would create an Energy Supply Financing Administration within the Department of Economic and Community Development. The amendments express the reluc-

tance of the General Assembly to create a new agency in a time of budget austerity.

The proposed Administration would be created to provide technical and financial assistance to developers of new energy supplies, in order to reduce the dependence of the State on imported energy (particularly oil) and to create additional jobs through such development. The Administration would have the authority to issue tax-free bonds, backed by existing or expected revenues; receipts from the bonds would be used to support feasibility studies, demonstration projects, and energy-supply development projects. This support would be primarily in the form of loans that would be attractive because of their relatively low interest rates and favorable repayment schedules. The Administration would also be responsible for taking an active role in the promotion of the development of new forms of energy, by acting as a source of information on the technical and financial aspects of such development. How aggressively the Administration could pursue this promotional role would of course depend on the size and capabilities of its staff. At present there is a provision in the bill that limits the Administration to one new staff position. Other staff support would have to come from the existing allotment within the parent Department of Economic and Community Development.

The bill in its present amended form appears to have broad support in both houses of the General Assembly. However, there is concern that there might not be sufficient time for it to be acted on before the close of the current session on 13 April.

State of Virginia. The Virginia Coal and Energy Commission established a Geothermal Subcommittee to study and make recommendations pertaining to the issues to be addressed in geothermal legislation. The Subcommittee report (Ref. 12) is complete and was summarized in the last Quarterly (Ref. 7).

Together with recommendations of the Geothermal Subcommittee, legislative workshops conducted by NCSL resulted in the drafting of a Geothermal Energy Bill (Ref. 13), which was passed by both Houses and awaits the Governor's signature to become law.

The Virginia state team has been organized and has submitted a proposal (Ref. 14) to DOE/DGE for initial support. The state team would see to the preparation of a state geothermal map and the publishing of a Prospectus for Development of Geothermal Energy in Virginia. Reference 14 also outlines items required in the preparation of a map and prospectus and assigns responsibilities for their preparation.

State of Delaware. During the 1979-80 legislative session, a Geothermal Act (Ref. 15) was passed by both houses, but the Governor vetoed the bill. A slightly modified bill is planned to be submitted during the 1980-81 legislative session.

Delaware has a geothermal resource team. Initial funding matched with state funding was

provided in FY 80. The state team was organizationally located in the State Energy Office. A recent reorganization has been proposed to transfer this office to the Delaware Development Office, Land and Water Resources (Ref. 16). The state team is well advanced in the preparation of the state geothermal prospectus.

The State Energy Office submitted a proposal for the utilization of a geothermal well at Lewes, Del., in response to the DOE solicitation (Ref. 17) for an Eastern Geothermal Drilling Program. The Delaware proposal was to recover magnesium hydroxide from the geothermal water and (dependent upon well productivity) to heat selected large buildings in the town of Lewes. Assistance has been provided to entities involved in planning for drilling a deep geothermal well.

REFERENCES

1. J. K. Costain et al., "Evaluation and Targeting of Geothermal Resources in the Southeastern U.S.," VPI&SU progress reports 5648-1 to 8.
2. "Definition of Markets for Geothermal Energy in the Northern Atlantic Coastal Plain," JHU/APL QM-80-75 (May 1980).
3. Section 18, Quarterly Report, Jan-Mar 1981, JHU/APL EQR/81-1.
4. Section 14, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.
5. "A Prospectus for Geothermal Energy - The Atlantic Coastal Plain," GRC Special Report No. 5 (Apr 1979).
6. "A Framework for a Site Prospectus for Geothermal Energy Development - Delmarva Peninsula," JHU/APL QM-79-145 (Jun 1979).
7. Section 18, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.
8. Proposed Geothermal Energy Legislation," JHU/APL Lett. CQO-2991, 23 Feb 1981.
9. "Additional Comments on Geothermal Energy Legislation," JHU/APL Lett. CQO-2998, 19 Feb 1981.
10. Public Hearing on House Bill 1264, March 13, 1981," JHU/APL Lett. CQO-3010, 23 Mar 1981.
11. "Discussion of SB-832," JHU/APL Lett. CQO-3012, 24 Mar 1981.
12. "Report of Geothermal Subcommittee to the Virginia Coal and Energy Commission," Commonwealth of Virginia, Richmond (1980).
13. "Geothermal Energy," Virginia State Legislative House Bill No. 1663.
14. "Preparation of Map and Prospectus for Development of Geothermal Energy in Virginia," proposal submitted to U.S. Department of Energy, Division of Geothermal Energy, 17 Feb 1981.
15. "Chapter 72, Geothermal Resources Act," Delaware State Senate 130th General Assembly - Senate Bill 469, 20 Mar 1980.
16. State of Delaware Executive Department Reorganization, 28 Jan 1981.
17. "Eastern Geothermal Drilling Project," Solicitation for Cooperative Agreement No. DE-RP-801D12132, closing date 9 Jun 1980.

GEOHERMAL ENERGY DEVELOPMENT PLANNING § 21 AND TECHNICAL ASSISTANCE

Development of Geothermal Energy in the Eastern

U. S. ZJ7CQO

Support: DOE/DGE

F. C. Paddison

January-March 1981

OVERVIEW - GEOTHERMAL ENERGY DEVELOPMENT IN THE EASTERN UNITED STATES

There are many sedimentary basins east of the Rocky Mountain states, some with depths in excess of 4000 ft (Fig. 1). There are hydrothermal and hot dry rock resource assessment programs, sponsored by DOE's Division of Geothermal Energy, in many of these areas (Table 1). The D'Appolonia study, a part of the Hot Dry Rock Program at the Los Alamos Scientific Laboratory, intensively analyzed the resource potential in a 100 mi² region from Crisfield, Md., to Wallops Flight Test Center, Va. (Ref. 1).

Several detailed hydrothermal programs are continuing or were started in CY 80.

The Atlantic Coastal Plain. Figure 2 shows the areas under study on the Atlantic Coastal Plain. The Virginia Polytechnic Institute and State University (VPI&SU) geothermal program continues to determine thermal gradients and heat flow, basement depth, and geologic setting. A preliminary definition of mid-Atlantic Coastal Plain resources is in hand; drilling in the southeastern states is in progress (Ref. 2). Figure 3 shows some of the results of these studies, i.e., the predictions of maximum temperature at the interface between the sedimentary sequence and basement under the Delmarva Peninsula.

APL has completed a market survey of the northern coastal states (Ref. 4), and a survey of Georgia is under way. The current status of the market studies for the coastal plain is: completed for New Jersey, Delaware, Maryland, Virginia, and northeastern North Carolina, and in process for Georgia. The ranking of eastern potential resource areas and colocated energy markets has been completed. The National Conference of State Legislatures (NCSL) has been conducting workshops with Delaware, Virginia, and Maryland, with assistance from VPI&SU, APL, the U.S. Geologic Survey, and various state agencies. The existing Maryland geothermal law is being revised to remove ambiguities. A geothermal resource bill has passed the Virginia Legislature and awaits the Governor's signature. Delaware is revising and resubmitting the bill that its Governor vetoed last legislative year.

* Contours adapted by APL from basement map of North America - 1967 AAPG and USGS

** From Gruy Federal, Inc., report DOE/NVO/1558-7(12/79).

Fig. 1 Potential geothermal resource areas in the Eastern United States. (81-1/55)

Table 1
Resource assessment in the Eastern United States.

Hot dry rock	
Coastal plain Crisfield, Md., to Wallops Island, Va. Gulf Coastal Plain New York Indiana/Ohio Mid continent New England	VPI&SU D'Appolonia University of Florida SUNY/Buffalo Kent State University Purdue University MIT
Hydrothermal	
Mississippi Alabama Delaware Capital region, New York Kansas Nebraska West Virginia, Michigan, Ohio, Pennsylvania, Virginia, Illinois, and Indiana East (in general) TVA region	State survey State survey State survey NYSERDA/Dunn Geo. State survey State survey Gruy Federal Gruy Federal Oak Ridge Associated University

Fig. 2 Areas of geothermal study in the Atlantic Coastal Plain. (81-1/56)

Legal and institutional activities of various states are summarized as follows: Geothermal Laws: Maryland, 1978, modification 1981; Delaware, 1980, Governor vetoed, being resubmitted; Virginia, 1981, bill submitted. Planned by NCSL: New Hampshire, South Carolina, North Carolina, New York, and Pennsylvania (heat pumps).

State development teams have been and are being organized in various states. Details are: Delaware - organized and funded, 1979; Virginia - organized, 1980; Maryland - proposing an Energy and Conservation Authority, 1981; Georgia, North Carolina, South Carolina, and New York - to follow, 1981-82. Geothermal fact

Fig. 3 Estimated maximum temperatures (in °F) at bottom of sedimentary rocks. (81-1/57)

books for the 50 states were published by APL in 1981.

Following the first resource confirmation well drilled at Crisfield, Md., DOE/DGE solicited proposals for a second well on the Delmarva Pen-

Table 2

Status of geothermal energy in the Eastern United States.

1976: Geothermal status, Eastern United States

Health spas, Pa., Ga., Ala., Ark., S.D.
 Space heating, Midland, S.D., high school and
 Headquarters, Hot Springs National Park, Ark.

1981: Space heating

St. Mary's Hospital, Pierre, S.D. PON
 Diamond T Range, S.D. PON
 School and sections of town, Phillip, S.D. PON
 Marlin Hospital and Chamber of Commerce,
 Tex. PON
 Corsicana College and Hospital, Tex. PON

Industrial process heat

Food processing plant (Campbell Soup) PRDA
 Cottage cheese plant, New York PRDA
 Recovery of MgOH, test well in process,
 Lewes, Del. SCA

Resource confirmation

50+ gradient wells, N.J., Del., Md., Va.,
 N.C., S.C., and Ga. DOE/DGE
 Crisfield, Md., well DOE/DGE
 Gasifying LNG, test well in process,
 Maryland DOE/DGE
 Wet corn mill, test well in process,
 New York DOE/DGE
 Space heat, Rochester, N.Y. UCRCP

NOTES: PON = Program Opportunity Notice
 PRDA = Program Research and Development Announcement
 SCA = Solicitation for cooperative agreement, Eastern
 Geothermal Drilling Program
 UCRCP = User Coupled Resource Confirmation Program

insula that will be put to practical use after completion. In addition, the Delaware State Energy Office was awarded funds of up to \$800,000 for a well at Lewes, Del. This well will soon be drilled. The well water will be used initially by the Barcroft Co. to recover magnesium hydroxide, an ingredient used in their product Maalox. Eventually, depending on well productivity, other uses may be found (Ref. 3).

The Columbia LNG Corp. has an LNG receiving terminal at Cove Point, Md. The use of geothermal water has been analyzed for gasification of all or part of the LNG (Refs. 4 and 5). VPI&SU is drilling a resource confirmation well at Cove Point.

New York State. Thermal gradients have been measured in central and western New York State and are slightly above normal. The depth to basement varies considerably; however, it is adequate to provide water with modest temperatures. Interest has been shown by the Standard Brands fructose plant at Montezuma for using the hot water in its wet corn mill plant if available in quantity. DOE/DGE has entered into a cooperative agreement to drill a 5000 ft well to determine temperature and water availability. This well should be completed in the spring of 1981.

Geothermal activities in the east are summarized in Table 2. The role of APL in these activities is to complement resource assessments; rank colocated resources and energy markets; perform application feasibility studies (on request); estimate costs of industrial applications and community heating and cooling; make energy market surveys and market penetra-

tion analyses; assist states to assemble commercialization teams, identify technical and economic legislative issues, and write geothermal how-to-do-it books; and identify research and development requirements and institutional problems.

Technical Assistance. APL offers technical assistance to parties requesting a preliminary economic or technical feasibility assessment of the application of geothermal energy. The Gruy Federal Corp. and VPI&SU offer technical assistance on the assessment of geothermal resources. There have been many forms of assistance furnished by APL, i.e., forwarding of reports, visits, and documented economic or technical studies. Some of these are listed in Table 3.

APL has developed several tools for economic analysis. These are described in Refs. 6, 7, and 8 and are listed below:

1. Geothermal Resource Economic Evaluation System (GREGS),
2. Geothermal Resource Interactive Temporal Simulation (GRITS),
3. Demand Specified Model (DSM),
4. Basic Interaction Geothermal Model for Aquifer Characteristics (Big Mac), and
5. Revised GRITS (GRITS plus DSM plus Big Mac) for Multiple Wells.

The Annual Technical Information Interchange Meeting. The fifth such meeting took place in November 1980 at Berkeley Springs, W. Va., and papers were given covering all phases of geothermal activity in the eastern United States. The minutes have been published (Ref. 9).

Table 3
APL technical assistance programs.

Completed or in process	Planned
<p>Space heating</p> <p>High School - Crisfield, Md.* Hospital - Crisfield, Md. Middle School - Pittsville, Md.* Hot Springs, Ark. Town of Newport News, Va.* Naval Air Rework Facility, Norfolk, Va.* NASA-Wallops Flight Test Center, Virginia Kings Bay, Ga.</p> <p>Geothermal industrial or agriculture process heat</p> <p>Standard Brands Fructose Plant - Montezuma, N.Y. Mariculture - Chesapeake Bay* Wet corn mill - Alabama (ethanol) Wet corn mill - North Carolina (ethanol) Seafood terminal - Newport News, Va. Bristol Myers - Syracuse, N.Y.</p> <p>Liquefied Natural Gas Terminal - Cove Point, Md.*</p> <p>Showell Farms (poultry industry)</p> <p>Combinations of above</p> <p>Industrial Park - Melfa, Va. Lewes, Del. Dover AFB - Dover, Del.</p> <p>Heat pumps</p> <p>Bellows Falls, Vt. Lebanon Springs, N.Y. Energy Concepts Corp. - Maryland New Hope, Pa. McGuire AFB, New Jersey</p>	<p>Heat pumps</p> <p>Borough of Forty Fort, Pa. Harlan, Ky. Richmond, Ind. Indianapolis, Ind. Burlington Clinic, Burlington, Ind.</p> <p>Industrial process or agricultural treatment</p> <p>Federal fish hatcheries - Pennsylvania Burlington Industries - North Carolina Smith Point, Va.</p> <p>Combinations</p> <p>Town of Salisbury, Md.</p> <p>Geothermal space heating</p> <p>Senior Citizens Center - Ocean City, Md. Charleston AFB - Charleston, S.C.</p>

*Completed

REFERENCES

1. C. E. Schubert and W. J. Johnson (D'Appolonia Consulting Engineers, Inc.) and J. C. Maxwell (Los Alamos Scientific Laboratory), "The Eastern Hot Dry Rock Target Prospect - A Case History," Geothermal Resources Council Transactions, Vol. 4, pp. 241-244 (Sep 1980).
2. J. K. Costain et al., "Evaluation and Targeting of Geothermal Resources in the Southeastern U.S.," VPI&SU progress reports 5648-1 to 8.
3. W. J. Toth, "Geothermal Energy Market Study in the Atlantic Coastal Plain, Definition of Markets for Geothermal Energy in the Northern Atlantic Coastal Plain," JHU/APL GEMS-002(QM-80-075) (May 1980).
4. A. Litchfield, "Utilization of Geothermal Energy at the Cove Point (Md.) LNG Receiving Terminal," Section XVIII, JHU/APL QM-80-185 (Dec 1980).
5. "Report on Technical Assistance for Columbia LNG Corporation," JHU/APL Lett. CQO-2850 (Mar 1980).
6. W. Barron et al., "GRITS: A Computer Program for the Economic Evaluation of Direct-Use Applications of Geothermal Energy," JHU/APL GEMS-008(QM-80-077) (Jun 1980).
7. P. Kroll et al., "The Demand Specified Model for Direct Applications of Geothermal Energy: A User's Guide," JHU/APL QM-80-131 (Dec 1980).
8. K. Yu and R. von Briesen, "Geothermal Energy Development in the Eastern United States, A Program for Capital Recovery Assessment for the HP-97 and other Desk Calculators," JHU/APL QM-80-125 (Aug 1980).
9. "Geothermal Energy and the Eastern U.S. Fifth Technical Information Interchange Meeting, Minutes," JHU/APL QM-80-185 (Dec 1980).

GEOTHERMAL ENERGY DEVELOPMENT PLANNING § 22 AND TECHNICAL ASSISTANCE

Development of Geothermal Energy in the Eastern
U. S. ZJ7CQO

Support: DOE/DGE

C. S. Leffel, Jr., F. C. Paddison, R. von Briesen,
R. F. Meier, and A. M. Stone
January-March 1981

COMMENTS ON LIMITED TASKS

ADMINISTRATION GEOTHERMAL BUDGET CUTS

The 1982 geothermal budget request of the previous federal administration has been drastically altered by the new administration. The new budget authority for geothermal research is \$142 million for FY 81 and \$48 million for FY 82. In contrast, the previous administration's FY 81 appropriation was \$156 million and the FY 82 request was \$91 million.

The major objectives of the new administration's Geothermal Energy Program are to foster commercial development of hydrothermal resources for electric power production and nonelectric direct heat applications and to evaluate the engineering and economic feasibility of recovering methane, hydraulic, and thermal energy from geopressured resources and thermal energy from hot dry rock resources.

The budget request for \$48 million in FY 82 will permit the following:

1. Completion of construction of the 50 MW flash steam demonstration plant,
2. Determination of the technical and economic feasibility of exploiting geopressured resources,
3. Continued construction of the Fenton Hill hot dry rock energy extraction loop to assess its economic viability, and
4. Development and demonstration of advanced technology components to reduce the cost of energy recovery from all geothermal resources.

The FY 82 budget request provides no funding for the 50 MW binary demonstration at Heber, Calif., and there will be a reduction of \$4 million for that facility in FY 81. An additional reduction of \$9.5 million in operating funds will eliminate certain hydrothermal resource near-term commercialization activities, which are to be assumed by the private sector.

The Geothermal Resources Development Fund will not solicit any additional loan guarantees, and the remaining reserve funds of \$22 million will be rescinded.

How these items are to be administered and what changes will be mandated by the Congress is unclear at the moment. Substantial changes in the planned FY 82 geothermal effort may be anticipated, and APL expects to reorient its efforts accordingly.

EINSTEIN REFRIGERATOR

The status of the Einstein refrigerator (Ref. 1) was outlined in a letter (Ref. 2) to the Director of the Energy Research Office of DOE and was discussed briefly with him in person. Since he anticipated an early departure

from DOE, he circulated the letter to his staff. R. Gajewski has been asked to consider the possibility of further support (Ref. 3). He, in turn, has asked for comments from others in DOE also concerned with heat pumps/refrigerators, and an opinion is now awaited.

REFERENCES

1. Section 23, Quarterly Report, Jul-Sep 1980, JHU/APL EQR/80-3.
2. JHU/APL Lett. CQO-2997 to E. A. Frieman, 18 Feb 1981.
3. DOE Lett., J. A. Snow to A. M. Stone, 4 Mar 1981.

WESTERN STATE-COUPLED RESOURCE ASSESSMENT AND COMMERCIALIZATION TEAMS, 1981 JOINT MEETING IN SEATTLE, WASH.

On 27-29 January 1981, J. E. Tillman represented APL at the annual meeting of the DGE-sponsored joint meeting of the State-Coupled Resource Assessment and Commercialization Teams. Workshops were held concerning regional efforts and new federal programs. The opening session featured speakers from the DOE/DGE Headquarters who discussed the outlook for the program under the new administration. A collaborative effort between Gruy Federal, Inc., and APL was made as a contribution to the poster session. Gruy displayed a map defining the potential and known moderate-temperature geothermal resources in the eastern United States and identified the geologic assessment team for each area. APL's display outlined the commercial activities surrounding each resource and the various technical, financial, and economic analysis programs available to assist potential users.

Reprints of the Coolfont meeting minutes (Ref. 1) were available to interested parties at the poster session.

REFERENCE

1. "Fifth Technical Information Interchange Meeting Minutes," JHU/APL QM-80-185 (Dec 1980).

OGLE MEETING

The 31st meeting of the Geothermal Coordinating Group (Ogle Committee) was held at APL on 10-12 February 1981. Two and one-half days of presentations began with a summary by J. Salisbury, Acting Director of DGE (Ref. 1), on the current status of the DGE programs for FY 81 and 82, followed by an account of the single- and multiple-attribute utility function methodology used in the EERI/TRAC study of market penetration dynamics.

This presentation was followed by reports on the DGE Outreach, Geoscience, Industrialization, Advanced Energy Systems, and Geothermal Loan Guarantee Programs. The national laboratories, the USGS, and the DOE Operations Offices discussed their programs. Finally, reports were given on geothermal work at APL (See Section 21 in this Quarterly Report), Lawrence Berkeley Laboratory, and Lawrence Livermore Laboratory.

REFERENCE

1. Section 19, Quarterly Report, Jul-Sep 1980, JHU/APL EQR/80-3.

GEOHERMAL PROGRESS MONITOR

Material relating to geothermal subjects in the eastern United States was submitted to DOE/DGE and the MITRE Corp. for inclusion in the scheduled fifth issue of the Geothermal Progress Monitor. Items on direct heat use in New York, Maryland, and Delaware, and drilling activities in Delaware and Maryland, are included as well as items describing exploration activities. The status of two technical assistance projects in Georgia and New Jersey is given. Finally, a summary is given of new or amended geothermal legislation in Virginia, Maryland, and Delaware.

REFERENCES

1. "Draft Material for GPM No. 5," JHU/APL Lett. CAS-8-81, 17 Mar 1980.
2. "Draft of Information for New York State," JHU/APL Lett. CAS-7-81, 4 Mar 1981.

THE CAMBRIDGE WELL

The Regional Aquifer Program of the U.S. Geological Survey, Water Resources Division, has drilled a well to basement on the State Hospital grounds at Cambridge, Md. The Water Resources Regional Office in Trenton, N.J., is responsible. The program is under the direction of H. Meisler. It is hoped that the well will provide stratigraphic, hydrologic, and water chemistry data and allow correlation with data from deep wells at Kent Island and Crisfield, Md. Further, the well may assist in predictions of hydrology across the Chesapeake Bay at Cove Point, Md. The well was completed to approximately 3200 ft and a 30 ft screen was placed between 3188 and 3218 ft. Pump tests were performed and water temperature (107°F) and chemistry were measured. It is planned to test three or four additional porous sections at shallower depths. The transition region between potable and brackish water is of particular interest. It is planned that the well will be retained for an observation well after testing is completed. Suggestions relating to simultaneous testing of the lower two porous zones were forwarded in Ref. 1.

REFERENCE

1. "The Cambridge Well," JHU/APL CQO-3006 (Mar 1981).

CONFERENCE ON GEOHERMAL DRILLING AND COMPLETION TECHNOLOGY

The International Conference on Geothermal Drilling and Completion Technology was held in Albuquerque, N. Mex., 21-23 January 1981. This conference was cosponsored by DOE, Sandia National Laboratories, and the Electrical Federal Commission of Mexico.

This conference was attended by over 300 persons involved with geothermal energy in many areas of the world. The majority of the presented papers dealt with the technologies involved in drilling for a geothermal source that would be capable of electrical production. Others were devoted to drilling for a geothermal source for direct use such as space heating. The main theme throughout the conference was to use proven as well as new technologies to reduce drilling cost and improve well completions. R. von Briesen represented APL. Reference 1 is a summary of the conference.

Papers were presented giving case histories of geothermal drilling and well completion in Mexico, New Zealand, Iceland, France, Germany, the Philippines, and the United States.

The last day of the conference was devoted to a field trip to the Los Alamos hot dry rock facility at Fenton Hill. This trip provided those people who were not familiar with drilling hardware the opportunity to see first hand the immense and costly equipment necessary for deep geothermal drilling. For example, the drilling rig has been at Fenton Hill over 700 days with an hourly rental rate of \$308. This \$5 million cost for the rig alone is less than half of the total drilling costs.

This conference was the first of what is expected to be a yearly event.

REFERENCE

1. R. von Briesen, "Attendance at the International Conference - Geothermal Drilling and Completion Technology," JHU/APL QM-81-015 (Jan 1981).

LOANS TO CONSTRUCT GEOHERMAL DISTRICT HEATING AND SMALL HYDROELECTRIC POWER FACILITIES; PROPOSED RULE MAKING AND PUBLIC HEARINGS

In support of efforts to accelerate the commercialization of geothermal energy, a draft of a proposed rule was prepared and forwarded (Ref. 1) by EG&G Washington Analytical Services Center (WASC) at the request of DOE. That rule implements provisions in Title VI of the Energy Security Act that amended the Geothermal Research, Development and Demonstration Act of 1974 (Public Law 93-410) and amends certain provisions in the Geothermal Loan Guaranty Program (10 CFR Part 790). Additionally, efforts were undertaken to review existing loan and guaranty agreements issued for geothermal projects. The purpose of that review was to evaluate whether provisions in these agreements are adequate to conduct necessary project monitoring by DOE. On the basis of that review, DOE determined that the agreements do not provide for the submission by borrowers and lenders of sufficient data so that DOE may carry out and meet its post-award loan guaranty authority and responsibility. Preliminary work was initiated by EG&G WASC to prepare a monitoring plan for DOE's implementation.

REFERENCE

1. Lett. to L. W. Seward, DOE/DGE, from EG&G Washington Analytical Services Center, Inc., 10 Feb 1981.

APL ENERGY STUDY TEAM

An ad hoc task group has been formed at APL to advise the Director on such future efforts in the field of energy as are consistent with the Laboratory's principles; namely (a) the task contributes to a national need or requirement, (b) the task is appropriate for a university, and (c) APL is uniquely fitted to carry out the task.

The ad hoc group is chaired by the Assistant Director for Research and is composed of representatives from ongoing energy tasks at APL, including geothermal.

The final report will contain recommendations of areas where the above three principles

apply and further recommendations on the administration of these ongoing and/or new energy programs, both within the Laboratory and in relation to The Johns Hopkins University Energy Research Institute (Ref. 1).

REFERENCE

1. Section 30, Quarterly Report, Oct-Dec 1980, JHU/APL EQR/80-4.

GAO EXAMINATION OF FINAL IRS RULES - INVESTMENT AUDIT FOR ENERGY PROPERTY

The General Accounting Office (GAO) is examining current IRS final rules for Investment Credit for Energy Property (Ref. 1). Among other questions, the office requested data on whether the proposed well head temperature limitation of 50°C (122°F) would preclude geothermal space heating and industrial use. References 2, 3, and 4 forwarded data to J. Schulze of the GAO on many potential uses of geothermal energy for resource temperatures below 50°C. It was recommended that, if a temperature limit is required to separate water-referenced heat pumps from direct geothermal applications, a temperature of 32°C (80°F) be used. In addition, GAO has

been examining the ruling that any equipment that has multiple use (such as a fossil-fuel peaking boiler and any equipments after the boiler such as water distribution controls) and radiation would not qualify for geothermal tax credits. Data on capital costs of typical system components and the necessity for peaking systems were supplied to GAO. In the case of district heating, the cost of peaking plant and head distribution systems can represent 60% of capital costs. GAO is to recommend an interpretation of rules to include all distribution and controls equipment for tax exclusion but not fossil-fuel peaking boilers. GAO will publish a report of its recommendations.

REFERENCES

1. 26 CFR Part 1, "Investment Credit for Energy Property," Federal Register, Vol. 46, No. 15, Rules and Regulations, pp. 7287-7298 (1981).
2. "Informal Transmittal of Studies of Applications of Modest Temperature Geothermal Resources" (28 Jan 1981).
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SITING OF CRITICAL FACILITIES

§ 23

Neotectonic Investigation F7K6CQO

Support: Nuclear Regulatory Commission

Site Safety Research

J. E. Tillman

January-March 1981

GEOLOGIC INVESTIGATIONS IN WESTERN CONNECTICUT AND ADJACENT NEW YORK

A number of geologic, hydrologic, and seismic phenomena must be carefully evaluated in the site-selection process for critical facilities in order to assess their potential impact on the integrity of the facility throughout its expected operating life. Detailed geologic investigations are required for many critical facilities (e.g., nuclear power plants, dams, liquefied natural gas facilities, hospitals, highways, hazardous waste repositories, etc.) by state and federal statutes.

Investigations commonly involve assessments of the potential magnitude and frequency of earthquakes and their associated effects on the site area, e.g., vibrating ground motion, ground rupture, and the liquefaction of saturated soils. Other natural or man-induced phenomena investigated are landslides, subsidence, ground water fluctuations, swelling clays, and high rock stresses that may produce rock squeeze problems. The potential impact of each of these features on a facility is a function of the local geologic setting and the nature of the design of the engineering structure. Therefore, all of these features are not exclusionary in that their presence does not necessarily remove a site from consideration. However, if it proves to be too costly to design the facility so that it can withstand the impact of their occurrence, then the extent of the phenomena must be determined and given a large weighting in the screening process.

The Nuclear Regulatory Commission promulgated a set of geologic and seismic criteria (Ref. 1) in the early 1970's for the siting of nuclear generating stations. These criteria required the identification of all of these site-related features and an assessment of their potential impact on the critical facilities. One of the most important criteria was the requirement for a minimum distance to be maintained between the power plant site and a capable fault. The definition of a capable fault was given as a fault that:

1. Has experienced surface rupture once in the past 35,000 years, or more than once in the past 500,000 years, or
2. Is structurally associated with a capable fault, or
3. Can be related to macroseismicity.

In the eastern United States, it is difficult to document surface rupture because of the lack of young sediments with which to date movements (Fig. 1). Furthermore, although eastern seismicity is commonly shallow (1 to 10 km), fault movements do not necessarily occur at the surface, resulting in a greater dependence on the

Fig. 1 The Mesozoic and Cenozoic deposits of eastern and central United States. The black line is the southern limit of continental glaciation and limited glacial deposits. Solid black areas are underlain by Triassic and Jurassic rocks, dotted areas by Cretaceous sediments, and vertical lines by Cenozoic deposits. (81-1/50)

Fig. 2 Brittle fault (1 m wide) and associated fracture fabric in the Thomaston granites near Brookfield, Conn. (81-1/51)

Fig. 3 Ductile fault zone in the Hartland Formation near Bethel, Conn. 2 m vertical exposure. (81-1/52)

third definition for capability. Macroseismicity is also a not easily quantified concept; however, in general those earthquakes measuring 3.5 or higher on the Richter scale are considered to be macroseismic events. Recognizing capable faults in the east solely on the alignments (presumably along a fault) of seismic events is not a very satisfactory approach. The historic seismic record is too short to be dependable and the epicentral locations are diffuse. Major earthquakes have occurred in the east; however, their recurrence interval is longer than our historic

record. Therefore we do not know with any certainty the location or timing of the next disastrous event.

To help quantify this risk, the U.S. Nuclear Regulatory Commission has funded an investigation of young faulting by the New England Seismotectonic Study team managed through Weston Observatory. APL's representative has been investigating one of the more seismically active zones in the eastern United States for over six years. The northern fall line (western Connecticut to Maryland) seismic belt appears to be related, at least in part, to a series of north-east trending faults. Our investigations have included extensive field mapping, geophysical surveys, and geochemical analyses. Results through the summer of 1980 were published last August (Ref. 2). Young brittle faults (Fig. 2) have been identified and separated from older ductile features (Fig. 3). The next stage of the investigation will involve deciphering the detailed faulting histories along these zones and establishing relative, approximate, and (where possible) absolute ages of movement. The successful completion of these efforts will greatly improve our confidence in siting and building critical facilities and should decrease the length of time presently required for licensing a site.

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SITING OF CRITICAL FACILITIES

§ 24

Earthquake Hazards Mitigation Program X78YCQO

Support: Task X/N00024-81-C-5301

J. E. Tillman

January-March 1981

DEVELOPMENT OF SEISMO-TECTONIC DOMAINS

The federal government has begun a comprehensive Earthquake Hazards Mitigation Program to identify and reduce the risks of major earthquakes. The U.S. Geological Survey, the National Science Foundation, and the Nuclear Regulatory Commission are all participants in research to improve our knowledge of and preparedness for earthquakes. APL is involved in geologic research in the assessment of earthquakes in southeastern New York and western Connecticut (Fig. 1) (Ref. 1). We have developed several new techniques to determine the ages of movement on fault zones and new approaches for developing seismotectonic domains.

The prominent method for assigning a value for the seismic-design of a critical facility (such as a nuclear generating station) in the Eastern United States is to determine the seismotectonic province in which it lies and use the highest magnitude event that has occurred in that province as the design-basis earthquake (Fig. 2). This approach has produced considerable controversy as to the definition and extents of the seismotectonic provinces. The principal reason for the controversy is that the geologic record in the eastern United States is dominated by old Paleozoic features (550 to 220 million years ago). The importance of these old surface features to recent seismicity is not known.

A better approach to developing seismotectonic provinces would be to use only data related to the present tectonic regime, that is,

Fig. 1 LANDSAT composite image of southeastern New York and southwestern Connecticut. (81-1/53)

Fig. 2 Earthquake epicenters 1800-1972. Contours of areal distribution of earthquake epicenters with epicentral intensity of MM III and greater (from Ref. 2). (79-4/57)

to analyze only those features that are clearly related to the geologic processes occurring today. This neotectonic regime is clearly different from the Paleozoic as well as the Mesozoic, and thus only Cenozoic features should be evaluated.

Although these data are limited, the details of faulting histories can be established by integrating geochemical analyses of fault zone minerals with mechanical examination of fault fabrics.

These efforts have produced detailed Cenozoic faulting histories on individual faults (Ref. 3). To extrapolate these data requires knowledge of the correlation between a series of separate fracture fabrics and discrete mineralization events. Once this has been determined, the younger fracture fabrics can be used to extend the boundaries of the seismotectonic province to the border of the structural domain.

Fig. 3 Preliminary neotectonic domain map. (81-1/54)

Figure 3 is a preliminary neotectonic domain map developed from these techniques.

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3. J. E. Tillman, H. L. Barnes, and J. A. Fisher "On Extending the Historic Record," Fifty-Second Meeting, Seismological Society of America (1980).

FRACTURE PERMEABILITY CONSIDERATIONS IN SITING HAZARDOUS WASTE REPOSITORIES

The most crucial aspect in the siting, development, and monitoring of radioactive and other toxic waste repositories is ensuring that the contaminated groundwaters are constrained. This requires a great deal of knowledge of the groundwater system of a potential or existing site. In areas where a simple aquifer system occurs, monitoring wells can routinely be placed to determine the depth to water table, the permeability, the sorption, and the distance and path to the point where the water will be used.

Fig. 1 Small fault zone with associated fractures in well-cemented Oswego Sandstone, western New York. (81-1/47)

However, where the repository is in bedrock, water flow is predominantly controlled by fracture permeability. This can be quite nonuniform, thus resisting straightforward modeling. An example is shown in Fig. 1, where a well-

Fig. 2 Comparison of post-Paleozoic faulting histories as determined from a combined geochemical and structural investigation. All isotopic age determinations shown are by the K/Ar method. (Ref. 2)(81-1/48)

cemented sandstone with extremely low primary porosity has been crosscut by a small (1 m wide, 1 km long, and 30 m deep) but highly permeable fault zone.

Through our geothermal program work on fracture permeability in sedimentary basins, we have developed techniques to differentiate between fractures and thus to locate zones of enhanced fracture permeability. We have found that many fracture sets may occur in a single area. Some of these may have low hydraulic conductivities caused by mineralization or by hydrostatic stresses being lower than the in situ rock stresses. Therefore, it becomes important to determine which fracture sets are affecting the hydrologic system as a function of depth. This requires detailed petrofabric analysis, the development of mechanical models of the repository host rock and geochemical analyses of fracture mineralogy to help differentiate the fracture systems and decipher the circulation

histories along each. The details of the circulation histories are recorded in the minerals on fault and fracture planes. Depths of burial, chemistries, temperatures, ages, and the extent of circulation of the fluids can all be obtained from this geochemical record. This approach and the results of our work are summarized in Fig. 2 and have recently been published in Ref. 1.

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ENERGY CONVERSION AND STORAGE TECHNIQUES

Utilization of Landfill Methane F7M3CPE

\$ 26

Support: Argonne National Laboratory

G. A. Yoshioka

January-March 1981

INSTITUTIONAL BARRIERS TO LANDFILL METHANE RECOVERY AND THE NEED FOR STATE LEGISLATION

A major hazard associated with sanitary landfills is the uncontrolled migration of methane gas. This gas is generated in the landfill as organic matter decomposes and it may rise or diffuse laterally through buried refuse and soil. Methane can accumulate to explosive concentrations in enclosed areas on or near a landfill. Gas control measures, which include venting the gas or installing impermeable barriers to prevent migration, are often necessary to meet the safety criteria recommended by federal guidelines.

At some landfills, methane gas has been collected and flared; however, in the early 1970's, it was recognized that this methane, the main constituent of natural gas, could be a valuable energy resource. In several California communities and in New Jersey and Illinois, landfill methane is now collected and sold commercially. End-use options include distribution to nearby customers, treatment and injection into a natural gas pipeline, or use as a fuel for on-site generation of electricity. Along with valuable energy, landfill methane recovery may produce environmental benefits by reducing uncontrolled gas migration. A further advantage is that methane recovery requires a relatively low capital investment compared to other municipal waste-to-energy systems.

GOVERNMENTAL RESPONSE

The federal government, through the Environmental Protection Agency and the Department of Energy (DOE), has helped to support several recovery projects to demonstrate the viability of the technology. DOE's program also includes sponsorship of an annual landfill methane conference (Ref. 1), a workbook for local decision-makers (Ref. 2), and a film explaining the technology.

Regulations promulgated by DOE and the Federal Energy Regulatory Commission (FERC) can help to encourage such projects (Ref. 3). For example, a recovery facility where the landfill gas is used to generate electricity on-site may qualify as a small power production facility under the Public Utility Regulatory Policies Act of 1978. A qualifying facility could be exempted from certain federal and state laws and regulations governing utilities. The Act also requires that FERC prescribe such rules as it finds necessary to encourage cogeneration and small power production, including rules requiring electric utilities to offer to sell electric energy to qualifying facilities and to purchase electric energy from them.

The state of California has enacted legislation specifically concerned with encouraging landfill methane recovery. The law requires that a feasibility study be undertaken by the State Solid Waste Management Board and that the board develop a proposed program, based on the findings of the study, to implement landfill methane recovery in the state. Recommendations for the program were submitted to the legislature in March 1980 (Ref. 4).

In Colorado, legislation giving counties and municipalities the authority to develop and market landfill gas has recently been enacted. In other states where local governments lack the authority to implement certain landfill methane recovery programs, the Colorado law can serve as a useful model.

NEED FOR COMPREHENSIVE LEGISLATION

In spite of these governmental efforts, the development of alternative energy technologies has been largely hampered by the existing regulatory and legislative framework, which is addressed primarily to the construction and operation of large, conventional energy facilities. For example, the regulatory burdens on multi-user solar energy systems have been well documented (Refs. 5 and 6), and some efforts have been made to exempt such systems from regulation as a public utility. Similarly, the multitude of approvals and permits required and the uncertainty of public utility status have been cited as obstacles to small-scale hydroelectric power development in Maryland (Ref. 7).

The California State Solid Waste Management Board's report to the legislature recommended amendment of the Public Utilities Code as a high priority item. The report pointed out that, under present state law, some landfill gas facilities could be subject to unnecessarily burdensome standards and regulation by the Public Utility Commission (PUC). To a person contemplating investment in such a facility, potential PUC regulation would pose a serious risk.

The governmental requirements and procedures that must be followed to get the necessary permits and approvals for recovery facilities has been characterized by some as the primary obstacle to the more rapid development of landfill methane as an energy source (Ref. 8). A report prepared for the American Gas Association (Ref. 9) also recognized those institutional barriers that tend to retard deployment of landfill methane recovery systems. Recommendations for state authorities include the encouragement by state utility regulatory commissions of landfill methane development and the assistance of state agencies responsible for the issuance of environmental and other necessary permits. The report points out that delay in permitting can increase the costs of a methane recovery project to the point where either the project is rendered uneconomical or is abandoned in sheer frustration.

STATUTORY PROVISIONS

It is clear that the technology necessary for the recovery of landfill methane should be encouraged. Recovery projects can help protect the environment and mitigate a safety hazard, while at the same time providing a new source of energy or revenue for local governments. The suggested statutory provisions presented below are designed to give recognition to the unique benefits offered by this technology, to remove uncertainties about public utility status

of landfill methane recovery projects, and to streamline the process by which the projects may be evaluated and approved.

These statutory provisions are in the form of a hypothetical act for the state of Maryland; however, to date no such law has actually been introduced in any state legislature. The need for this type of legislation and a preliminary version of the proposed act were discussed at the 1980 Symposium on Landfill Methane Utilization (Ref. 10). In practice, parts of the act might be adopted as statutes, ordinances, or regulations that can be tailored to the particular jurisdiction and legislative intent. A section-by-section analysis is included with the text of the act.

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ARTICLE - NATURAL RESOURCES

SUBTITLE 6. LANDFILL METHANE RECOVERY ACT

6-601. DEFINITIONS

(A) IN GENERAL - IN THIS SUBTITLE THE FOLLOWING WORDS HAVE THE MEANINGS INDICATED.

(B) "DEPARTMENT" MEANS THE DEPARTMENT OF NATURAL RESOURCES.

(C) "LANDFILL" MEANS ANY SITE FOR THE DISPOSAL OF SOLID WASTE INVOLVING THE PLACEMENT OF SOLID WASTE ON OR INTO THE LAND SURFACE AND INVOLVING COMPACTION AND COVERING OF THE DISPOSED SOLID WASTE. THIS IS NOT MEANT TO INCLUDE A HAZARDOUS WASTE FACILITY AS DEFINED IN TITLE 3, SUBTITLE 7 OF THIS ARTICLE.

(D) "LANDFILL METHANE" INCLUDES ANY MIXTURE OF GASES CONTAINING METHANE (CH₄) THAT IS PRODUCED BY THE ANAEROBIC DECOMPOSITION OF SOLID WASTE IN A LANDFILL.

(E) "PERSON" INCLUDES CORPORATIONS, COMPANIES, ASSOCIATIONS, FIRMS, PARTNERSHIPS, JOINT STOCK COMPANIES, INDIVIDUALS, AND GOVERNMENT AGENCIES.

(F) "RECOVERY FACILITY" INCLUDES STRUCTURES AND EQUIPMENT, ON OR ADJACENT TO A LANDFILL SITE, USED TO EXTRACT, TREAT, AND TRANSPORT LANDFILL METHANE FOR USE AS AN ENERGY RESOURCE.

(G) "SOLID WASTE" MEANS ANY GARBAGE, REFUSE, SLUDGE, AND OTHER DISCARDED MATERIAL FROM INDUSTRIAL, COMMERCIAL, AGRICULTURAL, AND COMMUNITY ACTIVITIES.

Section 6-601

Definitions for "Landfill" and "Solid Waste" are based on similar wording in U.S. Environmental Protection Agency regulations. Since raw and treated landfill gas both include varying concentrations of methane, "Landfill Methane" is defined to include landfill gas containing any fraction of methane. The definition of "Recovery Facility" is meant to include pipes, pumps, and gas treatment devices, whether they are on the landfill itself or immediately adjacent to it. The definition is not meant to include facilities for gas migration control, e.g., a gas venting or flaring operation that does not involve energy recovery.

6-602. LEGISLATIVE INTENT AND FINDINGS

(A) IT IS THE POLICY OF THE STATE TO ENCOURAGE THE DEVELOPMENT OF NEW DOMESTIC SOURCES OF ENERGY FOR USE IN MARYLAND'S HOMES, COMMERCIAL ENTERPRISES, AND INDUSTRIES.

(B) DURING THE NATURAL DECOMPOSITION OF SOLID WASTE IN A LANDFILL, SUBSTANTIAL QUANTITIES OF METHANE GAS, HAVING SIGNIFICANT ENERGY POTENTIAL, MAY BE PRODUCED.

(C) COLLECTION AND TREATMENT OF LANDFILL GAS MAY REDUCE THE POTENTIAL HAZARD OF EXPLOSIVE GAS MIGRATION, VEGETATION DAMAGE, AND ODOR NUISANCE AT LANDFILLS.

(D) FOR A LANDFILL METHANE RECOVERY FACILITY, THE EFFICIENCY OF THE PERMIT APPLICATION AND REVIEW PROCESS AT BOTH THE STATE AND LOCAL LEVEL WOULD BE IMPROVED WITH THE IMPLEMENTATION OF A PROCESS WHEREBY A PERMIT APPLICATION WOULD BE CENTRALLY COORDINATED AND ALL PERMIT DECISIONS COULD BE REVIEWED ON THE BASIS OF STANDARDS AND RECOMMENDATIONS OF THE DECIDING AGENCIES.

Section 6-602

Legislative intent and findings (A), (B), and (C) emphasize both the energy value of landfill methane recovery and the environmental benefits. Finding (D) reflects the need for streamlining the process of project evaluation and approval, while at the same time establishing a consistent set of standards by which all applications may be judged.

6-603. POWERS AND DUTIES OF THE DEPARTMENT

- (A) THE DEPARTMENT SHALL BE RESPONSIBLE FOR THE REGULATION OF LANDFILL METHANE RECOVERY IN THE STATE.
- (B) THE DEPARTMENT MAY CONDUCT AND PARTICIPATE IN DEVELOPMENT PROJECTS DESIGNED TO DEMONSTRATE THE FEASIBILITY OF LANDFILL METHANE RECOVERY.
- (C) THE DEPARTMENT MAY ESTABLISH REASONABLE FEES TO COVER THE COST OF PROCESSING PERMIT APPLICATIONS.
- (D) THE DEPARTMENT MAY PROMULGATE RULES AND REGULATIONS NECESSARY TO IMPLEMENT THIS SUBTITLE.

Section 6-603

The Department of Natural Resources (DNR) is given responsibility for regulating landfill methane recovery in Maryland. Although the Department of Health and Mental Hygiene is responsible for sanitary landfills and the Public Service Commission governs gas utility companies, DNR already has jurisdiction over gas and oil recovery as well as alternative energy resources such as geothermal resources. It is anticipated that close cooperation among the various state bodies will be necessary, and this is reflected in Section 6-604 (C).

6-604 PERMIT REQUIRED

- (A) EVERY PERSON IS REQUIRED TO OBTAIN A PERMIT FROM THE DEPARTMENT BEFORE CONSTRUCTING A LANDFILL METHANE RECOVERY FACILITY. A WRITTEN APPLICATION IS NECESSARY TO OBTAIN A PERMIT.
- (B) THE APPLICATION SHALL BE ACCOMPANIED BY THE FOLLOWING INFORMATION AND ANY OTHER INFORMATION AS REQUIRED BY THE DEPARTMENT.

- (1) A PROJECT DESCRIPTION SPECIFYING:
 - (I) WHAT IS PLANNED TO BE CONSTRUCTED, ITS PURPOSE, USE, LOCATION, ESTIMATED COST, AND SIZE; AND
 - (II) THE METHOD OF CONSTRUCTION, CONSTRUCTION SCHEDULE, AND OPERATION PROCEDURE.

- (2) ALL INFORMATION NECESSARY FOR ANY APPLICATION FOR A PERMIT, CERTIFICATE, FRANCHISE, OR SIMILAR DOCUMENT REQUIRED BY ANY STATE, LOCAL, OR REGIONAL AGENCY FOR CONSTRUCTION AND USE OF THE RECOVERY FACILITY.

- (3) DETAILED INFORMATION AS TO THE NEED FOR THE RECOVERY FACILITY AND FACTS CONCERNING ALTERNATE SITE LOCATIONS AS MAY BE REQUESTED BY THE DEPARTMENT.

- (C) AFTER PUBLIC NOTICE AND OPPORTUNITY FOR PUBLIC HEARING, AND AFTER RECEIVING THE ADVISORY COMMENTS AND RECOMMENDATIONS OF THE DEPARTMENTS OF STATE PLANNING, HEALTH AND MENTAL HYGIENE, AND ECONOMIC AND COMMUNITY DEVELOPMENT, THE DEPARTMENT MAY ISSUE A PERMIT FOR THE CONSTRUCTION AND USE OF A LANDFILL METHANE RECOVERY FACILITY IF IT FINDS THAT THE APPLICANT HAS DEMONSTRATED THAT THE USE:

- (1) CONFORMS WITH AND MEETS ALL APPLICABLE AIR, WATER, AND NOISE LAWS OF THE STATE.

- (2) CONFORMS WITH ALL APPLICABLE STATE AND LOCAL PLANS.

- (3) WOULD HAVE NO MATERIAL ADVERSE EFFECT UPON THE NATURAL ENVIRONMENT OF THE AREA, ITS SCENIC OR NATURAL BEAUTY, RARE OR IRREPLACEABLE RESOURCES, OR UNIQUE HISTORIC SITES.

- (4) WOULD NOT BE SO LOCATED, CONSTRUCTED, OR OPERATED AS TO HAVE A MATERIAL ADVERSE EFFECT UPON THE PUBLIC HEALTH, SAFETY, OR WELFARE.

- (D) ACCEPTANCE BY THE DEPARTMENT OF ANY APPLICATION FOR PROCESSING DOES NOT PRECLUDE THE DEPARTMENT FROM REQUIRING FURTHER INFORMATION FROM THE APPLICANT IF THE DEPARTMENT CONSIDERS THE ADDITIONAL INFORMATION NECESSARY FOR ADEQUATE CONSIDERATION OF THE APPLICATION.

- (E) NO PERMIT IS REQUIRED BY THIS SECTION FOR ANY ACTIVITY INVOLVING THE DRILLING OF TEST WELLS.

- (F) THE PERMIT REQUIRED BY THIS SECTION SHALL BE IN LIEU OF ANY PERMIT, CERTIFICATE, FRANCHISE, OR SIMILAR DOCUMENT REQUIRED BY ANY STATE, LOCAL OR REGIONAL AGENCY, OR FEDERAL AGENCY TO THE EXTENT PERMITTED BY FEDERAL LAW, FOR CONSTRUCTION AND USE OF THE RECOVERY FACILITY. THIS SUBTITLE SHALL SUPERSEDE ANY APPLICABLE STATUTE, ORDINANCE, OR REGULATION OF ANY STATE, LOCAL, OR REGIONAL AGENCY, OR FEDERAL AGENCY TO THE EXTENT PERMITTED BY FEDERAL LAW.

Section 6-604

The requirement for a permit, information to be contained in the application, and standards by which DNR evaluates the application are similar to the Maryland Geothermal Resources Act and the Coastal Facilities Review Act. Subsection (E) exempts the drilling of test wells from the permit requirement. Test wells are generally necessary for determining the feasibility of methane recovery at a particular landfill. It was felt that to require a permit would be unnecessary and impractical for a temporary testing program involving little or no energy recovery. The standards in subsection (C) are believed to satisfy most state and local requirements for construction and use of a recovery facility. Therefore subsection (F) is a broad waiver from those other permit requirements. In practice, it is anticipated that all concerned state, local, and regional agencies will have an opportunity to participate in the application approval process. Specifically, regional sanitary districts, the Department of Health and Mental Hygiene (with authority in Article 43 for solid waste acceptance facilities), and local governmental boards would have an interest in such projects. However, it is expected that most recovery facilities would have the potential for environmental benefits and a minimum environmental harm.

6-605. PUBLIC SERVICE COMMISSION REGULATION

(A) A LANDFILL METHANE RECOVERY FACILITY WILL NOT BE SUBJECT TO PUBLIC SERVICE COMMISSION REGULATION IF THE LANDFILL METHANE:

- (1) IS USED BY THE OWNER RATHER THAN SOLD TO CUSTOMERS, OR
- (2) IS SOLD TO A GAS UTILITY COMPANY FOR RESALE TO CUSTOMERS, OR
- (3) IS SOLD TO FEWER THAN TEN RETAIL CUSTOMERS.

(B) THE PUBLIC SERVICE COMMISSION SHALL PRESCRIBE RULES AS IT DETERMINES NECESSARY TO ENCOURAGE LANDFILL METHANE RECOVERY, REQUIRING UTILITY COMPANIES TO OFFER TO:

- (1) SELL ENERGY TO LANDFILL METHANE RECOVERY FACILITIES AT RATES WHICH ARE JUST, REASONABLE, IN THE PUBLIC INTEREST, AND NONDISCRIMINATORY TO SUCH FACILITIES, AND
- (2) PURCHASE LANDFILL METHANE FROM LANDFILL METHANE RECOVERY FACILITIES AT RATES WHICH ARE JUST AND REASONABLE TO THE CUSTOMER OF THE PURCHASING UTILITY, IN THE PUBLIC INTEREST, AND NONDISCRIMINATORY TO SUCH FACILITIES.

Section 6-605

The Public Service Commission (PSC) generally does not exercise jurisdiction over facilities involved in gas recovery for self-use or for wholesale sales, and at least one authority feels that the PSC would not regulate sales to fewer than ten retail customers. These conditions are made part of the Act in subsection (A). Subsection (B) is intended to prevent a utility company from discriminating against a landfill methane recovery facility either in sales of energy or in purchase of landfill methane. Federal law already makes such provisions for certain small electric power production facilities.

JHU/APL EQR/81-1

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