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# GEOTHERMAL ENERGY ACT

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## HEARING

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BEFORE THE

### SUBCOMMITTEE ON WATER AND POWER RESOURCES

OF THE

### COMMITTEE ON INTERIOR AND INSULAR AFFAIRS UNITED STATES SENATE

NINETY-THIRD CONGRESS

FIRST SESSION

ON

## S. 2465

A BILL TO AUTHORIZE THE SECRETARY OF THE INTERIOR TO GUARANTEE LOANS FOR THE FINANCING OF COMMERCIAL VENTURES IN GEOTHERMAL ENERGY; TO COORDINATE FEDERAL ACTIVITIES IN GEOTHERMAL ENERGY EXPLORATION, RESEARCH, AND DEVELOPMENT; AND FOR OTHER PURPOSES

NOVEMBER 7, 1973



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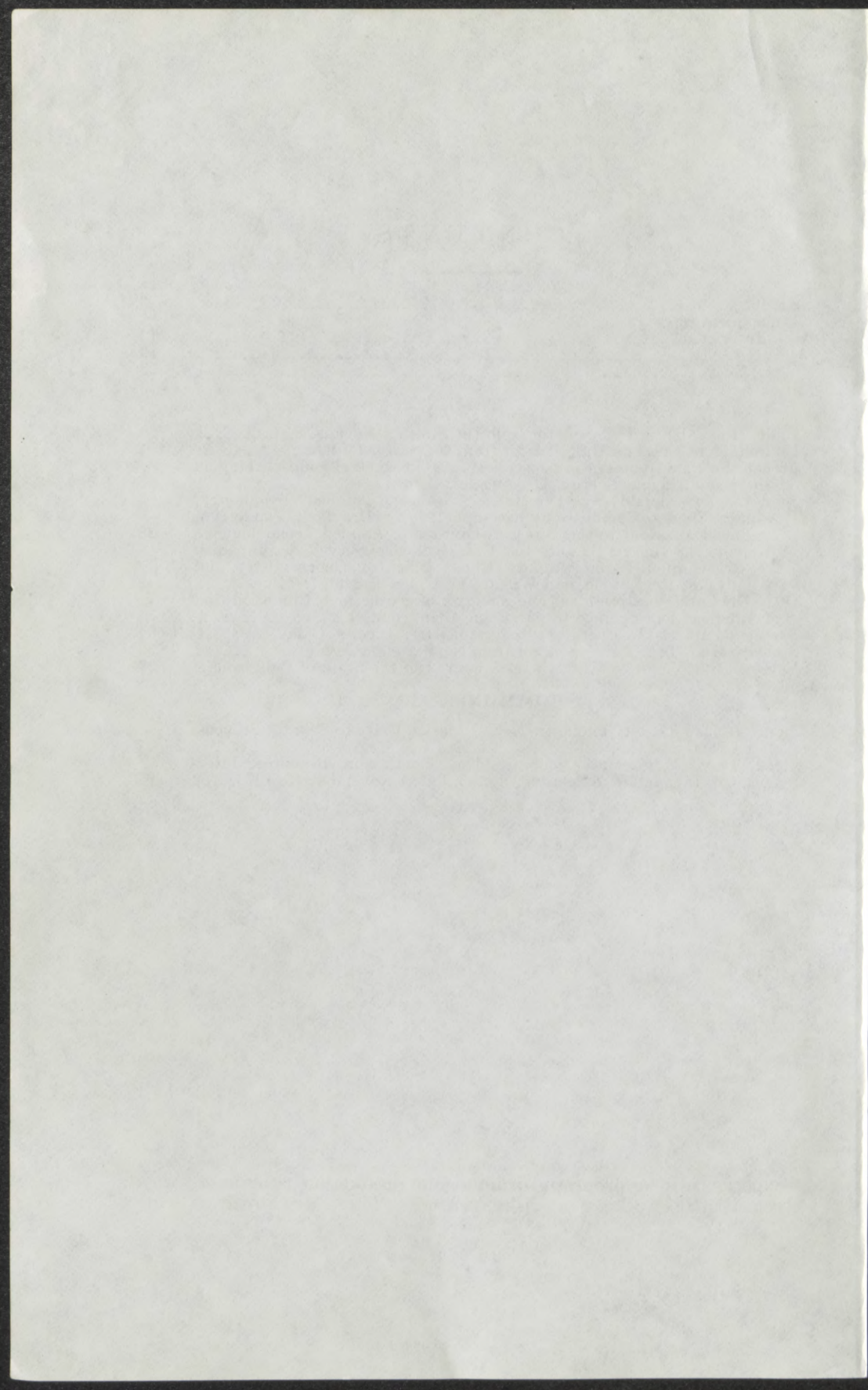
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# GEOTHERMAL ENERGY ACT

WEDNESDAY, NOVEMBER 7, 1973

U.S. SENATE,  
SUBCOMMITTEE ON WATER AND POWER RESOURCES,  
OF THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,  
*Washington, D.C.*

The subcommittee met, pursuant to notice, at 10 a.m., in room 3110, Dirksen Office Building, Hon. Frank Church, chairman, presiding.  
Present: Senators Church [presiding], Bible, Fannin, Hansen, Buckley, and McClure.

Also present: Jerry T. Verkler, staff director; Daniel A. Dreyfus and Jerry Gereau, professional staff members.

Senator CHURCH. The hearing will please come to order.

## OPENING STATEMENT OF HON. FRANK CHURCH, A U.S. SENATOR FROM THE STATE OF IDAHO

The purpose of this hearing before the Water and Power Resources Subcommittee this morning is to take testimony on S. 2465, a bill to authorize a Federal program to guarantee loans for geothermal energy development and an expedited program of exploration, research, development, and demonstration in geothermal resources.

This subcommittee has recently completed a series of hearings and field investigations of the power potential of geothermal resources. As the study shows, geothermal resources defy generalization. There are many forms of geothermal resources, and they represent varied opportunities and challenges. A few applications exist today and are easily competitive with alternative energy sources; other geothermal resources involve great uncertainties and will present difficult and costly scientific and engineering problems.

The subcommittee's investigations have established that there is great interest in getting on with geothermal development and they have established that the possible value of geothermal energy is great. But the hearings have also highlighted the tremendous uncertainties clouding early development of the resource.

The extent and nature of geothermal anomalies are not well established. No comprehensive exploration program is actively being pursued. Work has been done by some very good geologists in some regions, but it has been based almost exclusively upon surface indications and water and oil well data which are not well suited to the purpose.

Lack of information about the resource, coupled with insufficient experience in appropriate drilling and production techniques, make geothermal development risky ventures. Those private firms which

would like to undertake geothermal projects find financing difficult to obtain. Until more experience has been acquired through the construction and operation of demonstration facilities, private financing for ventures in geothermal energy will probably remain difficult.

In the more technologically complex applications, a strong measure of Federal financing participation in research and development may be necessary. There is no assurance that early attempts to tap geothermal resources of new kinds will result in reliable or economic ventures. The probability is that they will not. As in any new technology, prototype plans will provide primarily learning experience. Cost estimates will be unreliable and results uncertain. There is an understandable reluctance on the part of private industry to embark upon such ventures, particularly on the part of the electric utilities which are presently sorely pressed to finance and construct sufficient conventional capacity to meet increasing energy demands.

The pace of experimental installations could be greatly accelerated by a Federal program of cooperative financing and construction of prototype demonstration plants. The experience which would be gained from a number of such installations, based upon a variety of resources and technologies, would help to resolve such uncertainties as the environmental problems which might occur, the costs and reliability which might be expected of second generation plants, and the types of specific research which should be undertaken to improve performance.

Unfortunately, there is no concerted Federal program for research and development of geothermal resources. There are several agencies which are interested in the resource and there are some limited activities underway. These efforts lack a sense of urgency. They lack a lead agency with specific authority to coordinate Federal responsibilities for geothermal research and to cooperate with industry in a planned program of exploration, research, and development.

In the present energy situation, we cannot afford to overlook the potential of this attractive domestic resource. Several of us on the Senate Interior Committee have joined with Senators Bible and Fannin in introducing S. 2465 to authorize the Federal initiatives which are necessary.

I am hopeful that today's hearing will provide constructive advice on the measure so that prompt committee action can be taken, and I hope we can then move on to its consideration and adoption in the full committee.

The text of S. 2465 and the reports of the executive agencies shall be included in the record at this point.

[The text of S. 2465 and departmental reports follow:]

93<sup>D</sup> CONGRESS  
1<sup>ST</sup> SESSION

# S. 2465

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## IN THE SENATE OF THE UNITED STATES

SEPTEMBER 21, 1973

Mr. BIBLE (for himself, Mr. FANNIN, Mr. BARTLETT, Mr. BUCKLEY, Mr. CHURCH, Mr. HANSEN, Mr. HASKELL, Mr. HATFIELD, Mr. JACKSON, Mr. JOHNSTON, Mr. McCLURE, and Mr. METCALF) introduced the following bill; which was read twice and referred to the Committee on Interior and Insular Affairs

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## A BILL

To authorize the Secretary of the Interior to guarantee loans for the financing of commercial ventures in geothermal energy; to coordinate Federal activities in geothermal energy exploration, research, and development; and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*  
2 *tives of the United States of America in Congress assembled,*

3 That this Act may be cited as the "Geothermal Energy Act  
4 of 1973".

5 TITLE I—LOAN GUARANTEE PROGRAM

6 SEC. 101. (a) The Congress, in consideration of the  
7 Federal responsibility for the general welfare, to facilitate  
8 commerce, to encourage productive harmony between man

1 and his environment, and to protect the public interest, finds  
2 that the advancement of technology by private industry for  
3 the production of useful forms of energy from geothermal  
4 resources is important to all of those areas of responsibility.  
5 It is the policy of the Congress, therefore, to encourage and  
6 assist in the commercial development of practicable means  
7 to produce useful energy from geothermal resources with  
8 environmentally acceptable processes. Accordingly, it is the  
9 policy of the Congress to facilitate such commercial develop-  
10 ment by authorizing the Secretary of the Interior to guar-  
11 antee loans for such purposes.

12 (b) In order to encourage the commercial production of  
13 energy from geothermal resources, the Secretary of the In-  
14 terior, hereinafter referred to as the Secretary, is authorized  
15 to guarantee, to enter into commitments to guarantee, banks  
16 or other financial institutions against loss of principal or in-  
17 terest on loans made by such institutions to qualified bor-  
18 rowers for the purposes of acquiring rights in geothermal  
19 resources and performing exploration, development, and  
20 construction and operation of facilities for the commercial  
21 production of energy from geothermal resources.

22 (c) Any guaranty under this title shall apply only to  
23 so much of the principal amount of any loan as does not ex-  
24 ceed 75 per centum of the aggregate cost of the project with  
25 respect to which the loan is made.

1 (d) Loan guaranties under this title shall be on such  
2 terms and conditions as the Secretary determines; *Provided,*  
3 *however,* That no guaranty shall be made under this title if—

4 (1) the loan involved is at a rate of interest which  
5 exceeds the prime interest rate plus one-half of 1 per  
6 centum;

7 (2) the terms of such loan do not require full repay-  
8 ment within thirty years after the date thereof;

9 (3) in the judgment of the Secretary, the amount of  
10 the loan (when combined with amounts available to the  
11 qualified borrower from other sources) will not be suf-  
12 ficient to carry out the project; or

13 (4) in the judgment of the Secretary, there is no  
14 reasonable assurance of the repayment by the qualified  
15 borrower of the guaranteed indebtedness;

16 (e) The Secretary shall not guarantee any loan for any  
17 project the amount of which exceeds \$25,000,000, nor guar-  
18 antee any combination of loans for any single qualified bor-  
19 rower in an amount exceeding \$50,000,000.

20 SEC. 102. (a) With respect to any loan guaranteed  
21 pursuant to this title, the Secretary is authorized to enter  
22 into a contract to pay, and to pay, the lender for and on  
23 behalf of the borrower the interest charges which become  
24 due and payable on the unpaid balance of any such loan if  
25 the Secretary finds:

1           (1) that the borrower is unable to meet interest  
2           charges, and that it is in the public interest to permit the  
3           borrower to continue to pursue the purposes of his proj-  
4           ect, and that the probable net cost to the Government in  
5           paying such interest will be less than that which would  
6           result in the event of a default, and

7           (2) the amount of such interest charges which the  
8           Secretary is authorized to pay shall be no greater than  
9           an amount equal to the average prime interest rate for  
10          the preceding fiscal year as determined by the Secre-  
11          tary of the Treasury, plus one-half of one per centum.

12          (b) In the event of any default by a qualified borrower  
13          on a guaranteed loan, the Secretary is authorized to make  
14          payment in accordance with the guaranty, and the Attorney  
15          General shall take such action as may be appropriate to  
16          recover the amounts of such payments, with interest, from  
17          the defaulting borrower.

18          SEC. 103. No loan guaranties shall be made, or interest  
19          assistance contract entered into, pursuant to this title, after  
20          the expiration of the ten calendar year period following the  
21          date of the enactment of this Act.

22          SEC. 104. There is established in the Treasury of the  
23          United States a Geothermal Resources Development Fund  
24          (referred to in this title as the "fund"), which shall be

1 available to the Secretary of the Interior for carrying out the  
2 loan guaranty and interest assistance program authorized  
3 by this title, including the payment of administrative ex-  
4 penses incurred in connection therewith. Moneys in the fund  
5 not needed for current operations shall be invested in bonds  
6 or other obligations of, or guaranteed by, the United States.

7 SEC. 105. There shall be paid into the fund the amounts  
8 authorized to be appropriated by section 106 of this title and  
9 such amounts as may be returned to the United States pur-  
10 suant to section 102 (b) of this title, and the amounts in the  
11 fund shall remain available until expended: *Provided*, That  
12 after the expiration of the ten-year term established by sec-  
13 tion 103 of this title, such amounts in the fund which are not  
14 required to secure outstanding guaranty obligations shall be  
15 paid into the general fund of the Treasury.

16 SEC. 106. There are authorized to be appropriated (1)  
17 to the fund not to exceed \$50,000,000 annually, and (2)  
18 such amounts as may be required for the administrative costs  
19 of carrying out the provisions of this title.

20 SEC. 107. Business-type financial reports covering the  
21 operations of the fund shall be submitted to the Congress an-  
22 nually upon the completion of an appropriate accounting  
23 period.

1 TITLE II—COORDINATION OF FEDERAL ACTIVI-  
2 TIES IN GEOTHERMAL ENERGY EXPLORA-  
3 TION, RESEARCH, AND DEVELOPMENT

4 SEC. 201. The Congress, in consideration of the Federal  
5 responsibility for the general welfare, to facilitate commerce,  
6 to encourage productive harmony between man and his en-  
7 vironment, and to protect the public interest, finds that the  
8 advancement of technology with the cooperation of private  
9 industry for the production of useful forms of energy from  
10 geothermal resources is important to all of those areas of re-  
11 sponsibility. It is the policy of the Congress, therefore, to  
12 encourage and assist private industry through Federal as-  
13 sistance for the development and demonstration of practicable  
14 means to produce useful energy from geothermal resources  
15 with environmentally acceptable processes. Such means shall  
16 accordingly include exploration, research, and financial and  
17 technical assistance in the construction of pilot plants and  
18 demonstration developments with the objective of reaching  
19 commercialization in the most timely and practicable  
20 manner.

21 SEC. 202. The Secretary, acting through the Geological  
22 Survey, is authorized and directed to:

- 23 (a) develop and carry out a general plan for the  
24 orderly exploration of all forms of geothermal resources  
25 of the Federal lands and, where consistent with prop-

1     erty, rights and determined by the Secretary to be in  
2     the national interest, of non-Federal lands;

3     (b) conduct regional surveys, based upon such a  
4     general plan, using innovative geologic, geophysical,  
5     geochemical, and drilling techniques, that will lead to a  
6     national inventory of geothermal resources in the United  
7     States;

8     (c) publish and make available maps, reports, and  
9     other documents developed from such exploration to en-  
10    courage and facilitate the commercial development of  
11    geothermal resources for beneficial use and consistent  
12    with the national interest;

13    (d) make such recommendations for legislation as  
14    may from time to time appear to be necessary to make  
15    Federal leasing policy for geothermal resources consist-  
16    ent with known inventories of various resource types,  
17    with the current state of technologies for geothermal  
18    energy development, and with current evaluations of the  
19    environmental impacts of such developments; and

20    (e) participate with the Atomic Energy Commis-  
21    sion, the National Aeronautics and Space Administra-  
22    tion, and the National Science Foundation in research to  
23    develop, improve, and test technologies for the discovery  
24    and evaluation of all forms of geothermal resources.

25    SEC. 203. The Secretary shall coordinate the development

1 and implementation of the exploration plan with the geo-  
2 thermal research and development program of the Atomic  
3 Energy Commission to insure that information is developed  
4 in a timely manner for the optimum progress of geothermal  
5 development.

6 SEC. 204. In preparing or implementing the explora-  
7 tion plan, the Secretary is authorized to:

- 8 (a) employ contractors and consultants;  
9 (b) acquire by fund transfers the services of em-  
10 ployees and facilities of other Federal agencies; and  
11 (c) cooperate and enter into contracts with State,  
12 regional, and local governmental agencies and educa-  
13 tional and research institutions.

14 SEC. 205. The Administrator of the National Aeronau-  
15 tics and Space Administration, hereinafter referred to as  
16 NASA, is authorized and directed to prepare and transmit  
17 to the Secretary within six months from the date of this  
18 Act a proposal for the employment of space technologies and  
19 the services and facilities of NASA for exploration and map-  
20 ping of geothermal resources.

21 SEC. 206. The Secretary is authorized and directed to  
22 transmit to the President and the Congress, not later than  
23 one year from the date of this Act, the general plan including  
24 a schedule and objectives, for exploration of geothermal re-  
25 sources required by section 202 (a) and each year thereafter

1 a report on the status of activities authorized to be performed  
2 by the Secretary under the provisions of this Act.

3 SEC. 207. (a) The Atomic Energy Commission in co-  
4 operation with private industry is authorized and directed  
5 to:

6 (1) conduct, encourage, and promote basic and  
7 applied scientific research to develop effective, economi-  
8 cal, and environmentally acceptable processes and equip-  
9 ment for the purpose of utilizing all forms of geothermal  
10 resources for the production of useful energy forms;

11 (2) pursue the findings of research authorized by  
12 this Act having potential applications in matters other  
13 than geothermal energy to the extent that such findings  
14 can be published in a form for utilization by others;

15 (3) conduct engineering and technical work in-  
16 cluding the design, construction, and testing of pilot  
17 plants to develop and improve geothermal energy proc-  
18 esses and plant design concepts to the point of demon-  
19 stration on a commercial scale;

20 (4) conduct laboratory and field experiments and  
21 tests of exploration and development technologies neces-  
22 sary for the successful discovery and development of all  
23 forms of geothermal resources;

24 (5) study methods for the reduction and elimina-

1       tion of undesirable environmental impacts of geothermal  
2       development;

3               (6) study methods for the recovery and marketing  
4       of byproducts resulting from the production of energy  
5       from geothermal resources; and

6               (7) undertake engineering and economic studies to  
7       determine the potential for energy from geothermal re-  
8       sources to contribute to energy requirements on national  
9       and regional levels.

10       (b) The Commission shall coordinate the research and  
11       development activities authorized by this section with the  
12       activities of the Department of the Interior relating to ge-  
13       thermal resources research to insure the full utilization of  
14       expertise and information and to prevent duplication of  
15       efforts.

16       SEC. 208. (a) The Commission is authorized to investi-  
17       gate, negotiate, and enter into cooperative agreements with  
18       non-Federal utilities, industries, and governmental entities  
19       for the construction, operation, and maintenance of demon-  
20       stration developments for the production of electric or heat  
21       energy from geothermal resources.

22       (b) No agreement shall be entered into under the au-  
23       thority granted by this section unless the Commission de-  
24       termines that:

25               (1) the nature of the resource, the geographical

1 location, the scale and engineering design of the facili-  
2 ties, the techniques of production, or other significant  
3 factors of the proposal offer opportunities to make im-  
4 portant contributions to the general knowledge of geo-  
5 thermal energy, the techniques of its development, or  
6 public confidence in the technology;

7 (2) the potential non-Federal cooperating entities  
8 are willing and capable to contribute not less than 25  
9 per centum of the capital cost of the development, to  
10 operate the facilities, and to provide a market for the  
11 energy produced;

12 (3) no benefits have been obtained through the loan  
13 guaranty provisions of title I of this Act and applied  
14 to development of any facility for which funding assist-  
15 ance pursuant to this title is proposed;

16 (4) the development or the practical benefits of the  
17 development as set forth in clause (1) of this subsection  
18 are unlikely to be accomplished without Federal assist-  
19 ance or through the assistance provided by title I of this  
20 Act; and

21 (5) the Federal investment in each such develop-  
22 ment project will not exceed \$5,000,000.

23 (c) The Commission is authorized to investigate po-  
24 tential agreements for the cooperative development of major  
25 facilities to demonstrate the production of energy from geo-

1 thermal resources and to submit engineering and financial  
2 proposals to the Congress for consideration of authorization  
3 to proceed with implementation of said proposals. The Com-  
4 mission may consider:

5 (1) cooperative agreements with non-Federal gov-  
6 ernmental entities and utilities for construction of fa-  
7 cilities to produce energy for commercial disposal;

8 (2) cooperative agreements with other Federal  
9 agencies for the construction and operation of facilities  
10 to produce energy for direct Federal consumption.

11 (d) Before favorably considering proposals under sub-  
12 section (c) of this section, the Commission must find that:

13 (1) the nature of the resource, the geographical  
14 location, the scale and engineering design of the facilities,  
15 the techniques of production, or other significant factor  
16 of the proposal offer opportunities to make important  
17 contributions to the general knowledge of geothermal  
18 energy, the techniques of its development, or public  
19 confidence in the technology;

20 (2) the development or the practical benefits as set  
21 forth in clause (1) of this subsection are unlikely to be  
22 accomplished without such cooperative development; and

23 (3) where non-Federal participants are involved,  
24 the proposal is not eligible for adequate Federal assist-  
25 ance under the provisions of title I of this Act.

1        SEC. 209. There are authorized to be appropriated to  
2 remain available until expended to carry out the purposes of  
3 this title:

4            (a) \$10,000,000 for fiscal years 1974, 1975, and  
5 1976 to the Secretary of the Interior;

6            (b) \$35,000,000 for fiscal years 1974, 1975, and  
7 1976 to the Atomic Energy Commission;

8            (c) such amounts as may be required in fiscal years  
9 1974, 1975, and 1976 to NASA to carry out the re-  
10 quirements of section 205.

11        SEC. 210. As used in this Act, the term—

12            (a) "geothermal resources" means (A) all products  
13 of geothermal processes, embracing indigenous steam,  
14 hot water, and brines; (B) steam and other gases, hot  
15 water and hot brines resulting from water, gas, or other  
16 fluids artificially introduced into geothermal formations;  
17 and (C) any byproduct derived from them;

18            (b) "qualified borrower" means any public or  
19 private agency, institution, association, partnership, cor-  
20 poration, political subdivision, or other legal entity  
21 which the Secretary has determined has presented satis-  
22 factory evidence of a property interest in a geothermal  
23 resource identified, in a manner acceptable to the Sec-  
24 retary, as being of sufficient interest for research objec-  
25 tives, or the development and production of energy, and

1        which has the financial responsibility to establish and  
2        operate, utilizing such resource, a commercial facility;

3            (c) "pilot plant" means an experimental unit of  
4        small size used for early evaluation and development of  
5        new or improved processes and to obtain technical and  
6        engineering data; and

7            (d) "demonstration development" means a com-  
8        plete facility which produces electricity or heat energy  
9        for commercial disposal from geothermal resources and  
10       which will make a significant contribution to the knowl-  
11       edge of full-sized technology, plant operation, and proc-  
12       ess economics.



## United States Department of the Interior

OFFICE OF THE SECRETARY  
WASHINGTON, D.C. 20240

NOV 6 1973

Dear Mr. Chairman:

This responds to your request for the views of this Department concerning S. 2465, a bill "To authorize the Secretary of the Interior to guarantee loans for the financing of commercial ventures in geothermal energy; to coordinate Federal activities in geothermal energy exploration, research, and development; and for other purposes."

Although we support the general objective of encouraging development of geothermal energy sources, to the extent that the bill provides new authority for loan guarantees in Title I, of direct Federal support for geothermal development in Title II we recommend that the bill not be enacted at this time.

S. 2465 would establish a ten-year Federal program of guaranteeing loans by financial institutions for certain private geothermal resource developments. Annual appropriations of \$50 million plus administrative costs would be authorized, and loan guarantees could not exceed 75% of the cost of the project for which the loan is made. The bill also makes provision for the cooperative exploration, research and development of geothermal resources by Federal agencies. Among these provisions is authority to make direct Federal investments in certain geothermal projects.

Both the loan guarantee and the new exploration, research and development authority are premature in view of the present Federal activities and policies for the development of geothermal energy. This Department is in the process of issuing regulations under the Geothermal Steam Act of 1970 (30 U.S.C. 1001-1025) with a view to leasing and development of geothermal resources by non-governmental parties. This accords with our view that the most appropriate initial approach is for private enterprise to bear basic responsibility for such development, supplemented by Federal research and guidance. Adequate statutory authority exists for Federal action carrying out this responsibility. Indeed, we believe that the cooperative exploration, research, and development program provided for by S. 2465 is largely duplicative of existing authority, except to the extent it provides for direct Federal development of geothermal resources. Private industry has already undertaken to harness geothermal energy and we believe it

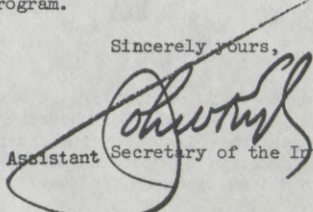


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can carry out this function, as energy needs require. Should future events cast doubt on the ability of non-Federal entities to do this, both the loan guarantee program and a program of direct Federal participation in geothermal development would warrant further consideration.

The Office of Management and Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely yours,



Assistant Secretary of the Interior

Hon. Henry M. Jackson  
Chairman, Committee on  
Interior and Insular Affairs  
United States Senate  
Washington, D.C. 20510



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
WASHINGTON, D.C. 20546

NOV 6 1973

REPLY TO  
ATTN OF:

Honorable Henry M. Jackson  
Chairman, Committee on Interior and  
Insular Affairs  
United States Senate  
Washington, DC 20510

Dear Mr. Chairman:

This is in further reply to your request for the comments of the National Aeronautics and Space Administration on the bill S. 2465, "To authorize the Secretary of the Interior to guarantee loans for the financing of commercial ventures in geothermal energy; to coordinate Federal activities in geothermal energy exploration, research, and development; and for other purposes."

S. 2465 has as its purpose the encouragement of research and development of geothermal energy in order to bring this energy source to the point of practical and commercial application.

Title I establishes a loan guarantee program under the Secretary of the Interior. The Secretary would be authorized to guarantee loans made by financial institutions to qualified borrowers for the purposes of exploration, development, acquisition of rights in geothermal resources, and construction and operation of facilities to bring these resources to use in the commercial production of energy. Loan guarantees would be available for up to 75% of the aggregate cost of the project. A geothermal resources development fund would be established in the Treasury and be available to the Secretary of the Interior for carrying out this program.

Title II states the policy of the Congress to encourage private industry with Federal assistance and leadership to develop and bring to the point of practical application the production of energy from geothermal sources.

The Secretary of the Interior, through the U.S. Geological Survey, would develop and carry out a plan for the overall exploration of all forms of geothermal resources on Federal

and non-Federal lands. He would also conduct surveys leading to a national inventory of geothermal resources and make available maps and other documents to facilitate commercial development. NASA is authorized and directed (section 205) to prepare a proposal for the use of space technologies and the services and facilities of NASA for exploration and mapping of geothermal resources. This report would be due in six months from enactment of this legislation.

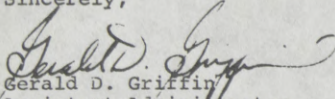
The Atomic Energy Commission (AEC) is given the lead research and development role in cooperation with private industry to bring geothermal resources to the point of commercial feasibility for the production of useful energy (section 207). AEC is given a broad charter to conduct all the necessary research, development, engineering, laboratory and field experiments and marketing, engineering and economic studies, etc. The Commission is instructed to coordinate its efforts with those of the Department of the Interior to prevent duplication. The AEC is also given authority to investigate potential interagency agreements and cooperative agreements with non-Federal entities and public utilities for the construction of commercial facilities.

The legislation would require NASA to prepare a proposal, as noted above, for the use of space technologies and/or NASA facilities and services for the exploration and mapping of geothermal resources. In section 209 there is authority to be appropriated to NASA "such amounts as may be required in fiscal years 1974, 1975, 1976 to carry out the requirements of section 205." Thus the only authority granted to NASA is the preparation of a report to be submitted within six months from enactment. Since there is no authority to do research and development work, the authorization for appropriations in three fiscal years is puzzling. It would seem that if NASA's proposal for the employment of space technologies and NASA services is acceptable to the Secretary of the Interior, he should have the specific authority to ask NASA to perform the necessary work. If this bill is to be considered further, we suggest that it be so amended.

As to the major policy considerations relating to whether S. 2465 should be enacted, the National Aeronautics and Space Administration defers to the Department of the Interior since it would assume the primary role under this legislation.

The Office of Management and Budget has advised that, from the standpoint of the Administration's program, there is no objection to the submission of this report to the Congress.

Sincerely,

A handwritten signature in cursive script, appearing to read "Gerald D. Griffin".

Gerald D. Griffin  
Assistant Administrator  
for Legislative Affairs



UNITED STATES  
 ATOMIC ENERGY COMMISSION  
 WASHINGTON, D.C. 20545

NOV 18 1973

Honorable Henry M. Jackson  
 Chairman  
 Committee on Interior and Insular Affairs  
 United States Senate

Dear Mr. Jackson:

Thank you for the opportunity to comment on S. 2465, a bill "[t]o authorize the Secretary of the Interior to guarantee loans for the financing of commercial ventures in geothermal energy; to coordinate Federal activities in geothermal energy exploration, research, and development; and for other purposes."

The Atomic Energy Commission is sympathetic to the purposes of S. 2465. However, at this time we do not support its enactment.

S. 2465 consists of two Titles. Title I, a loan guarantee program, would be administered by the Department of the Interior, to encourage commercial development of energy production from geothermal sources.

Title II of the bill would cover a coordinated effort by the Department of the Interior, the Atomic Energy Commission, the National Aeronautics and Space Administration, and the National Science Foundation to encourage private industry through Federal assistance for the development and demonstration of practical means to produce useful, environmentally acceptable geothermal energy.

In his testimony prepared for presentation before the November 7 hearing of your Subcommittee on Water and Power Resources, Dr. Gerald Johnson, Director of the AEC's Division of Applied Technology, expressed the AEC's interest in cooperative research and development and demonstration programs in the field of geothermal energy. We are looking toward initiation in this current fiscal year of programs which would both broaden the technological base for geothermal energy utilization and accelerate the commercial development of the resource.

However, as pointed out by Dr. Johnson, S. 2465 is somewhat duplicative of existing authority in part. For example, Section 31a(6) of the Atomic Energy Act of 1954, as amended (42 USC 2051 a(6)) authorizes the AEC to make arrangements for the conduct of research and development activities relating to "the preservation and enhancement of a viable environment by developing more efficient methods to meet the Nation's energy needs." Dr. Johnson also noted

the Administration efforts presently under way concerning the planning of and funding for five-year energy research and development programs, and the related organizational responsibilities for such programs. At this time, therefore, and for the reasons stated, the AEC does not support the enactment of S. 2465.

The Office of Management and Budget has advised that there is no objection to the presentation of this report from the standpoint of the Administration's program.

Sincerely,

John A. Erlwine

General Manager

Senator CHURCH. I want to recognize Senator Bible who is one of the principal sponsors of this bill.

Senator, if you have any remarks you would like to make at this time, they would be welcome.

**STATEMENT OF HON. ALAN BIBLE, A U.S. SENATOR FROM THE STATE OF NEVADA**

Senator BIBLE. Thank you, Mr. Chairman.

I first want to commend you in setting this bill down for hearing at such an early date. As you know, and I think you probably just mentioned it, the bill was introduced in cooperation with Senator Fannin of this committee. It has the cosponsorship of every single member of this committee on both sides of the aisle. I hope that this is a clear expression of the congressional intent to move the development of our Nation's geothermal energy resources off dead center.

It will soon be 3 long years since we joined forces here to pass the Geothermal Steam Act of 1970 to open public lands of the West to develop. There have been 3 long years during which the energy problems have continued to grow and they have been 3 long years of frustration.

Leasing regulations required by the 1970 act have still not been promulgated. (The first lease of public lands for exploration and development has yet to be made.) While we continue to receive promises from the administration, delay has followed delay and it is still unclear just when the leasing program will begin.

I understand that in the recent publication of the Department's final environmental impact statement the time for public comment on the regulations was extended to November 16, just over a week from now. However, I also note that a departmental release of October 23 indicates that no decision on the program's implementation has been made and it is left unclear as to just when this decision will be made.

Someone downtown has got to recognize the very basic fact that the bulk of the Nation's geothermal resources lie under the public land out West. Until those lands are open for development, the geothermal development program will remain largely stalled.

Although this is not a matter before the subcommittee this morning, I hope someone in the administration's witnesses will have something encouraging to say about it.

The bill now before the subcommittee represents a further effort to encourage and facilitate private enterprise and other interests in the development of the resources. It proposes to strengthen and coordinate the Government's geothermal research in the hope that by doing so we will be able to produce progress in the problems, and some early results.

Since geothermal is a new and relatively untried resource, financial interests are naturally wary of it, so this bill proposes a program of loan guarantee to encourage lending for geothermal development. Its purpose is to facilitate financing for responsible free enterprise and other energy developers.

I will be very interested in hearing the testimony on this aspect of the bill. I hope witnesses will focus sharply on the adequacy of the bill to do the job that it is intended to do.

With respect to the R. & D. features of the bill, I have long felt the administration has displayed no sense of urgency at all regarding the efforts needed to harness moneys for R. & D. The AEC funds have been impounded and little progress has been made by other agencies. Concerted effort is need. A crash program, if you will.

For too long we have seen outside research groups knocking at the Government's door for financial assistance in development tests on the scene in geothermal technologies only to be turned away because there has been no real Federal financial commitments. This bill seeks to begin correcting that situation.

I will be interested in any suggestions witnesses may have for improving what we have proposed.

Thank you very much, Mr. Chairman.

Senator CHURCH. Thank you very much, Senator Bible.

I want the record to show that Senator Bible has been first among the members of this committee in pressing for some recognition of the contribution of geothermal resources in the West which have been made in the generation of electricity.

I can appreciate your frustrations, Senator, when we consider that the approval of the Geothermal Steam Act came in December of 1970, and here we are in November of 1973 and the act has yet to really be implemented. It demonstrates that people will have a legitimate complaint when the shortage of fuel this winter begins to grip the country and begins to hurt.

Senator Fannin is also a cosponsor of this legislation, one of the principal cosponsors. He had planned to be here this morning but he and Senator Hansen, I understand, are attending a meeting at the White House that relates to energy. Therefore, they cannot be with us this morning.

I am also told, before we go to the testimony, that Senator Hatfield wanted to be here this morning but the Rules Committee hearing on the confirmation of Gerald Ford to be Vice President has prevented his appearance.

Senator Stevens and Congressman Veysey have submitted statements which I will place in the record at this point.

[The prepared statements of Senator Stevens and Congressman Veysey follow:]

STATEMENT OF HON. TED STEVENS, A U.S. SENATOR FROM THE STATE OF ALASKA

Mr. Chairman, it is a pleasure to be here today and to testify in support of S. 2465, "The Geothermal Energy Act of 1973", a bill I cosponsored. If passed, this bill would authorize the Secretary of the Interior to guarantee loans financing commercial ventures to develop geothermal energy, as well as coordinate the various Federal activities in geothermal energy exploration, research and development.

Now that the energy crisis is a reality the importance of geothermal energy must not be ignored nor should the geothermal potential of this country be left undeveloped because local communities, companies, and individuals do not have the funds or technology to undertake these projects. This bill would provide those funds at a very low cost to the Federal Government, by guaranteeing loans to qualified borrowers, as well as establish an aggressive program for Federal assistance in the exploration, research, and development of our geothermal resources.

These steps are necessary to go forward with the challenge of harnessing this valuable source of natural energy. Geothermal resources represent a great potential source for the development of less expensive, cleaner energy in many of our Western States.

There are three areas in Alaska that have already been classified as KGRA's (known geothermal resources areas) by the United States Geological Survey. These are the Pilgrim Springs area of the Seward Peninsula, the Geyser Spring Basin, and the Ormak Caldera of Umnak Island in the Aleutian Chain.

The United States Geological Survey has also classified other areas of Alaska as potentially valuable geothermal resources areas. These include hot springs areas located principally in a belt from Southeast Alaska, through the Interior, to the Seward Peninsula. They have also located volcanic related areas at Mt. Wrangell and the Alaska Range-Aleutian Range associated volcanoes from Mt. Spurr to the end of the Aleutian Islands.

Mr. Chairman, the State of Alaska has already taken great strides forward in the area of geothermal resources. In 1971 the Alaska Legislature passed the Geothermal Resources Act to encourage the exploration of discovery and production of geothermal resources. If S. 2465 becomes law even greater strides can be made in developing this very important alternative source of energy thereby reducing this nation's reliance on fossil fuel power plants. Our geothermal resources have the potential of generating electric power; of producing geothermal steam that may provide central heat for urban areas close to geothermal areas; and in addition provide the production of valuable minerals and other by-products associated with geothermal steam and accompanying brines.

Mr. Chairman, I would like to thank you for providing me an opportunity to testify in favor of S. 2465. At this time, I would like permission to include in the Record a letter from Roland D. Lynn, City Manager of Nome, as well as a resolution from the City of Nome expressing their desire to begin development of necessary geothermal resources and the need for federal financial assistance. I would also like to include in the Record a telegram I have received from Mr. Lynn outlining the position of the City of Nome on S. 2465.

CITY OF NOME,

*Nome, Alaska, September 26, 1973.*

Senator TED STEVENS,  
*Old Senate Office Building,  
Washington, D.C.*

DEAR SENATOR STEVENS: As you know, the City of Nome has been very interested in developing the Pilgrim Springs Geothermal Resource Area as a source of clean inexpensive electrical energy for the Seward Peninsula. The City Council feels strongly about the potential of the area and through Resolution No. 485 (copy attached) has authorized me and the City Attorney to initiate negotiations with Pilgrim Springs Limited for the investigation, development, and distribution of electrical energy by Nome Light & Power from Pilgrim Springs to Nome and other areas of the Seward Peninsula.

Prior to the development of the area it is first necessary to conduct an electrical resistivity survey, perform multi-spectral photography and interpret the data to determine the best location for placing a test hole. Incidentally, the test hole will be drilled by the Bureau of Mines. The cost to conduct the required survey work is in the neighborhood of \$25,000. I have asked the Alaska Power Administration to verify our estimates, and to provide additional technical assistance in substantiating our findings.

Because it may become necessary to obtain federal financial assistance in the development of the Pilgrim Springs I believe it is essential that you be kept informed on the steps which are being taken and on the progress being made. I might add that the need for electrical energy on the Seward Peninsula could be dramatically increased within a very short period of time. During a conversation with Mr. William R. Kastelic, Vice-President of Metal Mining Operations, UV Industries, Incorporated in Salt Lake City, Utah, and with Mr. Walter Glavinovich, Alaska Manager of UV Industries, I was informed that their company plans, pending final approval by the Board of Directors in New York City, to reactivate two dredges and two thaw fields by 1975. One of the dredges will be operating during 1974. This means that in one year Nome Light & Power could be called upon to double the number of kilowatts produced going from 12,000,000 KWH to 25,000,000 KWH and increasing when additional dredges are reactivated.

It is also very likely that Lost River and Bornite will require huge amounts of electrical energy within the near future. The City of Nome can, if the Pilgrim Springs potential is realized, electrify the Seward Peninsula with inexpensive energy.

Very truly yours,

ROLAND D. LYNN,  
*City Manager.*

## RESOLUTION No. 485

A resolution authorizing the city manager and city attorney to begin negotiating a contract with Pilgrim Springs, Ltd. for investigation, development, and distribution of electrical energy by Nome Light and Power Utility from Pilgrim Springs to Nome and other areas of the Seward Peninsula.

Whereas: the City of Nome requires power for its expanding electrical utility system; and;

Whereas: Pilgrim Springs, Ltd. has granted the City of Nome the right to investigate the geothermal potential at Pilgrim Springs, Alaska; and;

Now therefore be it *Resolved* by the Common Council of the City of Nome, Alaska: that the City Attorney and City Manager begin negotiating a contract with Pilgrim Springs, Ltd. for the Investigation, Development, and Distribution of Electrical Energy by Nome Light and Power Utility.

Attest:

ROBERT H. RENSHAW, *Mayor*.  
H. L. HENSLEY, *City Clerk*.

[Telegram]

NOME, ALASKA, *November 2, 1973.*

Senator TED STEVENS,  
*Committee on Appropriations,*  
*Capitol Hill, Washington, D.C.*

Your letter of 10/24/73 requesting a statement outlining the position of the City of Nome, regarding the Geothermal Energy Act of 1973 did not reach me until today. The City Council has strongly supported the development of geothermal energy by passing council resolutions number 485 authorizing me to secure funding for the investigation and development of the Pilgrim Springs KGRA. The city council's reaction is highly favorable to Senate Bill 2465 and they encourage Federal participation and involvement in launching investigation and demonstration projects dealing with this exciting new source of energy. My only question is whether it is necessary to delegate to several different agencies the responsibility for supervising various phases of the overall effort. It would seem to me that one agency should have overall authority to implement the entire research and development effort.

ROLAND D. LYNN, *City Manager.*

STATEMENT OF HON. VICTOR V. VEYSEY, A U.S. CONGRESSMAN FROM THE STATE OF CALIFORNIA

Mr. Chairman, Senator Bible, Senator Buckley: I am here today to support the general direction of the bill S. 2465 introduced by Senators Bible and Fannin and co-authored by the other distinguished Members of this Committee. At the same time, I would like to offer some suggestions for additions and changes which would make it better legislation.

Today is an appropriate day to commence hearings on this legislation. I understand that President Nixon will describe to the people of America the real energy shortage which we face this winter and on into the future, will call for energy conservation measures, and for prompt congressional action to provide breakthroughs in energy technology.

Let me congratulate the Members of the Committee for their farsighted action in pushing through the Congress three years ago the Geothermal Act of 1970 which provided for leasing of federal lands for the development of geothermal energy. Since that time the Department of the Interior has moved at a glacial pace, and only now, three years later, are actually proposing soon to take bids on the first leases. This is hardly a crisis oriented action.

Last spring, Senator Fannin, a distinguished Member of the Committee, spoke at a Geothermal Conference which I arranged at Palm Springs, California. Many persons at that conference spoke of the long delays in implementing the 1970 Act, and I believe that the strong statements made at that conference may have spurred the Department of the Interior to faster action.

It seems to me, Mr. Chairman, that the Administration and the American public have not seen geothermal energy in its correct perspective. Geothermal energy—energy from the earth—is the most immediately available of any new source of energy to supplement our national resources. It is environmentally acceptable. It is the cheapest source of electrical energy available today—cheaper per kilowatt hour and cheaper in capital investment than nuclear or oil or gas or cool fired boilers.

This has been proven in California at the Geysers where about 400 megawatts of electrical capacity has been installed and is in use—enough for one third of the electrical needs of the City of San Francisco. It has been proven in Italy and New Zealand years ago. More recently my neighbors across the border in Mexico have leaped ahead of us by starting up their geothermal plant at Cerro Prieto using a two phase resource—steam and hot water together.

We, in Southern California, wonder why, inasmuch as we share the resource with Mexico, we have not moved along as fast.

Geothermal energy has often been thought of as a local or regional resource. Not so! The heat of the earth is everywhere beneath us—more available in some places than others.

Geothermal energy is not a California phenomenon, nor a Western exclusive. It is an abundant resource in the Western United States to be sure. It exists in great potential in Alaska and Hawaii. It exists in the geopressed form in the Gulf Coast states and elsewhere. There is reason to believe it will be found in many other parts of the nation in the form of energy from hot, dry rocks.

Experts have estimated that by 1985 this nation should be developing 20,000 megawatts of electrical power from geothermal sources, and by the year 2000 we might develop 395,000 megawatts from the same sources. This would be approximately the equivalent of the nation's total electrical generating capacity today.

These expectations could be exceeded with good luck and much effort. They will not be met unless government moves, and this is why I back this legislation today.

Now, permit me to comment on a few of the specifics of the bill, S. 2465.

(1) The bill provides for government guaranteed loans to acquire rights, explore, develop, construct and operate facilities for the production of geothermal energy. An authorization of \$50 million annually is provided. \$50 million could go to a single borrower, and \$25 million to a "single project" and this definition is unclear. While there is serious need for capital for these purposes in the tight money markets existing today, I believe the limits per borrower and per "project" are too high, opening the prospect that one or a few operators could gobble up all of the assistance. It should be spread more beneficially and more safely among more.

(2) The definition of "geothermal resource" is too narrow. It should be expanded to include geopressed resources and also energy for hot, dry rocks.

(3) There is abundant need for close coordination of all governmental groups—Interior, AEC, and NASA in their respective work on geothermal energy. Clearly all have capable talent to lend to this development, but I fear that this bill will not bring about a hard hitting, fast moving project which will break through to early solutions. This bill seems to be more of a concession to maintenance of the several bureaucracies than it is a creation of a coordinated, effective, project oriented government operation.

(4) Lastly, the bill is silent on the tax treatment of geothermal resources. This uncertainty is one of the major barriers to the flow of capital into the infant geothermal industry. No one knows how intangible costs will be handled tax-wise. No one knows whether or not geothermal energy is a depletable asset for tax purposes.

These questions must be settled by federal law. Rightly handled, the tax provisions will attract abundant capital, and rightly handled they will vastly increase the revenue take of the federal government. I trust this important missing component will not be forgotten.

I thank the Committee for permitting me to make this statement on the bill. Despite the problems mentioned I hope you will proceed with its improvement and processing.

Senator CHURCH. Now we will hear from our first witness, Dr. Johnson, of the AEC.

**STATEMENT OF DR. GERALD W. JOHNSON, DIRECTOR, DIVISION OF APPLIED TECHNOLOGY, ATOMIC ENERGY COMMISSION; ACCOMPANIED BY DR. JACK VANDERRYN, TECHNICAL ASSISTANT TO THE DIRECTOR, DIVISION OF APPLIED TECHNOLOGY**

Dr. JOHNSON. Good morning, Senator Church and Senator Bible.

Senator CHURCH. Mr. Johnson, we want to welcome you. Please proceed with your statement, then we will have some questions.

Dr. JOHNSON. I have with me Dr. Jack Vanderryn, who is my technical assistant.

Mr. Chairman and members of the committee, I am pleased to have the opportunity to appear before this committee and provide comments on S. 2465, a bill to authorize the Secretary of the Interior to guarantee loans for the financing of commercial ventures in geothermal energy; to coordinate Federal activities in geothermal energy exploration, research, and development; and for other purposes.

As you know from testimony which I have given on previous occasions, the AEC is deeply interested in and working toward cooperative R. & D. and demonstration programs which would both broaden the technological base for geothermal energy utilization and accelerate the commercial development of this resource. We are looking toward initiation of this program in this current fiscal year.

In this context of facilitating full commercial development of geothermal energy utilization and R. & D. activities to support this goal, the Atomic Energy Commission is sympathetic to the purposes of the proposed bill.

We believe, however, that the cooperative exploration, research, and development program provided for by the proposed bill is, in part, already provided for by existing authority of the several Federal agencies involved in geothermal research and development. I should note, for example, that section 31a(6) of the Atomic Energy Act of 1954, as amended, authorizes the AEC to make arrangements for the conduct of research and development activities relating to "the preservation and enhancement of a viable environment by developing more efficient methods to meet the Nation's energy needs."

The members of this committee are aware of the efforts currently underway under the direction of Chairwoman Dixy Lee Ray in response to the President's request in his June 29 energy statement to review overall Federal research and development programs, including geothermal energy, to determine how best to coordinate and support an accelerated \$10 billion energy research and development program over the next 5 years. The report will be submitted to the Executive Office of the President by the Chairwoman on December 1.

The AEC Division of Applied Technology, under my direction, has in the past year, formulated a geothermal research and development program which is to be managed by the AEC. I would like to take this opportunity to briefly describe this program for you and to indicate its place in the overall national effort, both federally and privately supported, which would be required to assure that this national energy resource is adequately developed in order that it may appropriately contribute to meeting the Nation's energy needs from domestic resources.

The fiscal year 1974 AEC geothermal program to develop energy recovery technology consists of three categories of R. & D. activities, with research and development programs centered at a number of AEC laboratories. These categories include dry hot rock, hydrothermal, and systems analysis activities.

It is our intention to closely cooperate with the industry, including the utilities, in the conduct of the AEC program. Joint Government-industry cooperative projects leading to pilot plant demonstrations within 4 to 7 years will be encouraged to assure commercial application of the technology as soon as possible.

In many areas of the United States, granitic intrusions significantly above normal temperatures are known to exist at relatively shallow depths. Such geothermal deposits contain enormous amounts of energy. The economic recovery of this potential geothermal resource will require the development of new technology. The AEC's Los Alamos Scientific Laboratory has developed a concept which may be the key to the utilization of dry hot rock. It consists of drilling into an intrusion, fracturing the rock hydraulically—with the expectation of creating a vertical, lens-shaped fracture with a radius of some 1,500 feet—drilling a second hole to intersect the fracture at 1,000 feet shallower depth, and establishing a convective circulation pattern for coolant water under pressure. If the original fracture zone can be enlarged by thermal stress cracking and the newly exposed hot rock is adequately cooled by convective flow, the original dry hot rock can be mined of its heat content.

In essence, the process consists of the creation of an artificial hydrothermal reservoir. There is evidence that thermal stress enlargement of existing reservoirs may be occurring naturally at some sites, which bodes well for the concept. However, much theoretical and experimental work remains before the approach can be proven or disproven.

During fiscal year 1974 we plan the following activities:

(a) A seismic network will be set up to enable monitoring of seismological activity and to record microseismic noise from hydrofracturing operations.

(b) Engineering design will be carried out for surface equipment, including the bypass flow look for geochemistry and other circulation studies. The design effort should be completed in approximately 6 months.

(c) An exploratory hole will be drilled at a location compatible with Forest Service plans for the area near the west rim of the Valles Caldera in New Mexico to study the hydrology and investigate the hydraulic fracturing characteristic of the bottom hole granite. Later, concentric pipe circulation studies will be started.

(d) Potential production holes are planned to be approximately 7,500 feet in depth with a 10-inch inside bottom hole diameter. They will be located near the 4,500-foot hole. The return water hole will be drilled to intercept the initial fracture and establish circulation.

(e) The hydraulic fracture of granite will begin from the first production hole to determine the fracture pattern. After completion of the second hole, hydraulic fracture from the second hole will be carried out, if necessary, to establish the pressurized water circulation system.

The AEC geothermal program contemplates the development of liquid-dominated systems, both hot water and brine deposits, and pressurized sedimentary systems. The prime responsibility for "conventional" development of hot water and brine resources will be assigned to the Lawrence Berkeley Laboratory, and the "total flow" development of both hot water and brine and pressurized sedimentary systems will be assigned to the Lawrence Livermore Laboratory. "Conventional" development must be viewed from two standpoints. First, there are no commercial hot water systems producing

electric power in the United States. The techniques used in foreign developments, i.e., Cerro Prieto, are probably not environmentally acceptable in the United States. Second, many advanced concepts for improved technologies require pilot-plant testing before adoption by the commercial sector. These include turbine-type downhole pumps, the KROV power extraction system, the pure Magmamax system, and downhole heat exchangers. Thus, the "conventional" approach of Berkeley is only so by comparison with the even more advanced Livermore concept, discussed later. Both approaches will involve and require cooperative programs with industry.

(a) *The Berkeley (LBL) hydrothermal system development program*

The Berkeley program includes conceptual design of a hot water demonstration plant, preparation of an environmental impact statement, site analyses and evaluations in cooperation with USGS, and engineering studies involving, among other plant components, a downhole pump development program. Initial preliminary site evaluations are now being conducted in north-central Nevada under National Science Foundation sponsorship. The Berkeley program will also include feasibility studies of alternative candidate processes, studies of silica precipitation and dissolution, corrosion control investigations, reservoir fluid circulation studies, and other work essential to development and construction of hydrothermal plants.

(b) *The Livermore hydrothermal system development program*

A new "total flow" concept for recovery of energy from geothermal hot brine and pressurized sedimentary deposits has been proposed by the AEC's Lawrence Livermore Laboratory. The proposed method consists of allowing the brine to expand to the surface (i.e., "pump itself"), as is now being done at Wairakai and at Cerro Prieto, then expanding the total fluid stream through a nozzle to low pressure and high velocity. The kinetic energy of the entire fluid stream would then be used in a corrosion-resistant impulse turbine, modeled after typical hydroelectric devices, to drive an electrical generating system. Theoretically, this method should produce about 1.6 times as much power from a given well as either the flashed steam system or the binary fluid system. Since fewer mechanical components are required at the surface, capital costs should be less than with separated steam or pressurized recirculation plus a secondary working fluid, despite the need to protect against corrosive brines. The method should also apply to pressurized sedimentary systems.

The resource for which the total flow concept was originally conceived is that of the Salton Trough. The first year's work on the total flow concept applied to the Salton resource will emphasize turbine development and corrosion/erosion studies of such candidate materials as tantalum-clad steel, zirconium, and possibly titanium.

The first year's work on adaptation of the total flow concept to the geopressured resource will consist of detailed estimates of the size of the resource and the applicability of turbines to its effective utilization, plus corrosion and materials experiments. A cooperative program with the USGS and industry is contemplated.

The management of a program with as many ramifications and variables as that proposed for development of geothermal power needs a model with which to analyze research and development results as they

become available and to evaluate the potential benefit-cost ratios of new investigations as they are proposed. An economic model will be written at the AEC's Battelle Northwest Laboratory which analyzes the cost of power from geothermal systems. This model will include variables such as plant factor, economic lifetime, financing, capital cost, field development costs, thermal conversion effects by byproduct sales. Expected results of field experiments will be analyzed by the model to determine the impact of the results on power costs. As the geothermal projects develop, they can be analyzed to establish the cost effectiveness.

This completes my description of AEC's plans for geothermal research and development activities.

In addition to AEC's efforts, the Department of the Interior, mainly through the Geological Survey, would continue and expand its efforts for geothermal resource assessments, and related activities such as mentioned in title II of the proposed bill. The AEC has been and will continue to cooperate very closely with the Geological Survey in our geothermal research and development activities. In addition, we have been working with the Bureau of Reclamation, the Defense Department, and the National Science Foundation and others in Government and industry in planning geothermal research and development activities.

I believe that development of this new energy resource for the United States will require close cooperation between Government and industry. It is my opinion that an active, federally funded program will be required, but that, at the same time, industry will invest its own funds in those areas most appropriate to its expertise and interests.

In summary, Mr. Chairman, the AEC is sympathetic to the purposes of S. 2465, but we note the bill is somewhat duplicative of existing authority, in part. We also note that administration efforts are presently underway with regard to planning of and funding for 5-year energy research and development programs, and the related organizational responsibilities therefor. Geothermal research and development is included in all of these considerations. At this time, and for the reasons just stated, we do not at present support enactment of S. 2465.

I appreciate the opportunity to appear before this committee today.

Senator CHURCH. Thank you, Dr. Johnson.

I have some figures here that I would like to check with you. These figures show that for fiscal year 1974 the total original administration request for all research and development in the field of energy for all departments was \$886 million, of which \$4.1 million was earmarked for geothermal research, for all aspects of geothermal research and development.

That is about one-half of 1 percent of the Government's contemplated program allocated to geothermal dry rock and other programs. Is that correct?

Dr. JOHNSON. That is correct, yes, sir.

Senator CHURCH. Then Congress added \$60 million to the \$886 million, of which Congress designated \$7 million for expanding the geothermal steam program. So that Congress added almost twice as much money as the administration originally planned to spend for this purpose, is that correct?

Dr. JOHNSON. That is correct, yes, sir.

Senator CHURCH. Then the administration came along with a supplemental request to expand research and development in the energy field. In that supplemental request the administration did not provide for a single extra dollar for geothermal. In other words, they incorporated what the Congress had added, the \$7 million, but they earmarked no money additional to what Congress had added in their supplemental energy program.

Dr. JOHNSON. I think that is correct, yes, sir.

Senator CHURCH. When you take it all together and add it up, we have a \$1,115 million research and development program in the energy field, of which \$11.1 million is earmarked for geothermal research and development or 1 percent of the total. That is the result of congressional action, not administration action.

I do not read those figures as indicative of either much attention or generosity on the part of the administration. In fact, the low priority that the administration continues to ascribe to geothermal steam is obvious in the figures, wouldn't you say?

Dr. JOHNSON. Well, sir, it is a start. It is somewhat more than doubling the present effort. I think that this will provide a firm operative base to expand rapidly in succeeding years.

Senator CHURCH. Well, it is a start and it has doubled the original request only by virtue of the fact that Congress stipulated that \$7 million additional would be spent in this field. That has then been incorporated in the administration's program. But I think that Senator Bible is everlastingly right when he keeps pointing out that the departments, the executive departments of the Government, just won't move or won't attach any sense of urgency to the possibilities that do exist in developing this geothermal resource. The figures speak for themselves, it seems to me.

I do not know what—Maybe the President has discovered the energy problem and is going to speak to it this evening to the country or sometime this week. But it is disappointing to me that the AEC and other executive departments are still constrained to oppose legislation, the purposes and objectives of which you applaud. Don't you think, Dr. JOHNSON, that a more specific legislative mandate would strengthen your ability to plan and coordinate and fund a geothermal program?

Dr. JOHNSON. If, starting with the present activities in terms of the \$11.1 million and then, if the 5-year program is supported and implemented as we have every reason to expect it will be, then, I think we can make substantial and effective progress in the geothermal area. We, meaning the Government and the associated industries.

Senator CHURCH. Let's look at your statement as to the program that the AEC contemplates. You have assigned the responsibilities, the primary responsibilities for this program to the California laboratory, which is to handle the "conventional" phases of the program. That is the Lawrence Berkeley Laboratory.

You testified that in addition to the work the laboratory will do in conceptual designs of hot water demonstration plants, it will also make initial preliminary site evaluations that are now being conducted in north-central Nevada under the National Science Foundation's sponsorship.

I take it that the end objective of this effort will be to build one or more demonstration plants, is that correct?

Dr. JOHNSON. Yes, sir, we are proposing a number of demonstration plants in our program.

Senator CHURCH. Can you give me more specific information on that?

Dr. JOHNSON. Yes, I can. In the planning, if they are in fact funded, we would envisage demonstration plants tied to the low temperature waters. As you know, we are looking at a site in southern Idaho and we are looking at hot water systems in northern California and Nevada. Hot dry rock initial work is planned near Los Alamos, though there may turn out to be better sites. The turbine work directed at trying to exploit the very high salinity waters of the Salton Sea area is another site for a possible demonstration plant and another possibly along the gulf coast for the geopressed formations. Those are the five basic plants that we are proposing be built at about the 10 megawatt level. I don't know what exact size they will turn out to be, but large enough to demonstrate the technology for commercial acceptance and follow on.

Senator CHURCH. Have you any estimate of what these plants will cost?

Dr. JOHNSON. Our estimate for the experimental facilities at 10 megawatts which will, of course, include built-in flexibilities for testing various kinds of components and which will therefore cost more than would production plants of the same capacity, would be in the range of \$8 million for 10 megawatts.

Senator CHURCH. That is \$8 million for each plant?

Dr. JOHNSON. For each plant. And it will be up or down from that depending on the details of the process envisaged. We anticipate the production plants to be constructed for \$300 to \$400 per installed kilowatt. We think these are achievable goals. We also believe that such cost can be achieved at relatively small scale in the 30- to 40-megawatt range. It will provide a kind of capability that is useful to distribute through a utility system and where power requirements are not too high.

Senator CHURCH. Even that kind of a modest effort to establish three or four demonstration plants or five, assuming your estimates of cost are correct, means somewhere between a \$40 million and \$50 million expenditure. Your total program for the laboratory effort, the various theoretical exercises and analyses and all the rest for the coming year is only \$11.1 million. So this is going to be slow in coming and based upon the present level of funding, this thing is going to stretch out a long, long while with very little to show for it.

I am trying to contrast the projection, the planning, the money, with the fact that we are rapidly running out of energy, we are going to be in a very serious situation this winter. It is obvious that the national interests will be gravely disserved if we continue to rely so heavily upon increasing imports of petroleum to solve our problem. We need to find alternative sources, that must be obvious. Yet we have projected here a rather relaxed program in one area that could make a substantial contribution. It is really a very relaxed program. I don't know why the geothermal possibilities continue to get such a low priority. But the figures demonstrate this.

Let me ask you this question, Dr. Johnson. I know that you personally have a genuine interest in this field. I am not critical of you

personally in these remarks, I just have to draw the conclusions that lie on the paper here.

What money has actually been released to you? We are talking about budgetary figures and requests and all of that kind of thing, but we also have the problem of impoundment. I don't know how much money you actually have in hand at the present time.

Dr. JOHNSON. With respect to the \$7 million add-on?

Senator CHURCH. Yes.

Dr. JOHNSON. That money, to my knowledge, has not yet been apportioned. It might have been apportioned this morning, I don't know, but as of yesterday none of that money was available.

Senator BIBLE. Might I ask a question there, Mr. Chairman?

Senator CHURCH. Certainly.

Senator BIBLE. Does that mean it has been impounded? Is that what you are saying, up until this very minute?

Dr. JOHNSON. Well, I don't know at which point in time it becomes impounded. We have requested release of the money.

Senator BIBLE. You want to be careful in using those words at this particular point in time. There is a famous question in our lexicon today.

Dr. JOHNSON. We anticipate apportionment momentarily in all fairness. But it has not in fact been apportioned.

Senator BIBLE. Have you been assured that it will be released, portions of it? Are you going to have the money to make it work? Will you be able to use \$11 million?

Dr. JOHNSON. We have every reason to believe it will be, yes, sir.

Senator BIBLE. I hope you advise the chairman and the staff of this committee the very moment that it actually occurs. I know you are also sympathetic and hopeful and you expect, but you have been giving me that story, Dr. Johnson, ever since I have known you. You are a very reputable man.

Senator CHURCH. Dr. Johnson is a natural optimist.

Senator BIBLE. He is a natural optimist who is handcuffed and I do hope, Mr. Chairman, that just as you suggest, it might be very helpful to have as a witness whoever handles this for OMB. OMB is always the whipping boy for all of these witnesses who come in with great optimism. It may be that they can throw more light on this.

You work very well in this field, you have done so for many years and you and I have had many, many contacts and many questions and much optimism expressed by you, but none of it has ever come about. I would like to find the man who dampens your optimism and have him before the committee because that is the only way this thing is ever going to get on the road, Mr. Chairman, and I have worked on it for a good many years. I am responsible for that add-on. I think my name is very "verboden". Everything I add on they freeze, whether it is in the field of geothermal energy, steam, or whether it is in the field you are greatly interested in, Mr. Chairman, the Forest Service. Every add-on we added, without exception was frozen. I guess the administration has the final hand apparently. We have never broken that. We are trying to break that concept so we are working as a team. Congress is still part of the overall democratic process, we think. Sometimes we wonder.

I have no other questions. I thought I would point that out because the add-on is just frozen. I hope your optimism comes about. You just tell us when.

Senator CHURCH. Thank you, Senator. I agree, of course, with everything you have said.

I would like to ask you this, Dr. Johnson: if your optimism is well founded and this money is in fact released and apportioned, what part of the \$7 million add-on would come to the AEC, do you know?

Dr. JOHNSON. We would anticipate \$4.7 million.

Senator CHURCH. Of the \$7 million?

Dr. JOHNSON. Of the \$7 million.

Senator CHURCH. Because we conducted hearings in the West on geothermal potential, one of those hearings being in my State, in the city of Idaho Falls, which you attended and at which you testified. Will the AEC apply some of that money to the preliminary investigation of the site that we looked at in Idaho?

Dr. JOHNSON. Yes, sir, we are planning to start on that project using funds from the \$4.7 million.

Senator CHURCH. How much are you planning to allocate to that?

Dr. JOHNSON. We indicated between \$100,000 and \$200,000 this year. It depends on the details of when we start and what it is we actually do, but we plan to initiate the geophysical work in association with the specific site we examined, to determine its suitability. If it satisfies our requirements then, in the subsequent years we would carry out the design and construction. That plan is the same plan that we discussed with you earlier.

Senator CHURCH. And your position with respect to it is the same as you described it in Idaho Falls?

Dr. JOHNSON. That is correct.

Senator CHURCH. Mr. Dreyfus reminded me that since the administration is testifying negatively on the bill today, that you, therefore, are not in a position to formally suggest technical amendments to the bill that you might otherwise want to recommend. I am wondering, Dr. Johnson, if you and the other agencies that will participate in these hearings this morning would agree informally to meet with the staff of the committee in order that we might have the benefit of such recommendations that you might want to make with respect to technical amendments to the bill?

Dr. JOHNSON. Yes, sir, we would be happy to.

Senator CHURCH. I think the committee is pretty well determined to go forward with this bill and therefore we would invite whatever technical help you might want to give us in refining the provisions.

Dr. JOHNSON. We would be happy to do that.

Senator BIBLE. Could I ask a few questions, Mr. Chairman?

Senator CHURCH. Surely.

Senator BIBLE. Going to your own statement, Dr. Johnson, How much will it cost to do what you say you would like to do, that you had planned to do in the fiscal year 1974?

Dr. JOHNSON. You mean the \$4.7 million which is what we asked for?

Senator BIBLE. You outlined a very optimistic program here. You tell us all the things you are going to do and how you are going to do it. What will it cost?

Dr. JOHNSON. The total cost to do this job?

Senator BIBLE. This year first. How much will you spend this year?

Dr. JOHNSON. \$4.7 million. This is to initiate the work.

Senator BIBLE. That is in this fiscal year?

Dr. JOHNSON. Yes, sir.

Senator BIBLE. What is the total cost under your 5-year program, because you say you have a 5-year energy R. & D. program? How much will that cost just for your department, AEC, alone?

Dr. JOHNSON. Our plan is to move this development along at a high rate.

Senator BIBLE. And that is a 5-year plan?

Dr. JOHNSON. Five years, to meet the goals we have described here today and in previous testimony. The AEC part of that, we don't have any hard numbers on this, I am just giving you what I think it is likely to be, I think it is going to be in the range of \$120 million to \$150 million.

Senator BIBLE. Over a 5-year period of time? That is the total cost of the 5-year program?

Dr. JOHNSON. The 5-year program, yes, sir.

Senator BIBLE. Just for AEC's share alone?

Dr. JOHNSON. Yes, sir, based on this program.

Senator BIBLE. You say you are cooperating very closely with USGS, and I see Dr. McKelvey is here. He, I guess, would be the best witness on that. How much would be their cost?

Dr. JOHNSON. I think you should ask them, Senator.

Senator BIBLE. He is right here. What is your 5-year cost, Dr. McKelvey?

Dr. MCKELVEY. I am not able to answer it myself. May I ask Dr. Eaton?

Dr. EATON. I am afraid I did not hear the question.

Senator BIBLE. It is an AEC question and I will repeat it. The AEC says the 5-year cost to the AEC would be somewhere between \$120 million and \$150 million. What would be the USGS estimate as to their 5-year cost?

Dr. EATON. Are we referring here to the 5-year cost of the program that was submitted to the AEC?

Dr. JOHNSON. Yes, sir; it is the one that I mentioned in which we are planning several pilot plants over the next few years. Along with this would be the total resource assessment program of the USGS. We would cover part of USGS costs in the local surveys so the local work is perhaps covered in our estimates. The regional studies and the general geophysical developmental programs in association with the various programs, including the sedimentary basins, hot dry rock, the various hydrothermal systems—the high salinity, low salinity, high and low temperature waters—would be carried by the USGS.

Dr. EATON. \$79 million.

Senator BIBLE. \$79 million for a 5-year program would be USGS's estimated cost. You also cooperate with the Bureau of Reclamation. What will their cost be? William Klostermeyer, Bureau of Reclamation.

Mr. KLOSTERMEYER. Our 5-year cost for the program will be in the range of \$12 million for the desalting program.

Senator BIBLE. You say the desalting program?

Mr. KLOSTERMEYER. Desalting of geothermal brines.

Dr. JOHNSON. I didn't see any representative.

Senator BIBLE. This anticipates how much industry input in dollars?

Dr. JOHNSON. These are the estimated governmental costs.

Senator BIBLE. I understand. Do you have an idea of how it will work out with industry, is it a 50-50 situation, 75-25?

Dr. JOHNSON. I would think initially, at least in the higher risk areas, that the Government would carry the bulk of it. As the developments begin to move downstream to those that have lower risk from an industrial point of view, I would think the industrial participation would range between 25 and 50 percent, and in some cases 100 percent. Already industry is carrying on developments on their own in some areas.

Senator BIBLE. Are you saying the total cost of the 5-year program would be 100 percent Federal dollars?

Dr. JOHNSON. The numbers I have given you are, yes, sir. But in terms of national development we anticipate there will be joint programs and funding, in fact, in every plant we are considering we are encouraging joint participation. For example, as Senator Church is well aware with respect to the Raft River area, we are working with the organizations there and will determine how much they are going to put in. They may buy the plant and operate it after we get through with it. We anticipate various arrangements of this kind to occur. So we expect there may be some recovery of funds from turnover of these plants to industry, also.

Senator CHURCH. I might point out in that connection, just for the information of the committee, that the public utilities districts of the Northwest have volunteered to contribute money to assist the Raft River REA in making a contribution to the joint effort that is contemplated here. I think that is quite extraordinary because these public utilities districts are not the direct beneficiary, but they see the importance and potential of this and they want to contribute a participating member of their association, which I think demonstrates how much local interest there is and how much cooperation would be forthcoming once this Government program is finally launched.

Dr. JOHNSON. We found that very encouraging up there, Senator. We have a very good relationship in Idaho. Likewise, there are cooperative work proposals being developed with other industries in the other parts of the country. I can't answer your question, Senator, numerically, in terms of how much contribution industry will make in getting the whole show on the road, but I would expect them to be picking up the bulk of the load toward the end.

Senator BIBLE. At the end of this 5-year program, assuming funding, will you be to the demonstration plant stage?

Dr. JOHNSON. Yes, sir, we believe so. In fact, we have in mind and in our planning that each plant will be a demonstration plant. Each will have experimental aspects, but the plants will be at the 10 megawatt level which is a demonstration scale. The costs will be assessed and if they are attractive, then industry can take over completely from there and deploy the technologies.

Senator BIBLE. At the end of the 5-year period of time under your projections and under your program, what you are saying is that the demonstration plant will either prove that it is feasible or that it is

not feasible. If it is feasible then industry can take over for a larger plant at the end of the 5-year period of time. Is that a correct statement?

Dr. JOHNSON. That is the way we are thinking in the various areas. Of course, these plants will be staggered in time depending on how complex they are.

Senator CHURCH. It is also your thinking that these demonstration plants will be built on a scale that will actually meet the needs, the immediate needs of the participant? For example, in the Raft River area you happen to have an REA that needs additional electricity and a 10-megawatt plant—am I saying that correctly?

Dr. JOHNSON. Yes; 10 megawatts.

Senator CHURCH. A 10-megawatt plant would just coincide with their actual needs, so they can utilize the electricity. Then, it is your concept that if the plant proves feasible, that arrangements will be made by the Government to sell the plant to the participating industry?

Dr. JOHNSON. That is our intent, yes, sir. That is the kind of arrangements we would like to see worked out.

Senator CHURCH. You not only would be demonstrating a new technique for larger application by private industry, but you would be putting on the line a demonstration plant that will actually generate electricity and with the ultimate objective in view of transferring electricity from that plant in due course?

Dr. JOHNSON. Yes, sir, that is our hope.

Senator BIBLE. Will a 10-megawatt plant, if that proves feasible, will that also establish to your satisfaction that a larger megawatt plant, 50 or 100, whatever megawatt you go to, would that be equally successful? A 10-megawatt plant is more than just a pilot plant.

Dr. JOHNSON. Yes; we consider that to be demonstration size. We think that to scale it up to perhaps 50 megawatts could be done at low risk.

Senator BIBLE. What is the megawatt capacity at the geysers?

Dr. JOHNSON. 400 megawatts. It may not become completely onstream yet, but it will soon be 400 if it is not now.

Senator BIBLE. Are you saying that a 10-megawatt demonstration plant, if it proves feasible, economically, environmentally and so forth, that a 400-megawatt plant would be feasible economically?

Dr. JOHNSON. You realize, Senator, that at the Geysers, the units are not 400 megawatts in size. That is the total installed capacity. Something that size can be built up from 50- or 100-megawatt units. I don't remember the size units that are going onstream at the geysers.

At Cerro Prieto there are 37-megawatt turbines so each increment is 37 megawatts.

Senator Bible. What is the dependability of the supply in both Larderetto, Italy and in Australia, New Zealand, and in Geyserville? I think that is an important question and I think it should be spread on the record. I believe in Italy they have been operational since 1907 something like that, and there is very, very little diminution of the steam. Is that correct?

Dr. JOHNSON. Yes, sir.

Senator BIBLE. It seems to me to have unusual dependability.

Dr. JOHNSON. I think the Geological Survey ought to testify to this more than myself. But my understanding is that the analysis of reservoir depletion is an integral part of the program in each case. Each site has to be evaluated in terms of how much you can withdraw from the formation and at what rate. But the experience has been very good in these areas you have mentioned.

Senator BIBLE. Coming back to an earlier question which I don't think was adequately answered, you described this program over nine pages. For this fiscal year, how much will it cost?

Dr. JOHNSON. This program?

Senator BIBLE. The one you just described, the one you testified to, just for the AEC?

Dr. JOHNSON. The money for this program for this year is \$4.7 million.

Senator BIBLE. That will do what you have outlined in your prepared statement for this year?

Dr. JOHNSON. We will have activity started in all of these areas with that money, yes, sir.

Senator BIBLE. But total cost for the 5-year program will be between \$120 and \$150 million for the AEC's share?

Dr. JOHNSON. Yes, it is a rapid buildup. That includes construction money, too, of course.

Senator BIBLE. You say here the chairman, Dixy Lee Ray, has indicated that the program over the next 5 years for all energy and research and development would be \$10 billions and that her report would be submitted to the Executive Office of the President by the chairman on December 1. December 1 is just around the corner. I assume when she submits that program it is going to show that of that \$10 billion \$120 to \$150 million would be devoted to geothermal steam, is that a correct statement?

Dr. JOHNSON. I don't know what she will submit. I have given you my view of what I thought it ought to be as a personal view.

Senator BIBLE. Does she consult you, you talk to her, you know her?

Dr. JOHNSON. Quite well, yes, sir.

Senator BIBLE. I would guess those figures are those that might be revealed on December 1. I am just making a hazardous guess. I have been around long enough that I think maybe those are the figures that will come out. We will wait and see. I am not trying to put you in an undue spot anymore than I would like to. I think it is apparent if those figures you gave me are correct and if we have a \$10 billion energy research and development program for 5 years, that the geothermal steam program if it comes out as \$150 million over that period of time as the chairman says, is getting a very small percentage of the entire pie and I hope you take that into consideration, maybe reevaluate it. When the program comes out on December 1 maybe you can give a little more attention to geothermal steam.

How much of that \$10 billion would go to solar energy? Do you get into the solar energy field?

Dr. JOHNSON. No, sir, I don't. The Congress has added to the Commission's program \$600,000, as I remember, for solar energy, but we do not have a substantial program proposal in the solar energy area. That is being funded almost exclusively by the National Science Foundation.

Senator BIBLE. How many dollars has the AEC spent from its inception to date on geothermal research? I know I have personally added it because I am on the committee, year after year and it has been frozen year after year. You must have spent a little on it. How much have you spent on it?

Dr. JOHNSON. I can't answer that specifically, Senator. But I can recount a little bit of the history. I can't give you the dollar level. But as you are well aware, as early as 1957-58 the Livermore Laboratory began to study geothermal energy development. At that time it was tied to the use of nuclear explosives to release the energy in the hot rock formations. Later conceptual design work and some calculations were carried out in cooperative efforts between the Livermore Laboratories and Battelle Northwest examining possible stimulation techniques. All of the effort was analytical in nature. There were no specific experiments carried out in the field. There was a great deal of calculation, a great deal of analysis given to those specific applications. The investment, however, could not have been very large in terms of dollars. However a number of excellent individuals did spend a considerable amount of time studying it both theoretically and conceptually.

Senator BIBLE. You spent a lot of time studying geothermal and its potential. We have lots of crises in Government, inside and outside and in various areas. A great crisis exists today and, of course, the President of the United States is speaking on it, I guess, this evening. Could you hazard a guess as to how much contribution geothermal steam would make to help in the energy crisis?

Dr. JOHNSON. If you can excuse my perhaps optimistic assumptions with respect to the rate at which industry will pick up the new technologies that come on stream, assuming at least some of the numbers are correct, we think there might be on line in the United States by the mid 1980's, 20,000 to 30,000 megawatts.

Senator BIBLE. 20,000 to 30,000 megawatts. Relate that to outputs with which I would be familiar, Boulder Dam or maybe the Bonneville system. How much electric energy do they produce?

Dr. JOHNSON. I don't know those numbers. Perhaps someone else here does. I suppose they are around 5,000 megawatts. I don't really know. But the geothermal contribution would equate to four, or five, six operations of that magnitude. The large nuclear reactors are coming in at 1,100 megawatts. So this would correspond to 20 to 30 large nuclear plants.

Senator BIBLE. This would correspond to 20 or 30 large nuclear plants?

Dr. JOHNSON. Yes, sir, such as we are building now.

Senator BIBLE. The present total, I am told, by Dan Dreyfus, on generating capacity in the total United States is about 391,000 megawatts.

Dr. JOHNSON. Yes, sir, that is correct.

Senator BIBLE. The geothermal steam under your optimistic projections would create how many megawatts?

Dr. JOHNSON. 20,000 to 30,000 megawatts by the mid 1980's. And, as you know, we forecast an installed nuclear capacity by that same time frame of about 300,000 megawatts. That is nuclear. That is not total.

Senator BIBLE. I understand.

Thank you, Mr. Chairman.

Senator CHURCH. Thank you very much, Dr. Johnson.

Senator BUCKLEY, do you have any questions?

Senator BUCKLEY. No, I don't.

Senator CHURCH. Thank you very much, Dr. Johnson, for your testimony. We look forward to working closely with you.

I just have this one last question to put to you.

As you described the program that the ABC hopes to proceed with, isn't it fair to say that that program is entirely consistent with the provisions of this bill that relate to the AEC?

Dr. JOHNSON. I think so, yes, sir.

Senator CHURCH. Thank you very much.

Senator BIBLE. I might just ask one more question with your permission, because it is right along the line of the question you just asked.

I noted when you testified, if I heard you correctly, in going to page 9 of your statement where you say: "At this time, for the reasons stated, we do not support enactment of S. 2465." You added the word "presently." I suppose that that means that in a month or two you would be in a position to support it. Is that what that means?

Dr. JOHNSON. I was referring to the statement I just made with respect to the ongoing activities and with respect to the 5-year plan. Until those activities are complete and we see what the results are, it may be that those activities will meet the intent of the bill. That is all I am saying.

Senator BIBLE. Because I noticed that you added, though it is not in your written statement, you added the word "presently." "We do not presently support enactment of S. 2465." You say after you have gone into this a little further you may support it?

Dr. JOHNSON. I was referring to the ongoing activities as those things unfold in time.

Senator BIBLE. Thank you, Mr. Chairman.

Senator CHURCH. Thank you, Dr. Johnson.

Dr. JOHNSON. Thank you very much.

Senator CHURCH. Dr. McKelvey, I see you have a prepared statement. Would you like to proceed.

**STATEMENT OF DR. VINCENT E. MCKELVEY, DIRECTOR, U.S. GEOLOGICAL SURVEY; ACCOMPANIED BY DR. GORDON EATON, DEPUTY CHIEF, OFFICE OF GEOCHEMISTRY AND GEOPHYSICS; REID STONE, AND WILLIAM L. MILLER, BUREAU OF MINES**

Dr. MCKELVEY. Thank you, Mr. Chairman and Senator Bible. It is indeed a privilege to appear before you today to comment on Senate bill 2465, the Geothermal Energy Act of 1973. My appearance is made on behalf of the Department of the Interior, and, while my remarks reflect the formal position of the Department, I am especially pleased to be here myself because the scientific and technological responsibilities assigned to the department in title II of the bill are specifically directed through the Geological Survey.

With me today are Dr. Gordon Eaton, Deputy Chief of the Office of Geochemistry and Geophysics, which administers the Survey's research on geothermal energy, Mr. Reid Stone who led the work on

the preparation of the geothermal energy environmental impact statement, and Mr. William L. Miller of the Bureau of Mines.

I have brought for the committee a copy of the final environmental impact statement for the geothermal leasing program. It was, as you probably know, released to the public by the Secretary of the Interior on October 23. All of us concerned with the development of our Nation's geothermal energy resources have awaited eagerly the release of this document, and I am happy to provide it for the committee's use and for inclusion in the record here, if that is desired. On the day of its release, a group of specialists from the Department of the Interior including two members of my staff, briefed various members of congressional committees and offices on the broad contents and significance of the statement and on some technical aspects of geothermal energy developments, as well.

We can now anticipate the possibility of actual leasing, pending final decision by the Secretary, and that, of course, would mark the onset of full realization of the goals of the Geothermal Steam Act of 1970.

The wait—both for industry and the Nation—has been long and frustrating, but I believe that all involved here have their toes to the starting block and when, and if, the actual gun sounds, I am sure they will be off and running to bring this exciting energy resource forward toward full development. We in the Department are enthusiastic and eager to see this happen and stand ready to provide what support we can.

Along those lines, I am especially pleased to note that much of the world's current understanding of the occurrence and mechanisms of geothermal reservoirs has been the product of research in the Geological Survey over the past 2 decades. In addition, I am happy to report that we have already released the first of our findings from research undertaken in the last 2 years under an accelerated program made possible by the Geothermal Steam Act of 1970 and the good support of Congress—I might say, in particular, Senator Bible.

We also will be making available to the public on December 10 in San Francisco additional results concerning the Mono Lake-Long Valley, Calif. KGRA.

Turning now to the bill under consideration, the Department has sent its formal comments by letter to the subcommittee and I refer you to these comments for the particulars of the Department's position.

To summarize them in a few words, the Department believes that the research program envisaged by title II has much to recommend it and is generally consistent with our plans. However, to the extent that the bill provides new authority for loan guarantees in title I or direct Federal support for geothermal development in title II, we believe it should not be enacted at this time. The most appropriate initial approach is for private enterprise to bear the basic responsibility for geothermal development, supplemented by Federal research and guidance. Let me emphasize, however, that we expect to move vigorously in carrying out our research role.

Title II clearly recognizes the nature of the development problems facing us in bringing geothermal energy along in a rapid and orderly fashion and it sets forth what appears to us to be consistent with the

President's accelerated Federal program of geothermal exploration, research, and development announced in his October 11 energy statement. The mix of broad, programmatic responsibilities among the existing scientific and technological agencies is, in our view, already included in the President's accelerated fiscal year 1974 program. Furthermore, efforts are currently underway in the AEC, at the request of the President's June 29 energy statement, to review our overall energy R. & D. programs, including geothermal energy, and to determine how best to coordinate and support an accelerated \$10 billion energy R. & D. program over the next 5 years. The AEC report will be submitted to the Executive Office of the President on December 1.

Our scientists and engineers have participated at the working level for 2 years in an informal ad hoc committee on geothermal energy consisting of members from many different bureaus and agencies. The necessity of coordination is obvious. At the same time, we are impressed at how logically and naturally the total needs in geothermal energy development break down in terms of existing bureau expertise, with few overlaps or gaps.

To cite an example, a report issued through the Department in early fiscal year 1972 saw the principal R. & D. tasks as classifiable into the following broad categories:

(1) Exploration methods, (2) resource appraisal, (3) reservoir development and production, (4) utilization technology, and (5) environmental effects.

Expertise for the first two resided in the Geological Survey even prior to the passage of the Geothermal Steam Act of 1970, where it had been developed in the search for, evaluation of, and understanding of the origin of, deposits or accumulation of valuable minerals, fossil fuels, and water. Similarly, because many of the potentially undesirable environmental effects associated with geothermal energy production are of a geological nature, the equipment, expertise, and a body of principles necessary for understanding and controlling these effects is already in hand in the Geological Survey. At the same time, we clearly have no in-house competence for much of what is required in the development of utilization technology or for the design and construction of demonstration power developments.

Other examples of similar dovetailing of development problems with existing Federal expertise can be cited involving the Atomic Energy Commission, the National Aeronautics and Space Administration, and the National Science Foundation. Thus, the tasks are readily divisible; much, though by no means all, of the competence is in hand. What is now required is a mechanism for formal coordination and the fiscal means to get on with the job. Efforts are underway currently, in conjunction with the President's accelerated 5-year \$10 billion program to provide both the coordination and the necessary funds.

What are the benefits and implications of research in this broad field? How will such research pay off? If we agree it is desirable to develop geothermal energy, what can we expect from it? Published estimates of the ultimate potential of geothermal energy differ by six orders of magnitude. At one end of the spectrum is a scenario in which it is assumed we develop only those few U.S. geothermal reservoirs we

know, or believe, to exist, using current generating technologies, at current levels of cost. At the other end, beyond a list of as yet untested and perhaps even unrecognized assumptions, beyond the efforts of a great many talented people, and following a string of successful technological breakthroughs equal to those of the Manhattan project or our manned lunar landing program, is a world in which most of mankind's space heating, including living and working space and giant green houses in cold climate regions, is done with geothermal fluids brought up from great depths; where a substantial fraction of our Nation's power needs are met geothermally with the widespread and routine use of heat exchangers linked to abundant low-temperature hot water or hot, dry rock reservoirs; where commercial quantities of such valuable substances as iodine, boron, fluorine, lithium, potassium, and cesium are extracted from geothermal brines and where some of the important water needs of arid lands are met with self-desalinated geothermal waters from which the heat energy and minerals have already been extracted cheaply and beneficially. Three things, among others, separate these two scenarios—exploration, research, and development.

With a program of this sort—properly nourished, carefully monitored, and adequately staffed—we can begin to answer critical questions and test the important assumptions. Where and how abundant are U.S. geothermal resources—not by region, or by State, or by township and range, but in their totality? What controls their size, depth, temperature, and energy content? What is their economic lifespan? How do we best use the dry steam reservoirs, the hot water reservoirs, and the hot dry rock resources? How many of each are there? What are the geopressed reservoirs of the gulf coast actually capable of producing? These are difficult questions. The answers will not come easily nor cheaply. Nor will they be simple answers. Some of them will be sobering. Others will be discouraging. But these should only serve to send us down avenues of research for solutions to the problems they pose. We are confident that the answers will come and that ultimately geothermal energy will take its place as a highly valued energy resource in the United States.

Dialog between concerned geothermal scientists and engineers in Government, industry, and the academic community is vigorous. The major research tasks required for full development of the resource were defined at a meeting held in Seattle, Wash., in the fall of 1972, and reported in a publication released early this year by the University of Alaska under the auspices of the National Science Foundation.

Further consideration of these tasks by Federal scientists and engineers has helped pinpoint those areas of research and development where the role of the Federal Government is most clearly indicated. I would like to comment on a selected few of these in order to give you some of their flavor.

(1) As I commented earlier, estimates of the geothermal resources of the United States differ by as much as six orders of magnitude, largely because of our ignorance of the distribution of heat in the Earth's crust. The search for geothermal areas to date has proceeded haphazardly, focused mainly on hot springs or accidentally obtained subsurface indications. A systematic appraisal of large regions is needed to appraise the true national geothermal potential. The

information is essential for the wise use of geothermal resources and for informed policy decisions on balanced development and utilization of all energy resources.

(2) In order to appraise the magnitude of the national geothermal resource base and regional resources, and to identify promising broad target areas for exploration and development, a spectrum of effective exploration techniques and tools must be developed. Many of the methods used for locating oil, gas, or minerals are of limited use in locating concentrations of natural heat. Some, however, may turn out to be well suited to geothermal exploration. Thus, the existing methods need to be evaluated and adapted to the task. Clearly, other new techniques need to be developed. Some will come from the field of physical and chemical volcanology. The problem is especially acute in locating reservoirs of hot dry rock.

(3) Planned utilization of geothermal resources requires evaluation of environmental impacts. All of the effects and changes produced by the extraction and reinjection of fluid and heat from different types of geothermal reservoirs need to be identified and evaluated in order to improve predictive models, environmental regulations, and extraction procedures of energy producers.

(4) On the engineering side, it is clear that national geothermal field test sites should be established not only for one or more hot water reservoir systems but for a hot dry rock system, for a geopressured brine system, and perhaps even for an area where active magma occurs near or at the surface. Binary cycle system designs must be tested, as should zero-power heat-extraction loops, and down-hole, extreme-environment pumps. And methods for coping with the enormous problem of scaling, both in the production of hardware and in the reservoir rocks themselves, must be developed.

The list of questions is large. To refuse to consider them is to refuse before the fact, full development of geothermal energy. There are those who say this resource will contribute too little to the overall energy problem to justify the investment needed. They point to the fact that if geothermal energy production of electricity began way back in 1904 as it did, it would be much further along than now if it were really going to amount to anything. But to argue in this fashion is tantamount to arguing that Wilbur and Orville Wright, not Neil Armstrong and Buzz Aldrin, should have landed on the Moon.

We are not using our geothermal resources to their capacity today, given even our existing technology. This can be changed through research and development, if we make the commitment.

Thank you for the privilege of my opportunity to speak.

Senator CHURCH. Thank you very much, Dr. McKelvey. I am not going to rerun the budgetary figures, of course, with you, because we have been over that pretty thoroughly already with Dr. Johnson. But is it fair to say that provisions of this bill, as they relate to the USGS, are consistent with the function that you envision for the geothermal survey to play?

Dr. MCKELVEY. Generally speaking that is true, Mr. Chairman. The use of the word "exploration" in the part of the bill, as it refers to the Geological Survey, we would hope would be interpreted in its broadest connotation to include research not related to exploration in the search of individual deposits.

Senator CHURCH. Would you be prepared to do what Dr. Johnson said the AEC was prepared to do, namely to give the staff of this committee, on an informal basis, such recommendations as you might have for technical amendments to the language of the bill?

Dr. McKELVEY. We would be happy to consult with the staff, Mr. Chairman.

Senator CHURCH. I want to thank you for bringing along a copy of the environmental report. The table is just barely strong enough to hold it up.

You know, and I am sure that Senator Bible would want me to emphasize, how long we have been waiting for the implementation of the law that Congress passed back in 1970, December of 1970, the purpose of which was to make available a method whereby interested private companies could utilize the geothermal resources under public lands. Since the enactment of that legislation we have been attempting to devise the regulations and promulgate the regulations that would control this matter. Can you tell us now that the environmental impact study is finally completed, when you anticipate that you will be able to issue the final leasing regulations?

Dr. McKELVEY. Mr. Chairman, may I ask Mr. Reid Stone, the Department's geothermal energy coordinator, to respond to that, please?

Mr. STONE. Senator, the 23d of November will be the first opportunity that the Secretary could make a decision on the environmental statement and the regulations under the Environmental Policy Act. We would anticipate that between now and the 23d we will receive substantial comments on this particular statement and the regulations as they were published. However, we have gone through 3 years of hearings and three proposed regulations.

Senator CHURCH. Criticisms and new regulations and so on?

Mr. STONE. Right. We feel they are in reasonably final form and hope that very early in December we will be able to, preventing any unforeseen circumstance, implement the regulations.

Senator CHURCH. Assuming that by December these regulations will have taken final form and been approved by the Secretary and issued, will you then be ready to enter into leasing arrangements?

Mr. STONE. Yes; on the noncompetitive aspects we will expect to start receiving applications for leases in December. And, hopefully, to hold a lease sale on competitive leases in California early in January.

Senator CHURCH. That would be the first competitive sale?

Mr. STONE. Right.

Senator CHURCH. I hope you can keep to that schedule.

Mr. STONE. We hope we can do better than we have been doing.

Senator CHURCH. It has been kind of open-ended, I know. I know the problem. The problem has to be devise regulations. We will have to see whether the regulations prove workable, but I am glad we are at last coming to the point where we can anticipate that they will soon be issued and we can put them to the test.

At the last hearing both Assistant Secretary Horton and Mr. Stone of the Department of Interior were asked whether any private entities had indicated an interest in researching forms of geothermal resources such as the hot dry rock technique, and their answers were that they did not know if any had indicated an interest. Since then

have you found any—can you enlighten us, do you have any new information concerning the possible interest of private companies in developing hot rock or dry rock techniques?

Dr. McKELVEY. I am not aware of any, Senator, but may I ask Gordon Eaton if he is aware of any efforts on the hot dry rock reservoirs on the part of private industry.

Dr. EATON. I am afraid I am not certain either. There are members of private industry present in the room today, so they might correct me if I am wrong.

I think all of us today are watching very carefully what is going on in Montana. The research that has been conducted there, particularly by Southern Methodist University, only makes it look more exciting now than in June when we talked to you about it then. So it is possible that interest will be more forthcoming when we have actually put a hole down and see what is really down there under the subsurface of the ground. As of the present time, the further work makes everyone think, who is watching this field that this indeed is the hot dry rock resource, the first one we have really zeroed in on.

Senator CHURCH. It looks to me like everyone is waiting for the Federal work in this area. I suppose that given the risks and the fact that the investment may have to be substantial, the outcome is unknown, unproven, that it would be difficult to get the private companies to invest significant amounts of money in that kind of enterprise. If we could enlist the interest of some large utilities companies, I just have a feeling that we would make faster progress and I think that you ought to have your antenna out for such an opportunity if one presents itself.

In connection with your exploration work, I think that our testimony last time showed that your program is based primarily upon surface indications and whatever subsurface data is available for water and oil well logs. Would you describe this data collection program, both as to its present status and what may be needed in the future for an accelerated program?

Dr. McKELVEY. Again may I ask Dr. Eaton to speak to that, please.

Senator CHURCH. What is the most important data needed?

Dr. EATON. The single most important piece of data needed? Well, ultimately as Dr. McKelvey said; what we really need to know is what the distribution of heat in the Earth crust is and one of the kinds of data that helps us establish this kind of information comes from measurements of heat flow. This is done in wells and, as a matter of fact, this is how the Marysville, Mont., occurrence was discovered accidentally through a series of heat flow tests being made in that area. We also gain a great deal of knowledge about subsurface conditions from the chemistry of the waters that we either take from wells or from hot springs at the surface. You can estimate, for instance what the base temperature of the reservoir is in this way. So, in the Geological Survey, for example, we have had underway, now, for the last year and a half, a systematic program of sampling hot springs all over the Western United States and Alaska, and the first of these data has already been published in conjunction with the Idaho Department of Water Administration. So, this kind of data is also useful. I am restricting, now, my remarks to subsurface data. That is what I understood you to ask.

Senator CHURCH. Yes.

Dr. EATON. But, once again, all sorts of information that is of value in estimating what is present in the subsurface comes from geophysical well logs, the kind that are routinely gathered by oil companies. So, we have a program down in the gulf coast where one of our geologists is working very closely with the companies, working with privileged company information on physical properties of fluids and rocks in the subsurface along the gulf coast, particularly designed to study the geopressured brine reservoirs. So, you really need information from all these sources and you need the cooperation of industry and I am happy to say we are getting it. The geothermal fraternity is very small and everyone is still talking to each other very openly.

Senator CHURCH. Let me ask a question because I am completely unlearned in this field. If you were to drill a hole anywhere, just at random, if you drilled it deep enough, would you come to hot rock?

Dr. EATON. Yes, you would, yes; because, as you go down in the crust almost anywhere in the Earth the temperatures rise. The base of the crust may be anywhere from 200 degrees centigrade, which is way above the boiling point of water, up to 1,000.

Senator CHURCH. So what you are looking for, then, would be data that would enable you to determine how deep, at any given point, it would be necessary to go to reach rock of sufficiently hot temperatures?

Dr. EATON. Yes; and along those lines, the Geological Survey, in conjunction with the American Association of Petroleum Geologists, is right now, has in the manuscript stage and will be published sometime later this year, a map of depths to certain isogeothermal surfaces in the United States. This is based almost entirely on data provided by the oil companies. It is a very useful kind of thing to have to plan in the original exploration program.

Senator CHURCH. Is it possible that in some areas the temperatures will be higher than in other areas? Is there an irregularity in the pattern of heat that is likely to be encountered?

Dr. EATON. Yes; there is, and you can prejudice this and then test the idea. But in those areas, for example, in the United States where geologic activity has more or less ceased, where we do not find earthquakes occurring frequently, you generally find areas of low-heat flow, low-thermal gradients, meaning you have to drill to very great depths to encounter great temperatures. In the West where we have a lot of evidence of young volcanic activity that has taken place in the very recent geologic past, we have reason to believe, and in some cases we are certain, that molten bodies of rock are at very shallow levels. There you would not have to drill very deep. That would constitute high grade geothermal resources.

In the Soviet Union they are tapping waters from areas of deep sedimentary basins very much like the gulf coast, although they are not, as I understand it from conversations with them, encountering these very high pressures. But they are using this for space heating. So while we may not generate electricity for a great time from waters of this kind there are other uses and these would free up fossil fuels, for example.

Senator CHURCH. Though we do not put hot water to that use very extensively in the United States, it happens that in Boise it has been used since the turn of the century for space heating and very successfully so.

Is specific drilling helpful in checking the evidence of indications?

Dr. EATON. Yes; it certainly would be.

Senator CHURCH. Does the United States contemplate any such drilling?

Dr. EATON. In the 5-year program which we submitted to Chairwoman Ray in the AEC, we have a major part of one research project category concerning itself with drilling, the application of drilling development and so forth.

You actually need a spectrum. You can use very shallow drilling for thermal gradient measurements to help us target deep hole wells that have to be at 1,000 feet. At the present time most thermal evidence comes from shallow levels. No one knows what is down below 10,000 feet or so. It would be useful to drill in those areas. Maybe we are not tapping the vital parts of the system.

Senator CHURCH. Senator McClure, any questions?

Senator McCLEURE. Thank you very much, Mr. Chairman. I appreciate the chance to participate in the hearing this morning and I appreciate, too, the testimony that has been brought before us, even though it does not necessarily support the passage of our legislation.

As I gather the thrust of the statement, both from the AEC and from the Geological Survey, they are both saying, in essence, that the Administration wants to go ahead with geothermal development, and is expecting to go ahead with geothermal development but does not need additional authority. Is that correct?

Dr. McKELVEY. Senator McClure, I would interpret this a little bit differently. I think that the Administration, and the Department, are saying that it is not certain at this time that additional authority is needed along the lines provided in the bill. I don't think it constitutes a position of adversity necessarily to the procedures that are proposed here over the longer term, but simply a position of uncertainty that they are needed at this time.

Senator McCLEURE. How much risk is involved in geothermal development, financial risk, if a commercial enterprise were to want to involve itself in the production of commercial energy from geothermal resources, how certain would they be of a return on their investment if they were to embark upon one at the present time?

Dr. McKELVEY. I may ask my colleagues to speak on that, but I think in general, Senator, one could say that there is the same risk associated with geothermal development that attaches to the development of other kinds of minerals and of petroleum. There is first of all the risk in exploration. There will have to be drilling before it will be known for certain that there is a geothermal resource with commercial potential, and so there is the risk of exploration to begin with. I think perhaps that the risk diminishes somewhat beyond that, although that depends, at this stage, on the kind of geothermal energy that one is considering. If one were to approach, for example, the development of the geothermal hot dry rock reservoirs which are really very little known and have never produced energy commercially, one would have to recognize that there is indeed a very high risk in the development of that kind of geothermal energy. There would be considerably less risk, I think, in the development of energy from a geothermal steam reservoir once the existence of the reservoir had been established. In other

words, the plant technology for the development of energy from geothermal steam is already in hand. But the risk increases beyond that to other kinds of geothermal energy.

Senator McCLURE. Do any of the rest of you care to make any comment?

Mr. STONE. I believe that Dr. McKelvey has addressed it clearly. The real risk, I think, we might hear more from the industrial people who have entered into some of these enterprises, and I am sure they will speak to that this afternoon.

Senator McCLURE. The reason I ask the question is perhaps brought forth in Dr. McKelvey's statement, that says:

The loan guarantees that are provided for in this bill are not necessary, that the most appropriate initial approach is for private enterprise to bear the basic responsibility.

And then on page 3 of the statement—page 5 of the statement—is the following:

What is now required is a mechanism for formal coordination and the fiscal means to get on with the job.

I just thought there was a little bit of inconsistency with those two statements and I would invite your comments.

Dr. McKELVEY. Senator McClure, I think the coordination and the means to get on with the job, the Administration feels, is in sight and underway in conjunction with the work that is being done under the expanded energy research and development program called for by the President.

On the matter of industry participation, I think the Department feels that at this particular time, first of all, there has been a rather high interest among a number of industrial organizations in the resource and I think, until the leasing program is underway and there is an opportunity for industry to either participate fully or stand back, that it is uncertain that the traditional American way of free enterprise, with its own source of funds, won't work. So I think that is the position at the present time.

Senator McCLURE. Let me make just a brief statement, if I may, not directed toward any of the gentlemen at this table, because I have a very high regard for both the AEC and the Geological Survey. Both as institutions and in the people here today, I really appreciate what you have done and what you are attempting to do, and I appreciate your expertise and I look forward to a very friendly relationship, particularly on that project we are trying to get going out in Idaho. I want you to understand that whatever I say is not a personal criticism in any way nor necessarily directed toward your agency, but toward the activities of our Government.

I was a participant in the passage of the Geothermal Steam Act of 1970. Congressman Craig Hosmer of California on the House Interior Committee was very active in that and I was active in support and in conjunction with him. That was not the beginning of governmental interest and it was not the beginning of congressional interest. It was an expression of frustration at the slowness with which we had been acting up until that time. So if we only look back to 1970 as the beginning, we are overlooking all of the work that went on before that time.

But let me detail just a moment some chronology of events since 1970.

The Geothermal Steam Act was approved on December 24, 1970. Proposed rules were published July 23, 1971. A draft environmental impact statement was released on October 6, 1971. Additional proposed rules were published May 3, 1972. A supplemental to the draft of the environmental impact statement was released on May 3, 1972. Revised proposed rules were published November 29, 1972. Revised proposed rules were published July 23, 1973. Corrected proposed rules were published August 8, 1973; final environmental impact statement released October 23, 1973. The comment period on the proposed rules currently extended to November 16, 1973.

I detail that chronology only as a sense of frustration of one member of Congress at how slowly we move. I think the authors of this legislation, upon which the hearing is being held today, introduced legislation with the expectation that legislation might increase the pace at which we move in the development of a critically needed energy resource for our country. Then we hear testimony from the administration, well, we don't need any further legislation. We have enough authority to move. Well, for heaven's sake, what does it take to get the administration and the Government to move forward in the development of energy resources? We act as though we have all the time in the world to do it, and while, certainly, I would be the last person to indicate that geothermal resources are going to get us by the present crisis or will make a significant contribution on the total energy consumption in this country within the next 5 years, I think we have a very serious problem confronting us in the near term. But if we hadn't had to wait until now to get going, maybe we would be making some contribution now.

We talk about energy emergency, of priority legislation, the necessity of setting some kind of rationing procedures into effect because of the cutoff of Arab oil to our country, and 3 weeks ago we had responsible Members of the Congress and responsible members for the administration saying, don't worry about it, Arab oil, it is only 5 percent of our consumption in this country and those facts were wrong when they were used. The truth of the matter was it was from 12 to 15 percent of our domestic consumption. They were talking about 800,000 barrels a day up to 1 million barrels a day of Arab oil being consumed in this country when the facts are that right now it is over 3 million barrels a day.

We act as though we have no crisis and yet let me read just a moment from an October 23 memorandum of the Office of the Secretary of Defense in which they say definitely 3 million barrels per day net loss; 18 percent decrease in consumption if Arab oil is lost to us.

We look to what it would mean in terms of fuel in some areas of our country, one-half of the heavy fuel going into the east coast, 70 percent of New England electric power is generated from these sources. Then we act like we have time to react. I think it is high time that our administration and people who are responsible for policies of our Government recognize that the time has run out and time continues to run out on some of the decisions that must be made. I think it is high time that we concentrate on some of the available tools and

I agree with what you say about some of the existing authority, but it has not been used.

We have the Defense Production Act under which the President could react today to make steps possible in the allocation of fuels, and in the production of alternative resources. The Defense Production Act could be used in geothermal just to guarantee return on investment. That might do the job of getting private enterprise involved in the investments that are necessary and the Defense Production Act is not a new act, it has been on the books for a long, long while. But it is lying there unused as though we have the time to develop new legislation or to methodically and over a long period of time develop programs. How much of a crisis must we have before we move?

I again say to you that these comments are not being directed toward you, because I am quite satisfied that you gentlemen are not responsible for the delays. But when we look at 3 years' delay since the act was passed, the delay that led up to the passage of that act, the glacial progress that we are making, I hope you will forgive us or at least forgive me if some Members of Congress get a little frustrated when we talk about no emergency, no need for new legislation. It isn't just the administration. Congress has been just as guilty. We have not provided the funds, we have not provided the impetus, we have not made the statement of urgency and crisis in the terms that we should have. There are some of us that are scared to death, very frankly, of the consequences of inaction of Government by the Congress and administration that brings us to the point where our economy can utterly collapse because of our inaction in the past years and may collapse utterly if we do not take appropriate actions now.

I do not mean to overstate it but it seems to me that if we did not overstate it, somehow, the people are not going to get the word that we have a crisis confronting this country; it is very real.

If by the 15th of November, and, again, I will read from that memorandum from the Office of the Secretary of Defense. It is not something that is going to happen sometime in the future. This decrease of consumption on the East Coast of the United States and nationwide, and I will quote from the Office of the Secretary of the Defense now.

The pipeline is about three weeks long. That is deliveries to consumers will be running 18 percent short by November 15.

Then we look as though we have a feeling that there is no emergency, that we can respond as we would have in happier times with fewer problems than we have today.

Forgive me for having taken the opportunity, when you are at the table, when you are not the cause of the problem, but somehow, somewhere we have to get this sense of urgency indicated to the Administration and to the public and if we do not get that done we are going to be in very, very serious trouble by the end of next week. I hope that message is beginning to get through.

Thank you, Mr. Chairman.

Senator CHURCH. I can concur in those sentiments. I expect it is getting through because the President is going to address the people tonight or sometime soon on the energy crisis. I think the hearing

today bears out that even where Congress has added on additional money we are still waiting for that money to be released by executive action. It remains impounded as of today in this particular field.

As far as new legislation is concerned that is designed to accelerate the Government's initiative in the area, we have Administration instruction, obviously, to oppose it nor not to enforce it. So that it is a pretty sorry record, I think, in view of the fact that this energy crisis is going to fall on the country very soon. I think when it does that attitudes are going to change rather rapidly in Washington, but then it is going to be pretty late to cope.

Thank you, gentlemen, very much for your testimony.

Our next witness is Dr. Carel Otte.

**STATEMENT OF DR. CAREL OTTE, VICE PRESIDENT AND MANAGER OF GEOTHERMAL, UNION OIL CO., OF AMERICA; ACCOMPANIED BY DR. JOHN ALLEN, COUNSEL**

Dr. OTTE. Mr. Chairman and Senator McClure. I have no prepared statement to submit at this time. Inadvertently, I was unaware of this hearing until late last week. My appearance was made possible by some last minute rearrangements in my schedule.

I will thank you for allowing me to testify early before lunch so that I can return to the West Coast for another commitment.

My remarks will highlight a few problems that I see with S. 2465 in its present form. I will be happy to provide the committee staff with more detailed comments in a follow-up written statement.

I have prepared these notes in the airplane coming here.

My name is Carel Otte and I am vice president and manager of Geothermal of the Union Oil Co, of California. With me is Dr. John Allen, counsel with the Union Oil Co. in our Washington office.

Union Oil Co. has been engaged for 10 years in the development of geothermal resources in the United States, and more recently, the last 3 years, abroad in the Philippines. We have drilled many wells and we are the operators of the largest geothermal field in the world, in the Bay Geysers in California.

We are working in the Philippines under contract with its Government, and we hope shortly to be in a position to announce the results of the successful exploratory effort in New Mexico.

I feel that Union Oil qualifies as one of the pioneers of this industry and I am happy to say that I have been associated with Union's efforts since its beginning in the early 1960's.

I have testified many a time before this committee on geothermal legislation, particularly the leasing legislation, as well as for the House Interior Committee, and maybe some of the members may remember me from earlier testimony.

Recently I coauthored a book on geothermal energy with Prof. Paul Kreuger of Stanford University, and Senator Alan Bible was kind enough to write a foreword to this particular publication. I had the opportunity and the need to call on all my previous experience and training to collate the various contributions made by other students in the field. It was fascinating experience that I hope to do only once.

I state these facts for you to provide you with my background and experience so you may view my succeeding remarks in the proper perspective and context.

As I see it, there are two parts to S. 2465. Title I concerns the loan guarantee program, title II, addresses the program for Federal coordination of the exploration, research, and development aspects of the Federal Government.

Contrary to the previous witnesses, I believe that I will address myself specifically to the legislation. Let me say at the outset I welcome it.

Personally, as an individual, as well as a representative of my corporation, we would welcome some assistance. What has been accomplished to date has been largely the efforts of private enterprise. Some struggling private entrepreneur organization in the late 1950's began the development at the Geysers. Union Oil Co., shortly after followed them and if it were not really for the development currently at the Geysers which is becoming eminently successful, made possible because of the financial and technical resources of a corporation like the Union Oil Co., as well as the Pacific Gas & Electric Co., I would say both Union Oil as well as Pacific Gas & Electric are known probably industrywide and nationwide as pretty hardnosed organizations, because of the cooperation of these two organizations the feasibility of geothermal resources as a practical alternative form and contributive form of energy has been made possible because of these organizations. If it were not for these efforts I do not think we would be sitting here today with you worrying about the concerns that we all have as a nation for our future energy supplies. You could not sit here today to discuss, to offer geothermal as a possible contributor to our energy supply to this country.

With respect to the loan guarantee program, I, without addressing myself specifically to the preamble which is laudatory, I think what we are looking at here are what I would say fall in the category of development loans. You recognize here, apparently, with your intent of this legislation that there is an element of risk associated with these developments and for that reason maybe loans that would otherwise come from banking institutions or financial institutions would need to be guaranteed. For that reason I would like to call these soft loans, it is a program that is really somewhat new to the Federal Government. It has been done in the past in very specific instances but it is somewhat new to our way of doing business. I would have to classify them as soft loans.

For that reason I think there are two specific points that I would like to make. One, section 101(d), subsection 1, that states that the Secretary—

Senator CHURCH. What page is that, Dr. Otte? Do you have it?

Dr. OTTE. Yes; I have it right here, page 3.

To take you through the bill, that essentially grants the Secretary of the Interior, which is apparently the Department that is the implementing agency here, it grants to the Secretary of the Interior, subject to certain provisions, the authority to make loans up to 75 percent of the cost of the total money requirements for a geothermal venture. It is subject to certain conditions and condition (1) says: "The loan involved will be at a rate of interest which exceed the prime interest rate, plus one-half of 1 per centum."

I would like to suggest to you alternative language which would perhaps grant to the Secretary the authority to make loans at prevailing interest rates. I think in tight money situations perhaps this is an unrealistic low-interest rate by which private institutions, banking institutions may be reluctant to make money available, particularly for risk ventures, and leave it up to the discretion of the Secretary as to the relative merits of the project, what the money rates are, and to make money available.

Senator CHURCH. If the language were revised to establish the prevailing interest rate as the highest level, leaving the flexibility in the lower interest rate to be negotiated, that would be satisfactory?

Dr. OTTE. Yes.

Senator CHURCH. Because the Government guarantee ought to be an inducement?

Dr. OTTE. That is correct; yes.

Then, if I may take you to section 4 on the same page, and I will not read it to you here, as well as subsection (b) in the middle of the next page, and the two tied together somewhat. In other words, the Secretary under section 4 on page 3, the Secretary will not be permitted to make this loan if there is no reasonable assurance of repayment. Rather than state it in the negative, and I know the legal way of saying things is usually in the negative sense, I would say that perhaps he should be permitted to make this loan if there is a reasonable assurance of repayment. Turn it around. In other words, to use it as an incentive.

Likewise on subsection (b) on page 5 which ties into this general idea that in the event of a default by a qualified borrower on a guaranteed loan, and I will skip the Attorney General shall take such action as may be appropriate to recover the amounts of such payments with interest from the defaulting borrower. Here I would like to suggest that the amount to be recovered will be from the project, from the proceeds, or the assets of that project.

I am thinking here of the small companies that really pioneered some of the early geothermal work. These were risk ventures that raised equity capital in the risk financial market and if their total assets, corporate assets are pledged to a particular venture and if the Attorney General could go after the total corporate assets in order to redeem a loan that was guaranteed by the Government, I think it would probably inhibit the company to take the risk.

I would like to point out to you that the company, the borrower, the entity, will still be asked to invest 25 percent of the money or somehow organize and make available 25 percent of the financial needs of the venture in some other manner, probably from equity money that is available from his own organization.

In other words, if a venture is unsuccessful, I would certainly feel that incidentally this 25 percent should be subordinate to the Government loan and that the Government loan would have priority. But that, perhaps, is all that should be asked of the private entrepreneur or the organization that borrows, that 25 percent of that venture would be lost to him and not the total corporate assets.

I think, and I am really speaking here more from what I know of the geothermal industry rather than Union Oil Co. I don't think that Union Oil Co., will be coming to the Federal Government for support

on individual ventures, but I do know of several organizations that have made substantial contributions to the discovery of resources and I think they would probably benefit from this type of legislation and these corporate loans.

Senator CHURCH. Our purpose here is to create an incentive and I think you are quite right that we ought to be careful not to write the bill in such a way as to create more obstacles because we are trying to open the gate and I think your suggestions are very constructive.

Dr. OTTE. Finally, with respect to my comments to title I, I would like to refer you to section 107 on page 5, at the bottom, and that is that business-type financial reports are required and should be made to the Congress.

As I said earlier, the Secretary of Interior apparently is the implementing agent for this loan program. Yet, at the same time the Secretary of the Treasury has responsibility for making the funds available and keeping house, so to speak, on the funds. My question to you is could you clarify this as to who makes these financial reports? Is that going to be the Secretary of Interior or the Secretary of the Treasury or is this going to be the General Accounting Office, who I understand reports to the Congress?

My personal recommendation in this is that it will be the Secretary of Interior because, after all, he has the responsibility and the authority to make the loan and I think he also should have the financial responsibility for reporting. But this is just a technical clarification that I suggest.

Senator CHURCH. Those are excellent suggestions, all of them. I think in the case of section 107 it would be the administrating agency, in this case the Interior Department. But it ought to be spelled out in the language of the bill.

Senator Fannin, do you have any questions?

Senator FANNIN. Thank you, Mr. Chairman.

I just want to express my appreciation to Dr. Otte. As the chairman said, we are very appreciative that Dr. Otte has been willing to come here today.

Dr. OTTE. Senator Fannin, I also have additional comments to make on title II. Would you like to ask me about title I, or would you like to hold your questions until later?

Senator CHURCH. I thought you had finished, Doctor. Please continue.

Dr. OTTE. To refer back to title I, my comments, as you can see, are largely technical in that sense. I think with my observations on title II they are somewhat in the nature of more philosophical questions on the substance of your intent.

I refer back to the earlier testimony this morning by both Dr. Johnson of the AEC, as well as Dr. McKelvey of the USGS. I was very interested in listening to their prepared statements. They were somewhat uncomfortable apparently with some of the language, particularly in title II, and perhaps I am a little freer of constraints, so I can speak out and maybe some of my comments will strike a responsive chord on the part of those earlier witnesses.

Gentlemen, we are in favor. We look forward to cooperation and coordination with the Federal agencies. I think it is very necessary. I think as a geologist, which is basically my background, unfortunately

I am not an administrator, but as a geologist I look back in the past with close cooperation with the USGS in areas of fuel research and development programs.

In this bill, this section 202, at the bottom of page 6, subsection (a), the Secretary is directed to develop and carry out a general plan for the orderly exploration of all forms of geothermal resources under Federal lands and, where consistent with property rights and determined by the Secretary to be in the national interest, of non-Federal lands. I read this, that really the USGS is becoming and is directed to be an exploration company. I question this is really the objective of this legislation. But this is what it states and this is the way I read it.

I think the USGS is an excellent research institution of exceptionally high caliber and high professional integrity and it has also in the past enjoyed excellent relations with industry. The very thing that you are trying to promote, which is a closer cooperation and mutual programs is really going to be discouraged by this clause because a company cannot be cooperating and be in a cooperative enterprise if at the same time elsewhere they are going to be in competition with you, and this is what it really says and this is competition with private enterprise. I don't think, really, this mission is consistent with their charter.

Senator CHURCH. How would you propose to alter that?

Dr. OTTE. I think, really, it rather spells out what the Secretary is supposed to do in subsections (a), (b), (c), and (d). What I would recommend specifically, if I address myself to the structure of this present bill which is really all I have, is I would say, delete section (a) in its entirety and I would add some additional language to section (c): "engage in such investigations and make such basic studies, and publish and make available reports." In other words, really encourage them to do the very things that they are doing today, but to do more of them. That is what I would like to suggest.

Senator CHURCH. I think Dr. McKelvey must have had that in mind when he spoke of exploration in his testimony. He said he would like to make some suggestions as to how that material should be defined. I think he had in mind that he wanted to define it in terms that would be consistent with the past practices.

Dr. OTTE. I think so. This is the way I read his remark, too. But, again, I address myself to the remarks of this bill.

Senator FANNIN. It would emphasize the obligation, of promoting a general plan to be more consistent with the objectives of the legislation. That could be rewritten.

Dr. OTTE. Promote would indeed be softer language. What really concerns me is develop and they carry out which really means an intrusion to lead the mission.

Senator FANNIN. Yes; I understand.

Dr. OTTE. Marshal the forces and go forward.

Likewise, I guess this bill then direct really the Administrator of NASA to marshal its technical expertise to do somewhat of a similar thing. I refer you specifically to the language of section 205, on lines 18 and 20.

I am taking you through this rather quickly and I fear that I may be skipping too much. But there again NASA is being asked to engage in exploration and mapping of geothermal resources. Perhaps our

hangup is the difficulty in interpretation of the word "exploration." But with me that is exploration operations, it is the discovery of a resource for the purpose of a development and I don't think that is the intent.

Senator CHURCH. We have in mind here the use that NASA is putting satellites to use, for photographic work that assists in determining where these geothermal basins may lie. I think the difficulty you are having here is largely a semantic problem which we can correct.

Dr. OTTE. This is what I feel, too, but this is why I address myself to it at the same time. I think perhaps if we can clarify the philosophical approach to this bill then the proper language can be found in the sections to just clean it up and just clean it up and take care of these matters.

In the same context, I would like to comment on the——

Senator CHURCH. Excuse me. For example, on line 19, page 8, instead of "exploration" "for locating and mapping of geothermal resources." might be the more precise words.

Dr. OTTE. I had such general language as "study and investigate", but I think your language is entirely correct.

Senator CHURCH. Because that is the use, of course, that they are put to now.

Dr. OTTE. Correct, and I think their expertise is very unique and I think it should be brought to bear on it.

Again, looking at the structure of this measure that you are considering, the way I understand it, then, is the USGS will have the obligation to study the resource part, anything that is below the surface of the ground. And that NASA will kind of take care of the orbiting satellites on the mapping. The AEC will be largely, their mission will be associated with the utilization of the resource, the upgrading of the resource, and the application. This is the way it is structured and this apparently appears to be, that makes an awful lot of sense and that is very desirable.

Then, again, the measure spells out what there will be in the form of demonstration facilities and coordinate this closely with private enterprise and the AEC has a history of doing this and this has certainly been very useful, to make harnessing of the atom available to the Nation at large.

But, now, what concerns me under all this general statement in the preamble as well as the language, we go to page 11, and that is section 208, subsection (c), at the bottom of page 11, on line 23. In the earlier aspects there are some money limitations written into what the AEC can do as far as individual programs are concerned, but then in subsection (c), "The Commission is authorized to investigate potential agreements for the cooperative development of major facilities," and then it goes on to say, "to demonstrate the production of energy from geothermal resources," and then on the next page, page 12, it specifically says on lines 5 through 10, it identifies certain cooperative agreements with non-Federal Government entities to produce energy for commercial disposal, and in (2) "make cooperative agreements with other Federal agencies for the construction and facilities to produce energy for direct Federal consumption."

This, to my way of thinking, makes the AEC an operating entity, an operating power entity. Is this indeed the intent that you have with this legislation?

I think as long as it is limited to demonstration facilities and to cooperate with industry, this is indeed very desirable. But, then, as soon as it is workable, in fact even when the demonstration facility becomes commercial, I think perhaps a mechanism should be provided that this would be made available and sold and operated by private enterprise.

Senator CHURCH. Subsection (1) on line 5 is meant to relate to agreements between the AEC and a private utility or the REA or a public utility. But a non-Governmental entity, in which the non-Governmental part, the utility, would sell the power.

As Dr. Johnson earlier testified, the AEC would contemplate an arrangement whereby the facility itself would be conveyed to the utility in due course after the demonstration function had occurred and the plant had proven itself.

Subsection (2) really relates to a military facility where I understand the AEC has had a direct input in the past. It is not the same as (a). It is not a new departure.

Dr. OTTE. I see. I think, then, if perhaps this was the intent, then perhaps some additional language to reassure private enterprise, again it is the same concern that the corporate entity or any individual is reluctant to go into a cooperative agreement and reveal information and freely exchange information if this information can also be used against you again in another area and be competitive. If it is for the sole purpose of demonstrating capabilities and developed technology so that it will be made freely available for everyone to use that is entirely acceptable.

These are really the remarks that I wanted to make.

We welcome this legislation and in this form with this particular suggestion that I have made we would wholeheartedly support this legislation.

Senator CHURCH. Thank you very much, Dr. Otte. Your testimony has been very helpful and also your specific suggestions for improving the bill.

Senator FANNIN. Thank you, Doctor, and I, too, want to add my thanks to you. We are really indebted to you for some very constructive suggestions. I agree that when you testify on this subject, perhaps being one of the greatest authorities in this field, we certainly are going to respond to your recommendations. I had the opportunity to visit the Geyser field and commend you for what you have done there and for the work that you are bringing forward. It is certainly encouraging.

The R. & D. bill that we have been working upon recently does provide, as the Chairman explained, a provision where there will be a takeover whenever it seems most appropriate—when a plant is in production or where it has been proven a viable entity. So I think that you are certainly right. This should be handled on that basis; and I think it would be the intent of Congress to provide for that way of handling it.

I am very pleased that you do speak well of the legislation. I feel that you have helped to strengthen it and we do appreciate your testimony.

Senator CHURCH. Thank you very much, Dr. Otte.

Dr. OTTE. May I make another general statement in answer to a question that you raised earlier of Dr. Johnson, Senator Church?

I was doing some figuring. I believe it was a question that came from you as to how meaningful can geothermy be in the future, and maybe it was Senator Bible who was asking the specific question, and what percentage can geothermal energy be in making the contribution. Of course, we are in such a rapidly changing energy demand situation, we do not know the message that the President is coming out with tonight, we do not know what the rising prices are going to do to the situation, but I would like to leave one word with you, one concept with you. That it looks right now like the Geysers field will probably be in the order of at least 1,000 MW, maybe more than that. We have on line 400 MW at the present time and are installing 100 MW next year, and this will probably be accelerated in the succeeding years. One thousand MW compared with about the size of one major nuclear plant that is being considered these days, so it gives you somewhat of a measure for comparison. With the rate of the intensity of energy consumption that we have, a 1,000 MW plant supports all the electrical power needs of 1 million people at the intensity of consumption that we have in the United States today. A million people. But I am not talking about the domestic needs, I am talking about the commercial and industrial needs associated with supporting 1 million people. So 1,000 MW. So the Geysers field would be capable of, let us say, taking care of the city of San Francisco and the somewhat surrounding communities.

Earlier Dr. Johnson estimated that perhaps by the mideighties we may have as much as 20,000 to 30,000 MW of geothermal power on the line, so that would be the equivalent of 20 to 30 nuclear plants. I would somewhat concur with these numbers. These are sort of the numbers that we go by. This is with available technology, provided the Federal Government opens up the public domain lands, because, as you know, the Federal Government is the prime landowner in the Western United States, so it is very essential that these lands be opened up.

Incidentally, this legislation that you consider today will be empty legislation if these lands are not opened up because they are just denied to us as far as access.

With this as a context, I do not know what the power demands are going to be by 1984 because it is a rapidly changing situation. To get 1,000 MW producing a fossil fuel plant would be equivalent of a 400-million-barrel oil field. So to have 20 of such plants in the mideighties would be equivalent to 8 billion barrels of oil that would not have to be imported over the lifetime of these facilities, taking a 30 year life, 8 billion barrels of oil is a lot of oil with current pricing, and I do not know where the prices are going to go, they are no longer under the control of the United States as you have well discovered. Posted prices at the gulf coast mean nothing. It is posted prices in the Persian Gulf that dictate. Nigeria now raised the price to \$8 a barrel, so 8 billion barrels, if we talk about roughly \$10 per barrel at the end of the 1970's, we are talking about \$80 billion of foreign exchange savings and these are substantial sums of money that we are considering.

Senator CHURCH. That is as big as the Pentagon budget.

Dr. OTTE. We may talk about small contributions but they are meaningful if we put them all together over the lifetime.

Senator FANNIN. That is a tremendous amount of power. We are utilizing about 17 million barrels of oil per day, as I understand it, now.

Dr. OTTE. That is correct.

Senator FANNIN. Tied into that what displacement would you figure geothermal would have?

Dr. OTTE. I didn't get so far in my doodling this morning while the question was being asked, but I was just addressing myself to the foreign exchange impact of being able to develop a resource that is currently not being developed. It is not a shifting of what we have to some other thing, it is something that we do not enjoy the benefit of at the present time.

Senator FANNIN. I know that the time is short. Just one question concerning California. I know the potential that you seemingly have in northern California. Do you feel that with the work that has been done, you also have a good potential in southern California, although you do have different conditions to work with.

Dr. OTTE. There are some additional problems that have been associated. Union Oil Co. was one of the early pioneers. I think we got a little bloodied as scared in the process. We had some serious problems but none that were not solvable. They were all very costly but again with the entirely changing climate of the energy situation the value of energy, this can be reexamined and there are current programs underway. I am really quite hopeful that these problems can be solved. I think we have to solve them in an environmentally acceptable manner and as you know the Imperial Valley is also a very high intensive agricultural level and it makes very little sense to destroy one resource to try to develop another, a new one, so we have to do it compatibly.

Senator FANNIN. Thank you very much, Doctor.

Senator CHURCH. Thank you, gentlemen.

Our next witness is Mr. Stewart French.

**STATEMENT OF STEWART FRENCH, REPRESENTING JOSEPH W. AIDLIN, GENERAL COUNSEL, MAGMA POWER AND MAGMA ENERGY, LOS ANGELES, CALIF.**

Mr. FRENCH. Thank you, Senator. It is a rather strange sensation being on this side of the table after 22 years on the other as counsel to this committee.

I have the honor today to represent Mr. Joseph W. Aidlin of Los Angeles. Mr. Aidlin is a true pioneer in geothermal steam development. He is general counsel to the Magma Power and Magma Energy Companies. These companies are associated with Union Oil and P.G. & E. in the development of the geysers, and are actively involved in other geothermal activity. Mr. Aidlin has testified before this committee on a number of occasions, particularly on S. 1674 of the 89th Congress. That was the geothermal steam leasing bill that was pocket vetoed in 1966. I think the President received very bad advice on that measure.

Mr. Aidlin also testified on S. 23 of the 90th Congress, and S. 3687 of the 91st. This is the bill that became Public Law 91-581 which is the Geothermal Steam Leasing Act. He, his associate, Mr. McCabe, and the Magma Companies are true pioneers.

Mr. Aidlin has written to Senator Bible as the author of the bill before the committee today:

Dear Senator Bible: I have read and have the following comments to make on Senate Bill 2465, the Geothermal Energy Act of 1973.

The intent of the Act is without doubt a proper one and in the public interest Title II of the Act will undoubtedly aid in coordinating and expediting development of geothermal resources.

However, I believe that the provisions in Title I, Section 101(d) setting up the terms of loans which may be guaranteed are not realistic. In other words, I do not believe that such loans will be available in the marketplace, even if guaranteed, so that the purpose of Title I will be thwarted. The utilities do not require such loan guarantees. They have other sources of financing more available to them, and whether or not they invest in geothermal generating facilities will depend more on the treatment given to more rapid amortization of such facilities within the rate structure than the availability of funds for the construction of such facilities.

I suggest that instead of detailing the type of loan which may be guaranteed, Section 101(d) merely provide that the terms of the loan be reasonable and appropriate in light of the conditions existing in the money market and that the determination be made by the Secretary.

Respectfully yours,

JOSEPH W. AIDLIN,  
*General Counsel, Magma Power Company.*

That ends Mr. Aidlin's letter.

I telephoned Mr. Aidlin last night. He asked me to point out also that the 30-year amortization period might be a stumbling block. He questioned whether banks would or could make a loan for 30 years on a research and development loan. Real estate, he pointed out, is a different matter, but real estate would not be the basis of a loan application. Only a small quantity of real estate would be involved. So the rate of interest and the amortization period are his two points.

Senator CHURCH. The first is in line with what Dr. Otte has already recommended.

Mr. FRENCH. Yes, sir, squarely in line with it.

Senator CHURCH. I think the committee should take note of the second consideration, too. Both suggestions are helpful to us. We appreciate your coming.

Mr. FRENCH. Thank you very much.

Senator CHURCH. Do you have any question, Senator Fannin?

Senator FANNIN. I just want to commend you, too. I am just wondering on the basis of the amortization would you be able to give us more specific language on that or information in regard to what the recommendation would be?

Mr. FRENCH. Senator, I don't feel I am personally qualified and I hesitate to speak for Mr. Aidlin. I would like permission to supplement his statement if I may.

Senator FANNIN. We are going to consider that and I feel it is very important, Mr. Chairman, that we have expert advice.

Mr. FRENCH. I have never had occasion to try to borrow several million dollars.

Senator FANNIN. The legislation is designed, Mr. Chairman, to cover both the larger operations and to encourage smaller entrepreneurs to enter the field.

Mr. FRENCH. Yes, sir, I will try to research it myself.

Senator CHURCH. We want to think of the financial arrangements in the bill, both in terms of how they affect the large utilities and the smaller companies because there is need to get both involved.

Mr. FRENCH. Yes, Magma is relatively speaking a small company, compared with some of the others in the field. It has invested many

hundreds of thousands of dollars in exploration and Magma is one of the grandfathers for which this committee and the Congress make equitable provision in the geothermal steam leasing law. We are asserting Magma's grandfather rights. But they talk in terms of hundreds of thousands of dollars, rather than millions in the pioneering of geothermal activity on mining claims on the public lands.

Senator CHURCH. Thank you very much.

Our next witness was not originally scheduled but he has asked to be heard and we want to accommodate him before we close the hearing this morning. The witnesses scheduled that could not appear this morning for one reason or another will be invited to submit their testimony in writing. I hope to conclude the hearing this morning and I have not scheduled a further hearing this afternoon.

Our last witness then would be Mr. Albert M. Shepherd, Geo Energy Systems, Inc., from Los Angeles, Calif.

**STATEMENT OF ALBERT M. SHEPHERD, ENERGY SYSTEMS, INC.,  
LOS ANGELES, CALIF.**

Mr. SHEPHERD. Thank you, Mr. Chairman, Senator Fannin. I am grateful for the opportunity to make any oral statement. I have not had an opportunity to prepare a written statement, because I was not aware until the day before yesterday of this hearing.

I represent a company that owns the exclusive rights, indeed the proprietary rights to eight patents and has seven other applications which we claim to have the definitive breakthrough, certainly, in connection with the problem of the hot brines of the Imperial Valley where all other systems have failed, where we could put on line this 20 to 30,000 megawatts of power which the Rand Corp. said is the potentiality of the Imperial Valley of California. We do not have sponsorship. All of the ongoing technology has been by our little concern and it is little indeed.

The patent work, the feasibility studies. We have a feasibility study from Rogers Engineering Corp. of San Francisco which says that the down hole heat exchangers which is our basic engineering patent will produce an unlimited source of energy, clean, environmentally acceptable, uncontaminated energy in the Imperial Valley, energy cheaper, better than any other existing form of energy, geothermal energy which solves all of the problems, the problems which heretofore have plagued the development of the Imperial Valley. It was discovered by Allen T. Vanhusen, in 1957 when he drilled the four great discovery holes in the Imperial Valley and he encountered there the hot lead coming out of the ground at 5,000 pounds p.s.i., coming out at 5,000 degrees Fahrenheit, and so he went to technology and others tried to handle it above ground and he developed the idea of putting a down hole heat exchanger capped off at the bottom with a center pipe ring through it and demineralized water descending down that pipe rising as clean steam. Everything left out in one swell swoop solving all the problem of subsidence, poisonous gas and everything else.

Now, we submitted it to the Rogers Engineering Co. of San Francisco who did the feasibility study on the Magnamax who did the feasibility study for P.G. & E., in fact was instrumental in talking P.G. & E. into getting involved in the geysers when they were very

reluctant to in the first instance, and Rogers has come out with a published feasibility study stating that this energy will be produced cheaper and better than anything else. I would like a copy of that feasibility study made available to this committee for its inspection.

In addition to which we have submitted it to Dr. Stewart of Battelle Memorial Institute. On page 61 of the Merriville project is the only engineering diagram appearing in its entirety of that submittal which is in effect a reproduction of the Vanhusen down hole lead exchanger. We have eight patents, Mr. Chairman. If we had sponsorship, if we had somebody in Government to even take a good hard look at what we have, we think that we have got one giant step forward to the solution of the energy crisis.

Senator CHURCH. Mr. Shepherd, you have heard testimony this morning. Have you made any attempt to contact the AEC, establish a dialog with the AEC?

Mr. SHEPHERD. Don Stewart has recommended that we submit and he submitted the draft of the letter that we were to write to Dr. Dixy Lee Ray asking for \$1.8 million of research funding to put in test wells in the Imperial Valley. All other systems have failed in the Imperial Valley. We have done so. But they have no funds, they tell us.

Senator CHURCH. We have been through that with them this morning and we are trying to provide funds. The only funds that have been provided had been added on by the Congress. Up until now the administration has not seen fit to release those funds. Assuming they will be released, AEC has given us a description of its program and you have heard testimony from Dr. Johnson that they have hopes of building 4 or 5 demonstration plants to prove the feasibility of various techniques. My suggestion to you would be establish a dialogue with the AEC, acquaint them with your method and possibly they would be interested in it in connection with one or more of these demonstration plants. I don't know, but I think that is the place to go and this bill is merely an attempt to facilitate the development of geothermal resources and whatever techniques may be feasible. If they come from the private sector all the better. We don't think the Government has a monopoly on the inventive methods or upon the investigation of methods that may prove practicable.

Mr. SHEPHERD. May I just say on a personal note that I gave up a flourishing law practice, trial practice, in Chicago to join Mr. Roady and Mr. Vanhusen and Mr. Watasi, in pursuing this technology out in California. I believe in it with everything that's in me. I believe this is the answer, certainly, to the problems of the hot brines, and in fact it is the only answer that I can see to the problems of hot brines.

I am most grateful to have heard the expressions from the committee here today that the Senators are aware of the true dimensions of the nature of the problem. But for a small company like ours—who have brought the thing to the point where we have been granted patents—where we have the feasibility studies—where we have submitted it to the most preeminent authorities for their corroboration—when they in turn go so far as to draft the form of letters which they wish to submit to their colleagues and former colleagues who are now in high positions in Government—where does someone like ourselves go? We feel that we have the patent to fresh air, Mr. Chairman, while everyone is walking around with a gas mask.

I am so frustrated. I realize that this may not be the proper forum to express this kind of emotional reaction, but the most critical problem is the energy crisis today. This can be solved by somebody, somewhere. For goodness sake taking a good hard look at the range of this technology, we submit that we have more in-house patents.

You have heard this esteemed gentleman from Union Oil, you have heard the other people. We are the people with the range of patents. We have more in-house technology than any existing corporation in the geothermal field.

Senator CHURCH. All I can say to you is that it is not within the abilities of this committee to pass judgment upon any given techniques. We simply do not have that degree of expertise.

Mr. SHEPHERD. Except this committee does have private power and persuasive power upon the agencies of Government. In other words, to say why don't you folks take a good hard look at what these people have here.

Senator CHURCH. I think the AEC is just now on the threshold of involving itself in the general research and development of geothermal energy. If you find that you can get no hearing and you feel that you have been ignored, I think you should contact your Representatives in Congress. I think they would be willing to take the matter up with the AEC for some kind of accounting. That would be my suggestion to you. As a committee we have to really address ourselves to legislation that would stimulate.

Mr. SHEPHERD. I have looked at the bill and the bill is, I feel, will be encouraging to geothermal development.

Senator CHURCH. Good. We appreciate very much your coming.

Senator FANNIN. Mr. Chairman, I had the pleasure of talking to Mr. Shepherd before and I understood he was going to talk to the Department of the Interior officials. Didn't you or one of your associates bring your patents by the office, Mr. Shepherd, sometime ago? Where is your headquarters?

Mr. SHEPHERD. In Los Angeles.

Senator FANNIN. Have you talked to the San Diego Gas & Electric Power Co?

Mr. SHEPHERD. No, we haven't. In fact, we have 1,000 acres of leased land which is directly next to the San Diego project. I visited that same project that you did, Senator Fannin.

Senator FANNIN. Yes, I know. I understand that this program or this particular patent or some of the patents that your company has brought forward have been brought to the attention of not only myself but to the officials of the Department of the Interior?

Mr. SHEPHERD. I believe so, yes, under the name of Watasi, Inc., of Englewood, Calif.

Senator FANNIN. I wasn't sure you were the one, but I thought it was the same group that was involved. The San Diego Gas & Electric Power people, as you know, are spending a great deal of money. This is their experimental plant. If you have a patent that would work as you described, I would think they would finance it in a minute.

Mr. SHEPHERD. Actually not, because we are in the process right now of completing a contract with Southern California Edison Co.,

a 30-year contract, to supply them with 250,000 kilowatts of power in the Imperial Valley. But the gist of this contract is that we have to put in the first pilot well in the two stepoff wells which must meet certain criteria performance which is all well and good. But, then, of course, that raises the difficult question for us of raising the sufficient \$1.5 million or \$2 million that the three pilot wells will require. So that, for example, if this bill were in effect and if these funds were appropriated right now so that we could come up with 25 percent of it and Government could guarantee the balance, that would be, for example, our particular answer.

Senator FANNIN. You have had this patent for sometime, have you not?

Mr. SHEPHERD. This patent was applied for in 1965 and was granted in 1969.

Senator FANNIN. I was just trying to think back. I know at different times this has been brought to my attention and I understood that you were working with some of the officials back in the time when the Office of Saline Water was active.

Mr. SHEPHERD. We had written a letter to the Department of the Interior and the Department of Saline Water. Mr. Vanhusen had done so much with respect to this.

Thank you very much, sir.

Senator CHURCH. Thank you. I hope if this bill is enacted it proves helpful.

Mr. SHEPHERD. Thank you, sir.

Senator CHURCH. That concludes the hearing.

The other witnesses who were scheduled to appear will be invited to submit their statements in writing.

[Whereupon, at 1:30 p.m., the hearing was adjourned.]

[Subsequent to the hearing the following letter was received for the record:]

GEOTHERMAL RESOURCES INTERNATIONAL, INC.  
November 15, 1973.

HON. FRANK CHURCH,  
Chairman, Subcommittee on Water and Power, U.S. Senate, Washington, D.C.

DEAR SENATOR CHURCH: Geothermal Resources International is a major element in the fledgling and growing geothermal resources industry. Our capabilities have been enhanced by our participation in the Geysers development and elsewhere in California. Through our planned exploration and development activities on public and private lands in California we hope to contribute importantly toward supplying future energy needs while at the same time respecting and complying with all applicable environmental quality requirements, Federal, State, and local.

In the recent hearings on S. 2465, the Department of the Interior stated that it is in the process of issuing regulations under the Geothermal Steam Act of 1970 with a view toward leasing and development of geothermal resources by private industry. As one of the major applicants for conversion-right leases under the Act, we have been patiently waiting for this process to arrive at the operational stage. As this stage is reached, we trust that the Department will carefully consider the new urgency the present energy crisis has brought to bear upon the Congressional policies concerning the development of geothermal energy. We trust also that the Executive Branch will respect the intention of the Congress, as well as the plain meaning of the language employed in the Act, under which those of us who hold conversion rights are entitled to have those rights fully honored and respected. We fully expect the Department to accord us the priority and the certainty of consideration which are granted to us by terms of the Act, even though the Departmental regulations, as currently proposed, appear to fall short of doing this in some respects.

We concur in the purposes stated in S. 2465: the advancement by private industry for the production of useful forms of energy from geothermal resources; and the encouragement by the Government of commercial development using environmentally acceptable processes. We wish to be recorded by your Committee as favoring the enactment of S. 2465 provided it is amended along lines suggested on November 7 by Dr. Carel Otte of Union Oil Company.

Thank you for the opportunity provided for us to submit this statement for the hearings record.

Sincerely yours,

TRAVIS E. REED,  
*Executive Vice-President.*

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