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DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

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November 15, 1991

MEMORANDUM

TO:

Honorable William W. Paty, Chairman Department of Land & Natural Resources

Honorable John C. Lewin, M.D., Director

Department of Health

FROM:

Murray E. Towill

SUBECT:

Geothermal Injection Strategy

Attached is the response of our consultant, GeothermEx, to our request for information on injection particularly as it pertains to Puna Geothermal Venture's plans to inject non-condensible gases, including hydrogen sulfide, along with the other spent geothermal fluids.

This report raises a possibility that the injected gases from KS-3 and KS-4 and perhaps KS-1A can "breakthrough" at the production wells causing, as it did at the Coso Hot Springs field, a decline in power generation and the need for a costly surface hydrogen sulfide abatement system.

We understand that GeothermEx plans to conduct further studies and possibly model the predictive behavior of the injection wells for another client. We will share this information when and if it becomes available.

Should you wish to explain this matter further, we will be happy to arrange a briefing for you by the author of this report.

MET/GOL: jms: 255

Attachment

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GeothermEx, Inc.

TO

SUITE 201 \$221 CENTRAL AVENUE RICHMOND, CALIFORNIA 94804-582

(510) 527-9876 CABLE ADDRESS GEOTHERMEX TELEX 709152 STEAM UD FAX (510) 527-8164

MEMORANDUM

To:

Mr. Gerald Lesperance

Date:

October 23, 1991

Department of Business, Economic

Development and Tourism State of Hawaii (DBEDT)

130 Merchant Street, Suite 1060

Honoiulu, HI 96813 Fax: (808) 586-2536

From:

Subir K. Sanyal
Vice President

Page:

1 of 6

7.00

Subject:

Geothermal Development in the Kilauea East Rift Zone--Status of Reserves Assessment and Injection Strategy

This memo addresses some basic concerns regarding the status of reserves assessment and the development of an injection strategy for waste water and gases from any power plant to be developed within the Kilauea East Rift Zone (KERZ).

It is generally agreed that a considerable amount of exploitable geothermal reserves exist in the KERZ and possibly in the other rift zones of the Big Island. For example, the Puna Geothermal Venture (PGV) has been able to convince sophisticated investors and major financial institutions that at least a 30 MW (gross) power plant could be supported for 30 years from the reserves within a 500-acre portion of their leasehold. In fact, the Scientific Observation Holes (SOH) program of the State of Hawaii has confirmed the existence of a much larger geothermal system within the KERZ than had been proven before by commercial developers.

Figure 1 shows the temperature distribution at the -4,000 foot datum (below sea level) within the PGV's leasehold before the SOH wells were drilled. In figure 1, from a report written in 1990, the temperature contours on the western flank of the rift are dashed indicating the extrapolated, and therefore unverified, nature of the contours, because no wells then existed on the western side of the rift; for this reason, in 1990 the only proven reserves were considered to exist on the eastern side of the rift and over a few hundred acres of the leasehold in the vicinity of the HGP and the Kapoho State wells. Figure 2, drawn in 1991, shows the temperature distribution within the KERZ, at the -4,000 foot level, after the SOH wells had been drilled. Comparing figures 1 and 2 one can conclude the following:

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- Well SOH 1 confirmed the prior temperature extrapolations to the western side of the rift, thereby nearly doubling the proven thermal anomaly in the vicinity of the PGV project area.
- Well SOH 2 extended the high temperature anomaly, in the northeast direction along the rift zone, several miles beyond the PGV project area.
- Well SOH-1 also indicated the presence of a reservoir boundary on the western flank of the rift, symmetrical to the reservoir boundary indicated by well Lanipuna 6 on the eastern flank.

Besides confirming the existence of a large thermal anomaly, these SOH wells also encountered fractures, thereby proving the existence of exploitable reserves. These wells have confirmed and substantially expanded the proven and probable reserves within KERZ. Thus, the State funds in support of the SOH program have played a major role in establishing the extent of commercial geothermal resource prospects within the KERZ, as well as helping define the boundary of the reservoir, which needs to be known for planning geothermal fluid injection areas.

The best injection strategy for the commercial development of the KERZ is yet to be decided upon. For example, an optimum injection plan for the PGV project has not yet been clearly established. As regards the PGV project, the need for injection (of 100% of the produced mass) is primarily for environmental reasons: the disposal of the waste water and gases from the power plant. The production wells would not rely on injection pressure support.

The original plan of PGV had called for injecting the waste water and gases in a well (or wells) <u>outside</u> the southeastern boundary of the reservoir in the vicinity of well Lanipuna 6; this is a "dry" hole, and therefore, assumed not to be in communication with the reservoir. Lanipuna 6 was known to have encountered a relatively shallow (below 2,000 ft depth) zone of apparently high flow-capacity, which could be used for the disposal of waste water and gases through a well or wells to be drilled into this zone by PGV. The assumption underlying this plan was that the reservoir pressure could be maintained at an acceptable level without any injection into the reservoir; however, this assumption has not yet been validated by numerical modeling of the reservoir behavior. GeothermEx is scheduled to conduct such modeling on behalf of Credit Suisse in a few months.

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Assuming that the reservoir would not need injection pressure support, the above-mentioned plan appears reasonable. Normally, injection outside the reservoir over a long period would not be feasible because the injection pressure would continue to rise due to the lack of any reservoir depletion by production. Fortunately, in this case, injection outside the producing reservoir appears feasible because of two reasons:

- The very high flow capacity of the target zone.
- The relatively small volumetric flow rate (about 1,200 gallons per minute) of waste water requiring disposal.

The original plan for injecting outside the reservoir was meant to eliminate the possibility of cooling due to any premature breakthrough of the cooler injected water to production wells. The plan for injecting the gases as well as waste water from the production wells into the subsurface was based on the desire to eliminate the following:

- major cost of abatement of the noxious component (H₂S) from the non-condensible gases, and
- emission of the residual gases (mainly CO_2), after H_2S removal, to the atmosphere.

The total volume of gas emission to the atmosphere from this project would be small compared to many other geothermal projects because the fluid at the KERZ appears to have a relatively small amount of total dissolved gases. However, the cost of H₂S abatement would be a significant burden because, even though the total gas content is small, the H₂S content in the KERZ fluid is high compared to other geothermal projects.

There are two obvious questions as regards the abovementioned injection plan:

- Would the water flow rate in the injection stream be sufficient to allow injection of the gases?
- Would the gases or the injected water find their way to the ground water system or even to the ground surface?

Injection of gases in a well requires a minimum amount of simultaneous water injection; otherwise the injection pressure would become impractically high. It is expected that the available waste water injection rate would be nearly enough for gas injection. However,

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some make-up water from ground-water wells would have to be used to augment the injection stream. Fortunately, PGV appears to have an abundant ground-water supply.

We believe that the danger of gases or injected water appearing on the ground surface or in ground-water aquifers is very small for two reasons:

- The targeted injection zone is much deeper than the local ground-water aquifers.
- The gas concentrations would be diluted by mixing with the subsurface water in the injection zone and partially consumed by reaction with subsurface fluids and rocks.

It is theoretically possible, but largely impractical, to model the possible interaction between the gases and water injected into the target zone and the overlying ground-water aquifers, because of the following reasons:

- No practical numerical modeling approach exists that can simultaneously model the fluid flow, heat transfer and complex interactions between the gases, water and rocks in a non-isothermal ground-water system.
- No information exists on the hydraulic as well as chemical nature of the target injection zone or the exact chemical nature of the injection water and gases.

We have recently learned that PGV is reconsidering its original plan and now intends to inject into wells KS-3 and KS-4 and perhaps KS-1A, located within the production area, instead of in wells outside the reservoir. This plan has two advantages:

- It eliminates any potential leakage of gases or waste water into the ground-water aquifers.
- It would provide some pressure support to production wells.

However, it also has two potential disadvantages:

- Possible cooling of production wells due to the breakthrough of cooler, injected water, and
- possible breakthrough of the injected non-condensible gases at the production wells.

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We consider the second disadvantage to be a more serious concern.

The only geothermal field in the U.S. where non-condensible gases from production wells are being injected into the production reservoir is the Coso Hot Springs field in California. At Coso Hot Springs, the injected gases have broken through at several production wells. This has caused the following problems:

- The power generation level has declined due to the increase in the gas content of the steam.
- The capital cost has increased because of the need to install an H₂S abatement system not originally planned for.
- The operations and maintenance costs have increased due to the need for H₂S abatement.
- A gas discharge permit had to be obtained from the local air pollution control district which was not originally planned for.

It is possible that these problems would occur at the KERZ given the new injection plan.

It is theoretically possible to forecast the extent of the cooling and gas-breakthrough problems by reservoir modeling; but given the complexity of the problem, the scanty knowledge about this geothermal system and the relative lack of data, such modeling is difficult, if not impossible, at this time. GeothermEx will, however, develop such a model on behalf of Credit Suisse after the PGV's drilling and well-testing activities are completed. Because of our substantial experience in modeling this aspect of the Coso Hot Springs field, we anticipate being able to accomplish this difficult modeling task.

PGV points out that while the production and injection wells at the KERZ are closer to each other than at Coso Hot Springs, the vertical distance between the production and injection zones would be higher. However, this fact cannot be fully assessed until well KS-8 is tested and PGV updates their production/injection strategy.

Finally, it is worthwhile considering the steps that can be taken by the DBEDT to improve the confidence in the geothermal energy reserves underlying the KERZ and to help define an optimum production/injection strategy. We believe that the most practical step that the DBEDT can take at this time is to help finance drilling and testing of exploratory wells, either slim holes or production size wells. We do

TO

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not believe that other technical activities, such as surface exploration, laboratory studies or computer modeling, by themselves, would be effective in improving the confidence of investors in the geothermal development prospects in Hawaii.

After 15 years of geothermal exploration and the construction and operation of a demonstration power plant for 7 years, only 30 MW (gross) of power is under development in Hawaii. If the ultimate goal of 500 MW of power on the Big Island is to be realized, a minimum investment of 2 billion dollars would be necessary, not counting the enormous cost of a subsea cable. This amount of investment obviously cannot be funded either by the State or the Federal government. Major financial institutions and most equity investors would be willing to fund a power plant development only after the reserves are confirmed by drilling and testing of wells; exploration activity cannot be debt-financed. Surface exploration, laboratory studies or computer modeling, without a simultaneous program of drilling and well testing, would not have any attraction to potential debt-financiers or even most equity investors, and therefore, would not provide any impetus towards geothermal development in Hawaii. Indeed, because they are not "bankable," such studies would serve only to delay commercial geothermal development in Hawaii. By contrast, an impetus from the DBEDT is all the more necessary now that the drilling, environmental and public relations problems in the PGV and True-Mid Pacific projects have cast a shadow on the future financing prospects for geothermal development in Hawaii.

If you wish, I would be prepared to explain and amplify the above ideas, illustrating them with comparable case histories of several other fields, and answer any related questions in a meeting of the DBEDT and other concerned parties.

Best regards.

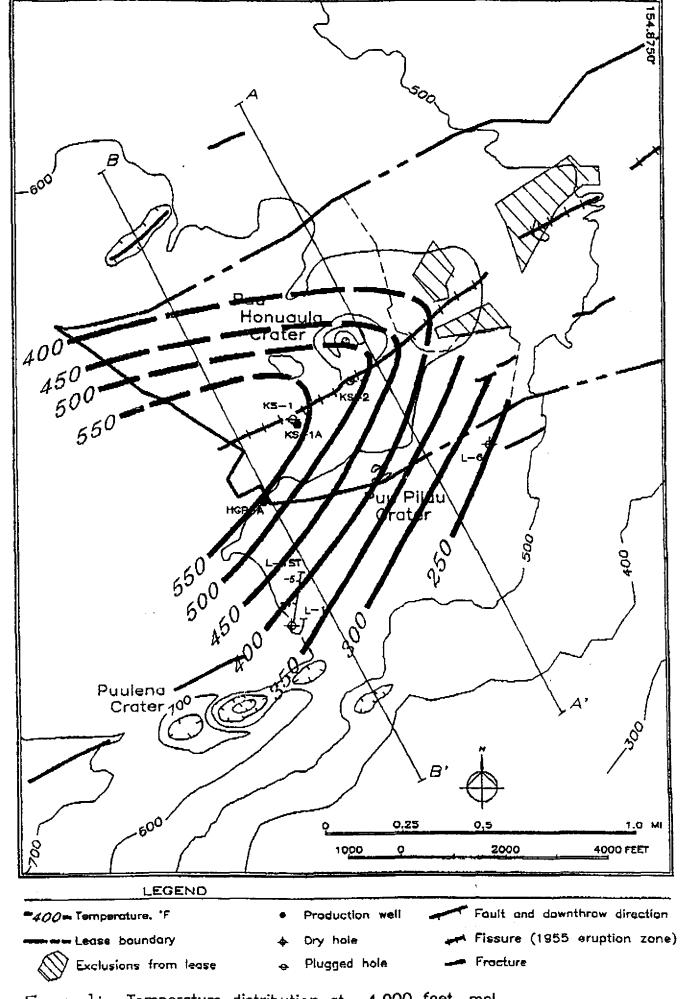
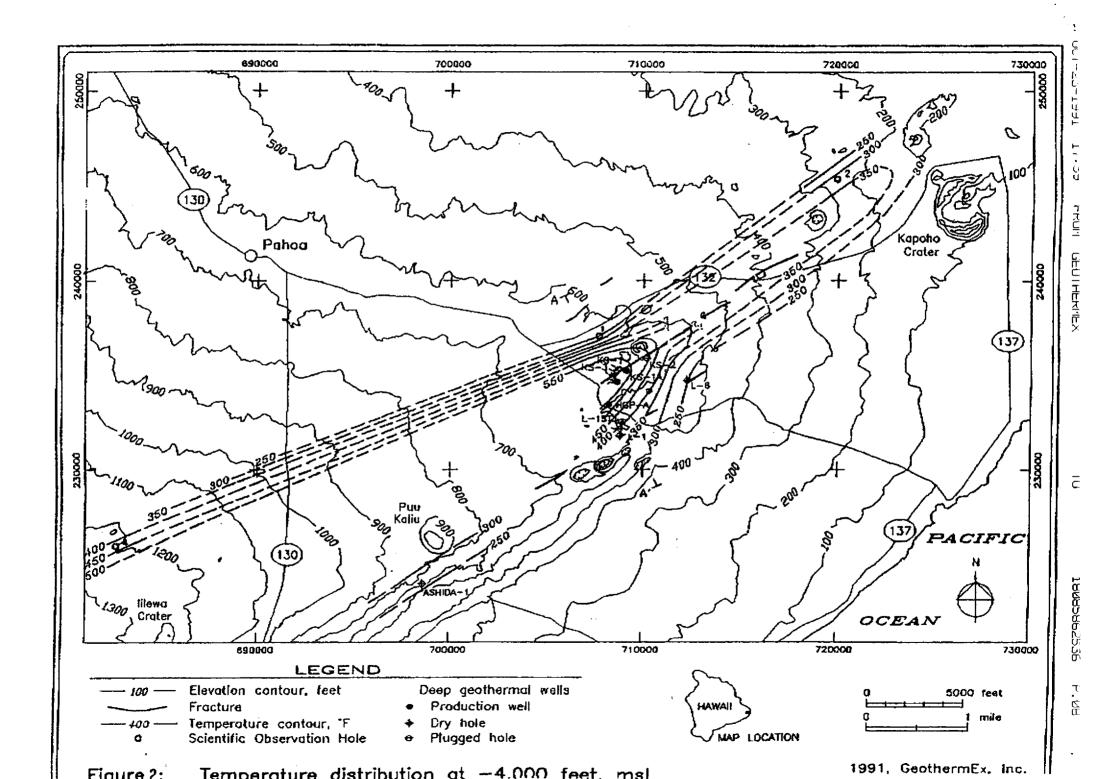


Figure 1: Temperature distribution at -4,000 feet, msl



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TELEFAX

To:

Mr. Gerald O. Lesperance

Date: December 11, 1991

Energy Division

DBED

Fax: (808) 586-2536

Page: 1 of 1

From:

Murray C. Gardner

Executive Vice President

In reply to your request, we think that the tasks additional to those discussed/costed by HIG that should be considered for State funding include:

- 1. Any useful new proposals from HIG; Don Thomas indicated in the November 5, 1991, memorandum; "Cost Estimates for Geothermal Program" that some geophysics proposals may be forthcoming.
- Future SOH site selection by the program team. This was recommended in GeothermEx's October 11, 1991, memorandum to you. For this, personnel time for photo/map analysis, travel and field examination, and reporting should be included. Direct costs for ground/air travel should also be considered. I estimate the total cost for this to be about \$12,000. If the professional time is already in staff budgets, then it is just a matter of getting the work done; direct costs may be \$2,000.
- 3. Site specific environmental work for future SOHs once the locations are picked. Harry Olson apparently has some ideas about contractors for this. I estimate \$60,000.
- 4. Additional temperature and pressure runs and hole instrumentation in the original SOHs. I estimate \$15,000 for the initial installation work by contractors, \$8,000 for data interpretation and reporting, and \$60,000 for continued monitoring, periodic equipment inspection, maintenance, replacement of tubing and chambers as required, data interpretation and reporting.

We already added \$15,000 to the geophysical task for initial gravity work under the Cooper-Moore proposal. This may be increased depending upon results. It would be worthwhile to reserve an additional \$20,000 for expansion of gravity work in the KEP7 on account of a second s

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TELEFAX

To:

Mr. Gerald O. Lesperance

Date: December 9, 1991

Energy Division

DBED

Fax: (808) 586-2536

1 of 15

From:

Murray C. Gardner

Executive Vice President

Subject:

Transmission of review of HIG proposals

Herewith are our comments on the submission by HIG of proposals and budgets for scientific work to be funded by DBED. The detailed analyses of the proposed tasks have been prepared by me with assistance from senior specialists for each of the disciplines. Please review the comments in confidence as you indicated would be done. I look forward to discussing the issue with you. I anticipate being in Honolulu late Tuesday afternoon, December 17 and Wednesday morning, in the event you want to meet prior to the TAC meeting on Wednesday.

I feel competent to address the issues of the HIG proposal, but it would be preferable to have others (Sanyal, Greensfelder) take a more active roll, including on-island appearances in the future. Some discussions and explanations of interpretations are not easily put into memoranda and reports and would make memoranda to burdensome for readers. We can talk further about this issue at your convenience.

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Drilling design and direction is a matter for expert drilling engineers, not for GTAC or Geoscience program personnel. The drilling program should not be overburdened with projects that interfere with the principal objectives of determining downhole temperature, pressure, deliverability of wells and reservoir conditions. The selection of locations of SOHs may be usefully guided by knowledgeable members of GTAC, but extraneous input may be counterproductive. A future memorandum and report by GeothermEx will propose and explain drilling methods for new SOHs under Task 2 of our contract.

The integrated DBED program is understood to have the objectives of encouraging geothermal exploration and development, while protecting the fresh groundwater system and the environment, and assuring resource development with minimal impact on the continued productivity of wells drilled into the geothermal reservoir. DBED is less concerned with subsidizing the growth of staff functions and research at HIG and other agencies which conduct idealized scientific investigations. The rationale by HIG that some percentage of a total DBED budget should be expended to support scientific research is not defensible. Each scientific investigation should justify its own funding. If scientific programs cannot clearly be applied to identifying and confirming the extent of the geothermal reserves, or methods of conservation and economical development, they should be funded elsewhere.

The State has undertaken its geothermal program to ultimately obtain the acceptance by and funding from financial institutions for the continued development of geothermal resources in the State. We agree that resource identification, reservoir assessment, resource management and environmental documentation all contribute to the acceptance of geothermal resources by such institutions. However, some of the programs submitted by HIG are impractical and/or have been proven to have little value to operators and financial institutions at geothermal fields elsewhere. Some of the Geoscience proposals may be professionally endorsed and represent worthwhile investigations which should be supported, perhaps by the University of Hawaii or the National Science Foundation, but not by DBED. Programs which are not appropriate for support by DBED include those which: 1) conserve great amounts of core for possible use of future generations; 2) analyze 300 samples to store and compare data when 50 analyses would be sufficient for interpretation by a trained investigator; and 3) conduct surveys which have already been tried and shown to have no useful application to mapping geothermal reservoirs in Hawaii.

It is acknowledged that drilling as an alternative to laboratory investigations is comparatively expensive; for example, one

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month of rig standby may consume more than \$100,000. However, this should not be a reason to expend similar amounts of money for unnecessary scientific programs. The following sections of this memorandum objectively discuss the merits of the several subtask proposals of the Geosciences program.

2. Comments on the Geology Program

The principles of the geology program appear well-founded. The aspects of core "curation" presented by Dr. Thomas were discussed in detail in our recommendations in the memorandum of November 6, 1991 entitled Review of Core Data from State of Hawaii Scientific Observation Holes, SOH-1, SOH-2 and SOH-4. The core curator (Ms. R. Evans?) should be primarily responsible for this recommended work; "student heip" should only be involved for fetch-and-carry assistance. This is work for professional staff. Ms. Evans should have access to senior geologic staff for confirmation of her interpretations and discussions of sample intervals selected for geochemical and XRD investigations.

The concept of total core splitting remains controversial. The cost-benefit to geothermal development of core splitting is questionable at best. Our opinion is that only the footage which is identified as meaningful to a study of reservoir conditions during the preparation of the core summary should be split and preserved for archive. It is simply not necessary to split every part of every flow of the repetitive sequence of eruptive rocks, especially the upper several thousand feet of each hole. As we have recommended before (October 11, 1991) in a memorandum entitled Recommendations for SOH and Geothermal Assessment Programs, one hole may be selected for splitting and archiving for future scientific investigation. The costs should then be assessed against those of alternative tasks if arguments are presented for any further splitting. In any case, the core curator should not be distracted from urgent technical tasks to split core at this time.

The budgeted cost for technical curation of \$57,824 is appropriate if it is for the scientific aspects of this work, not for core splitting and preparation. If the costs of the wages of graduate students (\$12,720, plus fringes) and materials and supplies (\$8,000) is partly for core splitting, it should be reduced to \$6,360 for wages plus fringes for general assistance and \$3,000 for supplies, inclusive of any core splitting and preserving. This would reduce the total budget from \$57,824 to about \$47,000.

Two specific geological proposals are presented: <u>Whole Rock</u> Chemical Analysis and Study of Secondary Mineralization. Both are

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important studies, although both are less applied to the development of geothermal resources than to academic interest. It is unlikely that the rocks from Mauna Loa volcano will have meaningful differences in reservoir characteristics than those from Kilauea. There may be small difference in initial structure, thickness of individual flows, silica content, gas inclusions and so forth that affect alteration and permeability.

It also remains to be proven that the work could lead to the ability to map the areal extent of fresh and saline water alteration episodes, and the impact of such alteration on reservoir permeability. The salinity of fluids circulating in the KERZ are best determined by sampling during flow tests of wells. Although salinity affects development practices, it has already been shown (in geothermal fields in the Imperial Valley and elsewhere) that highly saline geothermal fluids can be economically developed for power production.

The cost of the proposal for Chemical and Mineralogical Characterization of SOH Cores (Sinton and Hulsebosch) is determined by sub-sampling and preparation. The number of samples should be reduced to that number necessary to fulfill the goal of confirmation of description of cores. Every flow unit need not be examined. We have recommended an initial selection of 60 samples rather than 300. The proposer has stated that he wants this study to be precursor to later proposals to outside funding agencies. This should not be viewed as a valid reason for expending DBED budget to obtain detailed volcanic stratigraphy. We recommend that \$12,000 be initially budgeted for this task, including a complete report. The work should be closely coordinated with core curation.

The budget of the specific proposal for Mineralogic Assessment of Reservoir Fluid Conditions, SOH Geothermal Drill Holes (Sykes) is also determined by sample preparation and laboratory analyses. There may be some redundancy in preparation of sections for petrography with the Sinton proposal. With reduction to about 60 additional samples for XRD, microprobe and SEM analyses, plus the fluid inclusion work on 15 samples, and commensurate reduction of personnel time, the budget should be \$10,000, including a complete report to confirm the existing (binocular) descriptions, and discussion of relations of alteration to permeable zones, fluid rock ratios, fluid composition and paragenesis.

The total budget for the geological subtask as presented here is:

Curation

\$47,000

TO

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Chemical/Mineralogical Characterization

12,000

Mineralogical Assessment of Reservoir Fluids

10,000

Total

\$69,000

This contrasts with the estimation in HIG's proposal of \$133,479.

3. Comments on the Geochemical Subtask

GeothermEx has generally supported the principles and program of the geochemical subtask in a previous memorandum (October 11, 1991). We recognize that the work may be redundant with U.S Geological Survey programs in the KERZ; however, the program appears necessary to contribute in a timely way to a State EIS, to evaluate and forecast contamination possibilities, and to guide any future exploration in Hawaii and other countries.

There are some details of the program presented which are of questionable technical value and therefore questionable cost-benefit value. The principal criticism of the geochemical subtask proposal is of the attempt to marry the publicly funded geochemical program to a geothermal reservoir modeling and engineering program that is the responsibility of private operators and their consultants under the regulation of DLNR. In other words, analytical data and interpretations resulting from geochemical surveys should be obtained by operators at their cost in the course of their reservoir management programs and sent to DLNR for State review and use for regulatory purposes. Furthermore, we think that the personnel classifications and costs in the proposal are not realistic for this work. It is clear that this work would extend for more than one year. The following specific comments relate to the geochemical subtask.

- With respect to the relationship between the subtask and the four stated program objectives:
 - ASSESSMENT OF RESOURCE POTENTIAL OUTSIDE OF THE KERZ

To the extent that data are not already available for Maui and other counties, and Hawaii County outside the KERZ, this appears to be a reasonable program objective. It is also consistent with general geothermal exploration practice.

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CHARACTERIZATION OF THE IDENTIFIED RESOURCE IN THE KERZ

Continuous monitoring of "shallow" groundwater wells throughout the rift for temperature, water level and conductivity, combined with monthly sampling for chemical and isotopic analysis is likely to produce a tremendous volume of data. Based on our experience reviewing similar data collected at projects elsewhere, there is considerable likelihood that the volume of data will greatly exceed the reasonable needs of a modeling subtask or any questions about the groundwater system. It is possible, for example, that little or no variation in temperature, conductivity or chemical composition will be seen for months or even years at many or even all of the data collection sites.

As an alternative, we suggest that the "shallow" groundwater sources be sampled once every six weeks for one year, with temperature, water level and conductivity measured at the time of sample collection, and isotopes analyzed initially and after twelve weeks only if there are changes in chemical composition. If the chemistry at a given site shows significant variation during the year, more frequent data collection at that site can be considered. If there is no significant variation during the year, the data collection interval should be increased to 3 or 6 months during the second year. A shorter interval might continue at sites known to be close to geothermal injection locations and thought (from a conceptual hydrogeologic model) to be susceptible to injection effects.

The subtask description would be clearer if the approximate number and locations of "shallow" wells available for sample collection were included.

It is not clear why the State should fund or conduct the sampling and analysis of "deep" fluids and gases from new and existing private geothermal exploration holes and geothermal monitoring holes, unless as a paid service for the private operators. Private operators involved in exploration and field development are likely to be collecting geochemical data from well tests and downhole sampling. If they are not, they are missing opportunities for obtaining valuable information needed to meet their own program objectives.

TO

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It is possible that some operators may be poorly funded or using geochemical programs and methods which are poorly designed. Perhaps the State should consider: 1) setting up guidelines for mandatory geochemical methods and data collection, based on standard industry practices; 2) requiring that all operators follow these methods; and 3) requiring that copies of essential laboratory results be filed immediately with the State.

Included in the data to be generated are radioactive isotopes C^{14} , T, and Rn. Although we agree that selected analyses of T may be warranted, the need for data on C^{14} and Rn is questionable. In our experience, these isotopes have been of little use in resource assessment, even though they may be of scientific interest.

RESERVOIR MANAGEMENT SUPPORT

As stated above, it is not clear why the State should fund or carry out routine analyses of production and reinjection fluids on a long term basis, unless as a service paid for by the private operators. All responsible operators collect these data.

However, individual operators may not be very concerned with the integration of their data with those from other parts of the KERZ, or with modeling the KERZ as a whole. Therefore, it appears appropriate that a private operator's chemical data, collected according to standard industry practices and formatted in standard fashion, should routinely be made available for modeling by an appropriate party as discussed below in our comments on reservoir engineering.

D. ENVIRONMENTAL DOCUMENTATION

This documentation should be considered an integral part and objective of the shallow groundwater data collection program discussed under program objective B, above. All chemical analyses, water levels, temperatures, flow rates and well locations should be carefully and systematically compiled into a computer database.

II. With respect to the budget:

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We are concerned about the proposed team of one lab analyst, one lab/field technician and a graduate student. This team structure is less than optimal in terms of seniority and continuity of personnel.

It is unlikely that the analyst will be able to perform an adequate and quality job of determining dissolved species, gases, stable isotopes and radioactive isotopes. It is stated that some analytical support costs for the use of equipment not available in Puna will be needed, but no detail is given. Realistically, the Puna analyst should be able to perform high-quality analyses of dissolved species. All of the remaining analyses should be performed by outside labs specializing in gases or isotopes. The projected costs of this outside work should be documented; the budget of \$8,000.00 for analytical services seems low.

If it has been established that the Puna lab analyst can produce high quality, reproducible data on dissolved species, then gas analyses may be considered for addition, but only with back-up from outside sources to confirm data quality. We are very cautious about this because we have seen too often that labs attempting to provide too many services experience problems with data quality.

Another major concern is continuity of lab personnel. use of a graduate student to assist with data compilation and interpretation needs to be controlled carefully. The lab analyst should not be involved in compilation and interpretation because the analyst needs to concentrate his/her efforts on analytical methods and data quality. A few analysts are also capable of data reduction and interpretation, but not many and probably not someone funded at the proposed \$28,800/yr.

The graduate student will need to work closely with the analyst to monitor results, and both need to be monitored by someone with experience in geothermal geochemistry to assure that attention is focussed on appropriate tasks. Is this senior person Dr. Donald Thomas? If so, this should be discussed even if funded from other sources. In other words, a serious full-time activity is proposed under the geochemistry program. Timely and accurate results must be produced, and continuity from one graduate student to the next must be ensured. budget may be adequate if sampling and analyses of deep geothermal fluids from operators' wells and equipment for continuous monitoring is excluded. If this is the case, a budget of about \$160,000 is not excessive.

4. Comments on Geophysical Subtasks

TO

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The passive seismic and gravity surveys addressed in the introductory section are appropriate and potentially useful in furthering our understanding of the geologic structure and seismicity of the KERZ. However, the vertical seismic profiling (VSP) has doubtful utility, as discussed below, in the discussion of that proposal.

Concerning passive seismic studies, the letter (and the proposal by Drs. Cooper and Moore) does not describe priorities or phasing of the five tasks comprising this report. In our view, this omission represents a potential for inefficient use of resources. Most of the stated research objectives are reasonable, with one exception. We believe that the data which are proposed to be gathered to evaluate the possible movement of reinjection fluid and contamination of groundwater are unlikely to have the resolving power to answer such a question.

Gravity surveys should be confined to one or a few traverses of closely spaced stations, perpendicular to the trend of the KERZ, and located near and west of Puulena Crater, and should be tied to the previous regional survey. Although no budget request has been made, a minimum task as described above could be supported.

1. Comments on the Proposal to Conduct an Analysis of Seismic Activity on the Kilauea East_Rift Zone (KERZ)

GENERAL COMMENTS

The scope of work proposed is reasonable and potentially useful in defining the structure and seismicity of the KERZ in ways that may illuminate hydrothermal systems and potential geothermal drilling targets. As it stands, however, the proposal does not set forth priorities and relative levels of effort for the five elements or task included. While each of the tasks (excepting the use of VSP) is likely to be worthwhile, the proposers do not explain how the data, analyses, and resulting models are to be integrated.

It is important that the scientists and students undertaking this work have sufficient (that is to say, advanced) skills in geophysical forward and inverse modeling. Qualifications of the principal investigators have not been stated. The time allocated to the principal investigators (7 person months) may be insufficient for satisfactory completion of the HVO seismic data analysis. The duration of such a project would need to be at least one year, and two years is a more reasonable duration for the ambitious effort; adequate time to plan, conduct, modify, and repeat modeling procedures is vital. Rushed research is not a good investment. The proposed budget, appropriately

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reallocated according to the priorities described below, may be adequate and is certainly not excessive.

We feel that an incremental approach, in which successive phases of work build upon preceding ones, is required to achieve maximum benefit for the dollar resources expended. Too many elements are included in this proposal; VSP and microearthquake portable arrays should be omitted.

A large amount of high quality data has been collected by the HVO array of permanent seismographic stations over the past 22 years, and little work appears to have been done to analyze and interpret these data in relationship to hydrothermal activity and geothermal targets in the KERZ. Klein and Koyanagi (1989) have presented a comprehensive, brief summary of the seismicity of the Kilauea region, as observed by the HVO network. They point out that, since 1985, virtually all shocks with M>1 have been detected and The maps and cross sections presented in this article suggest located. that swarms of shocks have occurred around Puulena Crater and some geothermal wells, especially HGP-A.

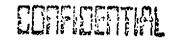
We believe that the first step in any research program on seismicity of the KERZ should be a truly thorough analysis of the HVO seismic data set, at least for the period since 1985. This work should precede collection of new seismic data with portable equipment, but might well be accompanied by conduct and interpretation of one or a few densely spaced gravity traverses transverse to the KERZ, in the general vicinity of Puulena Crater and perhaps to the west. The analysis and interpretation should include a variety of procedures for analysis of Pand S-wave travel times in order to interpret seismic velocity structure. Geophysical inverse modeling should include models which incorporate constraints based on other geophysical (e.g., gravity and aeromagnetic) and surface geologic data (e.g., dike occurrence). Source mechanism studies are addressed below, with spatial-temporal analyses of hypocentral locations.

Short-term microearthquake surveys with state-of-the-art equipment (PASSCAL portable seismographs) may be appropriate following thorough analysis and interpretation of available data. In this way, structural and earthquake source features developed out of the HVO data may be methodically selected and investigated.

Spatial-temporal windowing of hypocentral locations should be an important part of the program to analyze and interpret the HVO seismographic data. This would serve to isolate swarms and possible relationships among swarms, which may illuminate hydrothermal systems.

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In additional, these analyses should attempt to isolate and interpret source mechanisms (from first-motions) characteristic of various swarms and of structural features identified in the project, and of their interrelationships.

No consideration is given to the use of "calibration shots" to establish first-order receiver delays for observing epicentral areas of interest. This may be more useful than microearthquake surveys, and would certainly be more valuable than the VSP work described in the companion proposal. However, it is recognized that a variety of logistical and institutional problems may be encountered in conducting this kind of work.

- B. COMMENTS ON THE FIVE LISTED RESEARCH TASKS
 - Analysis of P-Wave Travel Times to USGS Stations

Research procedures for this task are not defined. It might be assumed that forward (ray tracing) and inverse modeling (two- or three-dimensional?) of travel time residuals would be employed, and both ought to be, as well as hypocentral relocation procedures. Use of "master-event" methods is not mentioned but is likely to be beneficial. None of these techniques, nor their probable resolving power, are discussed, nor are specific objectives described.

2. Construction of Initial Velocity Model

Use of zero-offset VSP profile data is proposed. However, the accompanying proposal on that subject states that the maximum depth of exploration is to be 2,000 feet. How useful can such shallow data be? It is said that published velocity models for "deeper" (deeper than 2,000 feet?) structure will be used. The comments above, under task 1, indicate the types of analyses that are appropriate and which will serve to model seismic velocity structure to depths of at least 20 km. work, together with task 1, may be expected to engage skilled seismologists for at least one year.

There is little advantage in investigating travel times if deep structure (to depths of at least 10 km) is not to be modeled. VSP profiling is not necessary, and would be of little help unless carried to depths of at least 10,000 feet in many wells, in the basic structural modeling that needs to be done. This is discussed in our comments on the VSP proposal.

3. Microearthquake Array Study

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This is potentially valuable as presented. However, it should not be part of the same proposal as task 1 and 2 above. Rather, it should follow satisfactory completion of that work.

Calculate P- and S-wave Slowness (etc.)

This properly belongs to tasks 1 and 2, and, as commented, needs to be discussed in detail. Vp/Vs ratio mapping is potentially useful, but should not be attempted before very thorough modeling or velocity structure, forward and inverse, is completed.

Earthquake Locations and Source Parameters

This task has not been defined, but important objectives and methods are noted above (under "General Comments").

Suggestions for Further Exploration

These should not be considered at this time, but may become important in the future, following completion of tasks 1, 2 and 5, if those tasks are thoroughly done as described in the comments above.

> 2. Comments on the Proposal for Acquiring a Zero-Offset Vertical Seismic Profile (VSP) in SOH

In the discussion of the first proposal, it was explained why this work would be of little use. The least attractive aspect of this proposal is its small maximum depth of exploration, just 2,000 feet. We fail to see how such shallow structural information can be an important part of the kind of work needed to illuminate the structure of the KERZ and its hydrothermal systems. VSP to depths of 10,000 feet in many wells might be useful, but that should not receive consideration until much other work has been completed, i.e., for some years.

From these comments, it follows that the budget for geophysics is recommended to be about \$115,000.00, including gravity surveys, for the proposal to Conduct Analysis of Seismic Activity on the Kilauea East Rift Zone by Cooper and Moore, as redefined by our technical advice. This contrasts with the \$140,887.00 proposed for the work.

5. Comments on the Reservoir Engineering Subtask (including Hydrological Modeling)

We have maintained that numerical modeling of the geothermal reservoir is not an appropriate effort and expense for the State of

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Hawaii, and particularly for the DBED (see memoranda of October 11, 1991 and October 23, 1991, by Gardner and Sanyal respectively). Workovers, additional measurements and tests of SOH-1, -2, and -4 are, however, appropriate works to be continued under the SOH program supported by DBED. Specifically, temperature and pressure measurements and monitoring should be implemented as soon as possible in the SOHs and perhaps HGP-A. This work should be conducted as before, by experienced professional scientists and technicians. The work should not be used as a reason to augment or train inexperienced staff. This is work that must be accomplished routinely and continually if data are to be accurate and useful, and should be conducted in its entirety by contractors and consultants with proper equipment. The State would also be exposed to general liability if its personnel perform this work.

1. Comments on the Proposal for Reservoir Engineering

We agree with the proposal that high priority should be given to monitoring downhole pressures in wells HGP-A, SOH-I and possibly Lanipuna 6, if it is available. (Lanipuna 6 is not likely to be made available as long as the operator is liable for damages.) Long-term monitoring of the reservoir response to future production/injection at the PGV plant will provide important data on reservoir properties. This monitoring should have priority over possible tidal monitoring in wells SOH-2 and SOH-4, particularly in view of the limited number of data loggers acquired for the SOH project.

Running of downhole temperature surveys should also be undertaken, as suggested by the proposal, but should not be conducted if significant pressure responses are occurring. Removal and reinstallation of capillary tubing to conduct temperature surveys generally causes a displacement of the pressure data, as it is very difficult to return the tubing to exactly the same depth in the observation wells.

However, it will be necessary during such a long-term pressure monitoring program to remove the tubing periodically for inspection and possibly replacement. The inspections and temperature surveys could be conducted at the same time. The cost of removing and reinstalling the tubing in the three wells on a periodic basis and possible replacement has not been considered in the budget. We would suggest that inspections should initially be done on a three monthly basis; the frequency can then be changed depending on the condition of the tubing.

2. Comments on the Proposal for Hydrologic Modeling

TO

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We agree with the proposal that modeling is an important part of reservoir management for the KERZ. However, in order to accomplish the objectives described in the first paragraph of the proposal regarding the interaction of the shallow and deep systems, it will be necessary to construct a single model of both systems rather than the two separate models discussed. In addition to this overall model, it will also be necessary to construct a separate, more detailed model of the area that is presently being exploited to thoroughly evaluate geothermal reservoir productivity issues. Both of these models should be based on a detailed conceptual model, as mentioned in the proposal.

The proposed budget also suggests the modeling will be done as a research project by a graduate student and that the principal investigators will have only a minimal role in the work. This is not realistic. The State will be left with neither a useful product nor an expert staff. Consultants will not be able to simply continue the work from a graduate thesis product. Although the principal investigators have considerable reputation in theoretical (rather than practical) aspects of groundwater modeling, this experience will be unlikely to suffice for geothermal reservoir modeling. GeothermEx is currently working with an experienced groundwater analyst on a project involving dewatering of a shallow geothermal system; much of his work is not applicable to geothermal reservoir modeling by integrated finite difference methodology. We cannot recommend any funding for this proposal as it is presented. The task should be assigned to practical, experienced professionals. The difference in budget is the total amount of \$167,000.00.

6. Conclusions

On the basis of the proposals as written, GeothermEx advises that DBED accept certain scientific studies and budget funds as follows:

Geology	\$ 69,000
Geophysics	115,000
Geochemistry	158,026
Reservoir Engineering	0
Reservoir Modeling	0_
Total	\$342,026

Additional budget may be committed elsewhere in the case of use-it-or-lose-it funding. This should be done based on the merit of alternative proposals, several of which have been suggested herein.

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The chemical species generated by the treatment of geothermal steam with sodium hydroxide (NaOH) include sodium carbonate (NaCO3), sodium bicarbonate (NaHCO3), sodium sulfide (Na2S), and sodium bisulfide (NaHS). The former two chemicals are environmentally benign and their disposal will have no significant effect on groundwater quality. Sodium sulfide and bisulfide can, however, have substantial impacts on water quality due to their toxicity at moderate concentrations and their potential for odor generation at extremely low concentrations. Hence, the fate of these chemicals under normal environmental conditions is of concern in considering their production and disposal as a result of treatment of geothermal steam.

Hydrogen sulfide abatement from geothermal steam has been accomplished in Hawaii by the injection of a 10% solution of sodium, hydroxide into the steam phase at a mole ratio of three moles of sodium hydroxide to one mole of hydrogen sulfide. The pH of the resultant solution will be in the range of 12 to 13 and hence the predominant sulfide species in solution will be sodium sulfide.

Because a quantitative reaction of hydrogen sulfide to sodium sulfide would require only two moles of caustic to one mole of sulfide, an excess of caustic will be present that will maintain the pH at a high level for a substantial period after the scrubber effluent is exposed to atmospheric air. Upon exposure of the sodium sulfide solution to air, the most important reaction that will occur is the oxidation of the sodium sulfide. Although the precise mechanism for the oxidation

the sodium sulfide. Although the precise mechanism for the oxidation of the sulfide involves a number of intermediate sulfur compounds (polysulfides and thiosulfates), the ultimate reaction product under conditions of high pH is sodium sulfate (NaSO₄). This compound is found in most natural systems and is present at moderately high concentrations in seawater and hence it is not considered to present a significant hazard to water quality.

Even though the ultimate reaction product of the oxidation of sodium sulfide may not be a problem, the rate of oxidation requires some analysis. A number of studies of sulfur oxidation rates have been conducted under laboratory conditions; this research has been reviewed by F. Millero in Marine Chemistry, Volume 18, 1986, pages 121-147. This work has shown that the rate of oxidation of sulfide is quite variable but, in general, is very high. The half-life of sulfide in oxygenated water (the time required to oxidize one-half of the total sulfide present) ranges from 0.3 hours to a maximum of 65 hours with the times varying according to the temperature, pH, oxygen availability, and concentrations of other ions in the water. The experimental data that seems most relevant to the current case (high pH and high temperature) suggests that the oxidation half life of sulfur would be less than a few hours in the presence of adequate oxygen.

Because the oxidation rate is so high, it is likely that oxygen will be the limiting factor in the conversion of sulfide to sulfate.

The magnitude of the oxygen demand can be calcualted from the estimated quantity of sodium sulfide generated. In the case of a well test, sulfide production would amount to 61 pounds per hour for a

total of 480 hours (20 days). The mass of sulfide generated would be 2.93 x $10^4\,\mathrm{lbs}$ or about 4.2 x 10^5 moles which would require about 8.4 x 10^5 moles of oxygen to oxidize the sulfide completely to sulfate. This volume of oxygen is contained in 9.41 x 10^4 cubic meters of air; given that the elevation of the discharge point is approximately 200 meters, this would be equivalent to the volume of air contained within a percolation radius of approximately 22 meters down to the depth at which the effluent would encounter the water table. The time over which the effluent would be exposed to oxidation in the unsaturated zone would, on the basis of rainfall percolation rates reported by Stearns and MacDonald of about 22 meters per day in the Puna area, amount to at least nine days. Given that the half-life of sulfide oxidation is only a few hours, the combination of lateral dispersion of the percolating effluent and normal ground air mobility should be sufficient to oxidize virtually all of the sodium sulfide discharged during a well test prior to its encountering the water table.

If a portion of the sulfide survives the descent to the water table, oxidation of the sulfide can continue as the effluent mixes with the groundwater. Rainfall recharge to the basal lens will contain approximately 2.8 x 10⁻⁴ moles of dissolved oxygen per liter. Hence, each mole of sulfide that survives must mix with approximately 5.6 x 10⁴ litres of rainfall recharge in order for complete oxidation to occur. Lateral groundwater migration rates have been estimated by Drueker and Fan (<u>Ground Water</u>, Volume 14, 1976, pp. 340-350) to be approximately 1.5 to 3 meters per day. Because the nearest well down-gradient from the project site is approximately 2 kilometers away (well number 2881-01) and the nearest source of drinking water is

about 4 kilometers, mixing of the effluent will occur over a period of at least 660 days before the sulfide could impact an existing groundwater source. Ouring this interval, 5.74×10^3 liters of rainfall recharge will enter the groundwater table per square meter of surface area of effluent plume. If the plume area amounts to slightly more than 0.5 km^2 , then the oxygen contained in the rainfall recharge will be sufficient to completely oxidize the the sulfide produced by a 20 day well test before it can reach the nearest existing groundwater well.

A major unknown at present is the actual direction of groundwater flow in the Puna district. This presents a difficult problem for monitoring the effect of geothermal discharge on the basal groundwater system. At the present time, the only way to be certain of encountering a discharge plume would be to drill monitoring wells that completely encircle the injection point. A possible method of determining the direction of groundwater flow would be to inject a highly conductive solution (salt water) into the basal lens and perform either a mis-a-la-masse survey around the injection well or perform a time domain electromagnetic survey around the injection point.

DNAKONO 11-14-60

SITE SPECIFIC NEEDS AFFECT PROCESS CHOICES FOR H2S ABATEMENT IN GEOTHERMAL POWER PLANTS

1988 Annual GRC Meeting October 10, 1988 San Diego, CA

By: K.A. Kenny, T.R. Bacon, L.H. Kirby The Dow Chemical Company U.S.A. Freeport, Texas The abatement of hydrogen sulfide in geothermal power plants has under gone considerable change in recent years. More stringent regulatory requirements for H2S abatement have increased costs. This paper will review the history of abatement technology, discuss the effect of operating conditions on the requirements for abatement processes, review process choices for both primary and secondary abatement, and provide two case examples of the economics of the Dow Chemical Company's GAS/SPEC RT-2 technology and the SulFerox* Technology (1,2,3).

Early Abatement Methods

When the maintenance of air quality became a problem in the early days of the geothermal power industry, effective technology was not available to abate H2S in the condensate. To compensate, acceptable practice was to abate H2S in the non-condensable gas using the Stretford process. To achieve maximum overall H2S removal without condensate treatment, condenser design shifted to surface condensers which increase the H2S partition to the non-condensable gas. Even so, H2S emissions from the condensate continued to be a problem for some sites, and finally, technology to treat the condensate emerged.

An early method for secondary abatement of H2S in the condensate revolved around the reaction of hydrogen peroxide and H2S.

$$H202 + H2S \longrightarrow S^{\circ} + 2 H20$$
 [1]

The H2S is oxidized irreversibly to a variety of sulfur species.

Improvement With Peroxide

Improvements were made in secondary abatement technology by using ferrous sulfate in conjuction with hydrogen peroxide. Divalent iron, Fe+2, reacts with peroxide to generate a hydroxyl radical, HO; by the following reaction:

Small amounts of the Fe+2 substantially accelerate the peroxide decomposition. The hydroxyl radical reacts with the ionized H2S the condensate. The rate of the overall reaction is reasonably fast.

$$OH + HS - \longrightarrow S^{\circ} + H20$$
 [3]

* Service Mark of Shell Oil

There are draw-backs to this technology. First, chemical costs are high. The hydrogen peroxide abatement reaction, the reaction between sulfide and the hydroxyl radical, is not specific. The hydroxyl radical will also oxidize elemental sulfur to a variety of sulfur compounds. In addition, a portion of the peroxide will decompose to water and oxygen. Iron consumption is also high because the iron catalyst precipitates as both the iron sulfate and the iron sulfide.

Secondly, the iron sulfate/peroxide process results in process problems, the precipitation of ferrous sulfide, ferrous sulfate, and elemental sulfur. These compounds tend to settle in the cooling towers basins of the geothermal power plant which require shutting down the tower periodically for cleaning. The cleaning process usually is manual, involving the use of shovels to do the job. Furthermore, the iron salts will stain the equipment brown or red.

The iron sulfate/peroxide technology was used commercially at the Geysers after 1974. The level of H2S abatement achievable with the iron/hydrogen peroxide process was an improvement, but still did not provide the air quality desired. To get that last bit of H2S requires a very large amount of chemical addition which was extremely expensive and generated tremendous amounts of solids in the cooling tower.

The Development of Chelated Iron Technology (4,5,6)

In the burst of growth of geothermal power, there were a number of cooling towers built with a corresponding increase in the pounds of H2S emitted. In the late 70's it became apparent that the volume of H2S being released from the Geysers must be curtailed not only to build new plants but to allow the plants that were running to continue. Retrofitting of running plants to better abatement technology would be required.

In searching for suitable alternate processes, Pacific Gas and Electric Company (PG&E) evaluated many primary and secondary abatement technologies. During this period, Dow Chemical talked to PG&E about adding a chelate compound to keep the iron in solution. Preventing iron precipitation would substantially reduce catalyst cost. In fact, it was thought a system could be developed that did not require any hydrogen peroxide. Preliminary tests were conducted. Dow and PG&E conducted a research field trial in January, 1980, which abated 90+% of the H2S. However, all the sulfur appeared as elemental sulfur in the cooling tower. Since PG&E felt that the solid sulfur problem was unacceptable, Dow and PG&E continued to work together. The low solids technology was developed from this co-operative effort. This technology converts H2S in the non-condensable gas to sodium sulfite which subsequently is added to the condensate to solubilize the sulfur produced by the chelated iron.

At this time, it appears that the old ferrous sulfate/hydrogen peroxide process is no longer being used commercially. There continues to be residual confusion in the geothermal industry about the role of iron in the various processes. Some are not convinced that the solubility problems in the earlier processes have been conquered.

From the research program of PG&E and Dow, two technologies actually evolved. The first technology (7) was an improvement of the hydrogen peroxide process. The improvement was the addition of a chelating agent to insure the solubility of the iron catalyst. This chelating agent or ligand works to prevent the iron precipitation reactions that occur with ferrous sulfate as the catalytic reagent. Furthermore, the chelated iron is maintained entirely in an ionic form which accelerates the peroxide decomposition reaction. Thus less chelated iron is required to maintain an identical reaction rate. Different chelating agents have different iron solubilizing strengths, and change the speed of the iron reactions. This advancement was patented by PG&E (7) and is commonly used in the geothermal industry.

The second technology (8) was the low solids process currently marketed by Dow. This technology uses a ligand to solubilize the iron, but it uses a completely different chemical reaction to abate H2S. The iron reacts directly with the hydrogen sulfide to form elemental sulfur.

2 Fe(III) Ligand + S(-2)
$$\longrightarrow$$
 2 Fe(II) Ligand + S°[5]

This reaction is spontaneous and specific. The reoxidation of the iron in the cooling tower allows the reuse of the regent.

Fe(II) Ligand
$$+1/2$$
 02 \longrightarrow Fe(III) [6]

These reactions produce sulfur in the cooling tower water, just as the other technologies discussed. However, use of the iron as a direct reduction agent for sulfur allows the use of an additional oxidant for elemental sulfur. The most effective oxidant used to date is sodium or ammonium sulfite.

$$S^{\circ} + S03(-2) \longrightarrow S203(-2)$$
 [7]

The reaction product is thiosulfate which is stable, and water soluble. This material is compatible with the myriad of other components in the geothermal condensate of the plants. The sulfite is made in place by burning noncondensable gas and scrubbing the SO2 formed. This allows the simultaneous abatement of both noncondensable gas and the condensate without solid waste being generated or processed.

Both technologies use iron chelate. In the improved hydrogen peroxide process, the iron chelate is merely a catalyst to decompose the hydrogen peroxide. In the low solids process, the iron is present as ferric (Fe+3), and actually oxidizes the H2S to elemental sulfur directly.

Both processes are currently installed at the Geysers geothermal power plants. Many units at the Geysers have switched from the hydrogen peroxide based system to the iron chelate based low solids process to reduce costs. Although the iron chelate is more expensive on a per pound basis than hydrogen peroxide, chemical costs are higher in the hydrogen peroxide based process. Unlike the ferric iron chelate, oxidation by hydrogen peroxide is not specific to H2S, and, therefore, requires more volume of hydrogen peroxide. Moreover, the peroxide is only used in a once-through path while the low solids process is reoxidized in the cooling tower and recycled a number of times. The result is that the cost of the iron chelate in the low solids process is significantly less than that of the peroxide. In addition, the iron chelate does not have the reactive hazard of peroxide, and is safer to handle.

Choosing an Abatement System

Choosing a practical and economical primary and/or secondary H2S abatement system for a geothermal power plant requires analysis of the factors affecting the individual plant site. Important considerations include: (1) the level of H2S in the steam and the level of abatement needed, (2) the partition of the H2S between the non-condensable gases and the condensate, and (3) the volume and quality of sulfur that might be produced. Sites with very low levels of H2S in the steam may be able to design the plant so that only primary or secondary abatement is needed; but not both. The H2S partition is profoundly affected by the level of ammonia in the steam. As the ammonia levels increase, the level of H2S remaining in the condensate increases. Sites with ammonia in the steam will almost always require secondary H2S abatement. The H2S partition is also a function of the condenser Indirect cooling favoring H2S partition toward the non-condensable gas. If a process that produces elemental sulfur is chosen, sulfur volume becomes an issue because of the associated disposal costs, particularly if the steam contains heavy metals that may ultimately contaminate the sulfur. Large volumes of sulfur may require additional processing such as re-melters to provide an acceptable form for sale as opposed to landfill disposal.

There are several choices for primary H2S abatement in the non-condensable gas. These will be discussed in terms of pros and cons.

Stretford Process (9)

The Stretford process uses an aqueous solution of sodium carbonate and anthraquinone disulfonic acid (ADA) with an activator of sodium metavanadate. The process takes place in five or more steps. In turn, the H2S is absorbed by the alkali, the ADA is reduced by a sulfur shifted, elemental sulfur is liberated by dissolved oxygen by air blowing. The process is technically capable of removing up to 99% of the H2S in the non-condensable gas.

The sulfur is recovered by blowing air into the bottom of the regenerator, or oxidizer, vessel where small particles of sulfur are collected at the top as a froth. The sulfur froth is skimmed from the solution and is filtered or centrifuged to remove the solvent from the sulfur cake. Further sulfur processing may included re-melting.

The chemicals used in the solvent are stable with the exception of the formation of sodium thiosulfate which is not regenerable. The environmental exposure of vanadium through solvent loss and that in the sulfur product present handling and disposal problems.

LoCat** Process (10)

The LoCat process from ARI operates by absorbing H2S into an aqueous phase where a catalyzed reduction/oxidation reaction converts H2S to elemental sulfur through the reduction of iron from ferric (Fe+3) to ferrous (Fe+2). The iron is held in solution by a chelant with the iron concentration in the circulating solution in the range of 500 to 2000 ppm. The circulating solution permits the recovery of solid sulfur and the oxidation of the iron through air blowing.

Sul Ferox

The SulFerox process is a regenerable iron chelate based process for removing H2S from gas streams. The H2S in the gas stream is reacted with the iron chelate solution via a contacting vessel like a spray tower or the proprietary pipeline co-current contactor. The H2S reacts with the iron in the contactor to form elemental sulfur. The circulating iron chelate is then regenerated using air sparging to oxidize the ferrous (Fe+2) to the ferric (Fe+3) form and recycled back to the contactor. The sulfur is recovered from the circulating solution by processing a side stream through a filtration /water wash in order to form a salable sulfur cake. The iron chelate is recovered from the sulfur via a water wash and returned to the circulating solution. Typical sulfur cake composition is 25 wt. % moisture. The sulfur cake can be sent to a melter for further processing. The technology is available from the Dow Chemical Company's GAS/SPEC Technology Group.

^{**} Trademark of ARI Technologies, Inc.

Thermal Oxidation

Thermal oxidation of H2S in the non-condensable gas and subsequent selective scrubbing with caustic results in essentially zero primary H2S emissions and a solution of sodium sulfite. The sodium sulfite when mixed with the condensate containing elemental sulfur, produces soluble thiosulfate. This method is an attractive primary abatement when used in conjunction with the RT-2 Technology in secondary abatement.

The choices for secondary abatement have been discussed in earlier sections of this paper. The choices include:

- 1. Ferrous Sulfate An obsolete technology.
- 2. Hydrogen Peroxide Used alone, it provides a process in theory, but is not widely practiced due to high cost.
- 3. Iron Chelate with Hydrogen Peroxide Broken into sub-groups
 - a. Iron-hydroxyacetic acid (HAA) Solubilizes iron, but not to the extent of Fe HEDTA. Minor degradation of the HAA results in precipitation of iron. The reaction rate is not as high as the Fe HEDTA.
 - b. Iron -hydroxyethylethylenediaminetriacetic acid (HEDTA) The Fe HEDTA solubilizes more iron and reacts faster. It is more resistant to precipitation of iron caused by degradation.

In the above applications, the abatement achieved is over 90% of the H2S in the condensate. Solubilization of the sulfur depends on the ratio of the sulfur and the peroxide. In general, peroxide is not an effective means of solubilizing sulfur.

- c. GAS/SPEC Iron Chelate Catalyzed to decreased reaction time while continuing to solubilized high levels of iron. It has the same stability as HEDTA.
- 4. RT-2 Iron Chelate with Sulfite Provides over 95% abatement in the condensate and in the non-condensable gas. If sulfite is produced on-site, over 95% of the sulfur in the condensate will be solubilized. Sodium sulfite can be produced from the non-condensable gas by utilizing a burner/scrubber system while achieving primary abatement. Purchased sodium sulfite will achieve the desired solubilization of sulfur, but at a higher cost and without the benefit of primary abatement.

Case Studies Involving the SulFerox and RT-2 Technologies

The following cases are examples of two different H2S abatement applications in the geothermal industry. In the first case, only trace amounts of ammonia are present in the steam. In the second case, the H2S is partitioned between the non-condensable gas and the condensate.

Case 1: The SulFerox Technology

The H2S partition is such that all the H2S is in the non-condensible gas. The steam condensate does not require any additional treatment.

The design basis for this case is as follows:

Non-condensible Gas Flow: 4.2 MMSCFD H2S in non-condensable gas: 1.2 mole %

The SulFerox process was chosen to abate the H2S in the non-condensable gas. The SulFerox technology utilizes a proprietary iron chelate solution to abate the H2S in a continuous loop process. The ferric chelate is contacted with the H2S (Equation 5) in the gas to form elemental sulfur in the reactor (Figure 1). The abated non-condensable gas exits the contactor into the separator vessel and is vented to the atmosphere. A side stream of the iron chelate solution is further processed to the vacuum filter in order to remove the sulfur solids from the process. This side stream is vacuum filtered and water washed to produce a moist sulfur cake (25 wt. % moisture). The purpose of the water wash is to recover the chelate contained on the the sulfur. The water wash stream is then returned to the circulating chelate. The ferrous chelate solution is oxidized to the ferric state by sparging air into the regenerator vessel, thus closing the loop on the SulFerox process (Equation 6).

The material of construction for the SulFerox process is 304L/316L stainless steel. Fiberglass, and lined carbon steel vessels can also be utilized.

The economics for the process are as follows:

Capital Costs: \$883,000

Annual Operating Costs:

Power: \$30,600

Chemicals: \$ 105,000

The capital cost reflects a total stainless steel construction at July 1988 prices. The capital costs includes the license fee for the technology.

In this particular application, the SulFerox unit has been designed to emit 20 ppmv H2S from the abated non-condensible gas. The unit can be designed to meet more stringent H2S specifications with minimal costs. The amount of sulfur cake produced in this case is 2 LTPD on a dry basis.

Case 2: RT-2 Technology

In this case, the H2S in the steam is partitioned between the non-condensable gas and the condensate. Hydrogen sulfide abatement will be required for both phases and will utilize the RT-2 Technology (Figure 2). In this application the non-condensable gas will be burned in a thermal oxidizer which will convert the H2S into SO2. The SO2 from the thermal oxidizer will then be further treated in a two stage caustic scrubber. The scrubber has been designed to run at pH's that allow the SO2 to react with the caustic to form sodium bisulfite, while the CO2 present in the gas passes through the scrubbers unreacted. The sodium bisulfite produced from the thermal oxidizer/scrubber unit is sent to the cooling tower circulating water to solubilize the sulfur produced from the iron chelate - H2S reaction in the condensate (Equation 5 & 6). This technology has been discussed in the secondary abatement section.

The materials of construction are 304/316 stainless steel for the thermal oxidizer and lined carbon steel vessels for the dual caustic scrubber. The iron chelate piping is 304/316 stainless steel. The prices reflect June 1988 costs for stainless steel.

The design basis is as follows:

Non-condensable Gas Flow: 3.5 MMSCFD H2S in the Non-condensable Gas: 3.2 mole %

Condensate Flow: 800 GPM

H2S in the Condensate: 180 ppmw

The economics for the technology are as follows:

Capital Costs: \$1.05 MM

Annual Operating Costs:

Power: \$60,000 Chemicals: \$900,000

The capital cost is for the Thermal oxidizer/scrubber unit and associated piping. The technology fee is not included in the capital cost.

The total sulfur emissions from the RT-2 design unit, including SO2 emissions from the caustic treaters and the H2S from the cooling tower drift, is 2 lb/hr.

References and Footnotes

- 1. Fong, H.L., Kushner, D. S., Scott, R.T.; "Gas Desulfurization Using SulFerox", Presented at the 37th Lawerence Reid Gas Conditioning Conference, Norman OK, March 1988.
- 2. Buenger, C.W., Kushner, D.S.; "The SulFerox Process Plant Design Considerations", Presented at the Gas Processors Association 67th Annual Convention, Dallas, Texas, March 1988.
- 3. Van Kleeck, D.A.; "The SulFerox Process and Its Application", Presented at the AICHE 1988 Spring Meeting, New Orleans, LA, March 1988.
- 4. Bedell, S. A. and Hammond, C. A: "Chelation Chemistry in Geothermal H2S Abatement", Geothermal Resources Council Bulletin August 1987.
- 5. A compound that can form a complex with a metal ion is known as a ligand. Ligands generally contain a functional group (an electron donor) with a negative charge or a lone pair of electrons. A chelating agent or chelate is a special type of ligand that contains more than one donor group. The formation of a metal-chelant complex (known as a chelate) is thermodynamically favored over a complex formed by ligands containing individuals donor groups.
- 6. Buenger, C.W., Bedell, S.A., Kirby, L.H.; "Chelates in H2S Removal", Presented at the 38th Lawerence Reid Gas Conditioning Conference, Norman, OK, March 1988.
- 7. Sharp, S.G.; U.S. Patent 4,363,215.
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- 9. Kohl, Arthur and Reisenfeld, F.C.; Gas Purification, Gulf Publishing, Houston, TX, 1979; pg. 476-487.
- 10. Kohl, Arthur and Reisenfeld, F.C.; <u>Gas Purification</u>, Gulf Publishing, Houston, TX, 1979; pg. 475.

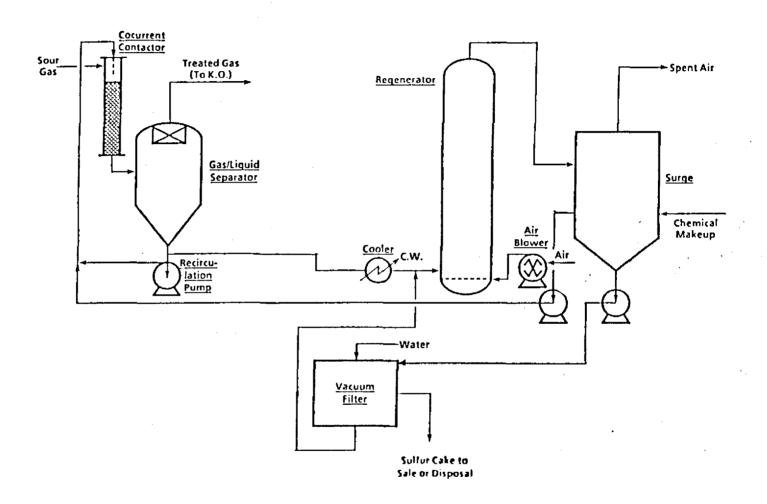
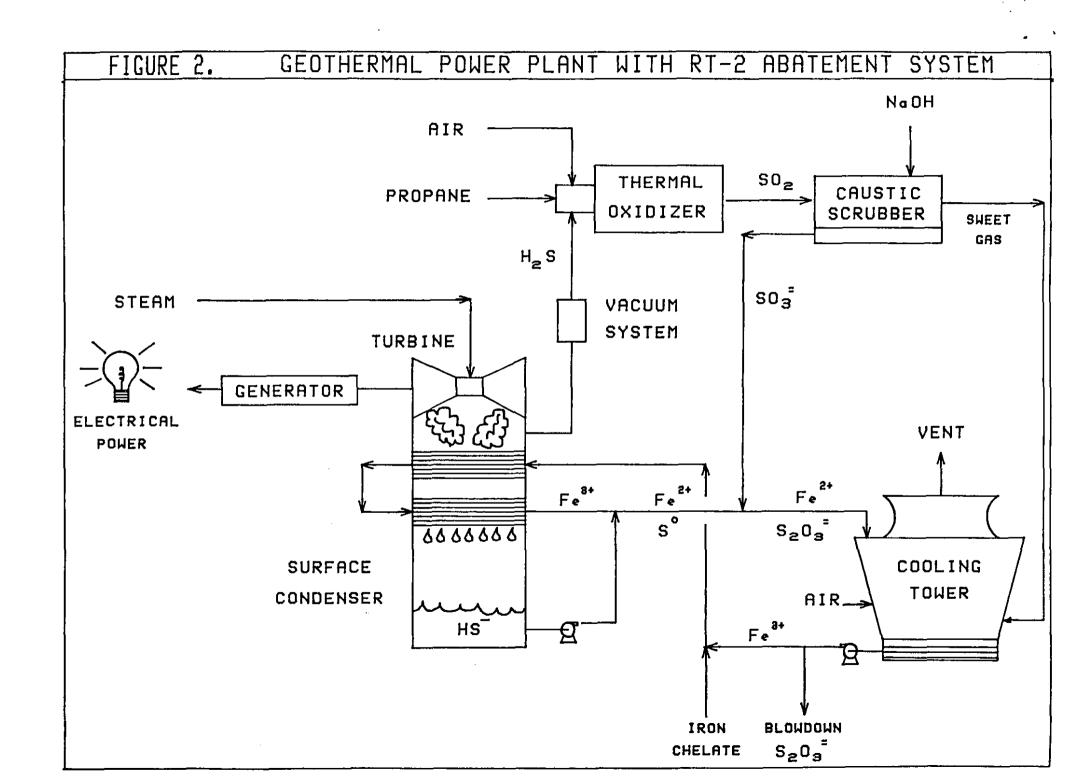


FIGURE 1 - SULFEROX FLOW DIAGRAM





STATE OF HAWAII

DEPARTMENT OF LAND AND NATURAL RESOURCES DIVISION OF WATER AND LAND DEVELOPMENT

> P. O. BOX 373 HONOLULU, HAWAH 96809

JUN 13 1994

KEITH W. AHUE, CHAIRPERSON BOARD OF LAND AND NATURAL RESOURCES

DEDUTIES

JOHN P. KEPPELER, II DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND
RESOURCES ENFORCEMENT
CONVEYANCES FORESTRY AND WILDLIFE HISTORIC PRESERVATION LAND MANAGEMENT STATE PARKS WATER AND LAND DEVELOPMENT

Mr. Steven Schmitz Alaska Department of Natural Resources Division of Oil and Gas P.O. Box 107034 Anchorage, Alaska 99510-7034

Dear Mr. Schmitz:

In response to your telephone request regarding our Geothermal program, enclosed are the following documents:

- 1. Rules on Leasing and Drilling Geothermal Resources.
- Hawaii Geothermal Drilling Guide. 2.
- Hawaii Geothermal Blowout Prevention Manual. 3.

If we can be of further assistance, please call Mr. Gordon Akita of the Flood Control

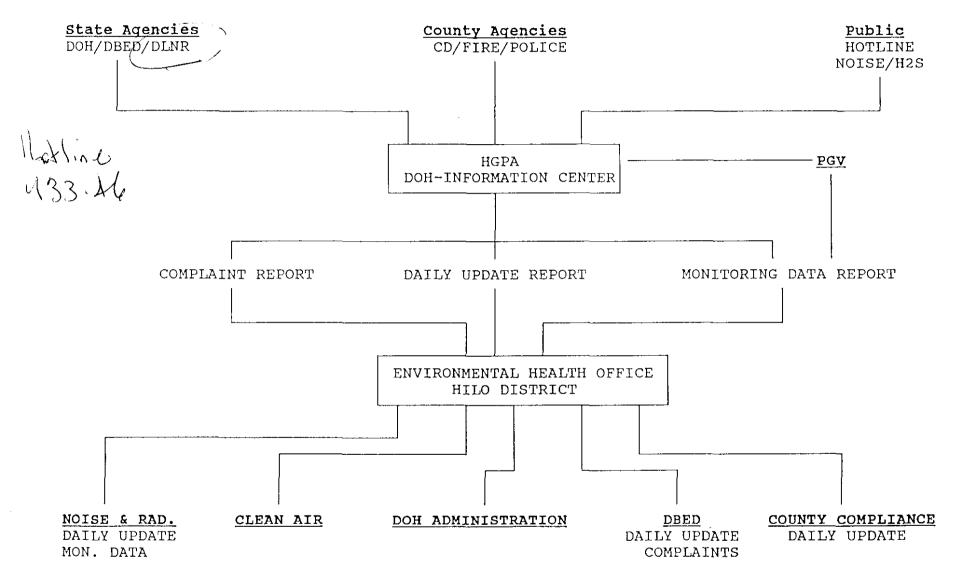
and Mineral Resource Branch at (808) 587-0227.

MANABU TAGOMORI Manager-Chief Engineer

Sincerely.

HY:ek Enc.

GEOTHERMAL INFORMATION FLOW CHART STANDBY AND 24 HOUR COVERAGE

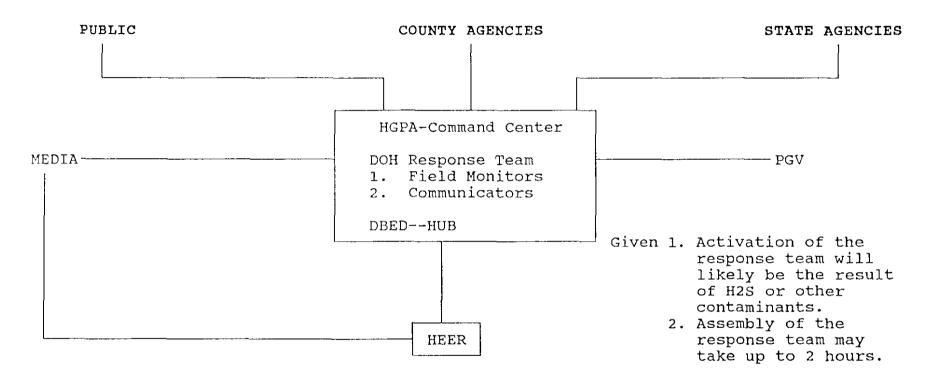


*The concept of this operational plan is to have field staff gather data (complaint investigation, monitoring data and updates on operations) and forward this data to the Hilo Office. The Hilo Office in turn disseminates the requested data to various office for their review. Both Air and Noise programs to use standard report forms. (Attached)

DRAFT

GEOTHERMAL INFORMATION FLOW CHART

EMERGENCY RESPONSE OPERATIONS TO UPSET CONDITIONS



^{*} Upon notification of a possible upset condition, the air personnel who may be on call or at site would need to make a determination. The determination to be made is whether or not to activate the DOH-Response Team.

DRAFT

DOH RESPONSE TEAM

AIR PROGRAM

NOISE PROGRAM

GLENN KAWANISHI CLIFFORD FURUKADO ED MIYAMOTO DONN HASHIMOTO NEWTON INOUYE AARON UENO

BACKUPS

OAHU STAFF GLENN TOMORI BILL HASHIMOTO OAHU STAFF JOHN NAKASHIMA LARRY SHIRO

The response team is to consist of 2 components, the field monitors and the communicators. The field monitors responsibility is to monitor the issues (H2S, noise, etc.) apply it to prevailing rules, permits, & standards if possible. Then forward this information to the communicators located back at HGPA.

The communicator's responsibility is to transfer information between the field monitors and outside sources (State Agencies, County Agencies, Public, PGV, etc.) The communicator is to refer complaint or medical complications to other sources and not to respond to media inquiries.

STATE OF HAWAII DEPARTMENT OF HEALTH

GEOTHERMAL COMPLAINT REPORT

Date/Time:		
Investigation requested By(Complainant):		
Telephone Residence:		
Address:		
Nature of Complaint (H2S, NOISE, OTHER):		
Complaint Descrived Due		
Complaint Received By:		
Date of Inspection:	Time:	
Person Contacted:	Telephone:	
Findings:		
Action Taken:		
<u> </u>		
Inspector:	Date:	

STATE OF HAWAII DEPARTMENT OF HEALTH

GEOTHERMAL ACTIVITY UPDATE

TIME	INI.	REMARKS
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DATE		

STATE OF HAWAII DEPARTMENT OF HEALTH

MONITORING DATA

SITE #	LOCATION	WIND/ETC	TIME	H2S(PPM)	dB(A)
					
	 				
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INVESTIGA	TOR			DATE	_

_		FLOOD CONTROL & MINERA	VE RESOURCE BRANCH
	* · ·	ision of Water and	Land Development
FROM:	fant	DATE: 6/2/12	FILE IN: Jeneral correspondence
<u>TO</u> :	INITIAL:	PLEASE:	REMARKS:
	G. AKITA L. Choo T. Kam S. Yong C.P. Chang Y. Xu T. Nakama J. Swift J. Florez M. Tanouye C. D'Araujo M. TAGOMORI L. Nanbu L. CHANG	See Me Call Review & Comment Take Action Investigate & Report Draft Reply Acknowledge Receipt Type Draft Type Final Xerox copies FOR YOUR: Approval Signature Information File REQUESTED BY:	Everyy bill + world halph what it - he sent the attention if.

R. A. PATTERSON 1274 Kika Street K (808) 262-5651 (Kailua, Hawaii 96734-4521 (808) 262-5350(FAX)

FACSIMILE COVER SHEET

TO:DEPARTMENT OF LAND AND NATURAL RESOURCESDOWALD	
ATTENTION:JANET SWIFT	
FROM:RALPH PATTERSON	
subj:GENERAL ARTICLES-RENEWABLES	
NO. OF PAGES INCLUDING COVER SHEET:	
DATE SENT:June 1, 1992	
Please call if you have a problem with receipt.	
NOTES:	

ENERGY NEWS

WP 27-May-92 18:00:00

House Approves Vast Energy Bill; Oil Use Would Be Curbed in Long Term

By Thomas M. Lippman Washington Post Staff Writer

The House passed a massive energy bill yesterday that would affect virtually everything from the structure of the electric utility industry to the amount of water used by shower heads.

The 381 to 37 vote came after a large majority of numbers easily defeated an attempt to make oil companies pay the cost of expanding the nation's Strategic Petroleum Reserve. The bill now goes to a conference with the Senate, which passed a similar measure 94 to 4 in February.

Either version of the legislation would have a vast impact eventually on the way Americane concume, transport and regulate electricity, natural gas and liquid fuels.

Both bills contain parts of President Bush's proposed national energy strategy, but the administration prefers the Senate version. Energy Secretary James D. Watkins called yesterday's vote "a major victory for fresident Bush's leadership" in energy policy but said the administration objects to provisions that would limit state natural gas regulation and offshore oil drilling.

Environmental and conservation groups are lukewarm about both versions, but prefer the House bill because it would go further in using tax credits, federal grants and mandatory standards to conserve energy, increase efficiency and promote the use of renewable fuels.

its chief architect, Rep. Philip R. Sharp (D-Ind.), chairman of an Energy and Commerce subcommittee, said the legislation would "reduce oil imports by 3 million barrels per day by 2010, save the equivalent of another 2 million barrels per day in electricity and other fuels and cut significantly the energy-related emissions of carbon dioxide, the chief greenhouse gas."

The United States consumes about 17 million barrels of oil daily, about half of it imported. It was that volumerability to imported oil - highlighted by a sudden price spurt on Tuesday inspired by a reported policy shift in Saudi Arabia - that underlay a furious debate yesterday over the nation's emergency oil reserve. The debate contared on a proposal by Sharp to increase the reserve in a way that would not add to the federal deficit - by having oil companies bear the cost.

The Strategic Petroleum Reserve consists of about 570 million barrels of government-owned cil stored in salt carerns in Yexas and Louisians. Congress and the Bush

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administration agree that the reserve should be expanded to one billion barrels, but buying that much oil at current prices would cost more than \$8 billion.



Sharp had introduced a provision that would have required oil importers and refiners to provide one percent of their stocks each year, or the cash equivalent, until the reserve was filled. The oil industry strongly caposed the plan, calling it a \$15 billion tax that would be passed on to consumers. Administration officials said Bush would veto the

bill if it contained this provision.

Sharp and Rep. John D. Dingell (D-Mich.), chairman of the Energy and Commerce Committee, argued that the plan amounted to "low-cost insurance" against oil supply interruptions that would drive prices up and cost consumers much more than the estimated half-cont a gallon Sharp's plan would entail. But Democrats from oil states joined Republicans to kill the provision, 263 to 135.

That leaves the billion-barrel target in place but with no mechanism in the energy bill for financing the required oil purchases. The Senate version has a provision encouraging the Energy Department to negotiate leases of oil with producing countries, but extended negotiations with Saudi Arabia, Venezuela and other producers have led nowhere.

One reason for the intensity of yesterday's debate over the off reserve was that it represented virtually the only provision in the bill The bill would not open additional areas of the United States to oil exploration and in fact would place most coastal waters off limits.

That would have lessened the ration's short-term vulnerability to oil cutoffs or embargoes. While the bill would affect many industries, it would not open additional areas of the United States to oil exploration.

To the contrary, it would place almost all coastal waters rexcept the Gulf of Mexico and most of the Alaska area - off limit to further oil development for the next decade. Moreover, the bill would impose no mandatory oil conservation targets, such as an increase in federal auto-mileage efficiency standards.

The bill would make it easier to build nuclear power plants and natural gas pipelines. It would extend federal tax credits for investment in solar and geothernal energy and provide a credit of 1.5 cents for each kilowatt hour of electricity generated from wind or agricultural fuel. It would limit to \$160 a month the amount of tax-free parking

RTW 26-May-92 02:23:00 JAPAN TO HELP REDUCE PHILIPPINE POWER SHORTAGE

MANILA, May 26, Reuter - Japan's Export-Import Bank is expected to provide at least US \$710 million in new loans to help the Philippines overcome its desperate electric power shortage, the Mational Power Corporation (MPC) said on Inesday.

A group of industrialists said on Tuesday the country's new government, expected to be headed by former defence chief Fidel Hamos, should give top priority to solving the power crists.

They said daily power blackouts had caused Philippine industry to lose 20 billion pesos (\$770 million) since the beginning of March in the Manila area alone.

APD chairman Mencesiao de la Paz told reporters after visiting Japan that two Joans from the Exim bank worth \$290 million would be signed in June to put up power lines and build a new 300 megawath plant in the Bataan peninsula, west of Manila.

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Mindanao, once 90 per cent dependent on hydro-power, has been hadly affected by a prolonged drought which has forced

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makila, May 25, Reuter - President Corazon Aquino ordered a crash programme to build extra power plants and curb a chronic electricity shortage in the Philippines that has caused daily power blackouts of up to seven hours a day.

in a statement, Aquino said she expected that with the coming rainy season, power blackouts that have crippled industry and angered private consumers for several months would be reduced to a minimum or completely eliminated.

The blackouts have been caused by persistent breakdowns of major power plants and by a drought that has reduced hydropower generation.

Despite Assistance, the Japan International Cooperation Agency (JICA) said in a study published today that the power biachouts would continue indefinitely because of poor maintenance.

The state-owned National Power Corp (NPC) said last week the crippling power shortage would continue until 1994 because of imadequate security of the country's power plants.

The government's openous procedure of approving new power stations had also exacerbated the problem, NPC President Pablo Malixi said in a memorandum to Aquino.

After talks with radixi on Monday, Aquino ordered a trash programme to provide an additional 200-300 megawatts capacity on the main Philippine island of Luzon within five to eight months.

She also ordered an extra 50-100 megawatts for the southern drought-struck island of Mindanso, which relies on hydropower for almost 90 bot of generating capacity.

3



ENERGY NEWS

MP 27-May-92 78:00:80

House Approves Vast Energy Bill; Gil Use Would Be Curbed in Long Term

By Thomas W. Lippman Washington Post Staff Writer

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that amployers could provide each worker. Employers could provide up to \$80 a month in tax-free transit passes, an increase from the current limit of \$21.

Most of the provisions of the 16-title bill would have little immediate impact on consumers or businesses. Over the coming decade, however, the legislation would: revolutionize the electric utility industry; lead the auto industry to produce more vehicles that run on fuels other than gasoline; increase the energy efficiency of buildings, motors and appliances; increase the use of natural gas, and pump more than \$15 billion into energy research and development.

Although the bill is the most ambitious energy legislation to come out of the House in more than 10 years, the debate about it was in many ways the story of the dog that didn't bank: Handly a word was said about the provisions that would change federal regulation of the electric utility industry, which a year ago seemed cartain to be the most controversial parts of the bill.

The House bill, like the Senate version, would encourage independent, non-utility companies to get into the electric-generating business by exempting them from regulation by the Securities and Exchange Commission. They could sell their output to any utility that would buy it, even across state lines.

Unlike the Senate version, the House bill would require utilities to transport other companies' power across their transmission lines, but it would allow the stilities to charge high enough fees to cover costs, ensuring that customers of one utility are not bearing the cost of some other utility's power.

Over time, these changes to the 1935 Public Utility holding Company Act could change the utility business the way the breakup of AT&T changed the telephone business. Some conservative utilities were strongly opposed to the changes, but opposition deindied over the past year as more and more utilities, consumer groups and environmentalists climbed appard a bandwagon in support of the changes, contending they would lead to less use of coal and more of lesspolluting natural gas.

Copyright 1992 The Washington Post

APF 24-May-92 08:33:00 OPEC Rystery

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BY SALLY JACOBSEN Associated Press Writer

VIEWNA, Austria (AP) -- It ended just as mysteriously as

OPEC's superstar -- Saudi Oil Minister Hisham Wazer -- at the last minute cancelled an appearance at a just-ended cartei meeting.

His stand-in failed to push for higher crude production in the summer -- billed weaks in advance as the Saudi line.

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Moreover, by all accounts, Saudi Arabia and Iran. frequent sparring partners, appeared to get along.

And, if that wasn't enough, Gulf delegates ended the meeting by saying the Saudis, long champions of modest crude prices, wouldn't mind seeing them several dollars a barrel higher.

Did the clues point to a significant change in Saudi policy at the meeting of the 13-nation Organization of Petroleum Exporting Countries?

Was the giant producer hoping to drive oil prices up to protest the Europeans' call for a stiff tax on oil to discourage its use and combat global warming?

Or was it in caboots with President Bush, wanting to push up prices to please Texas oil producers who might turn to Texan Ross Perot in the presidential contest?

Everybody had a reason.

"Let's be realistic," advised Algerian Cil Minister Mordine Ait Labussine, a tireless campaigner for higher

"i do not believe ... e one-day meeting in which Saudi Arabia was not represented by the usual head of delegation means a radical shift," he said Saturday.

Ait Laoussine offered a simple explanation: "Saudi Arabia, like any other country in OPEC, needs money."

Kuwait's cil minister, Homous ai-Roobsh, attributed the change to a desire for group harmony. "I don't think it's a shift in policy, rather (more) cooperation between GPEC, the Saudis and the tranians," he said.

Whatever, the 13 producing mations agreed late Friday to increase crude output slightly in the summer to about 23.4 million barrels a day.

Prices rose a bit after the deal was signed. Traders had been expecting a much larger supply boost.

The average price of an GPEC marker last week was about \$2.30 off the cartel's target of \$21 a 42-gallon barrel.

OPEC ministers hope their handiwork will nudge prices closer to the target during the July-September quarter.

A Gulf delegate normally knowledgable about Saudi policy said the producer would be "comfortable" if oil prices rose \$2 a barrel.

Moreover, he said, "Saudi Arabia is convinced that an increase of up to \$3 a barrel will have no effect on economic growth or demand for oil."

In the past, the Saudis have favored an easier cumping policy to keep prices moderate. They have worried high prices would encourage outsiders to move onto cartel

iran, Algeria and others prefer a tighter output policy and higher prices. They want more money for their financially strapped economies.

The Guif delegate, who refused to be further identified. suggested the Saudis are rethinking pricing policy because of the European Community's call for an energy tax to fight global warming.

The proposed tax would add \$10 to a barrel of oil by the end of the decade. Carbon dioxide emissions -- a major

byproduct of the burning of oil and other fossil fuels -- have been blamed for threatening to raise the earth's temperature.

OPEC fears the West is using the anvironmental issue as a way of cutting back on oil and developing alternative energy sources instead.

For those favoring conspiracy theories, another reason offered for the possible Saudi change was Bush's re-election campaign.

This theory, whispered by some analysts on the fringes of the OPEC meeting, was that Perot was a growing threat to Bush. Thus, higher prices would please Texas oil producers who might be leaning toward Perot.

Since the Gulf war, there have been suspicions the United States wields influence over Saudi pricing policy. The United States gave crucial military support to the kingdom during the war.

Though analysts doubt there is collusion between Saudi and American officials, they do think they share a common interest in having prices that are meither too high nor too low.

For the United States, the world's largest importer of chade, high prices burt consumers and the economy. But prices that are too low can pinch the U.S. oil industry.

RTN 26-May-92 02:23:00 JAPAN TO HELP REDUCE PHILIPPINE POWER SHORTAGE

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A group of industrialists said on Tuesday the country's new government, expected to be headed by former defence chief Fidel Ramos, should give top priority to solving the power crisis.

They said daily power blackouts had caused Philippine industry to lose 20 billion pesos (\$770 million) since the beginning of March in the Manila area alone.

NPC chairman Wenceslao de la Paz told reporters after visiting Japan that two loans from the Exim bank worth \$290 million would be signed in June to put up power lines and build a new 300 megawatt plant in the Bataan peninsula, west of Manila.

He said the bank was also ready to put up for approval to its board a proposal for a \$200 million loan to the NPC to buy diesel-powered movable generating stations with a capacity of 200 megawatts for the southern island of Mindagen

Another \$220 million would be used to develop a geothermal plant on Mount Apo, also on Mindanao.

Mindaneo, once 90 per cent dependent on hydro-power, has been badly affected by a prolonged drought which has forced a 35 per cent power cut to industry.

President Corazon Aquino on Monday ordered a crash programme to build more power plants and end blackouts of up to seven hours a day.

In a statement, Aquino said she expected that with the coming rainy season, power blackouts that have orippled industry and angered private consumers for several months would be reduced to a minimum or completely eliminated.

As well as drought, the blackouts have been caused by persistent breakdowns of major power plants.

Despite Aquino's reassurances, the Japan International Cooperation Agency said in a study that the power blackouts would continue for an indefinite period because of poor maintenance of generating plants.

NPC said last week the crispling power shortage would continue until 1934 because of the inadequate capacity of the country's power plants.

REUTER JPC JXK MEF

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RTF 24-May-32 21:45:00 AQUING ORDERS CRASH PHILIPPINE POWER PROGRAPME

MANILA, May 25, Reuter - President Conaton Aquino ordered a crash programme to build extra power plants and curb a chronic electricity shortage in the Philippines that has caused daily power blackouts of up to seven hours a day.

in a statement, Aquino said she expected that with the coming rainy season, power blackouts that have orippled industry and angered private consumers for several months would be reduced to a minimum or completely eliminated.

The blackouts have been caused by persistent breakdowns of major power plants and by a drought that has reduced hydropower generation.

Despite Aguino's assurance, the Japan International Cooperation Agency (JICA) said in a study published today that the power blackouts would continue indefinitely because of poor maintenance.

The state-owned National Power Corp (MPC) said last week the crippling power shortage would continue until 1994 because of inadequate capacity of the country's power wients.

The government's cherous procedure of approving new power stations had also exacerbated the problem, RPC President Pable Malixi said in a memorandum to Aquino.

After talks with Malixi on Monday, Aquino ordered a crash programme to provide an additional 200-300 megawatts capacity on the main Philippine island of Luzos within five to eight months.

She also ordered an extra 50-100 megametts for the southern drought-struck island of Mindanao, which relies on hydropower for almost 90 pct of generating capacity.

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A presidential palace statement said that to get around the problem of approval difficulties for new power projects, Aquino's executive secretary Franklin Drilon would call an inter-agency meeting this week to ensure the securing of all needed approvals by the end of June.

Several power projects have been held up because of environmental concerns.

The president also instructed that measures be taken to remove bureaucratic obstacles in the processing and approval of power projects," the statement said.

it said these "fast-track" projects would be in addition to a 54 billion peak two-year NFC development programme, which includes the building of several coal and bil-fired plants and development of a major geothermal field on the central island of Leyte.

it did not give the cost of the extra capacity approved.

The statement said the Philippines would have added an extra 650 megawatts to capacity before next year's dry season which starts in February.

But Fallx: has said this will not completely solve the supply problem.

On the southern island of mindanso, power curtailment remains at 35 pct due mainly to the shutdown of diesel-generation power barges for repairs, his memorandum said.

The power supply situation in mindanac is expected to improve in the third quarter after repair work on the barges is completed and the water level in take tanao increases, it said.

REVTER

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MP 28-May-92 18:00:00 Insufficiently Energetic

IN THE EMERGY bill that the House has just passed, you can see the political style of the 1990s clearly reflected. The bill is designed to change as much as possible without changing anything basically or visibly. It devotes great ingenuity to nudging the country gently toward conservation as far as it can without actually disturbing the ways people use - and over-use - energy in their daily lives.

This bill has much in common with its Senate counterpart, passed last February, and with the Bush administration's energy plan. All three avoid decisive changes in Americans national habits on grounds that the political will and support for them don't exist. But all three proceed from an uneasy acknowledgment that the country is using too much oil, too much coal and too much electricity for its own good. Americans consume too much because prices are too low - dangerously low, as experience has shown.

House, Senate and President Bush agree that they

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don't want to do anything about it.

The House bill's only attempt to affect prices directly was a gingerly tax of half a cent per gailon on oil to fill the Strategic Petroleum Reserve. That half-cent became wildly controversial and, after being denounced by the administration, it was deleted by a huge majority in the House.

What's left? A great variety of odds and ends of varying usefulness. The bill cushes highway transportation toward a goal of alternatives to bill—like ethanol and electricity—for 10 percent of its energy by the end of the decade. It would set efficiency standards for electric lights, windows and much else. It would prodistate utility regulators to encourage conservation. In dozens of ways the federal government is now deeply involved in the regulation of energy, and this bill generally represents incremental progress in the right direction.

But it doesn't do anything very forceful about the main issues of American energy policy. First: The country is using twice as much energy, in relation to its economic output, as its main compatitors abroad. Second: Because the country has evidently turned away from nuclear power, it will continue to rely mainly on coal to generate electricity. That, together with the present inefficient use of power, commits it to rising accumulations of greenhouse gases that will eventually change its climate. Third: The United States occasiones more than one-fourth of all the oil produced on this planet while producing only onersighth. Three Middle Eastern oil orises have resulted in painful recessions here in the past two decades, yet among the major industrial powers the United States has done the least to protect its economy from these periodic convulsions.

The House's energy bill is probably the best that could be expected in the absence not only of presidential leadership but of even minimal presidential interest.

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RTT 28-May-92 11:46:00 U.S. EMERCY BILLS BOOST MEN FUELS, CONSERVATION

MASHIMOTON, May 28, Reuter - The energy policy being written by the U.S. Congress would give a boost to alternative fuels and more efficient use of power but may offer little incentive for larger oil and gas production, analysts and industry spokesmen said.

The legislation is ready for the final round of work, the writing of a version that irons out differences between bills passed by the House and Senate. A bill could be sent to the White House as early as mid-summer.

It could be the most dramatic step in two decades to reduce U.S. reliance on imported oil.

Acting Deputy Energy Secretary Linda Stuntz said the Bush administration objects to three provisions in the House

bill. Two of them already have been listed as veto bait.

"Clearly, the (offshore drilling) provisions are the most serious," Stuntz said. "It's going to be a priority of ours."

Trade groups for the oil and natural gas industries also objected to the House plan to ban oil and gas drilling on 500 min acres of the outer continental shelf until 2002. The moratorium would affect most of the Nest and East coasts and parts of Alaska.

The Senate has endorsed a smaller total and is in accord with Bush administration proposals on offshore drilling.

Mowever, neither chamber would open the Arctic National Wildlife Refuge to oil and gas drilling, a White House goal.

Environmental groups lamented that, with House and Senate negotiators limited to resolving points of disagreement, nothing would be done to require higher automobile mileage.

Nonetheless, the bills would set efficiency standards for a wide range of products powered by electricity, require government buildings to be more energy efficient and promote renewable sources, such as solar energy and hydroelectric.

"The efficiency provisions in both bills, aside from cars, which were left off the table, are outstanding," said Jim Wolf, executive director of the monoprofit Alliance to Save Energy. "There is some encouragement to start the ball rolling for alternative fuel use in fleets. It's encouraging (but) a small step."

The House and Senate adopted identical plans to streamline the licensing of nuclear power plants.

Stuntz said the addinistration also opposed House language to limit states' promationing policies on natural gas. The White House has said the provision could prompt a veto

Stantz also announced administration opposition to language adopted Wednesday by the House to restrict the authority of the Federal Energy Regulatory Commission to license hydroelectric projects in parks and on rivers protected by state law.

The prorationing language infringes on state regulatory powers and invites lawsuits by using overly broad language to attack policies that result in higher prices by limiting production, she said.

Stuntz said it was "gross over-simplification" to blame recent price increase on adoption of prorationing policies.

Stuntz disagreed with suggestions that domestic oil prodution would not be sided. The House bill grants independent oil and gas producers relief on the alternative minimum income tax. An aggressive research program also would be created, she said.

"We're serious about seeing the domestic industry gets the technology it needs to compete," she said.

The National Association of Manufacturers said the House bill "fails far short" on domestic energy production although it would be "a major victory for electric energy users."

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1274 Kika Street Kafluo, Hamaii 36734-4621 (808) 262-5351 (808) 262-5380 (FAX) The mining industry objected to extension of a coal tax.

REUTER

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APf 27-May-92 19:53:00 Energy-In-Brief

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MASHINGTON (AP) -- Here are the key elements of a broadranging energy bill approved by the House on Mednesday:

--Eases licensing of nuclear power plants by requiring only a single permit for construction and operation.

--Provides tax breaks for renewable energy sources such as solar, wind and biomass, including garbage, and for some conservation practices such as using mass transit.

--Bans oil and gas drilling off most of the U.S. coast outside of central and western Gulf of Mexico. Cancels current leases off Florida, North Carolina and in Alaska's Bristol Bay.

--Fosters increased competition in the electric industry, allowing independent wholesale producers access to utility transmission lines.

--Requires the federal government to cut energy use in federal buildings and encourages the development of new efficiency standards for appliances, lighting and buildings in the private sector.

-Requires federal and private fleet owners to buy more vehicles powered by fuels other than gasoline.

--Removes some regulatory barriers to piteline construction to open new markets for natural gas.

RTW 27-May-92 00:02:00 BKDY SHOP TURNS TO WINDMILLS FOR EMERGY

LITTLEPAMPTON, England, May 27, Reuter - British beauty products firm Body Shoo international Plc, which campaigns on environmental issues, said on Wednesday it was turning to windmills for its power needs.

It is teaming up with two other firms to build a wind farm with the aim of becoming self-sufficient in energy.

Body Shop, founded in 1976 by high-profile businesswoman Anita Raddick, has grown into an international firm with sales of 147 million pounds sterling (\$269 million) and profits of 25.2 million pounds (\$46 million) last year.

The company prides itself on not testing cosmetics on animals.

It will take a stake in a project to provide electricity for its Watersmead manufacturing plant at Littlehampton, about 50 miles (60 km) south west of London.

"The first objective will be to work towards generating as much electricity by renewable means as we consume at our Wetersmead sits.

"Later it is hoped that this will be extended to the U.S. shops and ultimately encompass all our energy requirements," it addec.

REUTER UN LOU RU

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The Business Wife

新 B#125 MAY 28,1992

SH)(BSHNEYFLLLE-POMER-ACMIN) The Bonnerille Power Administration and four California utilities swap power

PORTLAND, One. -- (BUSINESS WIRE) -- Salmon will have more water flowing down the Columbia River and people in California will breathe a litter easier thanks to a power swap announced Thursday.

The Bornevilla Power Administration and four California utilities agreed to swap up to 725 megawatts — enough power to serve the cities of Portland, Eugene and Salem, Ore., combined.

The swap will put more water down the Columbia in the summer. That will help salmon while it produces power. California will use the hydrogomer to cut air collution.

Officials from Los Angeles Department of Water and Power, Southern California Edison and San Diego Bas and Electric and BPA signed the agreements during a news conference at Sylman substation on the outskirts of Los Angeles.

California Department of Water Resources previously had signed a similar contract.

Sylman is the southern point for a transmission line connecting the Northwest and the Southwest.

LADMF and Edison own the substation, BPA is a federal power marketing agency based in Portland.

The agreements expire agring 1993.

Under the terms, flows will increase in the summer between 2,550 and 3,100 cubic feet per second along the length of the Columbia River.

"Because of these exchange arrangements," SPA
Administrator Randy Hardy said, "SPA will meet its required
fish flow colligations for endangered wild saimon at
substantially lower cost than would otherwise be the case."

874 has been looking at a 4 percent to 8 percent increase in the wholesale power rates for its customers as a result of changing river operations for salmon. Hardy said seasonal exchanges would move the increase to closer to 4 percent.

Power generated by the increased water releases will be sent south. Edison will get ISO megavatts; Los Angeles, 200

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mm; San Diego, 140 mm. comm will get 535 mm in August, dropping to 35 mm in September and October.

SCE estimates that, by replacing power produced by fossil fuel plants with the Columbia River power, it alone can cut pollutants in the southern California air during the summer by about 63 tons.

California will return the energy to BPA in the fall and minter when the Northwest most needs the electricity.

Columbia River power operators normally capture apring flows in reservoirs. They hold the water until winter when it is released to produce the electricity the Northwest needs to light and heat homes and businesses.

The power swaps move water releases to spring and summer when they, along with the annual fish flush, will strengthen the current, and perhaps, guide fish downriver more quickly.

Not all biologists agree that young fish migrating in summer -- such as fall chinook -- need higher flows. BPA-funded research will track young summer migrants to test what effect the increased flows have on their survival.

The power swaps were modeled on a 200-sm agreement signed last year between Edison and SPA.

BPA is regotiating several other exchanges between the Northwest and California.

--30--CK/se

CONTACT: Bonnerfile Power Administration Karen Hoenes, 503/230-5359 (Fortland) Terry Esvelt, 206/553-1903 (Seattle) Wayne Lee, 509/353-2500 (Spokane) Tom Maggenhoffer, 509/522-6227 (Walla Walla)

KEYNORD: WASHINGTON OREGON CALIFORNIA INDUSTRY

KEYWORD: UTILITIES ENERGY

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	וע IVISION OF WATER AND LA	ND DEVELOPENT		
FROM:	DATE:	FILE IN:	<u> </u>	<u> </u>
TO: INIT:	PLEASE:	REMARKS:		
M. TAGOMORI L. Nanbu G. Akita L. Chang E. Lau A. Monden H. Young T. Kam G. Miyashiro D. Lee	See Me Call Review & Comment Take Action Investigate & Report Draft Reply Acknowledge Receipt Type Draft Yope Final Xerox copies File	Capinit & File #3	7	
	FOR YOUR:			
R. LOUI S. Kokubun	Approval Signature Information			



Civil Defense Agency

Lorraine R. Inouye Mayor

County of Hawaii • 920 Ululani St. • Hilo, Hawaii 96720 • (808) 935-0031 • Fax (808) 935-6460

TO:

Chief Daniel Ayala, Fire Department

Chief Engineer Bruce McClure, Dept. of Public Works

Planning Director Norman Hayashi Director John Lewin, Dept. of Health

Chairman William Paty, Dept. of Land & Natural Resources

FROM:

Wendell Hatada, Plans & Operations Officer

DATE:

April 10, 1992

SUBJECT:

Hydrogen Sulfide Safety Training

On behalf of the Hawaii County Civil Defense Agency, I would like to take this opportunity to thank your departments for participating in the Hydrogen Sulfide Safety Training held in Hawaii County from March 17 - 27, 1992.

Please distribute the enclosed certificates of completion to your personnel with our congratulations.

ayk

encl.

c.c. Sam Ruben, Dept. of Health w/o encl.

Donald "Don" Kiwimagi

SAFETY TRAINING REPORT

Safety Supervisor

Rt. 1 Box 95A1 Williston, ND 58801 (701) 572-6606 DATE: 24 MAPON 1992 INSTRUCTOR: NOI MAGI

COMPANY: DEPT OF LAW & RESCURIES PHONE:
COMPANY REP: / COUNTY/STATE: HAWA!
LOCATION: FAAU LIBPARC
SAFETY PROGRAM SUBJECTS: (check or complete all items taught)
H2S Safety Hazards/Properties/Emergency Procedures/Briefing Areas
H2S Rescue procedures/Detection/Monitoring/Equip
Breathing Apparatus/Work/Escape/Rescue
Hands on Training/Face Seal
Medic First Aid & Basic Skills
Primary Assessment/1 Rescuer CPR
Airway Management/Control Bleeding
Shock Management/Illness & Injury Assessment
Test/knowledge inventory given/signed
Billfold certificate given
We, the undersigned, employees of
ATTENDEES PRESENT (Have each sign if possible)
Jant C Stiff
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Mantonoge -
Man foroge
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Martinoge -
Martinoge -

(Over for additional names)

		DIVISION OF WATER AND LAND I	DEVELOPMENT
FROM:	7	707	FILE IN:
<u>TO</u> :	<u>INIT</u> :	PLEASE:	REMARKS:
	M. TAGOMORI L. Nanbu G. Akita L. Chang E. Lau A. Monden H. Young T. Kam G. Miyashiro D. Lee	See Me Call Review & Comment Take Action Investigate & Report Draft Reply Acknowledge Receipt Type Draft Type Final Xerox copies File	All grand correspondence
	R. LOUI S. Kokubun	FOR YOUR: Approval Signature Information	U

JOHN WATHEE



P. O. BOX 3378 HONOLULU, HAWAII 96801

March 25, 1992

In reply, please, refer to:

92-140

Mr. Manabu Tagomori Manager-Chief Engineer Division of Water and Land Development Department of Land and Natural Resources P. O. Box 373 Honolulu, Hawaii 96809

Dear Mr. Tagomori: \ Maraha

Enclosed is our response to Mr. Stephen Ponder of Coldwater Creek Operator Corporation.

Our response basically explains our proposed standards for hydrogen sulfide and the assurance that technologies are available to meet our requirements. Although we have proposed two standards, we will likely propose promulgation of rules with only one level, a one-hour average of 25 ppb. More stringent conditions can be imposed through our permitting process, if necessary.

If you have any questions, please do not hesitate to contact me at 586-4424.

Sincerely,

BRUCE S. ANDERSON, Ph.D.

Deputy Director for

Environmental Health

PFA:nm Enclosure



JOHN WATHEE



JOHN C. LEWIN. M.D. DIRECTOR OF HEALTH

P. O. BOX 3378 HONOLULU: HAWAII 96801

In reply, please refer to: EMD-CAB

February 26, 1992

92-100

Mr. Stephen H. Ponder, President Coldwater Creek Operator Corporation 1400 N. Dutton Avenue, Suite 23 Santa Rosa, California 95401

Dear Mr. Ponder:

This is in reply to your letter of February 13, 1992 to Governor Waihee expressing your concern regarding the proposed 10 ppb ambient air quality standard for hydrogen sulfide.

The Department of Health is proposing ambient air quality standards for hydrogen sulfide with two averaging times, a one-hour average of 25 ppb and a 24-hour average of 10 ppb. The median level for odor detection is approximately 5 ppb. Hydrogen sulfide becomes an odor nuisance to most people at 25 ppb. We have proposed this level for our one-hour standard, which is consistent with California's ambient air quality standard. The 24-hour standard is being proposed to prevent the ambient level from becoming an odor nuisance. We are aware that technologies are available to meet these standards which will not preclude geothermal development.

Extensive monitoring of background levels of hydrogen sulfide have been conducted in the Puna area. Background levels of hydrogen sulfide in the geothermal project areas are well below the 5 ppb level. In fact, the background level is less than 3 ppb in the area where geothermal projects are under construction and proposed.

Please be assured that the State of Hawaii is committed to the development of alternate energy sources, including geothermal energy. Any proposed ambient air quality standard takes into consideration technologies available to meet our standards. Because of the relatively close proximity of residents to existing and proposed geothermal development projects, we have no choice but to consider standards which will protect against odor nuisance in addition to the health and welfare of the public.

Thank you for sharing your concerns with me.

/erỳ∖truly yours,

JOHN C. LEWIN, M.D. Director of Health

		DIVISION OF WATER AND LAN	ID DEVELOPME
FROM	:	DATE:	FILE IN:
<u>TO</u> :	INIT:	PLEASE:	<u>REMARKS</u> :
	M. TAGOMORI L. Nanbu G. Akita L. Chang E. Lau A. Monden H. Young T. Kam G. Miyashiro D. Lee	See Me Call Review & Comment Take Action Investigate & Report Draft Reply Acknowledge Receipt Type Draft Type Final Xerox copies File FOR YOUR:	DOSO Les file great coneph
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HECENED

The Research Corporation of the University of Hawaii

1

Executive Director

March 23, 1992

92 APR 9 P1: 34

OF WATER &

The Honorable John Waihee Governor of the State of Hawaii 235 S. Beretania Street Honolulu, HI 96813

Dear Governor Waihee:

I wish to apprise you of an interesting potential development. Dr. Vince Peterson, Professor of Physics at the University of Hawaii at Manoa, has been active for many years in high energy physics research. RCUH handles one of his major projects called DUMAND, which is an international cooperative research project that is being conducted in the deep ocean off Kona. Dr. Peterson is known and respected nationally and internationally in the high energy physics field. He has kept me apprised of developments in the field and recently asked me for advice on how to proceed with locating a major international scientific facility on the Big Island.

He has been asked to host the next meeting of the U.S.-Japan Joint Committee on High Energy Physics in Kona on June 4-5, 1992. The attendees will include a dozen or so people each from the U.S. and Japan, including officials from the U.S. Department of Energy and the Japan Ministry of Education, as well as directors of the several national high energy physics labs in the U.S. and their counterparts from Japan.

One of the anticipated subjects of discussion is a linear collider to be jointly funded by the U.S. and Japan, which will be at the cutting edge of high energy physics research. The intriguing aspect of this discussion is that there seems to be a consensus developing that the best place to locate this \$1-1.5 billion (estimated cost) facility is Hawaii, half way between Japan and the U.S. It would be a major scientific laboratory and would add substantially to Hawaii's science/technology and economic base.

The other interesting aspect of this facility is that when it is in full operation it is anticipated that it will require up to 200 megawatts of power. If the project is realized, it would be a substantial user of the Big Island's geothermal power capacity, if that power source is successfully developed. Without that power, the project may not be feasible. Attached is a memo that Dr. Peterson provided me at my request.

If you endorse the idea, it would be appropriate for you to signal your support at the June meeting in Kona or at a preliminary meeting with Dr. Richter and Dr. Sugawara, the respective scientific leaders for the U.S. and Japan. Significant federal dollars will be involved, so our Congressional delegation will need to be apprised, especially Dan Inouye.

Fujio Matsuda 10: Pirector. DBE CONTRACTE WITH Attachment Dr. Vince Peterson 408 Varsity Building, Comment/Recommendation (required) 1110 University Avenue, Honolu An Equal Opportunity Employer Appropriate attention Tirect reply (cc/bcc: Governor) tour information/file ✓ Snort reply for Governor's signature Sollow up/report Submit copy of response (if ony) Keep enclosure(s) _ Raturn enclosure(s) Other Gw, 51, 30, CT Due seven working days from (if selay is encountered in meeting suspense date, please govise by telephone immediately In really, please refer to: 4.2.

206-04



University of Hawaii at Manoa

Department of Physics and Astronomy
High Energy Physics Group
Watanabe Hall • 2505 Correa Road • Honolulu, Hawaii 96822
Telefax: (808) 956-2930 • Telex: UHHEPG 7431844 • BITNET Node: UHHEPG
Telephone: (808) 956-7391

March 13, 1992

MEMORANDUM

TO: Dr. Fujio Matsuda, RCUH Executive Director

FROM: Vince Peterson, High Energy Physics Virice Peterson

RE: (a) US-Japan Joint Committee Meets in Kona June 4-5, 1992; (b) Possibility of Linear Collider in Hawaii, with Joint US-Japan Support

We discussed these matters at length this morning, and I suggested that I could put down some key information on paper. The following paragraphs sketch the background, plus names, dates, etc. If more details would be useful, please advise.

June 4-5 meeting in Kona: For many years there has been a Joint US-Japan Committee on Cooperation in High Energy Physics, which meets alternately in USA and Japan, to plan the "next-N-years" of cooperation in HEP research. The initial idea (back in 1950s) was to enable Japanese physicists to utilize American accelerator facilities on a "quid pro quo" basis (using Japanese funds to help support experiments). Even after Japan built its own National Accelerator Lab (called "KEK") the superior US facilities provided the motivation for continuing the US-Japan Joint HEP Program.

Prof. W.K.H. Panofsky of Stanford was particularly helpful to Japanese physicists' wishing to be "up-to-date" in particle physics. Prof. Burton Richter (Panofsky's successor as Director of SLAC) has maintained this tradition. Hence Japan has tended to favor electron accelerators, and this accounts for the close SLAC-KEK collaboration today in developing electron-positron linear colliders. (The US-Japan Joint HEP committee also supports projects at Fermilab, Brookhaven, LBL, and now the SSC; for example, Japan has funded the huge superconducting solenoid of FNAL's Collider Detector Facility, which has made important discoveries in colliding protons/antiprotons.)

The Joint Committee agrees on the best way to invest Japan's contributions (about \$10 Million/year) in particle physics experiments. The Committee makes both long-range (10 years) and short-range plans (the next year). Normally, the projects are limited to accelerator experiments; however, there are exceptions (e.g., the DUMAND project, which would normally be considered "cosmic rays" and thus "non-accelerator").

This year the Japanese requested that the meeting be held in Hawaii, specifically at Kona, perhaps because of some peripheral interests in both DUMAND and also because of the possibility of locating the proposed Next Linear Collider (NLC) in Hawaii — perhaps on the Big Island (see below).

I have been asked to be the host for the June 4-5 US-Japan Joint Committee meeting, working with DOE-HEP officials (Dr. P. K. Williams, Head of High Energy Physics Research -- the University-based program). The meeting will be held at the Keauhou Beach Hotel near Kona. Attendees will include about 12 USA + 13 Japanese physicists and/or HEP administrators from DOE or Monbusho. The USA delegation will consist mainly of the Directors of DOE laboratories (Brookhaven, Fermilab, SLAC, the Superconducting Super Collider lab, and perhaps LBL) plus the chairman of HEPAP (High Energy Physics Advisory Panel). The head of the USA delegation will be Dr. Wilmot Hess, who oversees both High Energy Physics and Nuclear Physics research (about \$1 Billion/year in DOE funding -- not including SSC Construction).

On the Japanese side the counterpart to Dr. Hess will be either the head of JSPS or someone from Monbusho, although the key physicist will be Dr. Hirotaka Sugawara, Director General of KEK (Japanese National Accelerator Laboratory). The Japanese side will include all the key physicists who influence Japanese decisions in High Energy Physics.

Hence this meeting is far more important than just the planning of how to spend \$10 Million in Japanese money for experiments at US accelerator centers (and a small fraction in Hawaii for DUMAND).

Linear Collider located in Hawaii? The KEK electron synchrotron was a big success, due in part to SLAC's help in getting started, as already noted. However, circular electron machines are limited in energy due to the rapid increase of radiation losses with energy (fourth power!). Hence the development of the linear accelerator at Stanford, and now the new idea of Colliding Linear Accelerator beams: electrons and positrons colliding head on, forming "pure energy" in a tiny volume and creating mass (E = Mc2) in a precise manner. This technique was pioneered at SLAC by Burton Richter (Panofsky's protege and successor as SLAC Director). Although circular electron-positron colliders are now operating successfully in Japan, USA, and Europe, at moderate energies, the high energy future (1000 GeV, or 1 TeV) lies with linear machines.

Japan built KEK to extend their interest in electron/positron accelerators and has succeeded in building TRISTAN, a medium energy e+e- circular collider. It will soon become obsolete, now that LEP (the large Electron Positron collider at CERN is operating successfully). SLAC also sees only linear colliders in its higher energy future.

Electron-positron machines are the "precision" instruments of HEP: e+e- headon collision energies can be controlled to 0.01% or better and create particles of known energy -- with almost no background. (Protons contain quarks, and proton-proton collisions are "dirty" -- lots of background. A proton-antiproton collisions analogy is "like banging two Swiss watches together to see what's inside." Although proton-proton collisions make a wide variety of particles and energies, unscrambling the plethora of particles is a problem. e+e- collisions provide a clean and precise method to explore a particular energy range.

The problems in building NLC (the Next Linear Collider) are (a) limited resources, in this SSC-building decade; and (b) the need to marshal talent in the e-e-field. Hence Richter, Panofsky, and others have moved in the direction of international cooperation in building the NLC. The two leading advocates are: SLAC and KEK. They have been collaborating for over a decade; SLAC-developed klystrons now power KEK, and KEK physicists provide magnets for SLAC.

The funding situation is such that neither KEK nor SLAC alone can expect to obtain the funds to build the NLC. The international collaboration is needed, with at

least Japan and the USA as members. Where to put the machine? One (inspired) idea is to "find someplace in midway between Stanford and Tsukuba" (Sugawara and/or Richter's words); i.e., Hawaii. The basic requirements are: land (16 km. straight, minimum); power (200 MW for a 1 TeV machine); cooling water, etc. The beamline must be very straight and the "platform" must be stable (only submicron variations over 5-10 meters and for low frequencies, typically 50 Hertz).

Ever since Panofsky and Richter enquired from me as to "Hawaii's interest in an electron-positron linear collider," I have tried to be an "honest broker": providing facts and contacts, even though I don't expect to be active in building or using such a wonderful research tool. There are others in our Hawaii HEP group (e.g., Prof. Fred Harris) who have been involved in electron accelerator experiments and who have longer term interest.

DOE support: due to the SSC funding problem (which could be helped if Japan comes through with an expected contribution of \$1 B this year), DOE has held back on endorsing the Linear Collider project. However, the HEP community (through HEPAP discussions and from all national surveys of physicists) has backed the concept of having both e+e- and proton colliders. DOE at least has been willing to support a continuing R&D program at SLAC to explore and solve the remaining technical problems: e.g., reducing the size of the beam spots to increase "luminosity" (probability of e+ beam colliding with e- beam!). The present SLC (SLAC Linear Collider) provides the best available "tool" to develop the means of producing the extremely small beams (40 x 200 Angstroms) required for the NLC. At SLAC DOE is funding (\$3.5 Million in FY92) a Final Focus Test Facility (FFTF) which is expected to show how to reach NLC-dimension spots by the end of 1994.

Japan's semi-independent Linear Collider program: Meanwhile, KEK's directorgeneral has decided to pursue coordinated design/development effort in Japan—via the
"Japan Linear Collider Project"—with the goal of realizing the NLC—somewhere,
perhaps in Japan—by the end of this decade. In practice, SLAC and KEK and
"dividing up" the projects. SLAC is supplying the high power klystrons for KEK
work, whereas KEK is helping to build magnet components for the Final Focus Test
Facility at SLAC. Given the funding situation, both Richter and Sugawara would be
quite willing to find a "neutral territory": i.e., Hawaii, if this helps to solve the
problems. Sugawara—san was quite candid, in a seminar on KEK's program delivered
last year at UHM, in stating that his hope was for the joint program with Stanford
— "best of all in Hawaii."

International Linear Collider (ILC) effort — and its relation to Hawaii: Richter and others have marshaled the interests of e+e- advocates worldwide in an International Linear Collider group, including experts from Germany, Russia, CERN, as well as Japan and USA. The first formal ILC was held last September in Finland. Hawaii sent Prof. Harris to this meeting, with instructions to cooperate in future planning. (Prior to that the meetings were held either at SLAC or at KEK. I showed you the JLC conference proceedings from 1990.)

Hawaii now has been asked to host the Second ILC conference, at Kona, in April 1993. Prof. Fred Harris is working on plans for this meeting, which should include 150-200 physicists worldwide. Although I plan a formal retirement from UHM in mid-1993, I hope to remain involved in special projects for a limited period after that time.

I'll be happy to provide details on any item which I haven't covered in sufficient detail in this note.

1494

DEPARTMENT OF BUSINESS, ECONOMIC DEVENT MENT &

MENT & TOURISM

Governor

MURRAY E TOWILL
Director

BARBARA KIM STANTON
Deputy Director

RICK EGGED
Deputy Director

JOHN WAIHEE

TAKESHI YOSHIHARA Deputy Director

Central Pacific F Mailing Address.

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Dischwas .

lulu, Hawaii

phone: (808) 586-2406 Fax: (808) 586-2377

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MEMORANDUM

TO:

The Honorable Joshua C. Agsalud Administrative Director Office of the Governor

FROM:

Murray E. Towill

SUBJECT: Geothermal Development Update

As a follow up to our October 7, 1991 memorandum concerning geothermal development, we would like to provide you with a status report of our efforts to date in responding to the concerns and recommendations raised in your memo of August 12, 1991 regarding geothermal activities. The following serves to update our previous response to the recommendations directed to DBED:

- a. Prepare by September 13, 1991, final recommendation on future of Scientific Observation Hole (SOH) project. All drilling activity has been voluntarily suspended until the completion of a Federal EIS. However, non-drilling testing and monitoring activity is being conducted for those wells already drilled. The Tonto drilling rig has been returned to the mainland until additional environmental documentation and permits for the next drilling phase of the SOH program are obtained. Analysis of the data obtained to date continues. Additional water sampling, hydrogeologic, geochemical, and seismic surveys, as well as injection and interference testing are being proposed for implementation as part of the continued SOH non-drilling program. For this purpose, we intend to use \$1.5 million of a \$3 million CIP appropriation for geothermal resource assessments to fund these surveys. The remaining \$1.5 million of that appropriation may be reprogrammed by the 1992 Legislative session for a directional drilling project at the Natural Energy Laboratory of Hawaii Authority.
- b. Complete by September 6, 1991, negotiations and all other requirements on the sale of HGP-A steam to PGV. Since the June 1991 blowout there has been no progress in the status of the negotiations between the Natural Energy Laboratory of Hawaii Authority and PGV. It is our understanding that PGV is unlikely to make any commitments on the use of the HGP-A steam until they have further evaluated

Dr. Joshua C. Agsalud March 20, 1992 Page Two

their own steam resource potential and requirements. Current plans are to use the HGP-A well only for monitoring purposes. NELHA has recently proposed the installation of a heat exchanger unit to extract waste heat from PGV's reinjection fluids inorder to circulate heated potable water (not geothermal fluids) to the Puna Research Center to continue NELHA's research program. To date, there has been no decision by PGV on this proposal. Further, PGV has expressed some concern regarding any program tied to HGP-A and its potential impacts related to the requirement of a Federal EIS.

- c. Recommend by September 13, 1991, to Governor on NELHA/DBED's position on purposes for which HGP-A steam sale revenues can be expended such as for Asset Fund, research and development, and geothermal regulatory and monitoring activities. Projected gross revenues from the steam sale amounts to approximately \$400,000 per year from which OHA's share, and operations and maintenance expenses must be deducted. At present, it is unlikely that PGV will enter into an agreement with NELHA to purchase steam from HGP-A. Therefore, an alternative source of State funding payable toward the Asset Fund may have to be considered. DBED is continuing its efforts to seek resolution of the issue of temporary and permanent relocation jointly with other State departments and the County. A number of options under consideration include a State land exchange program and the concept of a transfer of development rights (TDR).
- d. Prepare by September 30, 1991, recommendation on go/no-go decision on geothermal development including specific conditions under which development can proceed should the recommendation be a "go" decision. All of the recommendations identified in the joint State and County Task Force's Geothermal Management Plan have been implemented, thereby allowing the lifting of the County's suspension of drilling activity and the resumption of PGV's geothermal development activity. However, it is our understanding that DLNR has initiated a review of the True/Mid-Pacific Geothermal Venture's drilling procedures and has called for a reaffirmation of True's previously approved Emergency Response Plan.
- e. Integrate by October 31, 1991, State's work plan with that of Hawaii County. The development and implementation of the Geothermal Management Plan has provided the foundation and framework for the continued cooperation and coordination between the State and County. Close monitoring of PGV by State and County regulators has been established to ensure that actions required by the developer have been implemented and that activities are in compliance with State and County permits. We note that State funds administered by DBED have been provided to the County for the hiring of a County Geothermal Compliance Coordinator.

Dr. Joshua C. Agsalud March 20, 1992 Page Three

- f. Announce to public on November 1, 1991, State's short and intermediate range geothermal development plan. The State's current position on the short and intermediate range geothermal goals are reflected in our policy and priority statement prepared in response to item (g) below.
- g. Draft by September 30, 1991, State administration's policies and priorities on geothermal development incorporating State's overall energy policy and integrated resource planning efforts. Unveil on November 1, 1991, State's overall position paper on geothermal. The State has been denied our request to participate as a Co-Lead Agency with the U.S. Department of Energy in the preparation of the Federal NEPA EIS for a large-scale geothermal/cable development project. In addition, the DOE has rejected our request seeking judicial redefinition of the geothermal development project defined by the U.S. District Court. The State's current position is that the exploration and development that has been permitted to date have been stand-alone projects and should not, for the purpose of the Federal or State EIS, be construed as part of any integral first step toward a large-scale geothermal/undersea cable project.

As reflected in the revised Energy Functional Plan, the State is committed to support and assist geothermal development first to serve the electricity needs of the Island of Hawaii. The extent of continued State support for any large-scale geothermal development and the export of power interisland shall be dependent on the social, economic, and environmental feasibility and benefits. The very scope of such a proposal will depend upon the availability, nature, and extent of the geothermal resource, and only when that resource is reasonably confirmed can an interisland master plan and cable route be identified.

In recognition of the above, DBED is planning to complete a conceptual master plan for the development of geothermal resources in the Kilauea East Rift Zone and a State planning and evaluation/guideline document for private geothermal development. These documents will serve to better clarify our State's current geothermal policy and the administration's refocusing of efforts to meet the Big Island's energy needs. In the interim, a draft geothermal development policy statement and priority guidelines are attached for your consideration. We have also provided a copy to DOH and DLNR for their review and comment.

h. Determine by September 13, 1991, resources (funds, positions, equipment) required by DBED to fully discharge geothermal responsibilities. DBED has requested appropriation for \$90,000 to fund a State Geothermal Compliance Coordinator and a secretary. These positions, if funded, will provide for coordination between the regulatory efforts of DLNR and DOH and the enforcement role of the County, on-site where geothermal development is occurring. This person would also provide an important liaison function with the community.

Dr. Joshua Agsalud March 20, 1992 Page Four

This geothermal update of our earlier memorandum does not include responses from DOH and DLNR. We would like to continue our informal working group between the agencies in an effort to address any outstanding issues which may remain unresolved. I will keep you apprised of our further actions in this matter.

MET/DAN:js:315

Attachments

cc: Honorable William W. Paty Y Honorable John C. Lewin, M.D.

GEOTHERMAL DEVELOPMENT POLICY STATEMENT

The State of Hawaii will continue to strive to reduce our dependence on imported petroleum for electrical generation by increasing the use of alternate sources of energy and by encouraging the efficient use of energy within the State.

The State of Hawaii will strive for a balanced, integrated approach to energy resource development and utilization, with support for energy conservation and alternate energy resources such as solar, wind, geothermal, biomass, ocean thermal energy conversion, hydroelectricity, coal and natural gas.

The State of Hawaii recognizes that conservation efforts as well as various renewable technologies are at different stages of development. In Hawaii, energy conservation and development of biomass and geothermal are proven technologies that will become the cornerstones of our integrated move towards energy independence. Other sources of energy such as imported coal and natural gas must also be considered in order to reduce our present vulnerability.

Ongoing and proposed conservation efforts will serve to reduce our overall consumption of energy or decrease the growth of energy use as our State grows. However, even with conservation the State's almost total dependency on imported petroleum will remain. Of the available alternatives, geothermal energy has the best near-term potential to reduce this dependency.

The State of Hawaii will seek the commercial development of our geothermal resources to first serve the needs of the Big Island, and then to utilize the benefits of this resource for the remainder of the State provided sufficient resource quantities are found and development can proceed in a economic and environmentally sound manner.

The State of Hawaii will, through a commitment to public involvement in planning for geothermal development as well as other energy technologies, ensure that community, environmental, social, cultural and economic concerns are addressed.

PRIORITY GUIDELINES

The following are Priority Guidelines for implementation of the Policy Statement on integrated energy planning in the State of Hawaii and geothermal development on the Big Island.

- 1. Continue and complete the master development planning process to determine the most environmentally-sound means of proceeding with further geothermal development.
- Ensure that the designated responsible regulatory agencies establish
 performance standards (i.e. air quality and noise standards, set-back
 criteria, etc.). These criteria will provide a quantifiable unit of
 measure against which to monitor project development and operation
 compliance.
- 3. Require that responsible regulatory agencies develop resource conservation programs which include data collection and management, resource and facility monitoring, staff training and equipment, and research funding designed to monitor and evaluate development and operation activities.
- 4. Designate a State agency to be responsible for the continued updating and evaluation of the geothermal database, and ensuring that this information is available to the public, other agencies, and the geothermal industry.
- 5. Continue efforts to resolve relocation and compensation issues, and support establishment of the asset fund with administration by the County of Hawaii.
- 6. Continue support of permitted and future geothermal development projects necessary to meet Big Island electrical needs, enabling the benefits of energy development to go first to the island most affected by such development.
- 7. Encourage further exploration for geothermal resources in the Kilauea East Rift Zone, as well as other prospective areas such as the Kilauea Southwest Rift Zone, to determine if adequate geothermal resources exist to justify continued support of geothermal development.



University of Hawaii at Man

Hawaii Natural Energy Institute

Holmes Hail 246 • 2540 Dole Street • Honolulu, Hawaii 9

FAX TRANSMITTAL

ro:	Manabu Tagamori			
	DLNR			
FAX: _	587-0219			
FROM:	Harry Olson			
DATE:_	March 11, 1992			
PAGES:	to follow this cover sheet.			
NOTES:				

If you do not receive all of this FAX, please call (808) 522-5620

AN EQUAL OPPORTUNITY EMPLOYER

SOH DAILY DRILLING REPORT March 10, 1992

Activities

Run Capillary tubing in 80H-4 to 2,300 feet and install pressure gauge. Fluid level in hole at 1,000 feet and no well head pressure. Download data at SOH 1, 2 and HBP-A and run thru program to test equipment.

Cersonal
John Daymonaz ~ 80H Drilling Manager Jerry Margantini - Pruett Service Engineer Roger Hanneberger - Geetherman Reservoir Engineer Renne Evans - 20H Researcher

Plane

The tenative work schedule is as follows:

Wednesday, March 4 - Install capillary tubing in SOH-1. Thursday, March 5 - Complete prepatory work at HGP-A and run temperature/pressure survey in SOH-2 to 4,270 feet.

Friday, March 6 - Run capillary tubing and instrument HGP-A,

attempt to clear obstruction in SCH-2.

Saturday, March 7 - Install capillary tubing in SOH-2 and instrument capillary tubing at 80H-1.

Sunday, March 8 - Begin construction of wellhead/equipment

enclosures.

Monday, March 9 - Instrument SOH-2, test equipment.

Construct wellhead/equipment enclosures.

Tuesday, March 10 - Install capillary tubing in 80H-4 and test instrumentation at SOH 1, 2 and HGP-A. Construct wellhead/ equipment enclosures.

Wednesday, March 11 - Construct wellhead/equipment enclosures and general SOH site restoration.

Vieitors

No visitors during this reporting period.

Cepert_Distributions Michalle Wong-Wilson - DBED Dean Nakano - DBED Manabu Tagomori - DLNR Rodney Nakano - Hawaii County Planning

. . . .

JOHN WAIHEE

California 2



WILLIAM W. PATY, CHAIRPERSON BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

KEITH W. AHUE MANABU TAGOMORI DAN T.KOCHI

AQUACULTURE DEVELOPMENT
PROGRAM
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STATE PARKS
WATER RESOURCE MANAGEMENT

STATE OF HAWAII DEPARTMENT OF LAND AND NATURAL RESOURCES

P. O. BOX 621 HONOLULU, HAWAII 96809

REF:WRM-FC

DEC | 3 | 1991

Mr. Maurice A. Richard Puna Geothermal Venture 101 Aupuni Street, Suite 1014B Hilo, Hawaii 96720

Dear Mr. Richard:

Thank you for your recent letter requesting permission to modify the well monitoring program for the Puna Geothermal Venture Project. The Department has reviewed your proposal and would like to make the following recommendations concerning your modified monitoring program:

(Revised) Routine Monitoring Schedule of PGV Wells

- KS-1 Efforts should be made to clear the cellar and recover the well head inorder to allow for proper monitoring of the well. Provisions should be made to incorporate KS-1 into the proposed monitoring program, including the reinstallation of a well head pressure gauge. Unless the well is planned for some future use, KS-1 shall be properly plugged and abandoned within 12 months from the date of this letter.
- KS-1A Pressure readings should be taken daily. If there is any significant change in the well head pressure, gas and water samples shall be taken on a weekly basis, otherwise gas/water sampling may be done on a monthly basis.
- KS-2 Pressure readings should be taken on a quarterly basis. If the well is not proposed for any future use, KS-2 shall be properly plugged and abandoned within 12 months from the date of this letter.
- KS-3 No change same frequency of sampling as in KS-1A.
- KS-7 Water level and bottom hole temperature readings should be taken 3 times per week. Provisions should be made to plug and abandon KS-7 as soon as possible, if no future use of the well is contemplated. Consideration should also be given to the possible use of KS-7 as a monitor well.

- MW-1 Water temperature and water sampling for chemical analysis shall be performed at least once every two weeks (bi-weekly). Water level readings should also be taken, if possible.
- Water level and bottom hole temperature readings should be taken at a least 3 times per week or more frequently, if possible. (Consideration should be given to a continuous monitoring program for MW-2.) Water sampling for chemical analysis shall be conducted bi-weekly.
- MW-3 Consideration should be given to periodic sampling and testing of MW-3 similar to that prescribed for MW-1.

Regional Ground Water Quality Study

No changes are recommended to your proposed quarterly monitoring, sampling and testing of wells - MW-1, MW-2, Malama Ki, GTW-III, Pahoa Public Water Supply, and Kapoho Public Water Supply wells. However, concerning the proposed detailed chemical analysis of the regional ground water samples, please identify the specific elements that will be tested for in that analysis.

Should the above recommendations be incorporated into your plans, the Department has no objections to your modified monitoring program, as revised. If you have any questions, please contact Manabu Tagomori, Deputy Director, at 587-0214.

Very truly yours,

WIILIAM W. PATY



December 9, 1991



Mr. Dean Nakano State of Hawaii Department of Land & Nat. Resources P.O. Box 373 Honolulu, HI 96809

Dear Mr. Nakano:

The purpose of this letter is to introduce you to the services and products offered by Systems Application Engineering, Inc. (SAE) which may be applicable to you as a member of a governmental agency involved with the geothermal industry.

As an applications oriented independent systems integrator and software engineering organization, SAE analyzes the needs of its geothermal clients and designs computer based solutions to satisfy these needs. SAE provides computer systems and software services which are specifically designed to help developers and operators utilize their geothermal resources in a manner which is consistent with the following objectives:

- Environmental protection
- Resource protection through automated control consistent with defined operational guidelines
- Efficient use of resources
- Regulation compliance monitoring

SAE has been involved in the design, implementation and support of computer systems and software which are consistent with these objectives for the geothermal industry since 1979.

As governmental agencies become more involved in specifying and directing how geothermal developers must properly use the natural resources, it seems likely that SAE may assist your organization in the following areas:

- Providing low cost hand-held computers directly to your organization to be used for manual data collection of information during facility inspections. Please see the enclosed information describing the hand-held computer and software for some typical uses.
- Providing data acquisition and/or control systems to the geothermal developers and/or
 operating companies with which you are involved in a regulatory or operations
 management role.

SAE would appreciate any opportunity to further acquaint you with the services and/or products we provide which will be useful in geothermal projects. If you would like additional information about SAE, its services or its products, please feel free to contact me at (713) 783-6020 or by FAX at (713) 783-3434.

Sincerely,

SYSTEMS APPLICATION ENGINEERING, INC.

Ken R. Vestal
Senior Associate

KRV:kl

Encl.



THE POWER PACKAGE

POWER is a field proven system which combines the portability and ease of use of a ruggedized Hand Held Computer (HHC) with state of the art Personal Computer (PC) software to automate the gathering and reporting of oil and gas operations and production data. The HHC prompts the user for the required data and verifies the entries using a database downloaded from the PC. Data is stored in the HHC and calculations are performed to determine oil, gas and water production. The data and calculated results are then sent to the PC using a direct connection or dial-up telephone communications. The PC performs additional calculations and provides displays which allow users to review, edit and supplement the data. The PC also prepares daily and monthly production and operations reports. Special option packages and custom features are available to meet your company's needs.



BENEFITS

Improved Management Decisions

- Timely, Accurate and Concise Data
- Flexible Reporting
- Elimination of Delays

Reduction of Costs

- Reduced Labor and Phone Charges
- Reduced, Simplified Paperwork
- Increased Job Satisfaction

Flexible Software

- Field Proven, Over 2,000 Units in Use
- Broad Base of SAE Expertise
- Easy to Maintain and Update

System Support

- Complete and Easy-to-Use Documentation
- Comprehensive Training
- Cost-Effective Customization

FIELD PROVEN

POWER benefits are currently being realized by companies such as:

Amoco Production
Chevron U.S.A
El Paso Natural Gas
Louisiana Land & Exploration
Mobil Exploration & Production
Oryx Energy
Pacific Enterprises
Phillips Petroleum
Texaco
Union Texas Petroleum



THE POWER PACKAGE

the PC.

POWER makes it simple to define your data on the PC for downloading to the HHCs. Screens are provided to set up the following route data at your field location:

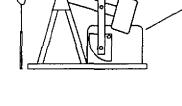
Leases
Batteries
Tenks and Strappings
Fluid Meters
Fuel Users
Downtime Codes

Wells
Gas Meters
Test Meters
Test Tanks
Tank Seal Locations
Oil and Gas Disposition Codes



The POWER PC also provides numerous production and operations reports using the data that has been collected and validated by the HHCs and transferred to





POWER supports the collection and in-thefield validation of all the data required for most operational and financial reporting needs including:

BATTERY PRODUCTION
Tank Gauges
LACT Meter Readings
Tank & Meter Run Tickets
Tank Dispositions
Battery Gas Meters
Oil & Gas Production
(calculated)

WELL DATA Metered Well Production Well Tests

- fluid sample testing
 separator testing
- test tank testing
 Well Downtime
 Injection Well Data
 Gas Lift Data

MISCELLANEOUS DATA
Gas Meter Readings
- orifice charts and electronic
Fluid Meter Readings
Fuel Usage Readings

ENHANCEMENTS AND SUPPORT

POWER is a standardized system derived from and proven by more than 2,000 installed HHCs.

Optional features and customization are provided to perform such functions as:

Prepare special/custom reports

Transfer the POWER data to standard PC database and spreadsheet packages Perform additional calculations in the HHC and/or the PC Support particular communications protocols for mainframe data transfer

SAE offers user training for both the HHC and the PC at our facilities or your site(s). Maintenance and upgrades are provided by SAE in a timely and cost-effective manner to ensure that your system continues to deliver its operational and economic benefits.

Put POWER to work for you. Please contact Bill Elliott or Jay Berlin at (713) 783-6020 to arrange for a demonstration of this technology and to discuss your particular requirements.

THE COMPLIANCE MANAGEMENT SYSTEM

INCONTROL



The number of regulations pertaining to health, safety and the environment are increasing rapidly. The task of insuring that your company is in compliance is becoming expensive, labor intensive and increasingly difficult to manage. A single oversight or one poorly performed inspection can have major safety, legal and financial implications.

INCONTROL is a PC-based system which combines Hand Held Computers and Bar Code technology to allow you a means of defining, organizing, scheduling, collecting and verifying that the inspections required by these regulations are performed.

INCONTROL generates the audit trail necessary to document that the inspections were performed properly, completely, timely and cost-effectively.

INCONTROL provides a "road map" through the maze of regulations and gives you the capability to insure that your company is in compliance.

INCONTROL puts you back in control of the confusion and uncertainty that has plagued even the most diligent compliance management activities.

FUNCTIONS

- Definition of the Requirements, the Tasks That Must be Performed and the Frequency
- Assignment of Equipment to Requirements
- Automatic Scheduling of Inspections
- Collection of Compliance Data Using Bar Code Technology
- Compliance Management Reports
- Optional Interaction with Mainframe Computer Systems
- Bar Code Assignment/Identification

BENEFITS

- Reduces Labor Costs
- Helps Avoid Penalties, Fines and Accidents
- Provides Audit Trail to Aid in Dispute Resolution
- Eliminates Forms to Print, Distribute, Track, Gather and File
- Easy To Use
- Scalable for Use by Companies of Virtually Any Size
- Field Proven Technology Backed By SAE's 20 Year Track Record

INCONTROL



2

Use of **INCONTROL** is as easy as 1-2-3. First the tasks such as checking fire extinguishers or safety related equipment are defined and an inspection frequency is assigned. Next, the compliance inspections are scheduled throughout the week, month and year and each Hand Held Computer (HHC) is downloaded with the schedule and tasks for the week or month. The HHC prompts the user for compliance with each

task procedure and records whether or not compliance is satisfied. Bar Codes are used to assure the item being inspected is correct and provide an Audit Trail for the inspection. This information is transmitted from the HHC to the PC where reports are generated so that compliance can be managed by the appropriate responsible personnel.

Complete functions and interactive screens available with INCONTROL include:

SCHEDULING

- Maintain Master Schedules
- Generate Monthly Schedules
- Adjust Monthly Schedules
- Schedule Special Events

TASK COMPLIANCE

- Support for "Completed", "Fixed During Inspection", "Repaired" and "Non-Compliant" Task Status
- Review and Edit Task Compliance Statuses

REPORTS

- Manpower Utilization
- Assignment Schedules
- Scheduling Exceptions
- Non-Compliance Reports
- Inspection Sheet Reports

SUPPORT

- Maintain Equipment, Postings, Personnel and Events
- Define and Maintain Equipment Location Information
- Define and Review Requirements and Task Procedures
- Bar Code Assignment/Identification

INCONTROL is a standardized system, derived from and proven by major oil and gas companies. Custom features and enhancements are available as required.

SAE offers user training for both the HHC and PC at our facilities or your site(s). Maintenance and upgrades are provided by SAE in a timely and cost effective manner

to ensure that your system continues to deliver its operational and economic benefits.

Put **INCONTROL** to work for your company. Please contact Bill Elliott or Jerry Sacks at (713) 783-6020 to arrange a demonstration of this technology and to discuss your particular requirements.



TEL:808-935-5562

16:10 No May 10,91



May 10, 1991

Mr. William Paty, Chairperson Department of Land and Natural Resources P.O. Box 621 Honolulu, HI 96809

Re: Clarification regarding rig test procedures.

Reference: Letter from William Teplow to William Paty, "Proposed changes to Plan of Operation, Puna Geothermal Venture", date May 2, 1991.

Dear Mr. Paty:

In Paragraph 4.1 of the above referenced letter it was stated that well flow through the horizontal muffler would be unabated for a period of 1-4 hours. Dispersion models on which the GRP and ATC conditions for flow testing are based show that this type of discharge may lead to H2S concentrations in excess of the 100 ppb limit allowed at the property boundary. Therefore, this procedure will not be used in the rig test. Any horizontal venting that will be used will be abated with caustic solution according to permit conditions.

A detailed rig test design and chemical treatment plan will be submitted to your office and the Hawaii Department of Health for approval prior to the rig test.

If you have any questions regarding this matter, please give me a call,

Sincerely,

PUNA GEOTHERMAL VENTURE

William J. Teplow

Field Manager

Manabu Tagamori, DLNR Dean Nekano, DLNR Eric Tanaka, DLNR John Lewin, M.D., DOH Chauncey Hew, DOH Nolan Hirai, DOH N. Clark

H. Richard

Kizis PUNA GEOTHERMAL VENTURE CONSTRUCTION

¹O. Box 1337

Hilo, Hawall 96721-1337

Telephone (808) 961-2786 •

Facsimile (808) 935-5562



May 2, 1991

Mr. William Paty, Chairperson Department of Land and Natural Resources P.O. Box 621 Honolulu, HI 96809

Re: Proposed changes to Plan of Operation, Puna Geothermal Venture.

Dear Mr. Paty:

Puna Geothermal Venture (PGV) is proposing to modify some aspects of the drilling program as presented in the Geothermal Resource Application Amendment, March 1989. For this purpose, PGV is hereby respectfully submitting for approval from your office the following changes:

- 1. Simultaneous use of two drill rigs on the PGV site.
- 2. Change in the designation and location of a well.
- 3. Change in sequence of drilling.
- 4. Execution of a 24-hour rig test.

The following is a description of each of these proposed changes:

1. SIMULTANEOUS USE OF TWO DRILL RIGS

PGV is arranging with True Drilling Company to bring a second drilling rig to drill three production wells on the PGV site at the same time that the Parker Rig No. 231 is continuing to drill. Air emissions and noise input the same time that the Parker Rig No. 231 is continuing to drill. Air emissions and noise input the same time for the same time for how been addressed in submittals to the Hawaii Department of Health (DOH) and Hawaii County Planning Department (CPD). A letter dated April 2, 1991 from our office to Dr. Lewin, Director, DOH, presented air quality data for the additional rig which demonstrated that project air quality standards will be met. Likewise, a letter dated April 5, 1991 to Bruce Anderson, Deputy Director, DOH, presented the environmental noise modeling on which we based our assertion that prevailing noise standards will be met. PGV is obligated to adhere to all air quality and noise emission standards as specified in the Geothermal Resource Permit (GRP) and Authority to Construct (ATC). Written approval from DOH and CPD offices will be received prior to moving the second rig on site.

Use of the second rig is expected to shorten the overall drilling time needed to complete the well field by approximately 5 months. The rig will work exclusively on Pad A drilling KS-9, 10, and 11 as shown in Table 2. The True rig is scheduled to commence work on June 1, 1991, provided that all approvals have been received from DCH, DLNR, and CFD.

(pgv\dlnrpoo)

PUNA GEOTHERMAL VENTURE CONSTRUCTION

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2. CHANGE IN THE DESIGNATION AND LOCATION OF A WELL

Well KS-7A will be drilled in lieu of KS-7 which is currently suspended. KS-7A will be drilled as an injection well on Pad D (Figure 1).

3. DRILLING SEQUENCE

The revised well drilling sequence and Well designations for the Parker rig and True rig are shown in the following tables:

TABLE 1 PARKER RIG NO. 231

DRILLING SEQUENCE	WELL NUMBER	WELL PAD	WELL TYPE
1	K\$~3	E	PRODUCTION COMPLETED
2	Ks-7	F.	INJECTION SUSPENDED
3	KS-1A REWORK	А	PRODUCTION REWORK SUSFENDED
4	KS~8	D	INJECTION DRILLING IN PROGRESS
5	KS-4	E	PRODUCTION
6	XS-5	E	PRODUCTION
7	KS-6	£	PRODUCTION
8	KS-7A	ם	INJECTION
9	K\$-12	В	PRODUCTION
10	KS-13_	B	PRODUCTION

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TABLE 2 TRUE RIG

DRILLING SEQUENCE	Well Number	WELL PAD	WELL TYPE
1	K5-9	λ	PRODUCTION
2	KS-10	A	PRODUCTION
3	KS-11	A	PRODUCTION

4. RIG TEST

puring or after the drilling of the bottom hole interval of production or injection wells including KS-8, which is currently being drilled, PGV may elect to execute a rig test. The purpose of this test is to define well flow characteristics and reservoir fluid chemistry while the drill rig is still on the well. In the event that flow results are not satisfactory, then further drilling operations such as deepening or redrilling the bottom hole section may be undertaken immediately.

Procedures for performing the rig test will consist of the following activities:

- 4.1 Rig up horizontal flowline including horizontal muffler and atmospheric flash tank or separator. Flowline will connect to the banjo box below double gate BCP.
- 4.2 RIH hole with open ended drill pipe to 2000' and unload well with compressed air.
- 4.3 Flow well through horizontal muffler for 1-4 hours unabated.
- 4.4 Transfer flow to separator and abate H2S in steam fraction. Steam and brine discharge Will be directed to a rock muffler. Abated flow will continue for up to 20 hours for a total of 24 hours of flow.

Previous flow test results indicate that a 24-hour rig test may eliminate the need for vertical venting and 10-day flow testing for each well as was contemplated in the Plan of Operations.

Each rig test will be approved separately by DOH through the procedure specified for venting and well testing as for the KS-3 well test. All GRP and ATC well testing conditions relating to notifications, emissions, and relocations will be followed for the rig test. A rig test facility plan and chemical abatement procedure will be submitted to DOH for approval.

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The well KS-8 is currently being drilled under Underground Injection Control Permit (UIC) No. 1529 authorization to construct for injection wells. The well is being completed with a production well casing string so that the option exists to convert the well to a production well with no modifications. The decision to convert the well to production will be based on the rig test. A separate application for conversion will be made to DLNR.

If you have any questions or comments regarding the above request for changes in the Plan of Operation, please give me a call.

Sincerely,

PUNA GEOTHERMAL VENTURE

William J. Teplow

Field Manager

cc: Manabu Tagamori, DLNR Dean Nekano, DLNR Erio Tanaka, DLNR John Lewin, M.D., DOH Chauncey Hew, DOH

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attachments: Figure 1

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