BEFORE THE BOARD OF LAND AND NATURAL RESOURCES

STATE OF HAWAII

In the Matter of the Designation of Kahauale'a, Puna, Hawaii as a Geothermal Resource Subzone	)	GS No. 8/27/84 TABLE OF CONTENTS OF WRITTEN TESTIMONY FOR CONTESTED CASE HEARING

TABLE OF CONTENTS OF WRITTEN TESTIMONY
FOR CONTESTED CASE HEARING

TESTIMONY OF CHARLES HELSLEY, PH.D.
FOR CONTESTED CASE HEARING

Chairman and Members of the Board of Land and Natural Resources, I am Dr. Charles Helsley, a professor of geophysics at the University of Hawaii and Director of The Hawaii Institute of Geophysics. I am testifying in my individual capacity today and not as a representative of the University. I have a Bachelor of Science and a Master of Science Degree in Geology from the California Institute of Technology and received my Doctor of Philosophy Degree in Geology from Princeton University. I have been actively involved in the field of geophysics for over 25 years.

I have reviewed the Statewide Geothermal Resource Assessment (Circular C-103) and the Geologic Hazards Impact Analysis of Potential Geothermal Resource Areas (Circular C-107) and believe that these documents are an excellent appraisal of the geothermal resource potential in the State of Hawaii. The Technical Committee's approach and analysis was very professional and thorough. Based on my experience as a geologist and as a participant in the evolution of geothermal energy in Hawaii, I wholly concur with the findings.

As far as geologic hazards are concerned, all parts of the rift zone of Kilauea are subject to lava inundation and this fact is well recognized by all the developers. Circular C-107 succinctly summarizes these potential hazards and the possible mitigation efforts that could be attempted. Almost all of the issues have been discussed previously in the Kahaualea EIS or the testimony related to the various hearings associated with the Kahaualea CDUA. This testimony is in fact the basis of some of the statements in C-107.

Perhaps one point brought out in C-107 needs to be emphasized. Since the geothermal resources of Kilauea are intimately associated with the cause of the volcanic hazard, it is essential for the welfare of the public that the geothermal development be distributed. Any individual eruption rarely, if ever, affects both the Lower and Upper East Rift Zone yet any one eruption could disrupt operations in either area. Thus it is essential for electrical power generating capacity stability that at least some facilities be developed in both areas. The distributed, yet interconnected, powerplant sites (A, B, C, D) proposed for the Kahaualea project clearly recognized this need for separation so that all of one's facilities would not be disturbed by any one event. But to do this one must have facilities. The geothermal resource subzone for the upper

portion of the East Rift zone as proposed by DLNR provides the necessary room to accomplish this separation. Moreover, the development plan presented in the CDUA provided a series of interconnected access roads into the area that is most likely to be affected by lava with the full realization that alternate evacuation routes would be necessary in case of emergency. In the proposed plan only the main access road which is unlikely to be subject to lava hazard is not redundant.

In evaluating the impact of geologic hazards, I believe that Figure 8 in "A Report on Geothermal Resource Subzones for Designation by the Board of Land and Natural Resources" should be revised slightly to show that the Lower Kilauea East Rift is subject to being impacted by ground cracks and ground subsidence. My opinion is based mainly on Figures 14 and 15 in Circular C-107. Figure 14 highlights the areas believed subject to relatively high risk of subsidence. Figure 15 delineates areas with high, medium, and low risk of surface rupturing. It is apparent to me that both the Lower and Upper East Rift is subject to high risk of subsidence and high risk of surface ruptures. All other things being equal, the Upper Rift Zone should not be excluded from geothermal subzone designations because of impacts of geologic hazards.

Finally, the current hazard associated with the Pu'u O eruption is an economic hazard, rather than a "people" hazard, that has always been recognized by the developers. This eruption will eventually end, as all eruptions do, and in my opinion the current activity supports rather than detracts from the economic viability of the proposed Kahaualea project.

Testimony of Gerald Niimi
for
Contested Case Hearing

I. BACKGROUND

Mr. Chairman and Members of the Board of Land and Natural Resources, this report is submitted on behalf of the True/Mid-Pacific Joint Venture and the Estate of James Campbell, developers and landowners of Kahauale'a located in the Puna District, Island of Hawaii. Kahauale'a is located in the East Rift Zone of Kilauea Volcano where geothermal steam and hot water have been discovered and is being produced approximately 13 miles away in the Lower Rift Zone.

The purpose of this report is to present information to the Board of Land and Natural Resources to support the Staff recommendation designating Geothermal Subzones in the State of Hawaii (Circular C-103). In addition to resource related areas, I have included additional information relative to Geologic Hazards(Circular C-107) and Geothermal Technology (Circular C-108).

I have worked directly in the geothermal industry since 1978 in engineering and management capacities. My expertise is in resource assessment, reservoir engineering, well testing, and operations management. I have advised clients in many areas of the U.S. and the world. My background is both

diverse and practical such that I believe my comments would be pertinent in planning and operating a geothermal project. Prior to working in the geothermal industry, I had 10 years of experience in the oil industry in both staff and supervisory positions. Those 10 years were spent working on major projects for Exxon Company USA in Texas, California, and Alaska. I am a Registered Petroleum Engineer in the State of California.

II. RESOURCE EVIDENCE IN KAHAUALE'A, UPPER EAST RIFT

Based on my review of the Statewide Geothermal Resource Assessment Report (Circular C-103), I strongly concur with the Technical Committee's recommendations. I also concur with their methodology in arriving at the location and extent of the high temperature geothermal resources. The Staff and Technical Committee should be complemented for their work, particularly in the face of a very tight time schedule.

In my report to the Technical Committee entitled "Evidence of Geothermal Potential in Kahauale'a", I presented all the information available to me to support the Developer's contention that a viable geothermal resource exists within the boundaries of Kahauale'a to justify an

exploration and development project. Probably the most compelling evidence is the fact that a commercial resource was found in the Lower Rift. Since the Upper Rift is the identical geologic province, the existence of a resource is highly probable. The Statewide Assessment carefully addressed the detailed evidence and arrived at essentially the same conclusion.

Even though there is a high probability of a commercial resource at Kahauale'a, the recent Kilauea eruption at Pu'u O requires further affirmation that drilling and production operations can be conducted safely if hazards are encountered and otherwise with minimum disturbance to the community and natural environment.

III. GEOLOGICAL HAZARDS

A lava flow is the most probable hazard that confronts a geothermal project in the East Rift Zone. Circular C-107 addresses, in some detail, the mitigating measures that are available and that could be employed. The frequency, location, and duration of eruptions are unpredictable such that certain risks are presented. During drilling the developer bears the entire risk. Even in the production

phase, private capital can bear the risk wholly or in part since the power plants can be privately financed and owned. The public will only bear a minimum risk no greater than the risk of routine weather related accidents to an electrical distribution system.

Drilling will be conducted with personnel safety and well security as high priorities. The following measures are planned:

1. As a practical matter, I would not advise drilling to be initiated near an active eruption.

2. Modern metallurgy is quite capable of handling situations where lava is encountered on the surface or sub-surface. Wellbore bridge plugs will be available to isolate any productive sub-surface formations if drilling operations must be curtailed. In addition, surface valves and blowout preventers will provide further security. The general practice is to install redundant valves or blowout preventers for reliaoility. The major supplier of geothermal wellheads and valves is W-K-M. They have stated that the wellheads and valves will not melt even if covered by a lava flow. Experiments by Sandia Laboratories in Kilauea Iki Lava Lake showed that casing can be installed even in molten lava and

that heat exchangers exposed to molten lava withstood the temperatures and gases.

3. Dikes or berms will be constructed where possible to divert a lava flow away from drill sites and power plants. In the Upper Rift Zone the topography has generally a steeper slope than the Lower Rift. As such, lava barriers would probably have better results there than in the Lower Rift Zone. Furthermore, the relative proximity to residential areas in the Lower Rift makes diversions more risky. There are more open lava fields in the Upper Rift where flows can be diverted.

4. Evacuation plans will be maintained and drills conducted to train personnel in proper procedures for an orderly operation.

5. Smaller plants may be utilized to reduce the size of each development and lessen vulnerability to lava flows. Areal diversification is the best protection for the public against disruption of electrical service. Most power plants can operate at higher than name plate ratings such that a 5 MW plant could generate nearly 10 MW. This could compensate for the loss of another power plant. The best illustration is the Occidental Geothermal Plant #1 in The Geysers where a

single turbine can produce twice its rated output by increasing the pressure and flow of steam to the turbine.

IV. GEOTHERMAL TECHNOLOGY

The high cost of geothermal operations has fostered the growth of technology in drilling, power plant design, and environmental protection systems. Industry continues to develop new equipment and skills to improve operating efficiency and safety for all concerned. Two areas, noise and H2S abatement, standout as having made outstanding progress toward responsible operations.

1. NOISE

Disturbance due to noise is a function of distance from the source and sound intensity. Noise levels at the drill site must be maintained below levels that may present a health hazard to rig personnel. The intent is to maintain operations that are in compliance with county noise guidelines. The loudest source of noise is when steam blows from a well without any muffling device. Since all air drilling will be conducted with a cyclone muffler (See Figure 3 in Circular C-108 Geothermal Technology), noise should be

under control. In fact, an additional noise abatement technique employed in The Geysers is to pump water into the blooie line. This reduces noise on the order of 10-20 db. During a well test, the well will always be connected to a muffler of some kind. In the event that blowing the well to atmosphere (venting) is the only alternative, then a temporary disturbance may occur in communities surrounding a drill site. The only condition that would force venting to occur would be if, for some reason, the well started to produce a large amount of rock and debris to the extent that plugging of the cyclone muffler or the rock muffler occurred. When such a condition occurs, the severity of the problem must be known, therefore venting is necessary to observe whether the condition is improving (cleaning up), staying the same, or getting worse. This knowledge is necessary in order for the field manager to decide on the proper course of action to correct the problem. Devices known as rock catchers can be installed downstream of the wellhead to remove the rock and prevent them from damaging the rest of the system. These devices must be custom made for the severity of rock problems.

HGP-A gives us an idea of what an operation might be like. Since the power plant started up, HGP-A has never been free vented without a muffler. This record is an important

reference point from which to measure noise impacts.

A noise-free operation is highly desired by the worker in a geothermal operation. No one wants to vent a well unless it is absolutely the last resort.

2. H2S ABATEMENT

Control of hydrogen sulphide(H2S) has a high priority in geothermal operations because of its potential hazard to personnel. Therefore, similar incentives to controlling noise apply to controlling H2S. People will not be available to work if the operation is unsafe and unpleasant. It is definitely to the developer's benefit to maintain the areas around power plants, drilling rigs, and wells in a safe, hazard free condition.

The technology for efficient H2S abatement is available in many forms depending on the resource and size of plant. No project can be planned, nor will they be approved, without such technology. In Geothermal Technology(Circular C-108, a statement is made on page 5 that well throttling as a means to reduce H2S emissions, may induce added stress which could damage a well's casing or wellhead. This could happen but is not likely because wells are designed to withstand at least

twice the expected pressure at the highest temperature expected. Further, expansion spools are available to allow as much as 4 feet of casing expansion or contraction. This device is widely employed on hot water wells in the Imperial Valley. The ability to throttle and shut-in wells is essential not only for H2S abatement but also for safety reasons. Fears that geothermal wells and power plants will spew poisonous gases is a myth held by the uninformed.

V. CONCLUSION

Geothermal is where it's found. It cannot be developed where desired. Therefore, a system of mutual respect and coexistence is a reasonable compromise that should be attainable. I do not see any reason why geothermal could not be developed in a responsible manner in Hawaii such that the industry and community would be proud of it.

TESTIMONY OF CHARLES H. LAMOUREUX FOR CONTESTED CASE HEARING

1. INTRODUCTION

My name is Charles H. Lamoureux. I am a professor of botany at the University of Hawaii at Manoa, where I have been employed as a faculty member since 1959. I mention this merely to establish my credentials since I am speaking today simply as a professional botanist; I am not representing the University of Hawaii nor the State of Hawaii. I hold a Bachelor of Science degree in botany from the University of Rhode Island, a Master of Science degree in Botany from the University of Hawaii, and a Doctor of Philosophy degree in Botany from the University of California at Davis. Since 1953 I have been actively involved in the study of Hawaiian botany and have conducted botanical field studies here. Since 1980 my research has centered especially on the study of Hawaiian ferns. The details of my experience, qualification and scientific publications are included in the curriculum vitae attached to this statement.

My familiarity with the botany of the proposed Kilauea Upper East Rift Zone (Kahauale'a) Geothermal Resource Subzone is based on a number of visits to nearby areas of the Kilauea Upper East Rift Zone between 1954 and

1976; on four days of fieldwork in the proposed Subzone itself in 1981 and 1982 (in connection with preparation of part of the environmental assessment for CDUA No. HA-3/2/82-1463); and on three more days of field work in and adjacent to the proposed subzone on December 1-3, 1984, just before the last phase of the Pu'u O eruption.

2. ADENOPHORUS PERIENS: AN UPDATE

In Kahauale'a and vicinity is the only known remaining large population of the endemic Hawaiian fern Adenophorus periens. (A small population of less than 100 plants, has recently been discovered on Molokai). This plant has been proposed for listing as an endangered species under Federal law, and is currently under review.

The record of In re the CDUA of the Estate of James Campbell (CDUA No. HA-3/2/82-1463) incorporates the testimony I presented on the distribution, ecology, and potential effects on this fern of proposed geothermal development at Kahauale'a. Today I wish to update that information based on recent studies of the status of the plant, after nearly two years of nearby volcanic eruptions, and a period of pronounced drought in the area.

The effects of recent volcanic eruptions have been of three types:

(a) some forest areas supporting the fern have been covered by lava flows originating from the Pu'u O vent;

(b) other forest areas have been impacted by tephra (cinder) fallout, associated with fountaining from the same vent; and

(c) the forest areas impacted by tephra, and additional forest areas, have been adversely affected by volcanic fumes.

In previous testimony estimated population size of Adenophorus periens was based on 6500 acres of forest in Kahauale'a of the type supporting 10 or more plants of the fern per acre. Recent lava flows have covered only a small part of this area. (The flows may have covered some additional fern habitat in the Wao Kele O Puna Natural Area Reserve, but this area was not included originally in estimating population size).

The tephra and volcanic fumes associated with eruptions from Pu'u O seem to have had a more severe effect on Adenophorus periens than have the lava flows. At one site about 1.5 miles NW of Pu'u O which we sampled on December 2, 1984, 50 of 51 Adenophorus periens plants appeared to be dead. This was in an area with about 2 inches of recently deposited tephra on top of the soil, pieces of the volcanic materials were still present on the tips of tree fern stems and in the crotches of tree

branches, and many of the plants here showed scorched or burned areas where the falling tephra had touched them.

Further from the vent the damage was less severe. For example, at a site about four miles N of Pu'u O, near the end of Captain's Drive, which we sampled on December 3, 1984, 57 of 100 plants were alive and apparently thriving, while 43 appeared to be dead. In this area there was no evidence of any recently deposited tephra.

While the tephra was obviously one source of damage at the first site, in both sampled sites it is probable that some of the damage observed resulted from the presence of volcanic fumes and some resulted from the rather severe drought which has recently occurred in the area. It was not possible to separate precisely the effects of the drought from those of the volcanic fumes. However, the effects of the drought would be expected to be similar throughout the area, while the volcanic fumes would be expected to be more severe closer to the vent.

There is no previous work on Adenophorus periens which would facilitate accurate prediction of what sort of recovery is likely to occur. Some other ferns in the areas have already started to recover, probably as a consequence of recent higher rainfall; some, including Adenophorus periens, are not yet showing significant recovery, but they may well do so with continued wet conditions. The recovery

rates and extents of most species would seem to be related primarily to rainfall, and it is also possible that the original damage from fumes and from cinders might well have been less pronounced had the plants not been suffering from drought at the time of the eruptions.

Given that there had not been eruptions of this magnitude in the Kahauale'a area for at least 200 years, I would suggest that the Adenophorus periens population in the area could eventually build up to its pre-eruption status again, although it might take several decades, or even a century or two to happen.

3. RELATIONSHIP BETWEEN CURRENT STATUS OF ADENOPHORUS PERIENS AND POSSIBLE GEOTHERMAL DEVELOPMENT IN THE PROPOSED SUBZONE

In comparison with conditions prior to the Pu'u O eruptions, the population of Adenophorus periens in the proposed Geothermal Resource Subzone is considerably lower today, and the activities associated with geothermal site development would probably result in direct damage to fewer plants of Adenophorus periens than was previously the case. Site development could interfere with recovery of the species, but the risks involved here are difficult to evaluate when the course of recovery is still uncertain. In any case, it is unlikely that interference with recovery would have any more significant effects on Adenophorus

periens than the project would have if it had been carried out under the conditions existing in the area before the recent eruptions.

The best remaining area of Adenophorus periens is now located outside and north of the proposed Geothermal Resource Subzone. It could probably be further protected by inclusion of some sort of sanctuary.

Of the four factors responsible for the recent decline of Adenophorus periens, lava flows, tephra deposits, emission of volcanic fumes and drought, the only one which might be affected in any way by geothermal development would be the emission of fumes from geothermal wells and power plants. It seems reasonable to assume that any air quality standards which have been or will be adopted will assure that quantities of emissions from geothermal development will be well below the amounts released during eruptions, and probably below the amounts necessary to cause damage to the native flora in the area. If such is the case, then the risks to the the flora associated wth geothermal development are no greater than they were at the time of the previous contested case hearing, and if the mitigation measures proposed then are adopted, the prospects for the long-term survival of Adenophorus periens should not be significantly different than they were then.