PUBLIC POWER CORPORATION

ATHENS, GREECE

MILOS GEOTHERMAL DEVELOPMENT

Consultants visit to Athens March 1989

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NATIONAL ENERGY AUTHORITY

VIRKIR CONSULTING GROUP LTD.

REYKJAVÍK, ICELAND

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MILOS GEOTHERMAL DEVELOPMENT

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Einar T. Eliasson,

April 1989

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CONSULTANT'S VISIT TO ATHENS MARCH 1989

In a telephone call from the PPC, on Feb. 28, Dr. Einar T. Elíasson was requested by Mr. A. Ghinis, Head of PPC's Geothermal Department, to come to Athens, March 6 or 7. The PPC had received a Technical Note from Mitsubishi Heavy Industries Ltd. containing a list of "Proposed Final Modification Items" for the Milos 2MW Geothermal Power Plant and a letter dated February 23, 1989, requesting from PPC outstanding payments, a Temporary and a Final Acceptance Certificate. The PPC needed prompt advise from Virkir/NEA regarding the above communications, because the management considered the Corporation bound by contract to reply to the MHI no later than March 15.

On receipt of a proposed travel plan for the trip from Dr. E. T. Elíasson the request was made formally on March 1, 1989,in a telex from Mrs. Rea Tassiou, Director of Alternative Energy Forms. The referenced Technical Note from MHI was express mailed to Virkir/NEA for perusal and comment, and received on March 3.

Prior to Dr. E. T. Elíasson's departure for Athens, the Report on the December 1988 Trip to Milos was completed. It was also made encompass Virkir/NEA's comments on the MHI Technical Note for PPC's expedience. Dr. Elíasson then hand carried ten copies of the report to Athens, where he delivered them at the offices of PPC.

The first of a three day series of meetings addressing MHI's above referenced Technical Note and letter requesting Temporary and Final Acceptance Certificate, started on March 7 in the office of Mr. A. Ghinis. Present at the meetings were the following of PPC's personnel: Mr. Ghinis, Mr. G. Koutinas, Mr. Koutroupis, Mrs. F. Vrouzi-Bacoboulou and Mrs. E. Delliou, and from Virkir/NEA Dr. E. T. Elíasson.

DAY 1: The first day started with a presentation of the Report on the December 1988 Trip to Milos with special emphasis on Virkir/NEA's comments regarding MHI's Technical Note and the Consultant's recommendations regarding the acceptability of the Milos Plant's reinjection system.

PPC informed the Consultant of the highly emotional anti- geothermal feeling amongst the people of Milos, which had among other things led to an atmospheric separator being dynamited. Threats have also been made to pour concrete into the production well cellar to make it inoperative. Ways and means of countering this last action were discussed at some length; the Consultant urging caution since the cure might lead to problems almost as serious as those caused by the threatened action.

It was also explained, that the PPC was currently negotiating with the Public Petroleum Corporation of Greece (DEP) to undertake the drilling of up to nine (9) geothermal wells in Milos or Nissyros. The latter alternative, which is less desirable because the surface exploration in Nissyros is not considered sufficiently advanced for effective production drilling, may have to be

selected in light of the present situation in Milos. The Consultant stated the ability and willingness of Virkir/NEA to partake in an expeditious exploration effort in Nissyros. He described a novel technique called the Transient Electromagnetic (TEM) technique, which has been developed in Iceland for geothermal resistivity surveying and recently applied in Djibouti by the NEA as a part of an UNDP exploration project. Upon request by Mr. Ghinis, the Consultant asked the NEA for a budget proposal for a TEM-survey to be carried out in Nissyros and PPC received same by telefax later that week. The TEM-survey proposal for Nissyros, which was sent to the PPC, is included in Appendix A.

After going over and discussing item for item Virkir/NEA's comments on the MHI Technical Note, Mrs. Delliou assisted by Dr. Elíasson drafted for Mr. Ghinis and Mr. Koutroupis a letter of reply to MHI's above referenced communication.

DAY 2: Mrs. Delliou's draft letter was perused by Mr. Ghinis and Mr. Koutroupis, both of whom offered highly constructive comments.

One important comment concerned the clean-up of the effluent ponds at wells M-1 and M-2 and disposing of the solid waste therein. Mr. Ghinis and Koutroupis interpreted the terms of the MHI/PPC Contract dealing with effluent disposal in such a way that the Contractor should furnish a complete solution to the problem, of which the ponds, their clean-up and the solid waste disposal were a salient part. The Consultant pointed out, that although this was a possible and a logical interpretation, the terms of the Contract were far from clear on this point. He suggested that the most important issue was to ensure a safe and a trouble-free operation of the plant, which in Virkir/NEA's opinion would be best achieved by effecting an acceptable improvement to the reinjection pump/control valve bottle-neck. Reminding PPC of the very intransigent attitude of MHI towards the pond clean-up issue during the December 1988 Meetings in Milos, Dr. Elíasson suggested that absolving MHI of the solid waste disposal issue might make the company more amenable to accepting some of the modifications proposed for the reinjection pump and control valve. After much deliberation, it was decided to adopt the last mentioned course of action and request instead from MHI the following modifications:

1) A Camflex II type control valve, which has given good service in heavy scaling environments in Iceland

2) An oversize, low speed, high internal clearance reinjection pump with an oversize motor and an electronic type speed control to be installed in parallel with the current two pump/one control valve installation.

The other important comment concerned the fact that as yet Virkir/NEA had not presented a final opinion on the acceptability of the Milos 2MW Plant's reinjection system. This opinion was needed from the Consultant at

this point in time, now that the Contract was drawing to a close. Dr. Elíasson, neither having the background information nor the expertise necessary, telephoned upon PPC's request to the NEA and asked the experts involved, Mr Sverrir Thorhallsson and Omar Sigurdsson, if they would be willing to comply with PPC's request for a written opinion on the general acceptability of the reinjection system. They responded with three telexes, which are enclosed in Appendix B.

While waiting for the reply from the NEA, which was con- sidered necessary for completing the reply to MHI's Technical Note, Mrs. Delliou started drafting a reply to MHI's written request for Temporary and Final Acceptance Certificate. Mr. Koutroupis and Dr. Elíasson assisted Mrs. Delliou in this matter. Opinions were quite divided on the issues presented in the letter and after lively discussions it was decided to defer it till the next day.

DAY 3: The day's work began with going over the draft reply to the Technical Note and discussing some minor qualifications and comments, which Mr. Ghinis and Mr. Koutroupis had to make on yesterdays version.

The telex from Virkir/NEA arrived the afternoon of March 9, one day after the request had been made. The contents of the telex were discussed and Dr. Elíasson requested to telephone again to Virkir/NEA for clarification on some of the points made. Virkir/NEA responded with telex no. 51/TH asking for further information to which PPC replied with telex no. ppc/deme/919/10.3.89 (Appendix B.). Dr. Elíasson explained Virkir/NEA's comments on the questions posed by PPC and it was decided to postpone finalizing the reply until such time as this later telex (telex no. 56/TH) had been received.

The work on the draft reply to MHI's letter, which had been deferred from the day before continued and was completed shortly after lunch. The principal issue taken as regards the two (2) plus two (2) month operation and the requested Acceptance Certificates, was the following:

1. The proposed one month accelerated turbine washing trials were approved on the condition that MHI accepted full responsibility and approved PPC's proposals on turbine washing procedure.

2. The PPC approved payment of outstanding moneys due MHI and the issuance of Acceptance Certificates as directed by the relevant terms of the Contract, provided MHI accepted the following final operating schedule.

3. The final operation will start with the one (1) month turbine washing trials, which will be followed by a two (2) month commercial operation and subsequently a two (2) month trial operation. The two (2) month trial operation is to complete what is considered left of the continuous

trial operating time agreed between MHI and PPC in a supplement to the Main Contract. The agreed modifications will have been completed prior to the continuous five (5) month operation, which will be carried out under MHI supervision and be entirely MHI's responsibility.

4. After completion of the commercial operation, which is specified in the MHI/PPC Main Contract, a Temporary Acceptance Certificate will be issued, provided the Milos 2MW Power Plant performs as decreed by the Contract. The Final Acceptance Certificate will on the other hand first be issued after the continuous five (5) month operation, provided the outcome of a plant inspection to be carried out right after turbine washing at the end of the above five month (5) continuous operation, proves acceptable to the PPC inspection team.

After perusal of the draft letter by Mr. Ghinis and Mr. Koutroupis, some minor changes were made and the letter prepared for typing pending receipt of Virkir/NEA's telex.

Several other matters were discussed in addition to the above. Amongst those was the possibility of arranging a lecture course on geothermal subjects, run by Virkir/NEA in Athens later this year. Such a course had earlier in the year been requested by and offered to the Public Petroleum Corporation (DEP), who informed Dr. Elíasson during his stay in Athens this time, that such a course would be of interest, but might only be attended by about 10 of DEP's staff. Mr. Ghinis, upon hearing of this, announced that PPC might be interested in partaking in this exercise.

Mr. Ghinis also informed Dr. Elíasson that Virkir/NEA would be given an opportunity to participate in bidding for the drilling in Nissyros, if the project comes off. Mr. Ghinis further intimated, that PPC might be interested in retaining Virkir/NEA's services for a composite interpretation of the results from diverse geophysical surface surveys, in order to obtain as clear a picture of the Nissyros geothermal field as possible prior to drilling.

Having completed his assigned task, Dr. Elíasson left Athens at 9:00 hours, Friday March 10, 1989, bound for Reykjavík, where he arrived at 18:45 hours local time.

E. Elíasson

Einar T. Elíasson,
Virkir/NEA

APPENDIX A

ORKUSTOFNUN
NATIONAL ENERGY AUTHORITY

Reykjavík, March 9th, 1989.

Ms. Rea Tassiou, director
Public Power Corporation
Direction of Alternative Energy Forms.
10 Navarinou Street, ATHENS 106 80

Information: A. Ghinis.

Dear Ms. Tassiou

With reference to a telephone call by Dr. Einar T. Elíasson on the 7th of March 1989 I send you short comments on possible geophysical exploration work in Nisyros and a estimated cost of doing a TEM-survey there.

We could start a TEM-survey in Nisyros in July 1989 or 2-3 months after reception of formal order from you and deliver a final report approximately 8 weeks after completion of the field work.

We would send a field crew of three experienced and qualified people (two geophysicists and one electrical engineer) to do the measurements. We estimate to perform at least two soundings per day and make preliminary inversion of the data at the end of each day. This approach enables us to scan the area initially by a coarse net of stations and then make additional measurements in interesting places according to the preliminary inversion of the data. A prelininary report wil be delivered at the end of the field work.

After return to our office we will make final interpretation of the collected data and take in account other existing and available data (geological, geophysical and geochemical) and complete our work in approximately 8 weeks. During four weeks of measurements we should be able to perform at least 48 soundings and thus make a dense net of measurements within the caldera and get a broad picture of the resistivity structure elsewere on the island.

We estimate the coast of a five week survey (four week of measurements, one week in transportation and preparation) to be close to 115.000 US dollars, excluding accomodation, sustenance and transportation and any taxes and customs duties within Greece but including the cost of mobilisation, travel from Iceland to Greece and back and

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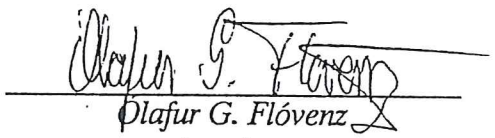
interpretation of the data. We expect you to supply us with two 4WD cars, 2 field assistants, one of them English speaking, accomodation and food at Nisyros and a room where we can service our equipment for example recharge it during the night and also make preliminary inversion of the data. If it is necessary to expand the survey we can offer an additional week for 22.000 US dollars, including interpretation. If the survey takes one week less the total sum will be reduced by the same 22.000 US$.

I would also like to inform you that we have experienced and highly qualified people in gravity and magnetotelluric work and excellent software to interpret and process such data in various ways.

A closer description on the TEM-method follows on a separate sheets.

In addition to this letter I will send you by mail some figures explaining the results of our previous TEM-surveys. If you need further information please do not hesitate to contact me.

Sincerely yours,



Ólafur G. Flóvenz
dr. scient
Head of geophysical department
National Energy Authority

GEOPHYSICAL PROSPECTING IN NISYROS

A short comment by Ólafur G. Flóvenz
National Energy Authority, Iceland

In a telephone call from Greece on March 7th 1989, Einar T. Elíasson asked me to make some comments on a geophysical exploration programme in Nisyros and estimate the cost of doing a TEM-survey there. Other possible prospecting methods are AMT-measurements and gravimetry.

Our experience is that geoelectrical measurements are the best methods to explore high temperature geothermal fields prior to drilling and make sensible basis for successful siting of boreholes. Gravity measurements can also be very helpful as they can give important structural information.

The most commonly used geoelectrical method, Schlumberger soundings (as well as other DC-sounding methods), is of limited use in an environment like in Nisyros. They are sensitive to topography and lateral vaiations in resistivity. As very long AB distance is neccessary (up to 4km in Nisyros) the apparent resistivity obtained in each sounding is an avarage resistivity over a very large volume of rocks which limits the resolution and depth penetration of the Schlumberger soundings seriously. In addition lateral inhomogenities such as the sea will affect the measured resistivity if the distance from the inhomogeneties to either of the current sources (A or B) is less than AB/2. This leads commonly to erroneous results such as false low resistivity layers. All these problems are absent or much less pronounced in TEM-soundings.

The principle of the TEM-sounding is as follows:

A square loop of cable (the transmitter loop) with a side length of 200-500m is put on the surface. Another but much smaller loop (receiver loop) is located at the centre of the transmitter loop. A strong current is transmitted into the transmitter loop for a while and a primary magnetic field is produced. Then the current is suddenly abrubted. The decaying magnetic field produces a inducion current within the earth below the loop and these currents give rise to a secondary magnetic field which decays with time. The time rate of change of the magnetic field is recorded in the receiver loop. From the signal in the receiver loop the electrical resistiviy of the earth below the loops can be calculated.

The TEM method has great advantages over the Sclumberger method:

1. Only a relatively flat area of 300*300m is necessary for each TEM-sounding while a straight line of 4km with flat topography is needed for similar Schlumberger sounding. Therefore the TEM-method is easy to perform in rough landscape.
2. The TEM is not very sensitive for lateral inhomogeneties far away from the transmitter loop while a Schlumberger sounding with AB=4000m is sensitive for lateral inhomogenities in resistivity in an area of 20 square kilometers.
3. The interpretation of the TEM-soundings is easier and less time consuming than the interpretation of Schlumberger soundings.

The depth penetration of the TEM-soundings is 600-1000m depending on the resistivity structure.

The National Energy Authority (Orkustofnun) of Iceland has been testing and running TEM-surveys in high temperature areas for some years with good results. Last summer we carried out a 6 week survey in Djibouti in East Africa where the resistivity structure is not very different from that of Nisyros. Based on this results we expect the result of a TEM-survey in Nisyros to point out the most interesting places for drilling. The information expected from a TEM-survey in Nisyros includes an exact determination of the groundwater table (anomalies in the watertable indicate geothermal upflow zones), lateral variation in the resistivity of the low resistivity layer in Nisyros (reflects changes in temperature and salinity) and what is probably most important, a possible local existence of a low resistivity anomaly within the otherwise high resistivity basement below the low resistivity layer indicating the main upflow zone of geothermal fluid. If such a upflow zone is narrow it could never be detected by Schlumberger soundings as they tend to average the resistivity over large volume of rock.

The AMT-method could in principle give information on the resistivity below the depth penetration of the TEM-soundings but some limitations of the method could make difficulties in an environment like on Nisyros. Our experince in magnetotelluric measurements shows that there are especially three factors which should be considered. Firstly lateral inhomogeneties could cause problems so two dimensional interpretation of the data is likely to be necessary. Secondly the coastal effect will cause trouble at frequencies lower than 1Hz. It will be almost impossible to correct for and will therefore always reduce the reliability of the results. Thirdly resistivity changes at shallow depth can easily cause big errors in the AMT-results (see a paper by Sternberg et al. in Geophysics vol 53 no 11, 1988, pp 1559-1468) but it is possible to correct for this effect by doing a TEM-survey prior to the AMT-survey at the same places.

Even though there are difficulties in the interpretation of AMT-measurements and the reliabiltity of the results of such a survey close to the sea can be questioned, it should be kept in mind that AMT-measurements are a cheap method so it might be worth wile to do it anyway.

Gravity measurements for structural purposes can be of great use in modelling the geothermal field and are therefore strongly recommended. The neccessary density of measurements and the accuracy of the corresponding elevation data depends on the sizes of the anomalies but the elevation should preferably to be known to an accuracy of 1 meter or less. If accurate elevation data is scarce it is recommended to make first an rough gravity map by measuring the gravity at sea level with 0.5-1km spacing around the island and then measure profiles with approx. 1km distance between stations along roads. The elevation at the gravity stations inland could be done with repeted measurements with high precision altimeter (barometer) and the best value found by least square approximations. By this an accuracy of 1-3 meters in elevation could be obtained. If the gravity anomalies obtained by this method are large enough to justify use of high precision altimeter for elevation determination the data density

can be increased by the same procedure. Our experience from Iceland suggest that the appropiate average distance between gravity stations should be 0.3-1.0km. If the anomalies turns out to be so weak that more accurate elevation data are required then it will be neccessary to use geodetic leveling to get the desired accuracy.

At the National Energy Authority we have recently developed software system to make directional filtering of gravity and magnetic maps. The purpose of this filtering is to sort out linear anomalies in different directions. The method is very powerful in detecting weak linear anomalies which are almost hidden by strong anomalies in different direction and is of great help in doing strucutral analysis from gravity and magnetic maps.

Reykjavík 9.3.1989

Ólafur G. Flóvenz
dr. scient

TRANSMISSION REPORT

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APPENDIX B

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MRS. REA TASSIOU, DIRECTOR
PPC, DIRECTION OF ALTERNATIVE ENERGY FORMS

INFO: A. GHINIS

RE: MILOS GEOTHERMAL POWER PLANT - BRINE LEVEL CONTROL

ACCORDING TO A REQUEST MADE TO DR. EINAR T. ELIASSON, WHO IS NOW IN ATHENS, VIRKIR/NEA WAS REQUESTED TO RECOMMEND A BRINE CONTROL VALVE TO REPLACE THE PRESENT ONE, AS PER VIRKIR/NEA RECOMMENDATION IN REPORT NO. 89@@@8, JUST SUBMITTED TO PPC.

A) A CONTROL VALVE OF THE TYPE MASONEILLAN CAMFLEX II HAS PROVEN @UITE RELIABLE AND TROUBLE FREE AT THE REYKJANES GEOTHERMAL CHEMICALS PLANT. THIS CONTROL VALVE SHOULD BE PROVIDED WITH A OVERSIZED ACTUATQR AND A POSITIONER.

B) SECONDLY WE RECOMMEND THAT PPC INVESTIGATE THE SECOND POSSIBILITY FURTHER, VIZ: TO INSTALL LARGER REINJECTION PUMPS, AND HAVE VARIABLE FREQUENCY CONTROL ADDED FOR SPEED REGULATION. IN THIS CASE THE CONTROL VALVE IS NOT NEEDED TO REGULATE THE FLOW, AND THUS SCALING AT THAT POINT IS MINIMIZED. THE ELECTRICAL CONTROL EQUIPMENT IS LESS EXPENSIVE THAN A CONTROL VALVE, AND REQUIRES PRACTICALLY NO MAINTENENCE.

THIS REQUIRES FURTHER ENGINEERING, BEFORE A SELECTION CAN BE MADE. FURTHER DETAILS CAN BE PROVEDED, SHOULD YOU REQUEST SO.

SINCERELY YOURS

SVERRIR THORHALLSSON, PROJECT MANAGER
VIRKIR/NEA

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&
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REK 1989/03/9 REF: 50/GB

MRS. REA TASSIOU, DIRECTOR
PPC DIRECTION OF ALTERNATIVE ENERGY FORMS

INFO: A. GHINIS

RE: MILOS GEOTHERMAL POWER PLANT - FINAL RECOMMENDATION

IN A VERBAL REQUEST MADE TO DR. EINAR T. ELIASSON, WHO IS NOW IN ATHENS, VIRKIR/NEA HAS BEEN REQUESTED TO FORWARD A FINAL RECOMMENDATION TO PPC ON THE REINJECTION SYSTEM OF THE 2 MW GEOTHERMAL POWER PLANT ON MILOS.

I. REINJECTION WELL:
THE REINJECTION WELL M-1 HAS RESPONDED UP TO NOW FABORABLY TO THE HOT INJECTION. ON THE PREMISE THAT THE QULAITY OF THE REINJECTED BRINE WILL NOT GET WORSE IN THE FUTURE, THE TIME UNTIL THE WELL NEEDS TO BE CLEANED OR REPLACED CAN BE EXPECTED TO BE 3 TO 5 YEARS. THE HOT REINJECTION METHOD IS THEREFORE ACCEPTABLE FOR WELL M-1.

II. REINJECTION SYSTEM:
THE REINJECTION WELL M-1 IS, HOWEVER, ONLY ONE PART OF THE REINJECTION SYSTEM, THOUGH AN IMPORTANT ONE. THE REINJECTION SYSTEM INCLUDES ALSO THE TRANSMISSION PIPE LINE, THE REINJECTION PUMPS, AND THE BRINE FLOW CONTROL VALVE. THE HIGH SCALING RATE IN THE HIGH PRESSURE PUMPS AND IN THE FIRST FEW HUNDRED METERS OF THE TRANSMISSION PIPE LINE (APPROXIMATELY 1 MM PER MONTH) ALONG WITH THE FREQUENT MAINTENANCE REQUIREMENTS FOR THE HIGH PRESSURE PUMPS AND THE CONTROL VALVE (REQUIRES OVERHAUL AND CLEANING ONCE A MONTH), MAKE THE HOT REINJECTION AT IT'S CURRENT STATE UNACCEPTABLE AS A BRINE DISPOSAL SYSTEM.

III. SUGGESTED REMEDIES:
ANY IMPROVEMENTS IN THESE TROUBLE AREAS ARE THEREFORE WORTHY OF CONSIDERATION, ALTHOUGH THEY DO NOT PROVIDE A FINAL CURE. FOR THIS VIRKIR/NEA HAS PROPOSED THE FOLLOWING IMPROVEMENTS:

A) REINJECTION PUMPS:
   INCREASE THE SIZE OF THE REINJECTION PUMP TO ALLOW GREATER CLEARANCES, AND USE SPEED CONTROL TO REGULATE THE FLOW IN STEAD OF THE CONTROL VALVE.
B) BRINE AEGING:
   INSTALL A RETENTION TANK BEFORE THE REINJECTION PUMPS, TO REDUCE THE SUPERSATURATION OF THE BRINE.
C) HYDROBLASTING CLEANING:
   THE MAINTENENCE FACILITIES FOR THE PLANT HAVE TO BE IMPROVED, AND A HIGH-POWER HYDROBLAST UNIT PROCURED FOR SCALE REMOAL. ACID BATHS WITH PROPER VENTILATION SHOULD BE INSTALLED FOR CELANING OF VALVE- AND PUMP PARTS.
D) CONTROL VALVE:
   IF ITEM A) IS NOT IMPLEMENTED, INSTALL NEW CONTROL VALVE OF THE MASONEILLAN CAMFLEX II TYPE.

NONE OF THESE METHODS WILL CURE THE PROBLEMS, WHICH ARE ASSOCIATED WITH THE BRINE ITSELF, BUT THEY SHOULD BE CONSIDERED AS WAYS TO IMPROVE THE OPERATION OF THE PLANT.

SINCERELY YOURS,

SVERRIR THORHALLSSON, PROJECT MANAGER
VIRKIR/NEA

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MRS REA TASSIOU, DIRECTOR
PPC DIRECTION OF ALTERNATIVE ENERGY FORMS
NAVARINOU STR. 10

INFO: A. GHINIS

RE: MILOS GEOTHERMAL PROJECT

IN A VIRKIR/NEA TELEX THIS MORNING (REF. 5Ø/GB) IT WAS STATED THAT THE HOT REINJECTION AT IT'S CURRENT STATE IS UNACCEPTABLE AS A BRINE DISPOSAL SYSTEM.

IN A SUBSEQUENT TELEPHONE CONVERSATION DR. EINAR T. ELIASSON, WHOIS NOW IN ATHENS, HAS INFORMED VIRKIR/NEA THAT A TENTATIVE AGREEMENT HAS SINCE BEEN MADE BETWEEN PPC AND MHI CONCERNING PLANT IMPROVEMENTS AND CONTINUED OPERATION OF THE POWER PLANT.

THESE NEW DEVELOPMENTS WERE UNKNOWN TO US THIS MORNING AND SINCE WE HAVE NOW BEEN ASKED TO CLARIFY OUR RECOMMENDATIONS WE KINDLY REQUEST THAT PPC PROVIDE VIRKIR/NEA WITH THE LATEST DECISIONS ON IMPROVEMENTS. ONCE VIRKIR/NEA HAS E RECEIVED SUCH INFORMATION, WE CAN REEVALUATE THE EARLIER RECOMMENDATION.

SINCERELY YOURS,

SVERRIR THORHALLSSON PROJ. MGR.

@
226310 DEI GR
2339 ORKUST IS

to : virkir/nea
attn : mr. s. thorhallsson

re : milos geothermal project

ref:(a) 51/th rek 1989/03/09

regarding your above ref (a) please be informed as follows :

during mr. e. eliasson presence at our athens offices, we discussed with him mhi's final technical proposal and exchanged experience and opinions about the necessary improvements be made at the milos power station in order to succed the continuous operation of the plant.

after the above said disconsions and taking also into consideration the virkir/nea's field report december 1988 of march 1989, ppc with mr. e. eliasson assistance wrote ppc's technical comments on mhi's final technical proposal.

as now ppc and mhi try to finalize the milos 2 mw project the modifications required from ppc should be considered as final.

especially for the brine disposal system ppc's position as it is written in the above mentioned ''ppc'c technical comments'' (not yet sent to mhi) is as follows :

hot reinjection system surface equipment modifications
ppc does not agree that appr. 3 weeks interval for overhauling of the reinjection pumps, even for the difficult quality of milos brine since mhi cannot specify the extension of the overhal period obtained by heating of the flushing water and ppc considers it is essential that brine can be reinjected at all times and bearing in mind that these will be the final modifications undertaken by mhi, suggests the following :

1) installing a third pump of lower speed, larger in size than the current ones, with larger internal clearances and oversized motor with speed control, in parallel with the existing two.

ppc realizes the lack of space in the reinjection pump well and suggest that the pump be installed on a steel frame at ground level if there is not any special safety or operational reason demanding that the pump be installed in a well.

mhi shall also ensure that sufficient spare parts for the existing reinjection pumps and for the new one are made available.

ii) ppc recommends that a camplex-type valve with an oversize stem and actuator be installed for the existing two reinjection pumps instead of a control valve identical to the present one (mhi technical proposal).

as ppc is contactually oblidged to reply to mhi about the acceptance or not of the hot brine reinjection, as brine disposal system for milos plant, please let us know, whether with the above described modifications on the surface equipment, the hot brine reinjection could be considered as acceptable.

in the case that, even after the above described modifications, your opinion remains that the ''hot reinjection is unacceptable as brine disposal system'', please clarify which exact modifications ppc must request from mhi, at this stage, (final technical improvements) concerning the brine disposal system in order to be acceptable.

as the answer to mhi is very urgent for ppc (contractual time limit) your prompt reply will be deply appreciated.

best regards

rea tassiou
director of alternative energy forms

c.c. mr. e. eliasson

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REK 1989/03/13 REF:56/TH

MRS. REA TASSIOU, DIRECTOR
PUBLIC POWER CORPORATION OF ALTERNATIVE ENERGY FORMS
NAVARINOU STR: 1E

INFO: E. DELLIOU
13. MARCH 1989

RE: MILOS GEOTHERMAL POWER PLANT - PPC'S TECHNICAL COMMENTS

REF: PPC TELEX PPC/DEME/919/10.3.89

IN YOUR ABOVE REFERRED TELEX YOU INCLUDE A SECTION FROM THE PPC'S TECHNICAL COMMENTS NOW IN PREPARATION, AND ASKS WHETHER WITH THE ABOVE DESCRIBED MODIFICATIONS ON THESURFACE EQUIPMENT, THE HOT BRINE REINJECTION COULD BE CONSIDERED AS A ACCEPTABLE. THE TWO SUGGESTED MODIFICATIONS ARE TO:
(A) INSTALL A THIRD REINJECTION PUMP WITH GREATER CLEARANCES AND SPEED CONTROL IN PARALLEL WITH THE PRESENT TWO PUMPS.
(B) REPLACE THE PRESENT CONTROL VALVE WITH A MASONEILLAN CAMFLEX II TYPE OF A CONTROL VALVE.
THESE WERE AMONG THE RECOMMENDATIONS VIRKIR/NEA MADE IN REPORT NO. 89003 TITLED MILOS GEOTHERMAL DEVELOPMENT, CONSULTANT'S FIELD REPORT: DECEMBER 1988 (SEE ALSO TELEX REF: 47/88 DATED 1989.03.09 FOR MORE DETAILS). VIRKIR/NEA CAN THEREFORE ONLY AGREE WITH THE REQUEST PPC IS MAKING TO MHI FOR IMPROVEMENTS. AT THIS TIME, HOWEVER, NO ONE CAN PREDICT BY HOW MUCH THESE IMPROVEMENTS WILL EXTEND THE TIME BETWEEN PUMP AND VALVE CLEANING AND REPAIR, BEYOND THE THREE WEEKS AT PRESENT.

EARLIER IN THE PROJECT, BEFORE REINJECTION WAS STARTED, VIRKIR/NEA WAS ASKED BY PPC WHAT THE CRITERIA FOR HOT REINJECTION SHOULD BE (REF. TELEX 707 DATED 28.8.76, TITLED, CRITERIA FOR JUDGING THE SUCCESS OF DIRECT HOT REINJECTION). QUOTING FROM THE TELEX, EQUIPMENT SUCH AS PUMPS, VALVES, INSTRUMENTS ETC. SHOULD HAVE A MEAN TIME BETWEEN OVERHAUL GREATER THAN 3 MONTHS. THE SAME RECOMMEDATION CAN BE FOUND IN MANY OTHER VIRKIR/NEA DOCUMENTS SUBMITTED TO PPC. UNTIL YOU HAVE ACHIEVED SUCH RESULTS IN PRACTICE VIRKIR/NEA CAN ONLY RECOMMEND THAT PPC SEEK IMPROVE-MENTS IN THE DESIGN AND OPERATION OF THE PLANT.

SEVERAL OTHER OPTIONS FOR IMPROVING THE REINJECTION SYSTEM WERE OFFERED BY VIRKIR/NEA IN THE REPORT, BUT TO QUOTE A PARAGRAPH FROM THE REPORT: NONE OF THESE METHODS WILL CURE THE PROBLEMS, WHICH ARE ASSOCIATED WITH THE BRINE ITSELF, BUT THEY SHOULD BE CONSIDERED AS WAYS TO IMPROVE THE OPERATION OF THE PLANT. ALTHOUGH A MINIMUM TIME BETWEEN OVERHAUL IS GENERALLY ACCEPTED AS THREE MONTHS, PPC HAS TO DECIDE WHAT IS ACCEPTABLE IN THIS CASE, CONSIDERING ALL OF THE FACTORS AND THE POLICY OF THE FIRM.

SINCERELY YOURS,
SVERRIR THORHALLSSON, PROJ. MGR.
VIRKIR/NEA

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