PUBLIC POWER CORPORATION

ATHENS, GREECE

MILOS GEOTHERMAL DEVELOPMENT

Budget Cost Estimate
for the Drilling of
9 Geothermal Wells
on Milos

ORKUSTOFNUN
NATIONAL ENERGY AUTHORITY

VIRKIR CONSULTING GROUP LTD.

REYKJAVÍK, ICELAND

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OS-88063/JHD-32B

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Report No: OS-88063 December 1988

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TABLE OF CONTENTS

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December 30, 1988

Subject: COST ESTIMATE FOR DRILLING 9 WELLS ON MILOS

Mrs. Rea Tassiou, director of DEME, requested at a private meeting in Athens on December 21, 1988 that Virkir/NEA prepare a cost estimate for drilling nine (9) new geothermal wells on the island of Milos. The cost estimate was to be based on the drilling programme described in a recent technical report from MERZ-DAL Geothermal Consultants to PPC entitled "Provisions of Scientific and Engineering Services for Milos and Nisyros Geothermal Projects. Locations, Drilling and Testing Programmes for 5 New Wells in the Island of Milos. November, 1988".

As described by Mrs.Tassiou, the nine wells are to be drilled in the period June 1989 to March 1990 and it will take two drilling rigs to complete the work within the time interval specified. Virkir/NEA was moreover requested to have the cost estimate ready and on your desk by January 2-3, 1989.

In spite of the short time allowed, Virkir/NEA has completed the cost estimate and the results are given in the following two tables; one for drilling contractor services, the other for material costs. The basic data, such material lists, drilling schedules, rig sizes etc, required to prepare this estimate have been taken directly from the MERZ-DAL report.

The Virkir/NEA cost estimate is based on the following:

1. The Tentative Drilling Programme given by MERZ-DAL.
2. The estimated Drilling Contractor's rates are largely based on results obtained last year from international bidding for geothermal drilling in Kenya and Djibouti. In our opinion they reflect current international rig rates. Amongst qualifed drilling contractors there is not a great price difference - the prices quoted by the six contractors, who qualified in Kenya, ranged in price to within 15%. The rig rates have been adjusted slightly downwards for Greece, because logistics there are easier, and the prices assume standard contractor responsibilities.
3. The materials are from EEC countries and the reported prices manufacturers' current FOB prices plus a 30% markup for shipping and handling. Competitive bidding may provide lower prices in some cases. For some minor items it was not possible to have recent price information in the short time allowed, and at this time of year.

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4. The local site conditions and costs could not be confirmed, and the reported cost for site preparation and water supply etc. is therefore based on similar projects in other countries.

5. The cost estimate is in German Marks (DEM) (Tables 1 and 2), and conversion to Drachmas is based on the current exchange rate (1 DEM = 80 Drachmas) plus a 20% adjustment for inflation and currency risk over the contract period. This adjustment is based on an assumed annual inflation rate of around 15% for Greece.

6. The Drachma cost estimate also includes a 25% withholding tax, according to the Greek regulations.

The resulting prices given in Drachmas are summarized in the following:

	DEM	DRACHMAS
1. Average price of drilling each well	2.719.778	326.373.360
2. Average price of materials for each well	1.845.490	221.458.800
Total costs per well	4.565.268	547.832.160
Total cost for nine (9) wells (x 9)	41.087.412	4.930.489.440

This high cost of the new wells is partly due to the well design adopted, which requires more materials, such as casing etc., than is typically specified for geothermal wells. The mud and cement requirements specified also seem high. This is clearly shown comparing the material and design for the new wells with that of previous wells drilled for the PPC on Milos.

We hope that the enclosed cost estimate is sufficiently detailed to allow you to evaluate the Tentative Drilling Programme of MERZ-DAL, and to serve you as a guide in selecting the drilling contractor for the job. The drilling programme is, however, not detailed enough as it stands to go out for international competitive bidding, which is an advisable procedure to obtain experienced drilling contractors and sound bids.

Virkir/NEA have access to experienced geothermal drilling contractors, who were amongst the final six (6) qualifying for both Kenya and Djibouti. We also have access to experienced geothermal drilling engineers, borehole geologists, borehole loggers as well as up to date equipment and computer software for data evaluation and interpretation. Further to that we have a long experience in geothermal well testing and reservoir evaluation. Due to our intimate knowledge of the geothermal field in Milos gained through four (4) years of fruitful cooperation with DEME, we feel confident in offering the PPC any or all of the above services, and hope this offer will be of interest to you.

Sincerely yours,

Sverrir Thorhallsson,
Project Manager

Virkir/NEA
1988.12.29

TABLE 1. DRILLING OF NINE GEOTHERMAL WELLS ON MILOS
COST ESTIMATE FOR DRILLING SERVICES

Tentative Drilling Programme according to MERZ-DAL, Nov. 1988

ITEM DESCRIPTION	UNIT PRICE DEM	TOTAL UNITS 9 WELLS	COST 9 WELLS DEM
1. Rig mobilization and transport to Milos	1.500.000	2	3.000.000
2. Rig demobilization from last well site	250.000	2	500.000
3. Site preparation, cellar, etc. (per well)	800.000	9	7.200.000
4. Rig transport between well sites (per well)	170.000	7	1.190.000
5. Drilling rig and crew hourly rate (DEM/hr):			
Working rate	680	12.000	8.160.000
Stand-by rate	375	1.200	450.000
Air compressor rate, working	210	1.000	210.000
Air compressor rate, stand-by	30	11.000	330.000
6. Water supply to drill site:			
Intake facilities, pipeline, storage pond	1	900.000	900.000
For pumps working (DEM/hr)	200	10.000	2.000.000
For pumps stand-by (DEM/hr)	30	2.000	60.000
7. Labour hourly rate, local res. (DEM/hr):			
Skilled labour	2,5	12.000	30.000
Unskilled labour	2,0	24.000	48.000
8. Local transport :			
Light trucks x 2 (DEM/km)	5,5	20.000	110.000
Heavy truck with crane x 1 (DEM/km)	9,0	10.000	90.000
Crane x 1 (DEM/day)	800	250	200.000
Total est. drilling contractor costs for 9 wells			24.478.000
Average contractor cost per well			2.719.778

Virkir/NEA
1988.12.29

TABLE 2 DRILLING OF NINE GEOTHERMAL WELLS ON MILOS
COST ESTIMATE FOR MATERIALS

Based on material requirements from MERZ-DAL Nov. 1988

ITEM DESCRIPTION	NO. OF UNITS PER WELL	UNIT PRICE DEM	TOTAL UNITS 9 WELLS	COST 9 WELLS DEM
Bits:				
Bits 26", milled tooth (pcs)	1	29.752	9	267.767
Bits 17 1/2", insert (psc)	4	30.711	36	1.105.612
Bits 12 1/4", insert (pcs)	10	19.639	90	1.767.513
Bits 8 1/2", insert (pcs)	1	9.802	9	88.220
Casings:				
Casings 20" J55 106.5# Buttress (m)	250	444	2.250	998.390
Casings 13 3/8" J55 68# Buttress (m)	750	282	6.750	1.903.473
Casings 9 5/8" J55 40# Buttress Slotted (m)	950	249	8.550	2.127.411
Casings 9 5/8" C75 43.5# Hydrill SEU (m)	750	207	6.750	1.399.613
Shoe 20" 106.5# Buttress (pcs)	1	4.142	9	37.276
Wood plug for 20" casing cementation (pcs)	1	575	9	5.177
Shoe 13 3/8" 68# Buttress (pcs)	1	1.081	9	9.733
Cementing Collar 13 3/8" 69# Buttress (pcs)	1	2.681	9	24.126
Top plug 13 3/8" (pcs)	1	690	9	6.213
Bottom plug 13 3/8" (pcs)	1	690	9	6.213
Centralizers 13 3/8" and Stop Collars (pcs)	40	184	360	66.269
Positive Central. 13 3/8" and Stop Coll. (pcs)	2	230	18	4.142
Guide Shoe 9 5/8" 40# Buttress (pcs)	1	725	9	6.523
Liner Swivel 9 5/8" 40# (pcs)	1	2.301	9	20.709
Liner Hanger 9 5/8" 40# Buttress (pcs)	1	12.195	9	109.758
Setting Sleeve 9 5/8" with 6' ext. (pcs)	1	1.841	9	16.567
Positive Centralizer 9 5/8" and Stop Coll. (pcs)	20	138	180	24.851
Tie Back Stem 9 5/8" 43.5" Hydr. SEU (pcs)	1	1.841	9	16.567
Orifice Float Collar 9 5/8" 43.5# Hydr. (pcs)	1	1.841	9	16.567
Dual Stage Cementing Collar Hydr. SEU (pcs)	1	21.169	9	190.523
Top Plug 9 5/8" (pcs)	1	345	9	3.106
Bottom Plug 9 5/8" (pcs)	1	345	9	3.106
Baker Lock Paste (box)	6	58	54	3.106
1 Geothermal Wellhead composed of:				
Temporary Casing Head 20" 2000 psi W.P. (pcs)	1	4.602	2	9.204
Casing head 12" 3000 psi W.P. (pcs)	1	11.505	9	103.545
Temporary 12" ANSI 900 Gate Valve Saf-T-Gard or actuated (pcs)	1	46.020	2	92.040

ITEM DESCRIPTION	NO. OF UNITS PER WELL	UNIT PRICE DEM	TOTAL UNITS 9 WELLS	COST 9 WELLS DEM
Expansion Spool 12" 3000 psi W.P. - 10" 3000 psi W.P. complete of Packing Unit, (pcs)	1	31.165	92	80.483
T E E 10" 3000 psi W.P. (wing 10" 2000 psi W.P.) (pcs)	1	18.408	9	165.672
Valves 10" ANSI 900 (pcs)	2	33.098	18	595.757
Valve 10" ANSI 600 (pcs)	1	25.463	9	229.166
Valve 3" 3000 psi W.P. (pcs)	5	8.695	45	391.297
Fittings (pcs)	1	9146	9	82.318
Base Mud Materials and Chemicals:				
Caustic Soda (tons)	10	1.451	90	130.631
Bentonite or seawater wettable clays (tons)	200	456	1.800	821.106
CMC L.V. (tons)	5	4.976	45	223.938
CMC H.V. (tons)	5	5.909	45	265.926
Sodium Polyacrylate (tons)	15	9.953	135	1.343.628
Lignosulfonate (tons)	15	2.737	135	369.498
Emergency Mud Materials:				
*For three (3) wells (Virkir/NEA assumption):				
Calcium Carbonate (tons)	100	622	300	186.615
Bentonite or seawater wettable clays (tons)	50	456	150	68.426
L.C.M. (tons)	20	1.286	60	77.134
Lime (tons)	5	415	15	6.221
Sodium Carbonate (tons)	1	1.037	3	3.110
Sodium Bicarbonate (tons)	1	1.659	3	4.976
Free Pipe Spot (drums)	12	1.111	36	40.010
*For nine (9) wells (Virkir/NEA ass.):				
Defoamer (drums)	2	829	18	14.929
H_2S Scavenger (drums)	10	705	90	63.449
O_2 Scavenger (drums)	5	1.145	45	51.506
Film Forming Amine (drums)	5	1.891	45	85.096
Cementing Materials:				
Cement Class G (tons)	450		4.050	
Silica Flour (tons)	150	684	1.350	478.979
Diatomite/Perlite (tons)	100		900	
$CaCl_2$ (ton)	1	415	9	900
Retarder (tons)	1	11.612	9	25.200
Turbulence Iducer (tons)	1	33.176	9	72.000
(Fluid Loss Additive) (tons)	1	0	9	0
Flow Check (drums)	40	829	360	72.000
Total est. cost of materials for 9 wells				16.609.417
Average material cost per well				1.845.490