

# **Demonstration of Improved Energy Extraction from a Fractured Geothermal Reservoir**

**A progress report for the period 1.10.1997 - 31.3.1998  
for the Thermie project GE-0060/96**

**Hita- og Vatnsveita Akureyrar, HVA  
Orkustofnun - National Energy Authority  
Uppsala University  
Hoechst Danmark A/S  
RARIK - Iceland State Electricity**

**OS-98023**

**May 1998**

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## **1. SUMMARY**

The design phase of the demonstration project at Laugaland lasted from September 1996 through July 1997. It involved design of the return water pipeline, injection pumps, automatic monitoring- and control system and the seismic monitoring network, as well as logging of the injection wells.

The manufacturing phase started in November 1996 by production and construction of the return water pipeline, followed by modification of existing seismic software and manufacture of monitoring equipment, injection pumps and seismic equipment. This phase lasted until the end of September 1997.

The assembly and installation phase lasted from June through September 1997. It involved assembly and installation of the monitoring- and control system, the injection pumps and the seismic network.

The commissioning phase of the project took place in August and September 1997, by start-up of the seismic network and reservoir monitoring. This was followed by the start-up of the re-injection on the 8th of September.

The monitoring phase of the project started on the 1st of October 1997. Presently reinjection into two wells is continuing at rates of 8 and 6 l/s, respectively. Comprehensive monitoring is on-going, and preliminary results of the project are positive.

The progress of the project has been mostly in line with the time- and cost schedule of the corresponding contract and no major deviations have occurred yet.

## **2. PROGRESS REPORT**

### **2.1 Introduction**

The structure of this progress report is based on the items described in the detailed breakdown of the project in table 21 of Annex I of the project contract, with some minor deviations. Work on the project started in September 1996 and the progress until end of March 1998 is described. A progress diagram for the project is shown on the following page.

### **2.2 Design**

#### *2.2.1 Overall design of the project*

This part of the project was mostly finished during the preproposal phase. The overall design was reviewed in connection with the more detailed design of individual parts of the project, resulting in only minor changes from the original design. The overall design of the project is under constant re-evaluation during the progress of the project, however.

### 2.2.2 Logging

The first logging phase was completed during the autumn of 1996 under the supervision of Orkustofnun. This included sonic-, resistivity- and borehole televiewer logging of the two re-injection wells as well as several other conventional logs.

### 2.2.3 Pipeline design

The general specifications for the return-water pipeline were available in October 1996 and its detailed design in November 1996. The design work was carried out by the technical department at HVA, with the assistance of consulting engineers.

### 2.2.4 Design of pumps

The design of pumps for the re-injection system was completed at the end of February 1997. This was carried out by the technical department of HVA in co-operation with Orkustofnun, RARIK and consulting engineers.

### 2.2.5 Design of seismic monitoring system

The design of the seismic monitoring system started in December 1996 and was finished by the end of June 1997. The design was the responsibility of the University of Uppsala in co-operation with Orkustofnun and HVA.

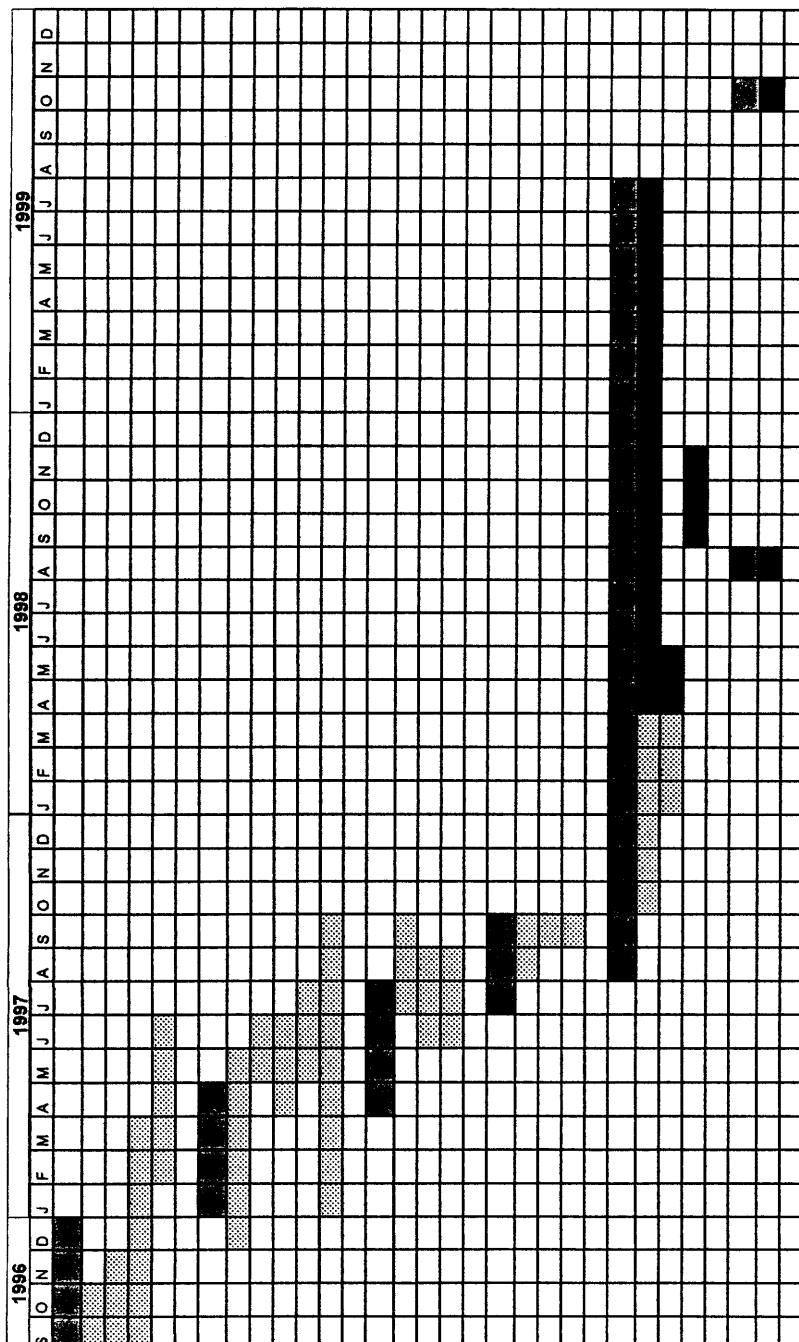
Field investigation of the Laugarland area, regarding selection of sites for the six seismic stations, was performed on January 17th. Good bedrock was found on hill-sides west and east of the river Eyjarfjardara, but the flat valley floor is covered by thick sediments, which cause unfavourable conditions for precise detection of high frequency seismic signals. The valley bottom was therefore avoided in site selections.

Genetic Algorithms were used to invert for the best location of the stations. The criteria used in the inversion was maximising the variance of the: a) distances up to 3500 m, b) angles from the source to the stations, and c) the angles within quadrant modules. The results showed a very strong dependency on the exact location of the closest station. To find a suitable site for the closest station, noise tests were carried out April 1997 to record the ground motion from pumps in the hot water production wells, which can produce large signals especially close to the resonance frequency of the pumps.

Contacts was established with the National Telephone Company P&S to get information about the availability of telephone lines in the area. The type of connection we were seeking ranged from: a) simple modem connection, b) X.25 connection, c) Internet subscription or d) ISDN connection. We selected the simple modem connection which was the alternative with the best price-performance ratio for our purpose.

Several alternatives were considered regarding the three component seismometers. Two main types of seismometers are available; active elements with feedback electronics and passive elements which do not include any electronic circuitry (pure mechanical). Considering the frequency range, the background ground motion and the

**Progress diagram for project GE-0060/96.**  
 The diagram shows the initial time schedule, the actual progress until 31.3.1998 and expected time schedule from that date



**Legend:**

- Time schedule according to the contract
- Actual/expected time schedule 31.3. 1998
- Time periods for the progress report



size of the expected seismic signals we excluded the active seismometers due to the noise characteristics of these devices. The final decision made was to purchase separate passive 4.5 Hz elements for each component (vertical, North-South and East-West) and assemble them in a robust housing. The assemble work was carried out by Orkustofnun.

There are not many digitizers on the market meeting the requirements of up to 1000 samples per second, high dynamic range and very low electronic noise. The units with the best price-performance ratio were found in the HRD-24 24 bit digitizer from Nanometrics in Canada.

## **2.3 Manufacture**

### *2.3.1 Pipeline construction*

Manufacture of plastic pipes for the 12 km long return-water pipeline from Akureyri to Laugaland was completed in early December 1996. Hocht Danmark was responsible for this part of the project with aid of a subcontractor, Set hf. The pipeline has an inner diameter of 150 mm.

An open tender for the construction of 8 km of the pipeline was launched in December 1996. The remaining 4 km were constructed by the staff of HVA as well as all welding and transport of the pipeline. A total of 5 contractors made bids. The lowest bid was accepted and a subcontract signed in December 1996. The lowest bid amounted to 38%, while the highest one was 83%, of the expected cost. These unusually low prices result from limited activities among contractors during the main winter season. The pipeline construction started in late December 1996 and 8 of the 12 km had been finished by the end of February 1997, in spite of difficult weather conditions. The remainder of the pipeline had been completed by the end of May 1997. The pipeline is buried at a depth of 1.2 m to avoid freezing in winter-time.

### *2.3.2 Monitoring equipment*

Automatic, computer-controlled equipment for monitoring various parameters describing the injection, and the response of the Laugaland reservoir to the injection, were manufactured in May and June 1997. These parameters include the flow-rate and temperature of the return-water leaving the pumping station in Akureyri, rate of injection, water temperature and well-head pressure for both injection wells, as well as flow-rate and water temperature for the three production wells at Laugaland. In addition the system monitors the frequency of the pump-motors involved.

### *2.3.3 Pumps*

Pumps for injecting the return-water into the two injection wells were manufactured during April through June 1997. These have capacities of 20 l/s at 30 bar pressure and 10 l/s at 10 bar pressure, respectively. A pump intended for pumping the return water from the pumping station in Akureyri towards Laugaland was manufactured during the same period.

### *2.3.4 Seismic equipment*

Digitizers of the type HRD-24 were ordered from a Canadian company, Nanometrics. Six vertical and twelve horizontal 4.5 Hz geophones were ordered from the company SENSOR in the Netherlands. An individual calibration test was ordered for each geophone element. Seven Pentium PC's with internal modems and one Sun SPARC Station was ordered from a local dealer. Optic cables for the data communication between digitizer in the seismic station vaults and the on-site computers were ordered from the National Telephone Company P & S. Power backup units are installed for all digitizers and all computers, both at the seismic stations and at HVA headquarters.

### *2.3.5 Modification of seismic software*

During December 1996 and January 1997 work focused on software development related to the interfacing of the Nanometrics HRD digitizer to the SIL Utility Software. Tests were performed for 500 samples per second on three channels using Pentium computer. The results showed a good performance. Configurable logging facilities was implemented for logging various "State Of Health" parameters available from the digitizer.

During the period Mars through May work concentrated on adaptation of the phase-detection procedure to the 500 cps configuration and the higher frequency content of the data. Adaptation of the rest of the seismological software was carried out during May through July. This involved among other things the change from using single float representation of coordinate and time information into double precision. This was necessary due to the small size of the network area. To make the interactive view of the seismic activity more sensible, information regarding source location is displayed relative to the injection borehole, both in distance and angle.

Work during May and June involved software development and configuration of the standard Unix-to-Unix communication package (UUCP). Some modifications of the acquisition software related to the communication between the stations and the center was done. This mainly involved modifications or rewriting of Unix shell scripts.

## **2.4 Assembly/Installation**

### *2.4.1 Monitoring equipment*

The automatic injection- and reservoir monitoring system was installed and tested during the period from July through September 1997. This work was carried out by the technical department of HVA, Raftákn Consulting Engineers and Raftó Electrical Contractors. Data collected by this system, as well as instantaneous information on the status of the injection and production wells, can be accessed through computers in the pumping station of HVA in Akureyri, as well as in its headquarters. Consequently these data are transmitted by e-mail to Orkustofnun for evaluation and analysis.

### *2.4.2 Pumps*

The pumps for pumping the return water from Akureyri to Laugaland, and hence into the injection wells, were assembled and installed during the period from June through



August 1997. This was done by the staff of HVA and RARIK with the aid of Raftó Electrical Contractors.

### *2.4.3 Seismic installations*

The vaults housing the seismic stations, and the associated infrastructure, were constructed during the period from late May through the middle of July 1997. Some less sophisticated vaults were constructed for additional mobile seismic stations to be operated in case of observed seismic activity located in the reservoir. The mobile stations are made available by Uppsala University. If seismic activity on faults within the reservoir is detected by the permanent network four additional mobile stations will be activated within 52 hours to secure the best possible recordings of micro-earthquakes on these faults. This is done to ensure the best available data on active faults due to the injection allowing for very accurate relative location of the micro-earthquakes leading to precise fault orientation.

The seismic network was installed during the period of July 15th through July 30th. Technically the network was in operation on July 30th and remotely available for parameter tuning and adjustments from Uppsala through Internet. During August and September the main work concentrated on tuning the network parameters for the highest possible micro-earthquake detection ability, within the reservoir. The large amount of earthquakes north and north-east of the area (50 to 100 km distance) are avoided by using different detection parameters for different regions. The day by day control of the network operation is done in Uppsala through the Internet. All saved earthquake data is also transferred to Uppsala through the Internet at night.

## **2.5 Commissioning**

### *2.5.1 Seismic network startup*

The start-up of the seismic network took place in late August.

### *2.5.2 Startup monitoring*

The start-up of the monitoring took place during September 1997. This involved water-level measurements in a number of observation wells inside, as well as outside, the Laugaland area. It also involved the collection of water samples from hot water production wells, and a return water sample, for chemical analyses, which will be used as references during later phases of the project. Furthermore, the start-up of monitoring involved additional logging of the two injection wells, as well as start-up of the automatic monitoring system. Some fine-tuning of the automatic monitoring system was also performed in September. In addition, the start-up included a step-rate injection test of the main injection well.

### *2.5.3 Startup injection*

The start-up of the actual injection took place on the 8th of September 1997. A nearly constant injection rate of 8 l/s was maintained through the remainder of September. The temperature of the return-water, as it was injected, was around 21°C. The well-head pressure increased slowly to about 6 bar-g during this period. At the end of the

start-up period a chemical tracer was injected into the injection well. The recovery of this tracer in the production wells in the Laugaland area will be monitored carefully.

## 2.6 Monitoring

The monitoring phase of the re-injection project at Laugaland started on October 1st 1997. Since that time 8 l/s have been continuously injected into well LJ-8. In addition 6 l/s have been injected into well LN-10 since January 29th 1998. A total of about 160,000 m<sup>3</sup> of water have, therefore, been injected during the six months since the beginning of the monitoring phase. This may be compared to the production from the field, which has varied between 40 and almost 130 l/s during the same period, amounting to about 800,000 m<sup>3</sup>.

In addition to production- and injection rates; water temperatures, well-head pressures and water-levels are observed by the automatic monitoring system mentioned above. These values are collected every ten minutes. The return water temperature has varied between 7 and 21 °C, and well head pressures have varied between 0 and 8 bars-g. Water levels are also monitored manually in a number of wells inside, as well as outside, the Laugaland area. Two tracer-tests have been successfully completed, each lasting a little over two months. The first one began at the end of the start-up period of the project, while the second one was started during the middle of March. A total of almost 500 tracer-samples, from a number of production wells, both inside and outside the Laugaland area, have been collected and analyzed during these tests.

During the first six months of the monitoring phase step-rate injection tests have been conducted for each of the injection wells. These will be repeated later during the project such that changes in well injectivity, due to scaling etc., may be detected. The temperature profiles of both wells have been measured during active reinjection. This has enabled fairly accurate estimates of the relative importance of different feed-zones in the main injection well, LJ-8. It is believed that these estimates are more accurate than results of spinner-logging.

No seismic activity, induced by the reinjection, has yet been detected by the seismic network. It should be kept in mind that well-head pressures have only been about 8 bars-g or less up to the present time. Much higher pressures (30 bars-g) are planned for later stages of the monitoring phase, making the occurrence of micro-earthquakes much more likely. The chemical content and water temperatures for the production wells in the Laugaland area have been monitored carefully. No changes, which may be attributed to the reinjection, have been noted in these parameters.

Only preliminary analysis of the great amounts of data collected, has been carried so far. In addition to continued monitoring and testing, later parts of the monitoring phase will include detailed data analysis and numerical model development. Preliminary results of the Laugaland reinjection project are, however, positive. On the one hand, water level measurements indicate that hot water production from the field may be increased significantly by reinjection. On the other hand, tracer test results show that an untimely thermal breakthrough is not to be expected in production wells in the field.

### **3.1 Financial report from Hita- og Vatnsveita Akureyrar**



**PART D - FINANCIAL REPORT Nr. 1**  
(to be submitted in 4 copies)

Nature of costs (1) :... Total cost

Name and address of the contractor: **Hita- og Vatnsveita Akureyrar**

Contract Nr: **GE- 0060-96**

Name of Financial Officer: **Franz Árnason**

Telephone: 354-461-2110

Telefax: 354-461-2591

Place designated for financial audit:

**Hita- og Vatnsveita Akureyrar, Rangárvöllum, 600 Akureyri**

Exchange rate applies for national conversion / ECU currency (4):

78,5642
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A) Expenditure incurred during the period from ...01.10.1997...to...31.03.1998

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	2.449.200	31.175
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	160.452	2.042
4. Subcontracting	2.564.080	32.637
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	633.170	8.059
<b>Indirect costs (10):</b>		0
8. Personnel overheads (Annex I)	1.993.200	25.370
9. Equipment overheads (Annex 3)		0
<b>VAT (12)</b>	0	0
<b>TOTAL A</b> (to be carried over)	7.800.102	99.283

30% contribution of the commission	3.120.041	29.785
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(*) See page "Contractors Declaration" and Part D of Annex II to the contract for declaration and explanatory notes on the expenditure submitted.
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Carry Over of Total A

7.800.102

99.283

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	19.429.600	246.383
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	14.866.227	188.516
4. Subcontracting	15.702.956	199.126
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	72.960	925
7. Other expenditure (9)	8.329.535	105.625
<b>Indirect costs (10):</b>		
8. Personnel overheads (Annex I)	15.063.000	191.011
9. Equipment overheads (Annex 3)	0	0
Adjustment of previous expenditure (11)	0	0
<b>VAT (12)</b>		
<b>TOTAL B</b>	<b>73.464.278</b>	<b>931.586</b>
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	21.878.800	277.558
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	15.026.679	190.558
4. Subcontracting	18.267.036	231.763
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	72.960	925
7. Other expenditure (9)	8.962.705	113.684
<b>Indirect costs (10):</b>		
8. Personnel overheads (Annex I)	17.056.200	216.381
9. Equipment overheads (Annex 3)	0	0
<b>VAT (12)</b>	0	0
<b>TOTAL C</b>	<b>81.264.380</b>	<b>1.030.869</b>

## CONTRACTORS CERTIFICATE (13)

We certify that

- the above expenditure was incurred for the work specified in the contract and that it was necessary to the proper performance of this work;
- this involves actual expenditure which falls within the definition of allowable costs specified in the contract;
- all the necessary authorizations were obtained from the Commission;
- all the documents justifying the costs are available for the purpose of audit;
- any necessary adjustments to expenditure reported in previous expenditure statements have been incorporated in this statement.

Date: 18.5.1998

Date: 18.05.1998

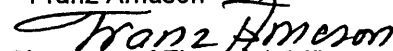
Name of Project Manager

Magnús Finnsson

  
Signature of Project manager

Name of Financial Officer

Franz Árnason

  
Signature of Financial Officer

### NOTES

- 1 Insert the applicable indication: TC (total cost); AC (additional cost).
- 2 Cross out the useless indication - for the associated contractor, see Article 3 of Annex II. Each associated contractor has to give a separate statement of expenditure via the contractor with whom he is associated - his costs should not appear in the statement of expenditure of the contractor concerned.
- 3 The associated contractor must specify the contractor's name with which he is associated.
- 4 The exchange rates must correspond to the rate indicated in Article 21, paragraph 1 of Annex II.
- 5 Separate details need not be provided for each specific category in the annexes that follow.
- 6 Equipment must be depreciated - see Article 19, paragraph 2 of Annex II.
- 7 See Article 19, paragraph 4 of Annex II.
- 8 See Article 19, paragraph 5 of Annex II.
- 9 See Article 19, paragraph 6 of Annex II. They must be approved by the Commission.
- 10 See Article 20 of Annex II. The contractors who apply the method of additional cost can attribute up to 20% of the direct costs to personnel, material, travel, consumables, computer costs and other high costs specific to the project.
- 11 Does not apply to the first cost statement. Any correction has to be detailed and justified.
- 12 For any invoice or note specific to the project, drawn up by a supplier where the amount exceeds ECU 2.500, see Article 3, paragraph 2 of the contract.
- 13 The technical and the financial officer responsible must sign the certificate.
- 14 This concerns the person appointed as being directly responsible for the completion of the work - see Article 2, paragraph 3 of Annex II.

**1. PERSONNEL AND OVERHEADS**

ANNEX 1

Staff categories (1)	Names A	Number of hours or of days B	Wage rate (2) C	Time scale for overheads (3) D	Amount for personnel (B) * (C)	Assembling overheads (B) * (D)
Project leader	Franz Árnason	62	2200	1800	136.400	111.600
Engineers:	Ármi Árnason	955	2200	1800	2.101.000	1.719.000
	Magnús Finnsson	23	2200	1800	50.600	41.400
	Árni Kristjánsson	10	2200	1800	22.000	18.000
	Vignir Hjaltason	36	2200	1800	79.200	64.800
Technicians and equivalents	Diverse technicians	0	2000	1640	0	0
Other categories (to be specified)	laborers	48	1250	800	60.000	38.400
Sub-totals					2.449.200	1.993.200
<b>TOTAL (Personnel + overheads)</b>						<b>4.442.400</b>

1 Use the categories corresponding to the contractor's valid salary structure.

2 This wage rate contains the items indicated in Article 19, paragraph 1 of Annex II.

3 The principles applicable to overheads are indicated in Article II of the contract. This column should remain empty when contractors apply the method of additional cost.



2. CONSUMABLE EQUIPMENT EXPENDITURE

ANNEX 3

(national currency)

Date of purchase	Accounting reference	Suppliers	Type of equipment	Amount
1. Consumables/ materials				
1.1.- Direct purchases				
1.3- Internal supplies	550978-0169	HVA	Miscellaneous	160.452
Total consumables				160.452
Overheads of equipment				

(1) Where necessary , indicate the overheads specifically applicable to the equipment (quality control, handling and storage expenses)

**4. SUBCONTRACTING**  
**(Services, Studies, Consultancy)**

ANNEX 4

(national currency)

Invoices		Suppliers (1)	Brief description of type of assistance	Amount
Dates	ACC. Refer.			
	6661076-0119	Raftákn	Electronic & comp. serv.	271.123
	560175-0869	VN	Engineering consulting	232.794
	560197-2769	Halldór Baldursson	Pipeline construction	546.595
	500269-5379	OS	Scientific consulting	871.406
		Diverse	div.	94.278
	510269-1879	Póstur og sími	Telecommunication	211.421
	620385-0509	Alprent		100.000
		Dr. S. Th. Rögnvalds		79.170
	560187-2039	Tölvutæki	Software consulting	306.551
	530696-2949	Nett/ Intís	Software consulting	71.103
	590279-0219	Ösp	Pipeline construction	-930.000
	590279-0220	Ösp	Pipeline construction	709.639
<b>TOTAL 4</b>				<b>2.564.080</b>

1) Any relationship , ownership or control between the supplier and contractor must be declared

**7. OTHER EXPENDITURE**

ANNEX 7

(national currency)

Invoices		Suppliers	Type of expenditure	Amount
Dates	ACC. Refer.			
	460289-1309	Sandbl. og málmh	Construction material	14.182
	470269-1469	Möl og Sandur	Construction material	77.281
	710269-3869	Þór	Construction material	62.116
	510883-0559	Kemia	Construction material	53.253
	550978-0169	HVA	Construction machines	0
	661093-2509	Skinnaíðnaður	Construction material	15.000
	600966-0149	Radiovinnustofan	Construction material	22.980
	550978-0169	HVA	cars	326.741
	550978-0169	HVA	lorries	22.429
		Diverse	construction material etc.	39.188
<b>TOTAL 7</b>				<b>633.170</b>

**8. SUMMARY OF THE PARTICIPANTS' CONTRACTUAL COSTS (IN ECU)**

ANNEX 8

For the period from: 1-okt-97 to: 31-mar-98

Title of the project: **Demonstration of improved energy extraction from a fractured geothermal reservoir**  
 Contract nr: **GE-0060-96**

The participant's name <sup>1</sup>	Position <sup>2</sup>	Total costs (ECU)	community contribution (ECU)	Nature of the costs <sup>3</sup>	Comments <sup>4</sup>
HVA	COO	99.283	29.785	TC	
OS	CR	66.916	20.075	TC	
UU	CR	11.655	3.496	TC	
Rarik	CR	4.036	1.211	TC	
Hoechest	CR			TC	
<b>TOTAL</b>		<b>181.890</b>	<b>54.567</b>		

The original copy of the statement of expenditure signed by each participant is attached.

Certified by the person(s) appointed by the contractors (5) as being essential to work carried out under the contract.

Name: Franz Árnason  
 Position: director  
 Signature: *Franz Arnason*  
 Date: *28/3 1998.*

Name:  
 Position:  
 Signature:  
 Date:

- 1) Coordinator, contractors, associated contractors and, if the contract requires it, principal subcontractors.
- 2) Insert the corresponding indication: COO (coordinator), CR (contractor), AC (Associated contractor).
- 3) Insert the corresponding indication: TC (total costs), AC (additional costs).
- 4) When a participant does not give a statement of expenditure, indicate "no statement" in the column "Remarks". If the statement of expenditure of a participant covers more than one period, indicate the number of periods in the column "Remarks". Separate cost statements must be given for each period.
- 5) Or persons designated for the purpose of Article 2 (b), paragraph 2 of Annex II

### **3.1 Financial report from Orkustofnun**



**PART D - FINANCIAL REPORT Nr 1**  
(to be submitted in 4 copies)

Nature of costs (1) :...Total cost.....

Name and address of the contractor: **Orkustofnun**

Contract Nr :**GE-0060-96**

Name of Financial Officer: **Jón Haukur Guðlaugsson**

Telephone: 569-6000

Telefax: 568-8896

Place designated for financial audit:

Orkustofnun, Grensásvegur 9, 108 Reykjavík, Iceland

Exchange rate applies for national conversion / ECU currency (4):

78,5642

A) Expenditure incurred during the period from ...1.10.97...to...31.03.1998.

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	1.631.701	20.769
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	0	0
4. Subcontracting	0	0
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	2.357.790	30.011
<b>Indirect costs (10):</b>		0
8. Personnel overheads (Annex I)	1.267.709	16.136
9. Equipment overheads (Annex 3)		0
<b>VAT (12)</b>	0	0
<b>TOTAL A</b> (to be carried over)	5.257.200	66.916

30 % contribution of the commission	1.577.160	20.075
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(\*) See page "Contractors Declaration" and Part D of Annex II to the contract for declaration and explanatory notes on the expenditure submitted.

Carry Over of Total A

5.257.200

66.916

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	3.066.901	38.499
2. Depreciation of Equipment (6)		
3. Consumable equipment (8)		
4. Subcontracting		
5. Data-processing costs (8)		
6. Travel and related costs (7)		
7. Other expenditure (9)	1.423.900	18.056
<b>Indirect costs (10):</b>		
8. Personnel overheads (Annex I)	2.382.749	29.911
9. Equipment overheads (Annex 3)		
Adjustment of previous expenditure (11)		
<b>VAT (12)</b>		
<b>TOTAL B</b>	<b>6.873.550</b>	<b>86.466</b>
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	4.698.602	59.268
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	0	0
4. Subcontracting	0	0
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	3.781.690	48.067
<b>Indirect costs (10):</b>		
8. Personnel overheads (Annex I)	3.650.458	46.047
9. Equipment overheads (Annex 3)	0	0
<b>VAT (12)</b>	0	0
<b>TOTAL C</b>	<b>12.130.750</b>	<b>153.382</b>



## CONTRACTORS CERTIFICATE (13)

We certify that


- the above expenditure was incurred for the work specified in the contract and that it was necessary to the proper performance of this work;
- this involves actual expenditure which falls within the definition of allowable costs specified in the contract;
- all the necessary authorizations were obtained from the Commission;
- all the documents justifying the costs are available for the purpose of audit;
- any necessary adjustments to expenditure reported in previous expenditure statements have been incorporated in this statement.

Date: 1998-05-19

Date: 1998-05-19

Name of Project Manager  
Guðni Axelsson

Name of Deputy Financial Officer  
Guðrún Aðalsteinsdóttir

  
Signature of Project manager

  
Signature of Deputy Financial Officer

### NOTES

- 1 Insert the applicable indication: TC (total cost); AC (additional cost).
- 2 Cross out the useless indication - for the associated contractor, see Article 3 of Annex II. Each associated contractor has to give a separate statement of expenditure via the contractor with whom he is associated - his costs should not appear in the statement of expenditure of the contractor concerned.
- 3 The associated contractor must specify the contractor's name with which he is associated.
- 4 The exchange rates must correspond to the rate indicated in Article 21, paragraph 1 of Annex II.
- 5 Separate details need not be provided for each specific category in the annexes that follow.
- 6 Equipment must be depreciated - see Article 19, paragraph 2 of Annex II.
- 7 See Article 19, paragraph 4 of Annex II.
- 8 See Article 19, paragraph 5 of Annex II.
- 9 See Article 19, paragraph 6 of Annex II. They must be approved by the Commission.
- 10 See Article 20 of Annex II. The contractors who apply the method of additional cost can attribute up to 20% of the direct costs to personnel, material, travel, consumables, computer costs and other high costs specific to the project.
- 11 Does not apply to the first cost statement. Any correction has to be detailed and justified.
- 12 For any invoice or note specific to the project, drawn up by a supplier where the amount exceeds ECU 2.500, see Article 3, paragraph 2 of the contract.
- 13 The technical and the financial officer responsible must sign the certificate.
- 14 This concerns the person appointed as being directly responsible for the completion of the work - see Article 2, paragraph 3 of Annex II.

## 1. PERSONNEL AND OVERHEADS

ANNEX 1

Staff categories (1)	Names A	Number of hours or of days B	Wage rate (2) C	Time scale for overheads (3) D	Amount for personnel (B) * (C)	Assembling overheads (B) * (D)
Project leader	Guðni Axelsson	423	2600	2020	1.099.800	854.460
Experts	Grímur Björnsson	2	2600	2020	5.200	4.040
	Sigvaldi Thordason	59	2600	2020	153.400	119.180
	Krisján H. Sigurðsson	16,5	2600	2020	42.900	33.330
	Guðrún Sverrisdóttir	32	2600	2020	83.200	64.640
	Ómar Sigurðsson	6	2600	2020	15.600	12.120
	Helga B. Sveinbjörnsdóttir	31	2600	2020	80.600	62.620
	Ólafur G. Flóvenz	29	2600	2020	75.400	58.580
	Eifur Sif Sigurðardóttir	18	2600	2020	46.800	36.360
	Oddur Sigurðsson	2	2600	2020	5.200	4.040
	Vigdís Harðardóttir	7,5	2600	2020	19.500	15.150
Technicians and equivalents					0	0
					0	0
Other categories (to be specified)	Sylvia Jóhannsdóttir (assistant)	3	1367	1063	4.101	3.189
				Sub-totals	1.631.701	1.267.709
				TOTAL (Personnel + overheads)		2.899.410

1 Use the categories corresponding to the contractor's valid salary structure.

2 This wage rate contains the items indicated in Article 19, paragraph 1 of Annex II.

3 The principles applicable to overheads are indicated in Article II of the contract. This column should remain empty when contractors apply the method of additional cost.

**7. OTHER EXPENDITURE**

ANNEX 7

(national currency)

Invoices		Suppliers	Type of expenditure	Amount
Dates	ACC. Refer.			
		internal	Well logging	320.967
		internal	Chemical analyses	2.036.823
<b>TOTAL 7</b>				<b>2.357.790</b>



### **3.1 Financial report from Uppsala University**



**PART D - FINANCIAL REPORT Nr. 2**  
(to be submitted in 4 copies)

Nature of costs (1) : Total cost  
Name and address of the contractor /  
Uppsala University

Contract Nr: **GE-0060-96**  
Name of Financial Officer: Inga-Stina Hansson  
Telephone: 46-18-183312  
Telefax: 46-18-181640  
Place designated for financial audit:  
Uppsala University, Villavaegen 16, S-75236 Uppsala

Exchange rate applies for national conversion / ECU currency (4):

8,53929

A) Expenditure incurred during the period from .....1.10.1997.....to...31.03.1998.....

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	35 752	4 187
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	0	0
4. Subcontracting	0	0
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	12 412	1 454
7. Other expenditure (9)	20 569	2 409
<b>Indirect costs (10):</b>		0
8. Personnel overheads (Annex 1)	30 790	3 606
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
<b>TOTAL A</b> (to be carried over)	99 523	11 655

30% contribution of the commission	29 857	3 496
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(\*) See page "Contractors Declaration" and Part D of Annex II to the contract for declaration and explanatory notes on the expenditure submitted.

Carry Over of Total A

99 523

11 655

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	486 227	58 238
2. Depreciation of Equipment (6)		
3. Consumable equipment (8)		
4. Subcontracting		
5. Data-processing costs (8)		
6. Travel and related costs (7)	4 760	551
7. Other expenditure (9)	1 316	152
<b>Indirect costs (10):</b>		
8. Personnel overheads (Annex I)	418 744	48 433
9. Equipment overheads (Annex 3)		
Adjustment of previous expenditure (11)		
VAT (12)		
<b>TOTAL B</b>	<b>911 047</b>	<b>105 374</b>
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	521 979	60 425
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	0	0
4. Subcontracting	0	0
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	17 172	2 005
7. Other expenditure (9)	21 885	2 561
<b>Indirect costs (10):</b>	0	0
8. Personnel overheads (Annex I)	449 534	52 039
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
<b>TOTAL C</b>	<b>1 010 570</b>	<b>117 029</b>



**CONTRACTORS CERTIFICATE (13)**

We certify that

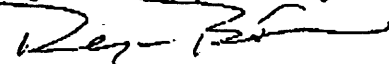
- the above expenditure was incurred for the work specified in the contract and that it was necessary to the proper performance of this work;
- this involves actual expenditure which falls within the definition of allowable costs specified in the contract;
- all the necessary authorizations were obtained from the Commission;
- all the documents justifying the costs are available for the purpose of audit;
- any necessary adjustments to expenditure reported in previous expenditure statements have been incorporated in this statement.

Date:

980528

Name of Project Manager  
Reynir Böðvarsson

Signature of Project manager



NOTES

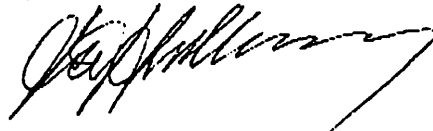
Date:

MAY 28, 1998

Name of Financial Officer

~~Inga Stina Hansson~~  
LEIF LUNDQVIST

Signature of Financial Officer



- 1 Insert the applicable indication: TC (total cost); AC (additional cost).
- 2 Cross out the useless indication - for the associated contractor, see Article 3 of Annex II. Each associated contractor has to give a separate statement of expenditure via the contractor with whom he is associated - his costs should not appear in the statement of expenditure of the contractor concerned.
- 3 The associated contractor must specify the contractor's name with which he is associated.
- 4 The exchange rates must correspond to the rate indicated in Article 21, paragraph 1 of Annex II.
- 5 Separate details need not be provided for each specific category in the annexes that follow.
- 6 Equipment must be depreciated - see Article 19, paragraph 2 of Annex II.
- 7 See Article 19, paragraph 4 of Annex II.
- 8 See Article 19, paragraph 5 of Annex II.
- 9 See Article 19, paragraph 6 of Annex II. They must be approved by the Commission.
- 10 See Article 20 of Annex II. The contractors who apply the method of additional cost can attribute up to 20% of the direct costs to personnel, material, travel, consumables, computer costs and other high costs specific to the project.
- 11 Does not apply to the first cost statement. Any correction has to be detailed and justified.
- 12 For any invoice or note specific to the project, drawn up by a supplier where the amount exceeds ECU 2.500, see Article 3, paragraph 2 of the contract.
- 13 The technical and the financial officer responsible must sign the certificate.
- 14 This concerns the person appointed as being directly responsible for the completion of the work - see Article 2, paragraph 3 of Annex II.

ANNEX 1

1. PERSONNEL AND OVERHEADS

Staff categories (1)	Names (A)	Number of months (B)	Wage rate (2) (C)	Time scale for overheads (3) (D)	Amount for personnel (B) * (C) (B) * (C)	Assembling overheads (S) * (D) (S) * (D)
Project leader	R. Böövarsson	0,5	35 752	30 790	17 876	15 395
Engineers	B. Lund R. Slunga	0 0,5	35 752 35 752	30 790 30 790	0 17 876	0 15 395
Technicians and equivalents					0	0
Other categories (to be specified)					0	0
Sub-totals					35 752	30 790
TOTAL (Personnel + overheads)						66 542

1 Use the categories corresponding to the contractor's valid salary structure.

2 This wage rate contains the items indicated in Article 19, paragraph 1 of Annex II.

3 The principles applicable to overheads are indicated in Article II of the contract. This column should remain empty when contractors apply the method of additional cost.

ANNEX 6

6. TRAVEL AND SUBSISTENCE FOR CONTRACTOR'S STAFF

Date	Place	Purpose	Name	Expenditure (national currency)		
				Travel	Hotel & expenses	TOTAL
<u>6.1. Trips inside the EU</u>						
<u>6.2. Trips outside the EU<sup>1</sup></u>						
1997-07-31	Iceland	Network installation	Björn Lund	3 922		3 922
1997-07-31	Iceland	Network installation	Ragnar Slunga	3 532	1 266	4 798
1997-12-03	Iceland	Network installation	Reynir Bödvarsson	3 692		3 692
				<b>TOTAL 6</b>		<b>12 412</b>

1) See Article 19. paragraph 4 of Annex II

**7. OTHER EXPENDITURE**

ANNEX 7

(national currency)

Invoices		Suppliers	Type of expenditure	Amount
Dates	ACC. Refer.			
1997-12-15	16033630	Telia	Network communication	20569
<b>TOTAL 7</b>				<b>20569</b>

### **3.1 Hoechst Danmark as**

**No financial report for this period from Hoechst Danmark as since the participation of Hoechst was finished before the starting time of this report.**



### **3.1 Financial report from RARIK**





**PART D - FINANCIAL REPORT Nr 1**  
(to be submitted in 4 copies)

Nature of costs (1) :... Total cost.....  
Name and address of the contractor: **Rarik**

Contract Nr :**GE-0060-96**  
Name of Financial Officer: **Tryggvi Aðalsteinsson**  
Telephone: 569-6000  
Telefax: 568-8896  
Place designated for financial audit:  
Rarik, Óseyri 9, 600 Akureyri, Iceland

Exchange rate applies for national conversion / ECU currency (4):

78,5642

A) Expenditure incurred during the period from 01.10.1997....to...31.03.1998.

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	0	0
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	0	0
4. Subcontracting	0	0
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	317.065	4.036
<b>Indirect costs (10):</b>		0
8. Personnel overheads (Annex I)	0	0
9. Equipment overheads (Annex 3)		0
VAT (12)	0	0
<b>TOTAL A</b> (to be carried over)	317.065	4.036

30 % contribution of the commission	126.826	1.211
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(\*) See page "Contractors Declaration" and Part D of Annex II to the contract for declaration and explanatory notes on the expenditure submitted.

Carry Over of Total A

317.065

4.036

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	791.200	9.983
2. Depreciation of Equipment (6)		0
3. Consumable equipment (8)	0	0
4. Subcontracting	0	0
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	233.861	2.966
<b>Indirect costs (10):</b>		
8. Personnel overheads (Annex I)	632.880	7.986
9. Equipment overheads (Annex 3)	0	0
Adjustment of previous expenditure (11)	0	0
<b>VAT (12)</b>		
<b>TOTAL B</b>	1.657.941	20.935
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
<b>Direct costs:</b>		
1. Personnel	791.200	9.983
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	0	0
4. Subcontracting	0	0
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	550.926	7.002
<b>Indirect costs (10):</b>		
8. Personnel overheads (Annex I)	632.880	7.986
9. Equipment overheads (Annex 3)	0	0
<b>VAT (12)</b>	0	0
<b>TOTAL C</b>	1.975.006	24.971

## CONTRACTORS CERTIFICATE (13)

We certify that

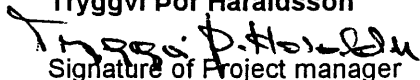
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- this involves actual expenditure which falls within the definition of allowable costs specified in the contract;
- all the necessary authorizations were obtained from the Commission;
- all the documents justifying the costs are available for the purpose of audit;
- any necessary adjustments to expenditure reported in previous expenditure statements have been incorporated in this statement.

Date: 18.5. '98

Date: 18.5. '98

Name of Project Manager

Tryggvi Þór Haraldsson

  
Signature of Project manager

Name of Financial Officer

Tryggvi Aðalsteinsson

  
Signature of Financial Officer

### NOTES

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**7. OTHER EXPENDITURE**

ANNEX 7

(national currency)

Invoices		Suppliers	Type of expenditure	Amount
Dates	ACC. Refer.			
31/5 - 31/8		RARIK	Electrical power	317.065
<b>TOTAL 7</b>				<b>317.065</b>



