

Demonstration of Improved Energy Extraction from a Fractured Geothermal Reservoir

**A progress report for the period 01.04.1998 - 30.09.1998
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-98061

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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 reinjection on the 8th of September.

The monitoring phase of the project started on the 1st of October 1997. At the end of September 1998 about 390,000 m³ had been reinjected into two wells, corresponding to an average rate of 12 l/s. Return water is currently injected at a rate of 20 l/s into one of the wells, at a well-head pressure of 2.5-3.0 MPa. Comprehensive monitoring is on-going, and results of preliminary data interpretation 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 September 1998 is described. The data collected, as well as results of some preliminary analysis, are presented in the mid-term report for the project, issued last September. 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 pre-proposal 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 reevaluation 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 televiwer logging of the two reinjection 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 reinjection system was completed at the end of February 1997. This was carried out by the technical department of HVA in cooperation 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 cooperation with Orkustofnun and HVA.

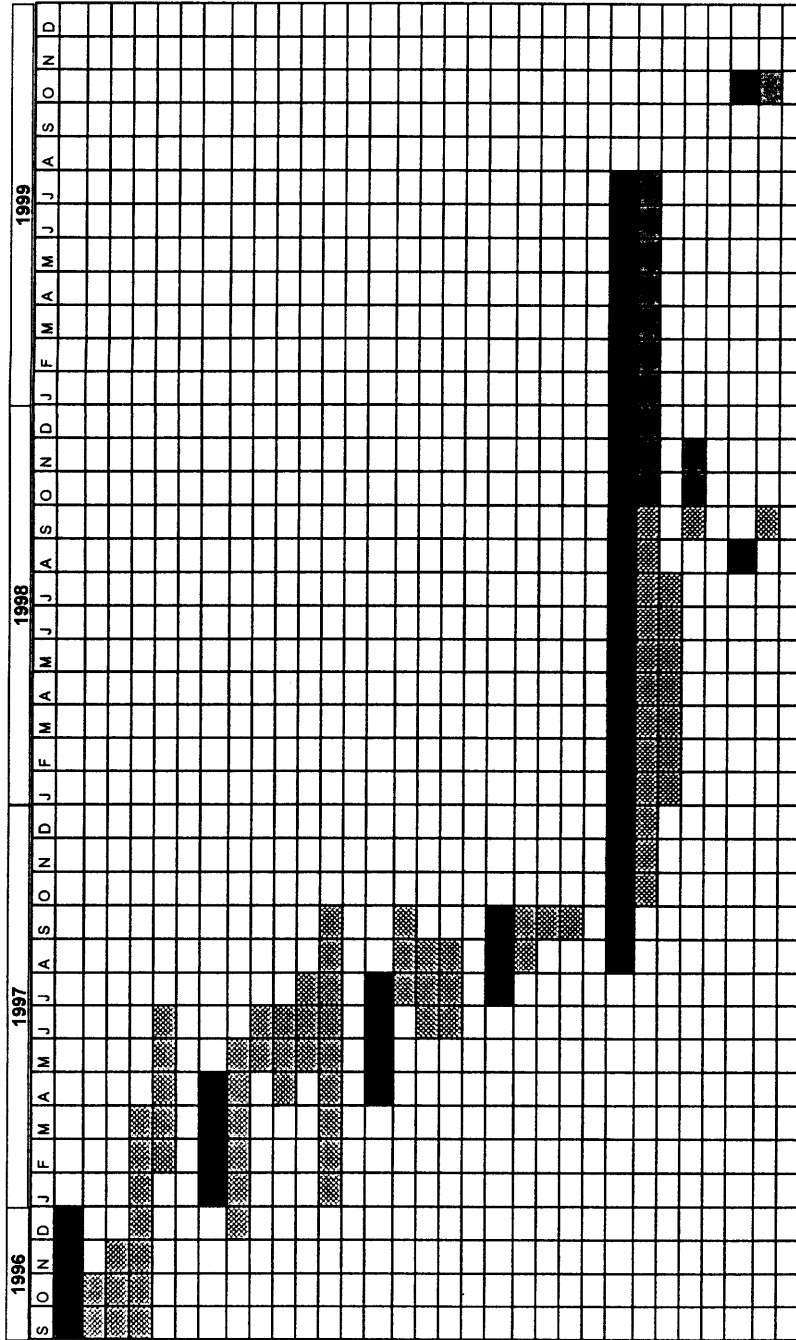
Field investigation of the Laugaland area, regarding selection of sites for the six seismic stations, was performed on January 17th. Good bedrock was found on hillsides west and east of the river Eyjarfjardara, but the flat valley floor is covered by thick sediments, which cause unfavorable conditions 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 maximizing 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 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.

Progress diagram for project GE-0060/96.
 The diagram shows the initial time schedule, the actual progress until 30.9.1998 and expected time schedule from that date



- Design:**
 - Logging
 - Pipeline
 - Pumps
 - Seismic monitoring system
- Manufacture:**
 - Pipeline construction
 - Monitoring equipment
 - Pumps
 - Seismic equipment
 - Modification of seismic software
- Assembly / Installation:**
 - Monitoring equipment
 - Pumps
 - Seismic installations
- Commissioning:**
 - Seismic network startup
 - Startup monitoring
 - Startup injection
- Monitoring:**
 - Seismic/chemical/res. monitoring
 - Second injection hole
 - Increased injection pressure
- Reports:**
 - Reports

Legend:

- Time schedule according to the contract
- Actual/expected time schedule 30.9. 1998
- Time periods for the progress report

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 wintertime.

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 3 MPa pressure and 10 l/s at 1 MPa 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 start-up

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 0.6 MPa 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 reinjection project at Laugaland started on October 1st 1997. Since that time reinjection has been mostly continuous. Until the end of January 1998 about 8 l/s were injected continuously into well LJ-8. From that time an additional 6 l/s were injected into well LN-10. Reinjection into LN-10 was discontinued in late August 1998. In early September 1998 injection into well LJ-8 was increased to 20 l/s, which has raised the well-head pressure of the well to 2.5-3.0 MPa. A total of about 390,000 m³ of water have been injected during the 13 months since injection started. This may be compared to the production from the field, which has varied between 0 and almost 130 l/s during the same period, amounting to about 1,320,000 m³.

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 22 °C, and well head pressures have varied between 0 and 3 MPa.

Water levels are also monitored manually in a number of wells inside, as well as outside, the Laugaland area. Two tracer-tests were successfully completed during the winter of 1997/98, 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 more than 730 tracer-samples, from a number of production wells, both inside and outside the Laugaland area, have been collected and analyzed during these tests.

Three step-rate injection tests have been conducted for the injection wells, during the first year of the monitoring phase. The first test for well LJ-8 was repeated 8 months later, such that changes in well injectivity, due to scaling etc., could be detected. No such changes were noted. The step-rate test for well LN-10 will also be repeated. The temperature profiles of both wells have been measured during active reinjection. This has been done on three occasions for the main injection well, LJ-8, which has enabled fairly accurate estimates of the relative importance of the different feed-zones of the well. It is believed that these estimates may be more accurate than results of conventional spinner-logging.

No seismic activity, induced by the reinjection, has yet been detected by the seismic network. The seismic network is believed to operate as expected. This is confirmed by the fact that a small earthquake north of Iceland was clearly detected by the network, as well as a small explosive device, which was detonated in April 1998 to test the network. The well-head pressure of well LJ-8 was only of the order of 0.4-1.2 MPa up to the beginning of September 1998. During the last month the well-head pressure has approached 3.0 MPa, but without causing detectable micro-seismic activity. Reinjection will continue at this high well-head pressure for the next one or two months, making some such activity more likely than during the first year of monitoring. 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 out 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, tracer test results show that an untimely thermal breakthrough is not to be expected in production wells in the field. On the other hand, water level measurements indicate that hot water production from the field may be increased by reinjection. Data on the water-level recovery due to reinjection is somewhat inconclusive, however. Emphasis will, therefore, be placed on studying and evaluating this aspect of the reinjection at Laugaland.

3.1 Financial report from Hita- og Vatnsveita Akureyrar

PART D - FINANCIAL REPORT Nr. 4
(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):

81,8551

A) Expenditure incurred during the period from ...01.04.1998...to... 30.09.1998

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	2.644.200	32.303
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	0	0
4. Subcontracting	166.404	2.033
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	462.250	5.647
Indirect costs (10):		0
8. Personnel overheads (Annex I)	2.163.560	26.432
9. Equipment overheads (Annex 3)		0
VAT (12)	0	0
TOTAL A (to be carried over)	5.436.414	66.415

30% contribution of the commission	1.630.924	19.925
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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

5.436.414

66.415

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
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
Indirect costs (10):		
8. Personnel overheads (Annex I)	17.056.200	216.381
9. Equipment overheads (Annex 3)	0	0
Adjustment of previous expenditure (11)	0	0
VAT (12)		
TOTAL B	81.264.380	1.030.869
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	24.523.000	309.861
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	15.026.679	190.558
4. Subcontracting	18.433.440	233.796
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	72.960	925
7. Other expenditure (9)	9.424.955	119.331
Indirect costs (10):		
8. Personnel overheads (Annex I)	19.219.760	242.813
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	86.700.794	1.097.285

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: 98-11-03

Date: 98-11-03

Name of Project Manager
Magnús Finnsson

Name of Financial Officer
Franz Árnason

Signature of Project manager



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 Engineers:	Franz Árnason	118	2200	1800	259.600	212.400
	Ármi Árnason	1007	2200	1800	2.215.400	1.812.600
	Magnús Finnsson	46	2200	1800	101.200	82.800
Technicians and equivalents	Diverse technicians	34	2000	1640	0	0
					0	0
Other categories (to be specified)	laborers	0	1250	800	0	0
					0	0
Sub-totals					2.644.200	2.163.560
TOTAL (Personnel + overheads)						4.807.760

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.

4. SUBCONTRACTING
(Services, Studies, Consultancy)

ANNEX 4

(national currency)

Invoices		Suppliers (1)	Brief description of type of assistance	Amount
Dates	ACC. Refer.			
	510269-1879	Landsíminn	Telecommunication	102.816
	530696-2949	Nettllntís	Software consulting	63.588
TOTAL 4				166.404

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.			
	550978-0169	HVA	Cars	158.504
	520885-0139	Varmaverk	Material	44.085
	680169-2769	KEA	Material	9.044
	560187-2039	Tölvutæki	Material	6.598
	651185-0849	Straumrás	Material	4.237
	460289-1309	Sandbl. & málmh.	Material	4.873
	600269-0469	Slippstöðin	Material	2.710
	550978-0169	HVA	Material	59.224
	690269-3769	Vélsm. Steindórs	Services	112.450
	220143-4309	Rafn Kjartansson	Sevices	53.400
	550169-4799	Air Iceland	Freight	7.125
		Diverse	construction material etc.	
			TOTAL 7	462.250

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

ANNEX 8

For the period from: 1-apr-98 to: 30-sep-98

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

The participant's name ¹	Position ²	Total costs (ECU)	community contribution (ECU)	Nature of the costs ³	Comments ⁴
HVA	COO	66.415	19.925	TC	
OS	CR	55.775	16.732	TC	
UU	CR	12.093	3.628	TC	
Rarik	CR	7.283	2.185	TC	
Hoechst	CR			TC	
TOTAL		141.565	42.470		

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

Name:

Position: director

Position:

Signature: *Franz Arnason*

Signature:

Date: 3 Nov. '98

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

3.2 Financial report from Orkustofnun

PART D - FINANCIAL REPORT Nr 4
(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):

81,8551

A) Expenditure incurred during the period from ...1.04.98...to...30.09.1998.

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	1.700.402	20.773
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)	1.473.281	17.999
Indirect costs (10):		0
8. Personnel overheads (Annex I)	1.391.758	17.003
9. Equipment overheads (Annex 3)		0
VAT (12)	0	0
TOTAL A (to be carried over)	4.565.441	55.775

30 % contribution of the commission	1.369.632	16.732
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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

4.565.441

55.775

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
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
Indirect costs (10):		
8. Personnel overheads (Annex I)	3.650.458	46.047
9. Equipment overheads (Annex 3)	0	0
Adjustment of previous expenditure (11)	0	0
VAT (12)		
TOTAL B	12.130.750	153.382
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	6.399.004	80.041
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)	5.254.971	66.066
Indirect costs (10):		
8. Personnel overheads (Annex I)	5.042.216	63.050
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	16.696.191	209.157

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.

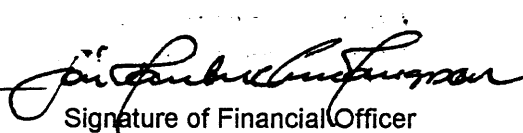
Date: 1998-10-30

Date: 1998-10-30

Name of Project Manager
Guðni Axelsson

Name of Deputy Financial Officer
Jón Haukur Guðlaugsson


Signature of Project manager


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.
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- 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	375	2600	2020	975.000	757.500
Experts	Grímur Björnsson	7	2600	2020	18.200	14.140
	Benedikt Steingrímsson	32	2600	2020	83.200	64.640
	Kristján H. Sigurðsson/ Vigdís Harðardóttir	3	2600	2020	7.800	6.060
	Guðrún Sverrisdóttir	22	2600	2020	57.200	44.440
	Ómar Sigurðsson /Steinar P. Guðlaugsson	20	2600	2020	52.000	40.400
	Helga B. Sveinbjörnsdóttir	17	2600	2020	44.200	34.340
	Ólafur G. Flóvenz	17	2600	2020	44.200	34.340
	Kjartan Birgisson / Guðlaugur Hermannsson	31	2600	2020	80.600	62.620
	Þórólfur H. Hafstað	5	2600	2020	13.000	10.100
			0	0	0	0
Technicians and equivalents	Arnar Hjartarson	288	1100	1100	316.800	316.800
Other categories (to be specified)	Sylvia Jóhannsdóttir (assistant)	6	1367	1063	8.202	6.378
				Sub-totals	1.700.402	1.391.758
				TOTAL (Personnel + overheads)		3.092.160

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	521.561
		internal	Chemical analyses	951.720
TOTAL 7				1.473.281

3.3 Financial report from Uppsala University

PART D - FINANCIAL REPORT Nr. 4
(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: 46-18-181-640
Place designated for financial audit:
Uppsala University, Villavaegen 16, S-75236 Uppsala

Exchange rate applies for national conversion / ECU currency (4): 9,18914

A) Expenditure incurred during the period from1.04.1998.....to...30.09.1998.....

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	59.706	6.497
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)	0	0
Indirect costs (10):		0
8. Personnel overheads (Annex I)	51.419	5.596
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL A (to be carried over)	111.125	12.093

30% contribution of the commission	33.338	3.628
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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

111.125

12.093

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
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
Indirect costs (10):	0	0
8. Personnel overheads (Annex I)	449.534	52.039
9. Equipment overheads (Annex 3)	0	0
Adjustment of previous expenditure (11)	0	0
VAT (12)		
TOTAL B	1.010.570	117.029
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	581.685	66.922
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
Indirect costs (10):	0	0
8. Personnel overheads (Annex I)	500.953	57.634
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	1.121.695	129.122

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: 981021

Date: ~~October 23, 1998~~

Name of Project Manager
Raynir Böðvarsson

Name of Financial Officer

~~Inga Stina Hansen~~

LETTEKUNDI36724

Signature of Project manager

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 months B	Wage rate (2) C	Time scale for overheads (3) D	Amount for personnel (B) * (C)	Assembling overheads (B) * (D)
Project leader	R. Böövarsson	0	35.752	30.790	0	0
Engineers	B. Lund	0	35.752	30.790	0	0
	R. Slunga	1,67	35.752	30.790	59.706	51.419
Technicians and equivalents					0	0
Other categories (to be specified)					0	0
Sub-totals					59.706	51.419
TOTAL (Personnel + overheads)						111.125

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.

3.4 Hoechst Danmark A/S

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

3.5 Financial report from RARIK

PART D - FINANCIAL REPORT Nr 4
(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): 81,8551

A) Expenditure incurred during the period from 01.04.1998....to...30.09.1998.

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
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)	596.110	7.283
Indirect costs (10):		0
8. Personnel overheads (Annex I)	0	0
9. Equipment overheads (Annex 3)		0
VAT (12)	0	0
TOTAL A (to be carried over)	596.110	7.283

30 % contribution of the commission	178.833	2.185
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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

596.110

7.283

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
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
Indirect costs (10):		
8. Personnel overheads (Annex I)	632.880	7.986
9. Equipment overheads (Annex 3)	0	0
Adjustment of previous expenditure (11)	0	0
VAT (12)		
TOTAL B	1.975.006	24.971
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
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)	1.147.036	14.284
Indirect costs (10):		
8. Personnel overheads (Annex I)	632.880	7.986
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	2.571.116	32.253

CONTRACTORS CERTIFICATE (13)

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- 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: 3.11.1988

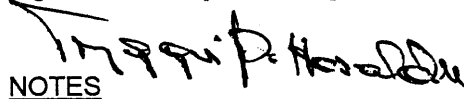
Date: 

Name of Project Manager
Tryggvi Þór Haraldsson

Name of Financial Officer
Tryggvi Aðalsteinsson

Signature of Project manager

Signature of Financial Officer


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7. OTHER EXPENDITURE

ANNEX 7

(national currency)

Invoices		Suppliers	Type of expenditure	Amount
Dates	ACC. Refer.			
1/4 - 30/9		RARIK	Electrical power	596.110
TOTAL 7				596.110