

Demonstration of Improved Energy Extraction from a Fractured Geothermal Reservoir

A progress report for the period 01.10.1998 - 31.03.1999
for 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-99056

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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 1997.

The monitoring phase of the project started on the 1st of October 1997. At the end of March 1999 about 640,000 m³ had been reinjected into two wells, corresponding to an average rate of 13 l/s. Return water is currently injected at a rate of 21 l/s into one of the wells, at a well-head pressure of about 2.5 MPa. Comprehensive monitoring is continuing, and results of on-going data interpretation and modelling 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.

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 1999 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 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.

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.

2.4.4 Installation of an additional pump

Because of the small diameter of the return-water pipeline, as well as the long distance between Akureyri and Laugland, its transport capacity is rather limited. As originally designed, the pipes maximum capacity is of the order of 15 l/s. Therefore, a new pump was installed in March 1999, about halfway between Akureyri and Laugland, to boost the capacity of the return-water pipeline. This boosted the transport capacity of the return-water pipeline to 21 l/s, or by about 40%.

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 Start-up 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 Laugland 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 Start-up 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 Laugland area will be monitored carefully.

2.6 Monitoring

The monitoring phase of the reinjection project at Laugland 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. Since early October 1998 the injection rate into well LJ-8 has varied between 15 and 21 l/s. At present the rate is 21 l/s and the well-head pressure about 2.5 MPa. A total of about 640,000 m³ of water have been injected during the 19 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 2,380,000 m³.

Before the installation of the booster pump discussed in section 2.4.4 injection rates above 15 l/s were enabled by injecting a mixture of return water and 80°C geothermal water available at Laugaland. Since the installment of the booster pump in March 1999, this has not been necessary.

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. Tracer samples are still being collected, since the tracers are still being recovered in the production wells in the field. It may also be mentioned that the tracer from the first tracer injection is being recovered at an increasing concentration in a different geothermal field, Ytri-Tjarnir, located about 1.8 km north of Laugaland. A total of almost 1200 tracer-samples, from a number of production wells, both inside and outside the Laugaland area, have been collected and analyzed up to the end of March 1999.

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 four 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. The latest temperature log was measured at the end of March 1999.

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 following month the well-head pressure did approach 3.0 MPa, but without causing detectable micro-seismic activity. Reinjection is presently continuing at a well-head pressure above 2.5 MPa, and will continue for the next few months, making some such activity 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.

Detailed analysis and interpretation of the great amounts of data collected is on-going and numerical model development is starting. The last six months of the monitoring phase of the reinjection project at Laugaland will involve continued monitoring and testing (final tracer test, step-rate test and temperature logging) as well as continued data interpretation and modelling. The presently available results of the project are 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. This has been quantified at 60-70% of the reinjection. Water level measurements indicate, in addition, some water level recovery in fields located some 1-2 km from Laugaland, which may most likely be attributed to the reinjection.

3.1 Financial report from Hita- og Vatnsveita Akureyrar

PART D - FINANCIAL REPORT Nr. 5
(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):

78,4760

A) Expenditure incurred during the period from ...01.10.1998...to...31.03.1999

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	3.703.975	47.199
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	170.258	2.170
4. Subcontracting	1.826.587	23.276
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	0	0
7. Other expenditure (9)	924.079	11.775
Indirect costs (10):		0
8. Personnel overheads (Annex I)	2.955.800	37.665
9. Equipment overheads (Annex 3)		0
VAT (12)	0	0
TOTAL A (to be carried over)	9.580.699	122.084

30% contribution of the commission	2.874.210	36.625
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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

9.580.699

122.084

B) Total expenditure previously submitted	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
Adjustment of previous expenditure (11)	0	0
VAT (12)		
TOTAL B	86.700.794	1.097.285
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	28.226.975	357.060
2. Depreciation of Equipment (6)	0	0
3. Consumable equipment (8)	15.196.937	192.728
4. Subcontracting	20.260.027	257.072
5. Data-processing costs (8)	0	0
6. Travel and related costs (7)	72.960	925
7. Other expenditure (9)	10.349.034	131.107
Indirect costs (10):		
8. Personnel overheads (Annex I)	22.175.560	280.478
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	96.281.493	1.219.369

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: 99-04-30

Date: 99-04-30

Name of Project Manager
Magnús Finnsson

Name of Financial Officer
Franz Árnason

Signature of Project manager



NOTES

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.

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	122	2200	1800	268.400	219.600
Engineers:	Ármi Árnason	1257	2200	1800	2.765.400	2.262.600
	Magnús Finnsson	114	2200	1800	250.800	205.200
					0	0
					0	0
Technicians and equivalents	Diverse technicians		2000	1640	0	0
					0	0
Other categories (to be specified)	laborers	335,5	1250	800	419.375	268.400
Sub-totals					3.703.975	2.955.800
TOTAL (Personnel + overheads)						6.659.775

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	680865-0199	Ísl. Jónsson	Pump Grunfors LP100-160	170.258
1.3- Internal supplies				
Total consumables				170.258
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

Construction

(national currency)

Invoices		Suppliers (1)	Brief description of type of assistance	Amount
Dates	ACC. Refer.			
	510269-1879	Landsíminn	Telecommunication	240.370
	530696-2949	Nett-Intís	Software consulting	90.267
	560175-0869	Verkf.st.Norðurlands	Consulting engineers	50.199
	590278-0219	Ösp	Construction	37.349
	661076-0119	Raftákn	Electronich&comp serv.	345.188
	440297-2429	Raftó	Construction	192.089
	500795-2479	G.V. gröfur	Construction	57.598
	500269-5379	Orkustofnun	Scientific consulting	795.011
	580489-1099	Bæjarverk	Construction	4.016
	210860-2239	Högni Júl. Kjab.&st S	Construction	14.500
TOTAL 4				1.826.587

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	277.300
	550978-0170	HVA	Lorries	50.201
	550978-0171	HVA	Construction machines	71.968
	680169-2769	KEA	Material	16.577
	560187-2039	Tölvutæki	Material	8.725
	651185-0849	Straumrás	Material	6.942
	460289-1309	Sandbl. & málmh.	Material	6.205
	600269-0469	Slippstöðin	Material	4.984
	550978-0169	HVA	Material	269.306
	550169-4799	Air Iceland	Freight	16.851
	610278-0359	Set	Material	44.436
	600966-0149	Radióvinnustofan	Material	2.892
	410487-1799	Sturl. Jónsson	Material	3.692
	160831-4489	Jóhann Ingólfsson	Rental cost	36.000
	110862-4319	Benedikt Hjaltason	Rental cost	36.000
	161055-4339	Vilberg Jónsson	Rental cost	36.000
	200141-2619	Pór Aðalsteinsson	Rental cost	36.000
			TOTAL 7	924.079

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

ANNEX 8

For the period from: 1.okt.98 to: 31.mar.99

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	122.084	36.625	TC	
OS	CR	68.208	20.462	TC	
UU	CR	0	0	TC	
Rarik	CR	13.105	3.932	TC	
Hoechest	CR			TC	
TOTAL		203.398	61.019		

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: 30.4.1999

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 5
(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):

78,476

A) Expenditure incurred during the period from ...1.10.98...to...31.03.1999.

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	2.294.960	29.244
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)	1.082.916	13.799
Indirect costs (10):		0
8. Personnel overheads (Annex I)	1.974.800	25.164
9. Equipment overheads (Annex 3)		0
VAT (12)	0	0
TOTAL A (to be carried over)	5.352.676	68.208

30 % contribution of the commission	1.605.803	20.462
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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

5.352.676

68.208

B) Total expenditure previously submitted	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
Adjustment of previous expenditure (11)	0	0
VAT (12)		
TOTAL B	16.696.191	209.157
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	8.693.964	109.285
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)	6.337.887	79.865
Indirect costs (10):		
8. Personnel overheads (Annex I)	7.017.016	88.214
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	22.048.867	277.364

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: 1999-04-30

Date: 1999-04-30

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.
- 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	407	2600	2020	1.058.200	822.140
Experts	Grimur Björnsson	0	2600	2020	0	0
	Benedikt Steingrímsson	0	2600	2020	0	0
	Kristján H. Sigurðsson/ Vigdís Harðardóttir	0	2600	2020	0	0
	Steinunn Hauksdóttir	73	2600	2020	189.800	147.460
	Sigvaldi Thordarson	14	2600	2020	36.400	28.280
	Helga B. Sveinbjörnsdóttir	2	2600	2020	5.200	4.040
	Ólafur G. Flóvenz	21	2600	2020	54.600	42.420
	Kjartan Birgisson / Guðlaugur Hermannsson	22	2600	2020	57.200	44.440
	Þórólfur H. Hafstað	13	2600	2020	33.800	26.260
			0	0	0	0
Technicians and equivalents	Arnar Hjartarson	781,6	1100	1100	859.760	859.760
					0	0
Other categories (to be specified)	Sylvia Jóhannsdóttir (assistant)	0	1367	1063	0	0
				Sub-totals	2.294.960	1.974.800
				TOTAL (Personnel + overheads)		4.269.760

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.

7. OTHER EXPENDITURE

ANNEX 7

(national currency)

Invoices		Suppliers	Type of expenditure	Amount
Dates	ACC. Refer.			
		internal	Well logging	299.775
		internal	Chemical analyses	783.141
			TOTAL 7	1.082.916

3.3 Financial report from Uppsala University

PART D - FINANCIAL REPORT Nr. 5
(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: 46-18-4713312
Telefax: 46-18-4711640
Place designated for financial audit:
Uppsala University, Villavaegen 16, S-75236 Uppsala

Exchange rate applies for national conversion / ECU currency (4): 8,9525

A) Expenditure incurred during the period from**01.10.1998**.....to...**31.03.1999**.....

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)	0	0
Indirect costs (10):		0
8. Personnel overheads (Annex I)	0	0
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL A (to be carried over)	0	0

30% contribution of the commission	0	0
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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

0

0

B) Total expenditure previously submitted	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	581 685	66 922
2. Depreciation of Equipment (6)		
3. Consumable equipment (8)		
4. Subcontracting		
5. Data-processing costs (8)		
6. Travel and related costs (7)	17 172	2 005
7. Other expenditure (9)	21 885	2 561
Indirect costs (10):		
8. Personnel overheads (Annex I)	500 953	57 635
9. Equipment overheads (Annex 3)		
Adjustment of previous expenditure (11)		
VAT (12)		
TOTAL B	1 121 695	129 123
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	57 635
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	1 121 695	129 123

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.

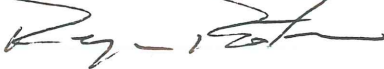
Date: 990422

Date: APRIL 26, 1999

Name of Project Manager
Reynir Böðvarsson

Name of Financial Officer
LEIF LONDBERG

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	0	35 752	30 790	0	0
Technicians and equivalents					0	0
					0	0
Other categories (to be specified)					0	0
Sub-totals					0	0
TOTAL (Personnel + overheads)					0	0

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 A/S 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 5
(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):

78,476

A) Expenditure incurred during the period from 01.10.1998....to...31.03.1999.

Category of expenditure (5)	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	20.800	265
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)	991.496	12.634
Indirect costs (10):		0
8. Personnel overheads (Annex I)	16.160	206
9. Equipment overheads (Annex 3)		0
VAT (12)	0	0
TOTAL A (to be carried over)	1.028.456	13.105

30 % contribution of the commission	308.537	3.932
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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

1.028.456

13.105

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)	1.147.036	14.284
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	2.571.116	32.253
C) Cumulative expenditure since the work commencement date	Expenditure per period	
	Nat. currency	ECU
Direct costs:		
1. Personnel	812.000	10.248
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)	2.138.532	26.919
Indirect costs (10):		
8. Personnel overheads (Annex I)	649.040	8.192
9. Equipment overheads (Annex 3)	0	0
VAT (12)	0	0
TOTAL C	3.599.572	45.359

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: 1999 - 04 - 30

Date: 1999 - 04 - 30

Name of Project Manager

Tryggvi Þór Haraldsson


Signature of Project manager

Name of Financial Officer

Tryggvi Aðalsteinsson


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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- 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.
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- 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 B	Wage rate (2) C	Time scale for overheads (3) D	Amount for personnel (B) * (C)	Assembling overheads (B) * (D)
Project leader	Tryggvi Þór Haraldsson	0	0	0	0	0
Engineers	Arnar Sigtýsson	0	0	0	0	0
	Þórhallur Hjartarson	8	2.600	2.020	20.800	16.160
Technicians and equivalents	Diverse technicians	0	0	0	0	0
Other categories (to be specified)					0	0
Sub-totals					20.800	16.160
TOTAL (Personnel + overheads)						36.960

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.			
1/10.98 - 31/3 99		RARIK	Electrical power	991.496
TOTAL 7				991.496