

PD-ABR-510



BURNS AND ROE ENTERPRISES, INC.

DELIVERY ORDER No. 26

**SEISMIC OIL & GAS EXPLORATION PROJECT
Final Report**

ARMENIA

March 9, 1998

Prepared by: BREI/Gray & Associates

Submitted to: U.S Agency for International Development

Contract No.: CCN-0002-Q-00-3154-00
Energy Efficiency and Market Reform Project
Delivery Order No 26,
Seismic Oil & Gas Exploration Project
Final Report

1 0 INTRODUCTION

The Government of Armenia (GOA) has been interested in developing its indigenous resources to provide energy independence and help stabilize the Armenian economy. In support of this goal, the USAID authorized funding during 1996-1997, to implement a Seismic Oil & Gas Exploration Project (SOGEP) under Delivery Order (DO) No 26. This DO provides for the development of the capability for the GOA to perform oil and gas exploration. Burns & Roe Enterprises, Inc (BREI) was selected by USAID to manage the DO. BREI engaged the services of the geophysical consultants Gray & Associates (G&A) to implement this work. The GOA entity to implement this work was the Armenergyseismicproject or Seismic Institute (SI). Work was performed over the period of August 1996 through December 1997.

2 0 BACKGROUND

During Former Soviet Union times, a significant amount of oil and gas exploration had been performed in Armenia. This data was generated using Soviet designed equipment, and processing and interpretation techniques. Through the European Union's TACIS program Partex-CPS of Portugal and Simon Petroleum Technology of the UK performed an assessment of the existing data. It was determined that although there was a tremendous amount of data it was virtually useless. The data was not of the quality and accuracy that would entice a serious private investor or oil company to initiate an exploration project in Armenia. As an example of 204 exploration wells that were drilled in Armenia only 16 were considered true exploration well quality, less than ten percent.

Based on a request from the GOA, USAID decided to provide for the upgrade of the existing equipment by using U.S. supplied equipment to improve its accuracy and reliability to meet western standards. Some U.S. equipment was provided to the GOA during 1993, namely a Texas Instrument DSF-V computer, controller, printer, plotter, copier and other ancillary supplies. A list of this equipment is provided as *Exhibit #1*. This equipment was in storage at the SI and was the starting point for the new USAID project. BREI was authorized to start work in August, 1996.

3 0 DESCRIPTION OF WORK PERFORMED

All technical work for this task was managed by Dale Gray of G&A. The procurement, logistical support and overall management was performed by BREI.

The general areas of work performed under this DO are as follows:

- Preparation Period
 - Upgrading of the existing seismic equipment, including integration of Russian/U.S. equipment

- ▶ Testing of the existing seismic equipment
- ▶ Rehabilitation of the SI vehicles to make them operable
- ▶ In-country classroom and field training on the new equipment for data collection
- Field Testing and Training Phase of the USAID Project
- Training in the USA for Armenian geophysicists in seismic processing and interpretation

Preparation Period

Verification of Previously Supplied Equipment--

Upon authorization in August, 1996, BREI dispatched Mr Robert Hinson of Seis-Tech, who was a subcontractor to G&A, to verify the condition completeness of the equipment delivered in 1993 from the U S This was completed in September 1996 It was determined that all equipment was accounted for and in good working order The computers and copier were being used for word processing, games etc , and the copier had been used to the extent it needed additional toner, but the equipment was all in working order Mr Hinson operated each piece of equipment as part of his verification

In addition, this trip identified other equipment that would be needed to make the upgrades current and reliable Specifically, the additional equipment needed was a multi-source processor with five memory boards and cabling, upgrade in the SeisCam software for correlation capabilities, 8mm tape backup, radio with the frequency of the Belarussian vibrator trucks, a sweep generator, spare cards for the DFS-V, and an emergency generator to provide a power source for the recorder station

Upgrading of Seismic Equipment--

The upgrade of equipment took place at the SI facility at Ashtarak A panel truck (URAL-4320) was designated for use as a Seismic Station This truck needed an alternator, 2 tires, fuel pump, belt set and other miscellaneous parts It was fitted with tables for mounting the DSF-V, ocilliscope, radios and other miscellaneous control and processing equipment

The four vibroseis trucks (KRAZ-255B), which supply the signal for processing, were in good condition There were some maintenance items that needed attention, such as batteries, alternators, new hydraulic hoses, oil, etc BREI provided this material to the SI from local suppliers

However, the other supporting vehicles were not usable for the project without substantial repairs These vehicles included 3 panel (doghouse) trucks (GAZ-66), 1 fuel truck, 3 jeeps, 1 bus (crew transport), etc BREI provided all the necessary parts for this repair work from local suppliers The mechanics from the SI made the necessary repairs

In-Country Training --

The in-country training focuses on the DSF-V equipment. Two weeks of classroom training was provided. Mr. Hinson provided all this training. The training was done while the installation work was ongoing. The installation included troubleshooting equipment, normally a part of this type of work, in addition to the challenge of obtaining the materials necessary locally in Armenia.

Classroom training for five staff personnel from the SI and one from BREI. They were

Ashot Geozalian
Abrek Musaelian
Arthur Karapetian
David Arutunian
Gevork Manaserian
Georgi Aslanian

Completion of Preparatory Period--

Upon completion of the preparatory period on January 13, 1997, all the equipment was tested and witnessed by G&A and BREI. On June 14, 1997, an Act stating the acceptability of the equipment and its readiness to be taken to the field was signed in BREI's office by SI, BREI and G&A. A copy of this Act is provided as *Exhibit #2*.

Field Testing and Training Phase of the Project

During the course of the USAID project, the GOA signed a contract with the Armenian American Exploration company (AAEC) for the drilling of wells and collection of the seismic data. Therefore, it was decided to place more emphasis on training than data collection. With this in mind, the selection of the field test site had to be tailored to ensure adequate testing of the U.S. seismic recorder (DSF-V) that has been interfaced with the Belorussian Seismotechniques Vibrators. In addition, this field work and training would ensure that the SI crews are adequately trained to work on the AAEC project. The location of the test area was based upon the criteria that the test area should be in a "good" data quality area located near Yerevan, and be located in an area with "easy" to moderate terrain.

After a review of the Partex and Simon reports, discussions with the Oil & Gas Exploration Project Implementation Unit, it was decided to select a previously shot line, NRY-87-14. This line is approximately 4.5 km to the west of the country's best oil show well, Shorakhpur #1. The field test area is within 25 km of Yerevan and is located on a reasonably straight road. The road is actually oriented obliquely from NRY87-14 about 15 degrees, but the advantages of easy road

access for better training outweigh the necessity of exact duplication since the main mission is training not location of a new well. The line was scouted by Dale Gray (G&A) on June 12, 1997, and he was able to verify the above criteria and the absence of basalt flows in the test area as well. For more details on the data collection field testing approach *see Exhibit #3*

The field work lasted from June 16, 1997, to June 27, 1997. This phase of the work included transporting the equipment to the test site, training the crews in how to lay the geophone arrays, selecting the optimum geophone array based on testing, operation of the vibrator equipment, use of the stacker correlator to run vibrator similarities, and data recording. This testing period verified that all of the SI vehicles and electronic equipment was operating properly and the personnel were qualified to begin their project for the AAEC and do a professional job. On June 27, 1997, the project was declared complete and was documented by an Act as shown in *Exhibit #4*. All equipment was returned to Ashtarak. The director of the SI, Mr. Frederick Arakalian, sent BREI and G&A a letter of appreciation for successful implementation of this project, *see Exhibit #5*.

U S Training in Processing and Interpretation of Data

The AAEC had entered into a leasing agreement with the GOA for the collection of seismic data and the drilling of three wells over a one year period. This fact reduced the importance and urgency of the data collection which was to be performed under DO#26. However, what was needed by the SI was additional training in data processing and interpretation of the data. Therefore, BREI/G&A recommended, and USAID agreed, to make the emphasis of DO#26 to be more training and less field data collection. Specifically, training for 5 Armenian geophysicists in the USA was provided for 6 weeks.

The training was managed by G&A and took place mainly at the Western Geophysical Processing Center in Denver, Colorado. This training used the data collected in the USAID project for training of the Armenians in addition to other Armenian data. This made the training directly applicable to the work the individuals performed for AAEC when they returned to Armenia. The type of analysis and training will also be applicable for other industries such as coal, mineral resources, etc.

Prior to the start of the USA training, G&A prepared a Training Plan which is attached as *Exhibit #6*. This plan laid out the purpose and highlighted the key hardware and software to be used in the training. The specific training provided, training results and recommendations for additional training are provided in *Exhibit #7*.

Exhibit #8 provides photos of various pieces of equipment during the rehabilitation phase.

Funding for Rehabilitation and Equipment--

USAID funding for DO #26 provided for the procurement of U S supplied equipment, procurement of locally supplied materials to implement this work, training, and processing of data in the U S A breakdown of these funds is as follows

ITEM No	DESCRIPITON	AMOUNT, \$ (USD) (Approx Values)
1	U S Supplied Equipment and Software	\$140,000
2	Locally supplied materials	\$26,000
3	U S training	\$40,000
4	Processing of Seismic Data	\$20,000
5	TOTALS	\$226,000

40 SCHEDULE

A milestone schedule for this DO is provided below

DATES	ACTIVITY	COMMENTS
Aug 1996	DO Authorization	
Aug 20-Sept 10, 1996	Robert Hinson, in-country to verify equipment condition	All equipment was accounted for and was in working condition
Nov 1 - Feb 1, 1997	Procurement of new equipment	
Feb 1997	Started discussions regarding potential contracting options to use with the SI	Initially the SI indicated that they would be privatized in one month This was not to be the case Therefore, BREI could not contract with them as a GOA entity for their services

April 25-May 23, 1997	Seismic Equipment Training	Classroom training for five staff from the SI and one from BREI They were Ashot Geozalian Abrek Musaelian Arthur Karapetian David Arutunian Gevork Manaserian Georgi Aslanian
April 1997- June 13, 1997	Started the process of rehabilitating the SI equipment	
June 13, 1997	SI vehicles declared operational Repair phase completed	An "Act" was prepared and signed by the SI, BREI and G&A, see Exhibit #3
June 16-27, 1997	Field testing and training	This phase was declared on June 27, 1997
July 23 to Sept 5, 1997	USA Training in Denver, Colorado	
Dec 31, 1998	DO completion date	

5 0 RESULTS AND CONCLUSIONS

Results--

Major results of DO#26 are as follows

- Provided training in Armenia on the use and maintenance of the DSF-V equipment supplied to the SI
- Procured additional upgrades to the software and hardware needed to perform this work
- Interfaced Soviet designed seismic vibrator equipment with USA supplied hardware and software
- Rehabilitated the four existing vibrator trucks
- Rehabilitated eight other vehicles needed for the implementation of the seismic campaign
- Tested equipment for 10 days, taking actual seismic data
- The SI contracted with the AAEC

- ▶ The SI shot 120Km for the AAEC at \$3,000/KM, generating \$460,000 in revenues for the SI
- ▶ There were no significant failures of the equipment repaired with USAID funding, in performing their work for the AAEC
- ▶ The SI successfully completed their contract with AAEC
- Five Armenians were trained in the U S to perform processing and interpretation of seismic data on state-of-the-art hardware and software
- Three of these Armenians were able to be involved in the processing of data using the PROMAX equipment leased by AAEC AAEC is performing the detailed processing and interpretation back in the U K

Conclusions--

Based on the above results, it is clear that this project was a success By providing the SI with the tools and training necessary to implement a seismic project, they were able to contract with a private American company and successfully deliver a service It is also clear that although the SI had not used the vibrator equipment for quite some time, they had retained enough technical resources to implement a significant project

6 0 RECOMMENDATIONS

Recommendations are as follows

- The SI staff should reinvest funds for "capital preservation" of the vibrators, seismic station and other equipment needed for seismic data collections This will allow them to quickly mobilize if other opportunities arise
- The SI should expand the use of this equipment to areas other than oil & gas, such as coal, minerals, etc
- USAID should consider additional training and procurement of a state-of-the-art PROMAX system similar to that used by AAEC for processing and interpretation This was recommended by G&A, but could not be implemented because of funding restrictions

MITCHAM INDUSTRIES, INC

Post Office Box 1175
Huntsville Texas 77342-1175

Huntsville (409) 291 2277

Houston (713) 353 4475

Fax (409) 295 1922

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<i>Item</i>	<i>Qty</i>	<i>Description</i>	<i>Price</i>	<i>Amount</i>
1	1	TEXAS INSTRUMENTS 120 CHANNEL DFS-V		
2		W/ 50 HZ NOTCH COMPLETE KIT		
3	1	CONTROLLER MODULE S/N 05718		
4	2	ANALOG MODULE S/N 20433, 20436		
5	1	10 TAPE TRANSPORT S/N 00716		
6	1	SET OF POWER & INTERCONNECT CABLES		
7	1	SET OF SHOCKS & MOUNTING RACKS		
8	1	BOARD LEVEL SPARES KIT W/ EXTENDERS		
9	1	DECODER 200 S/N 214107 IN BACK-		
10		PACK W/ PT400 RADIO S/N 7028IG		
11		ALL INTERCONNECT CABLES & CHARGER		
12	1	ENCODER 200 S/N 64507 W/ CABLES		
13	1	MITREK RADIO S/N 433H32473 W/		
14		WIRING HARNESS, MIC, SPEAKER,		
15		SELECTOR HEAD, INTERCONNECTS		
16	1	COMPONENT SPARES KIT		
17	1	SPARES KIT FOR ENCODER & DECODER		
18	2	LAMBDA POWER SUPPLIES 12 VOLT		
19		S/N H35715, H74846		
20	1	I/O RLS-240M ROLL SWITCH S/N 55967		

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<i>Item</i>	<i>Qty</i>	<i>Description</i>	<i>Price</i>	<i>Amount</i>
1	1	SEIS-CAM PLOTTER COMPLETE WITH		
2	1	KEYBOARD S/N 20166		
3	1	SET MANUAL & COMPUTER DISK		
4	1	SET OF POWER & INTERCONNECT CABLES		
5	1	HP LASER JET PRINTER		
6		S/N JPBG061329		
7	1	DECODER 200 S/N 174107 (SPARE)		
8	1	PT-400 RADIO S/N 232AFN0071		
9	1	LINE FILTER DEGAUSSER S/N 37		
10		W/ CABLING		
11	1	PVS-820 S/N 11 W/ CABLING		
12	1	TEKTRONICS 465 OSCILLOSCOPE		
13		S/N B098201 W/ PROBE		
14	1	FIELD ENGINEERS TOOL KIT W/		
15		CRIMPING TOOL, PIN EXTRACTOR,		
16		WIRE WRAP TOOL, METER		
17	2	SPARE ELCO CONNECTORS W/ PINS		
18	2	220 VOLT A/C UNITS		
19	14	12 VOLT BATTERIES		
20	16	12 VOLT HEAVY DUTY BATTERIES		

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<i>Item</i>	<i>Qty</i>	<i>Description</i>	<i>Price</i>	<i>Amount</i>
1	131	CDP CABLES W/ 2 TKO'S @ 110'		
2		INTERVAL W/ TITAN II'S		
3	280	MARK PRODUCTS L15A 14 HZ 600 OHM		
4		STRINGS OF 12 W/ KC2M4 TKO'S		
5	1	LOT OF SPARES FOR CABLES & PHONES		
6		INCLUDING DUST CAPS FOR KC2M4 &		
7		TITAN II'S, ELEMENTS IN CASES,		
8		ELECTRICAL TAPE, FRICTION TAPE,		
9		SCOTCHKOTE, BANANA PINS, SPIKES		
10	1	TRAVIS ELECTRONICS CC-120 CABLE		
11		TESTER W/ SHORTING PLUG		
12	100	REELS OF 10" X 2400' RECORDING		
13		TAPE		
14				
15				
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Gray and Associates
International Geophysical Consultants

1-982 N 78th Street Suite 4
Scottsdale AZ 85257
(602) 905 8689 phone
(602) 905 8818 fax

June 13 1997

Frederick Arakelian Director
ArmEnergy Seismic Projects
Hrazdan Canyon
Yerevan
Republic of Armenia

cc Dr Garen Galustian Deputy Minister of Energy
cc Dr Andre Aghabalyan Petroleum Projects Implementation Unit
cc Mr Doug Tuckhorn Burns and Roe

RE Completion of Equipment Preparation of Seismic Training
USAID Project

Dear Frederick

Mr Robert Hinson (Gray & Associates) Mr Doug Tuckhorn (Burns and Roe) Mr Levon Yegiev (Seismic Institute) and I went to the Ashtarak to inspect and test the seismic field equipment that has been prepared for the Field Test and for routine field operations

We first inspected the four vibrators We confirmed that each one was capable of driving had proper equipment and was capable of generating a seismic signal (sweep) We then tested all four of the vibrators with a wireline similarity to confirm that all four vibrators were capable of generating the exact signal required for seismic field operations together (Similarity Test) The results of the similarity test confirms the working order of each vibrator individually and the four vibrators, collectively A copy of these tests which have a time and date stamp at the top of the form are attached to this letter Each truck was tested and approved for engine performance and safe operations

We inspected the three trucks (reel trucks") that will be used for transportation of the geophones and cables to the field for seismic operations Each truck was repaired to a safe status for field operations

The recorder (seismic station) was tested for the working elements of the DFS V, Seiscam and tape drive All were approved as being in working order to manufacturer s specifications This information was stored on computer tape for confirmation processing in the United States by Gray & Associates The recorder truck was tested and is in good working condition The generator was tested and approved as well

The field operations jeep was used for field investigations by Mr Dale Gray and Mr Abrek Mousaleian on June 12 1997 and was in working order The survey jeep was reviewed and is in good working order

The field transportation bus was inspected and approved for field operations

The fuel truck parts were delivered on June 13 and will be repaired by Monday June 16 The repairs on the fuel truck relatively minor and should not delay operations on June 16

There are a few remaining repairs but none that will not allow the seismic crew to commence field operations on Monday June 16, 1997

The most significant repair remaining is the replacement of the hydraulic fluid for the vibrators The replacement of hydraulic hoses on the four vibrators was largely completed by the Seismic Institute on Saturday June 14 with money supplied by a third party Burns and Roe staff are trying to find a source for hydraulic fluid and the fluid will be replaced as soon as a supply of the fluid is found This is anticipated to be on or before June 20 The field experiments will commence on Monday June 16 with three vibrators The fourth vibrator will be used once the hydraulic fluid is found and provided to the Seismic Institute One remaining repairs is the repair of the fuel truck which were still in progress at 5 00 pm on Saturday June 14 The second Jeep the observer s troubleshooting vehicle for cable and geophone testing / replacing was approved for repair on Thursday June 12 and should be ready for assisting field operations by mid week (June 18 +/-)

None of the list of on-going repairs should stop the Seismic Institute from starting field operations on Monday June 16 1997

A list of additional equipment needs and repairs was presented to Burns and Roe and Gray & Associates on Saturday at a 8 30 pm meeting at the Burns and Roe office in Yerevan following a meeting at 5 00 pm at the Seismic Institute facility in Ashtarak This list will be reviewed and a formal response by Burns and Roe by Friday June 20 There were no items on this list that are of immediate need that would stop the crew from starting operations on Monday June 16 with three vibrators for the Field Tests The action items on this list will be considered a part of the on-going field operations

We are therefore declaring that the "Equipment Preparation" phase of the USAID operation was completed at the end of the business day on Saturday, June 14, 1997 and that the "Field Testing and Training" phase of the project will commence at 9 00 am on Monday, June 16, 1997

Accepted by


Robert A. Hinson
Seismic Field Operations Engineer


Levon Yegiev
Chief of Party


Abrek Mousaleian
Chief Geophysicist


Hrant Hakopian
Chief Engineer


G. Dale Gray
Senior Project Geophysicist


Douglas D. Tuckhorn
Project Director - Burns and Roe


Frederick Arakelian
Director - Seismic Institute

Date June 14, '97

Июнь 13, 1997

Фредерик Аракелян, Директор

"Армэнергосейсмопроект"

Разданское ущелье

Ереван

Республика Армения

Копии Г-ну Карену Галстяну Зам министра Энергетики

Г-ну Андрею Агабяну, Директору по осуществлению проектов по нефтепродуктам

г-ну Дугласу Такхорну, Директору проекта, компания 'Burns and Roe'

Тема Завершение подготовки сейсмического оборудования по проекту USAID

Дорогой Фредерик,

г-н Р Хинсон ("Gray & Associates" Company), г-н Д Такхорн ('Burns and Roe' Company), г-н А Егиев ('Армэнергосейсмопроект') и я посетили Аштарак для проверки и испытания сейсмического оборудования и определения степени его готовности для испытания в полевых условиях и для проведения ежедневных полевых работ

Во-первых, мы испытали 4 вибратора Мы подтверждаем, что каждый из четырех вибраторов готов к использованию, имеет все необходимое оборудование вибраторы могут получать и собирать сейсмические сигналы ("свипы") Затем мы испытали 4 вибратора, соединив их проводом со станцией для подтверждения того, что все четыре вибратора получают точные сигналы, необходимые для одновременного осуществления полевых работ (испытание на идентичность)

Результаты данного испытания подтверждают, что каждый из вибраторов находится в рабочем состоянии, и также все 4 вибратора вместе взятые находятся в хорошем рабочем состоянии

К данному письму прилагаются копии тестовых записей, полученные в процессе испытания с указанием времени и даты испытания на верхней части бланка Каждое транспортное средство испытано и может быть принято с точки зрения работы мотора и безопасности функционирования Мы испытали 3 смотки, которые используются для транспортировки геофонов и кабелей в поле для выполнения полевых работ Каждое транспортное средство отремонтировано и функционирует нормально Рекордер (сейсмический комплекс) испытан для подтверждения функционирования всех компонентов DFS-V Seiscam и транспортера ленты Все указанное оборудование находится в нормальном рабочем состоянии в соответствии со спецификациями производителя Данная информация хранится на ленте компьютера для обработки в США компанией "Gray &

Associates" Грузовик, где установлен рекордер испытан, находится в хорошем состоянии Генератор испытан и тоже находится в хорошем рабочем состоянии

УАЗ-469, который предназначен для использования в полевых исследованиях, проверен г-ном Д Грейем, г-ном Мусаеляном и также находится в хорошем рабочем состоянии

Автобус, предназначенный для транспортировки, испытан и одобрен к использованию в полевых условиях

Запасные части к бензовозу были поставлены 13 июня, ремонтные работы завершатся к понедельнику, 16 июня Бензовоз не требует больших ремонтных работ и будет готов к функционированию 16 июня

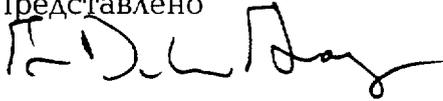
Осталось осуществить небольшой объем ремонтных работ, но эти работы не могут препятствовать началу работы сейсмической группы в полевых условиях в понедельник, 16 июня 1997 г

Наиболее важный вопрос, требующий решения, - это замена гидравлического масла вибраторов Замена гидравлических шлангов 4 вибраторов в основном завершена Институтом "АРМЭНЕРГОСЕЙСМОПРОЕКТ" к 14 июня на финансовые средства, представленные 3-ей стороной Штат компании "Burns and Roe" старается найти Поставщика гидравлического масла, и масло будет заменено, как только будет найден Поставщик масла Мы надеемся, что это вопрос будет решен к 20 июня Мы начинаем испытания в полевых условиях в понедельник, 16 июня, используя лишь 3 вибратора Четвертый вибратор будет включен в работу как только будет найден Поставщик масла, и масло будет поставлено в Институт "АРМЭНЕРГОСЕЙСМОПРОЕКТ" Осталось завершить ремонт бензовоза, основной объем работ выполнен к субботе 14 июня, в 5 00 вечера Ремонт второго УАЗ-469, предназначенного для работы механика (обнаружение помех, неисправностей кабелей, геофонов/ замена) был обнаружен в четверг, 12 июня, и он готов для использования в полевых условиях к середине недели (18 июня \pm 1 день) Все эти ремонтные работы (перечень предоставлен выше) не могут препятствовать началу работ в понедельник, 16 июня 1997 г

Список дополнительных статей расходов для ремонта и других материалов был представлен компании "Burns and Roe" и "Gray Associates" в субботу в 8 30 вечера во время встречи в офисе компании "Burns and Roe", Ереван, после встречи в 5 00 вечера в Аштараке (Институт "АРМЭНЕРГОСЕЙСМОПРОЕКТ") Необходимо просмотреть данный список, официальный ответ будет представлен компании "Burns and Roe" в пятницу, 20 июня Данный список не включает предметов первой необходимости, что может помешать началу работ в

понедельник, 16 июня, с использованием 3 вибраторов, которые будут использоваться в полевых испытаниях Работы, которые должны быть выполнены согласно этому списку, являются частью текущих полевых работ

Представлено



Г Дейл Грей
Старший геофизик



Роберт Хинсон
Инженер по выполнению
полевых работ



Дуглас Такхорн
Директор проекта



Левон Еги́ев, Начальник партии



Абрек Мутселян, Старший
геофизик



Грант Акопян, Главный инженер



Фредерик Араке́лян
Директор

"Арменергосейсμοпроект"

14.06.97г

Дата

June 14, 1997

**Seismic Field Test
Near
Seismic Line NRY-87-14**

Executive Summary

The objective of the Seismic Field Test and Training is to evaluate the US manufactured seismic recorder (DFS V) that has been interfaced with the Belorussian Seismotechniques Vibrators and provide final field training in seismic system operations and field operation techniques. Additionally field tests will be conducted to determine optimum field parameters for seismic operation within the Republic of Armenia. The location of the test area is based upon the criteria that the test area should be in a 'Good' data quality area, be located close to Yerevan, and be located in an area with 'Easy' to 'Moderate' terrain.

Many areas within the Republic of Armenia are covered with surface volcanic basaltic lava flows. The data quality in these areas range from 'Poor' to 'Fair'. It is difficult to prove conclusively that the new system is performing better in areas where the data quality is variable and may be poor in spite of the improved quality of equipment as a result solely to the unfavorable surface geology. Another advantage is that the data quality can be observed in the field for better identification of field data quality problems by the experienced observers and technical advisors.

There are many advantages in performing the Field Test close to Yerevan. First, the equipment and the crew can avoid long travel distances. This results in lower fuel costs, no requirement for providing the crew and technical advisors with camps or hotel arrangements. Another advantage is there are facilities nearby for parts and emergency repairs. The final advantage is that many different representatives from state ministries and US government representatives can visit the field operations with relative ease.

The final criteria, 'easy to moderate terrain', allows the technical advisors to teach the Seismic Institute employees the different aspects of field operations without needing a large staff. In areas with 'easy' terrain and access, the technical advisors can move across the 3.6 kilometer field test area within a few minutes. This allows one advisor to provide training to several different groups at the same time. The second advisor can review the results in the computer containing Seismic Recorder. Additionally, techniques can be taught that will improve field operations efficiency and therefore improve production, which in turn improved field crew profitability.

The Field Test area was selected because it has 'Good' data quality on existing seismic data with a seismic time structure at a time of 1.5 seconds - 2.1 seconds centered within 500 meters of station 6500 on Line NRY-87-14. The seismic line is located approximately 4.5 kilometers to the west of the country's best oil show well, Shorakhpur #1. Based upon the Simon / Partex Report, 'Evaluation of Armenia's Potential Hydrocarbon Deposit', issued in July, 1995, is at a depth of 1.8 seconds at the top of the

Middle Eocene (Report TA-CIS / 92 / EAR001 Report No 7617/11b/ Enclosure 8 5)
The Field Test area is located within 25 km of Yerevan and is located along a reasonably straight road that has minimal traffic since there are landslides that have blocked the road to the northeast of the test area. This allows easy terrain and access without troublesome noise due to car and truck traffic. The line will cross NRY-87-14 at station 4000 and roughly parallel the line to Station 7600. The road actually is oriented obliquely from NRY-87-14 about 15° but the advantages of easy road access for better training outweigh the necessity of exact duplication since the main mission is training not location of a new well. The line was scouted on June 12, 1997 by Dale Gray, a registered geologist and geophysicist to identify the above criteria and to verify the absence of basalt flows in the test area as well.

Field Acquisition and Processing Parameters - NRY-87-14

The original seismic line NRY-87-14 was recorded using the following parameters

Recorder	Russian made Progress
No of Channels	96
Source	Shothole dynamite
Charge size	5 kg (12.5 lbs)
Sample rate	4 ms
Record length	4 seconds (no data below 2.5 seconds)
Source interval	25 m
Geophone interval	25 m
Geophone array	50 m length (2 stations) 32 geophones in-line
Fold	4800%
Spread Configuration	In line - offset - on end
Near trace offset	400 m
Far trace offset	2775 m
Recorder filter	10 Hz low cut 40 Hz high cut Notch - assumed in (50 Hz)

The date of the recording is assumed to be in 1987 based upon the line number. This seismic line was acquired roughly parallel with the Seismic Test Line and about 1000 m to the east.

The original seismic line NRY-87-14 was processed using the following parameters

- 1) Demultiplex
- 2) Input trace normalization
- 3) Sum - 4800% stack
- 4) Coherency filter

- 5) Suppress coherent noise
- 6) Velocity analysis (approximately every 2.5 km)
- 7) Deconvolution

Display parameters

8 traces per inch horizontal scale
 10 cm / sec vertical scale
 Polarity Positive
 Display Station Numbers increase L to R

(Note The data label indicated that the software was probably processed in Gomel using old Petty Ray Geophysical software)

Velocity Analyses

There are two applicable velocity analyses for the Field Test. Velocity analyses needed for data processing corrections for normal move out but are used to roughly calculate depth

Station 4750

Time (sec)	Velocity (m / sec)
0	2800
400	2900
500	3000
700	3200
1000	3300
1400	3400
1700	3600
2000	4000

Station 7200

Time (sec)	Velocity (m / sec)
0	2400
400	2600
600	2800
800	3000
1000	3200
1200	3400
1400	3600
1600	3800
1800	4200
2000	4300
2500	4500

Proposed Field Tests

Monthly Recorder Test - recorded to tape
Wireline similarity required on changes of sweep

Geophone array test

All inline and equal separation

1 - 24	12 geophones Bunched at flag
25 - 48	12 geophones over 30 m
49 - 72	24 geophones over 30 m
73 - 96	12 geophones over 60 m
97 - 120	24 geophones over 60 m

Layout	1	24
	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
	48	25
	49	72
	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
	96	73
	XXXXXXXXXXXXXXXXXXXXXXXXXXXX	
	97	120

Sweep Tests

Frequency content

12 second sweep length + 4 second listen time
Sum 8 sweeps
10 - 40 Hz (two octaves)
10 - 60 Hz
10 - 80 Hz (three octaves) (use for sum test dump and save by 4 s)
10 - 100 Hz²

Sweep Energy

10 - 80 Hz Sweep
8 second sweep length + 4 second listen time
10 second sweep length + 4 second listen time
(12 is already done and on tape)
14 second sweep length + 4 second listen time
16 second sweep length + 4 second listen time

Sum Test

(see above)

10 -80 Hz sweep 12 sec sweep length + 4 second listen time

Sum of 4 8 12 16 20 sweeps

(dump and save as separate files)

Source Array Test

(sum 8 12 and 16)

The length of the four trucks bumper to bumper is approximately 30 m

No move up test - first and last truck are on a station flag

(centers array on 1/2 station)

4 Vibs over 30 m - equal spacing (measure length of trucks bumper to bumper)

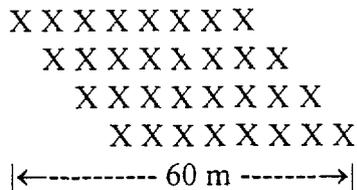
first and last on 1/2 flag (centers array on 1/2 station)

4 vibs over 60 m - equal spacing

Select optimum number of sweeps following test

Move Up Test -

this will require the vibs to back up after each shot unless fold parameters (source interval increased to 60 m) are reduced to 30 fold not 60 fold



approximately 4 m move up after each sweep

First truck = Start on a flag - end on a flag

Select optimum parameters and move vibrators up line 24 36 48 60 and 72 stations

Part one complete - save everything to tape - make duplicate tape

Results of test will be processed in Processing training exercise in Denver under the supervision of Mr Dale Gray

Part two - Full line test

Layout entire line - 120 channels using optimum geophone array, sweep every station using optimum # of sweeps and optimum sweep Listen time is 4 second Determine gap from bunch geophone offset test but it can be no larger than 6 stations - 150 m (roll along switch limitation)

Shoot entire line every station

Line will be processed in the US for 15 20 30 and 60 fold to determine the optimum source interval and fold for field operations

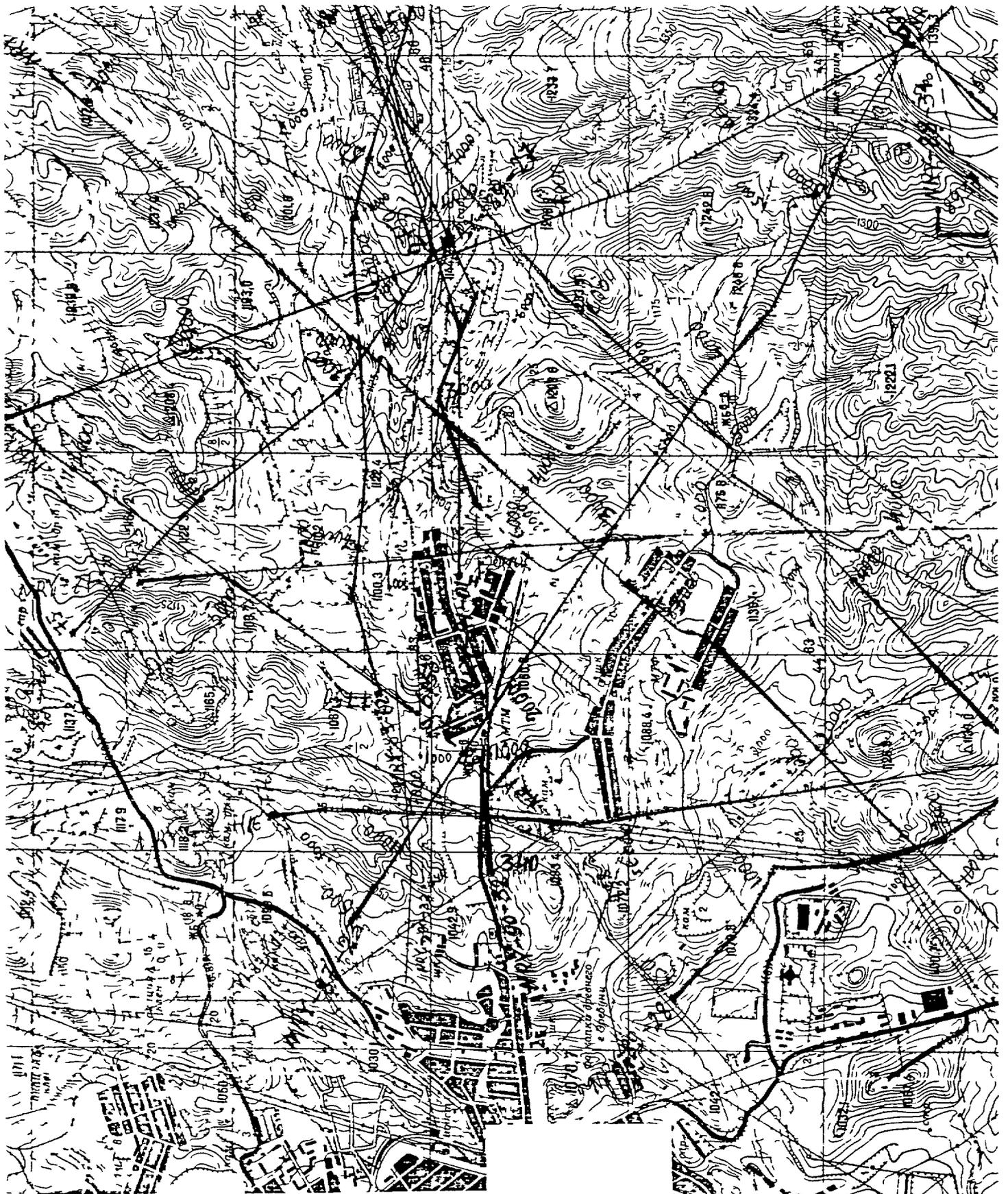
The line can be also processed to determine the maximum skip interval that can be allowed by dropping stations from the center of the line in a good data area

SEISMIC DATA PROCESSING

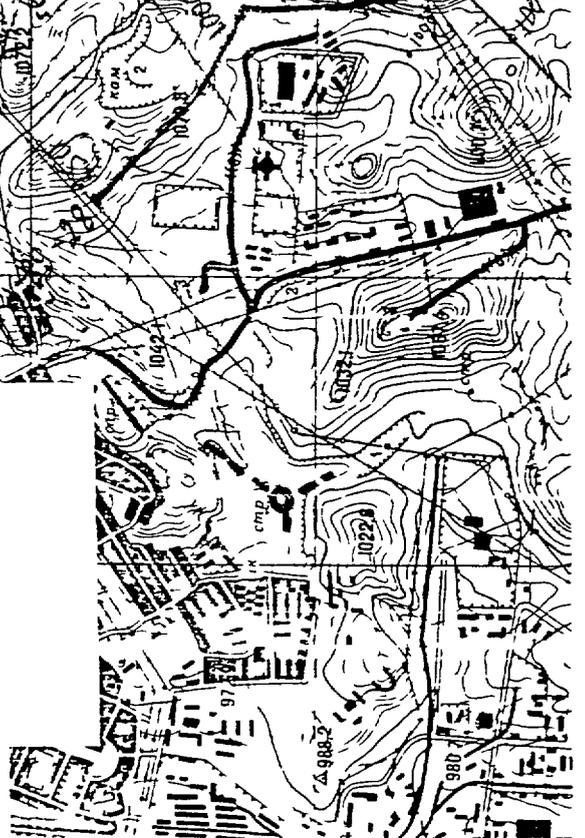
The seismic data recorded for the test will be processed at a seismic data processing company in Denver Colorado for use in processing training for the Armenian geophysical staff There will also be teaching examples and existing Armenian seismic data used in the training sessions

The results of the testing will be reported back to the Seismic Institute as soon as they are available There is not currently any seismic data processing capability in the Republic of Armenia

There is an older DOS version of VISTA data processing and a 486 PC computer at the Seismic Institute The system is obsolete and has never been operational The DOS Vista software will require a software upgrade to work with the new seismic recorder since it has a newer tape drive (Exabyte) The American company that is going to use the Seismic Institute crew upon completion of the Field Testing and Training Phase of the Project is going to use a US based PC software package ProMax The training sessions in Denver will include processing training in the older DOS version of VISTA the Windows upgraded version of VISTA and more intensive training in ProMax This Processing Training phase will commence upon completion of the Field Testing and Training phase of the Project



MASIS SEVAN
Between
Vardashen
&
Nabarashen



SEISMIC EQUIPMENT TRAINING

I DFS-5 Operator Training

A *Analog Module*

- 1) Switch Settings and Purpose of each
- 2) Boards
 - a) Purpose of Each and Data Flow
 - b) Internal Switch Settings and Adjustments
- 3) Power Supply
 - a) Description and Regulated Voltages
 - b) Voltage Adjustment

B) *Controller Module*

- 1) Switch settings and Purpose of Each
- 2) Boards
 - a) Purpose of Each and Data Flow
 - b) Internal Switch Settings and Adjustments
- 3) Power Supply
 - a) Same as Power Supply in Analog Module

C) *Tape Transport*

- 1) Switch Settings-
- 2) Boards
 - a) Purpose of each and Data Flow
 - b) Internal Switch Settings
 - c) Adjustments
- 3) Power Supply
 - a) Description and Regulated Voltages
 - b) Voltage Adjustment

D) *DFS V Manuals*

- 1) How and Where to locate Information and Schematics

E) *DFS V Calibration Schedule*

- 1) Zero Analog Module
 - a) A/D Converter
 - b) Main Amp
 - c) F M Cards
- 2) Set Gains
 - a) O C Card / Oscillator Adjust (5120)
 - b) F M Cards (4720)
- 3) Notch Filter Adjust (50 Hz)
 - a) F M Cards
- 4) A/D Linearity Adjustment
- 5) Degaussing Line Filters

F) *Testing DFS V*

- 1) Run Set of Monthly Tests
- 2) Run Set of Daily Tests

II I/O RLS 240M Rota-Long-Switch

- A) Geophone Input Wiring - 240 sta input**
- B) Geophone Output Wiring - 120 sta ~~input~~ OUTPUT**
- C) Roll-Bar Gap Capability**

III I/O 200 Series Encoder (Dynamite Only)

- A) Purpose and Operation**

IV I/O 200 Series Decoder (Dynamite Only)

- A) Purpose and Operation**

V Travis Electronics CC-120 Cable Tester

- A) Purpose and Operation**

VI Seiscam DFS V Merging System with Stacking and Correlation

1) Convert DFS V System to Operate without 10" Tape Transport

- a) Controller Back Plane Wiring Change
- b) Install Customer Option Board
- c) Change out N Z Board with Modified N Z Board
- d) Change 3 Program Plugs
 - 1) 1 on T M Card (Non Data Protect Option)
 - 2) 2 on M S Card (Non Data Protect Option)

2) Install Seiscam DFS V Merging Computer to DFS V System

- a) Test System to Insure Proper Operation

3) Seiscam DFS V Merging System Computer Training

- a) Main Menu
- b) Setting System Parameters - First
- c) File Function
- d) Tape Function
- e) Choosing Data Base
- f) Creating Data O B Log
- g) Acquire Data Stacking/ Correlation
- h) Processing - filter Settings
- i) Plot Data to Printer
- j) Noise Level Selection
- k) Help Mode
- l) Exit Mode
- m) Running Daily, Monthly Tests

VII Installing DFS V and Computer and All Related Equipment in Truck URAL-4320 Seismic Station

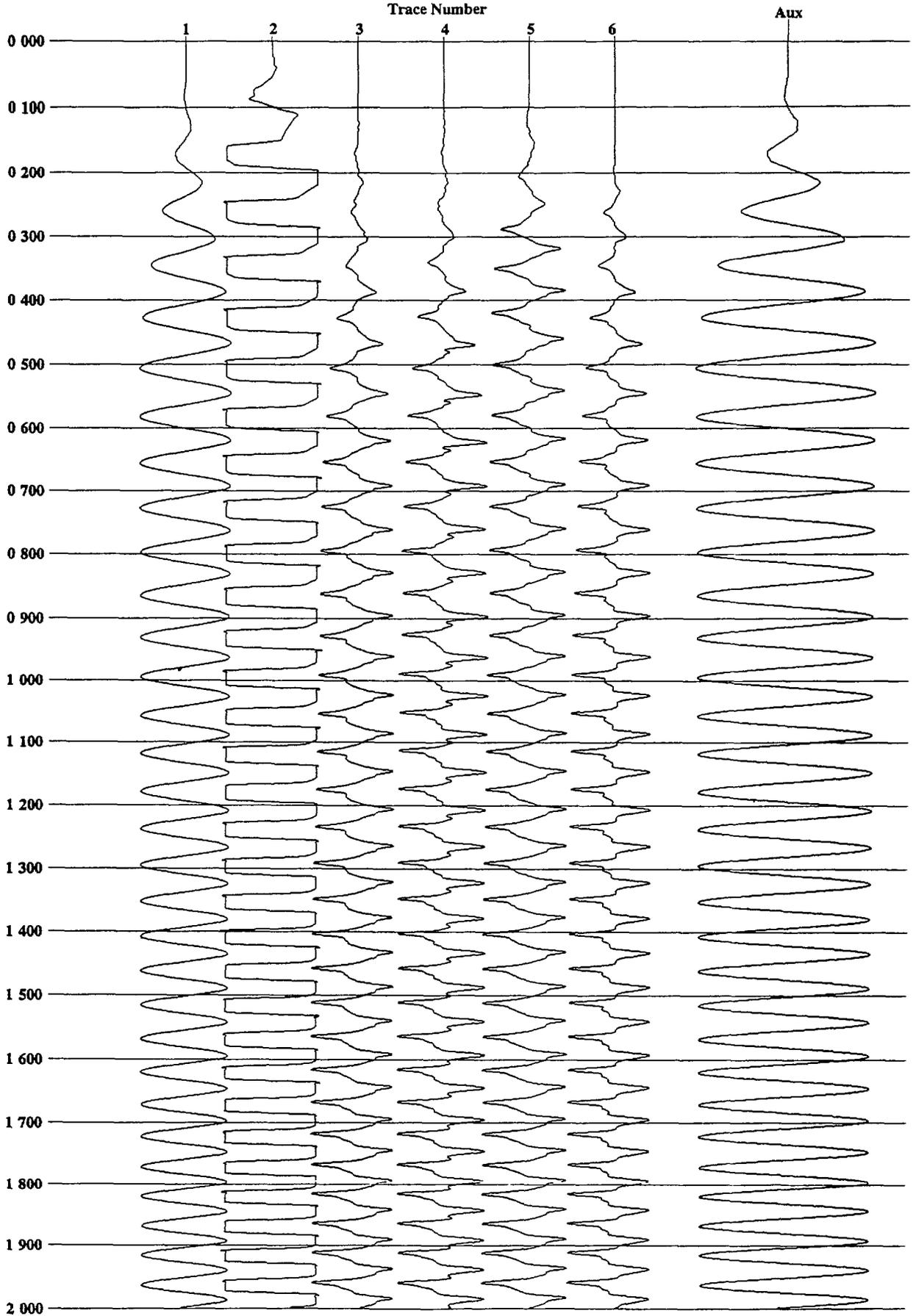
VIII Take All Trucks, Equipment to the Field to Start Field Operations

PLOT OF VIBRATOR SIMILARITY

Prospect USAID/S I
Crew S I # 001
Area LAKE SEVAN
Line TEST LINE

Client USAID
Date Fri Jun 13 15 38 42 1997
Highcut Frequency NONE
Lowcut Frequency NONE

Notch Frequency NONE
AGC Oper NONE
Polarity NORMAL
12db/sec Gain Applied NO



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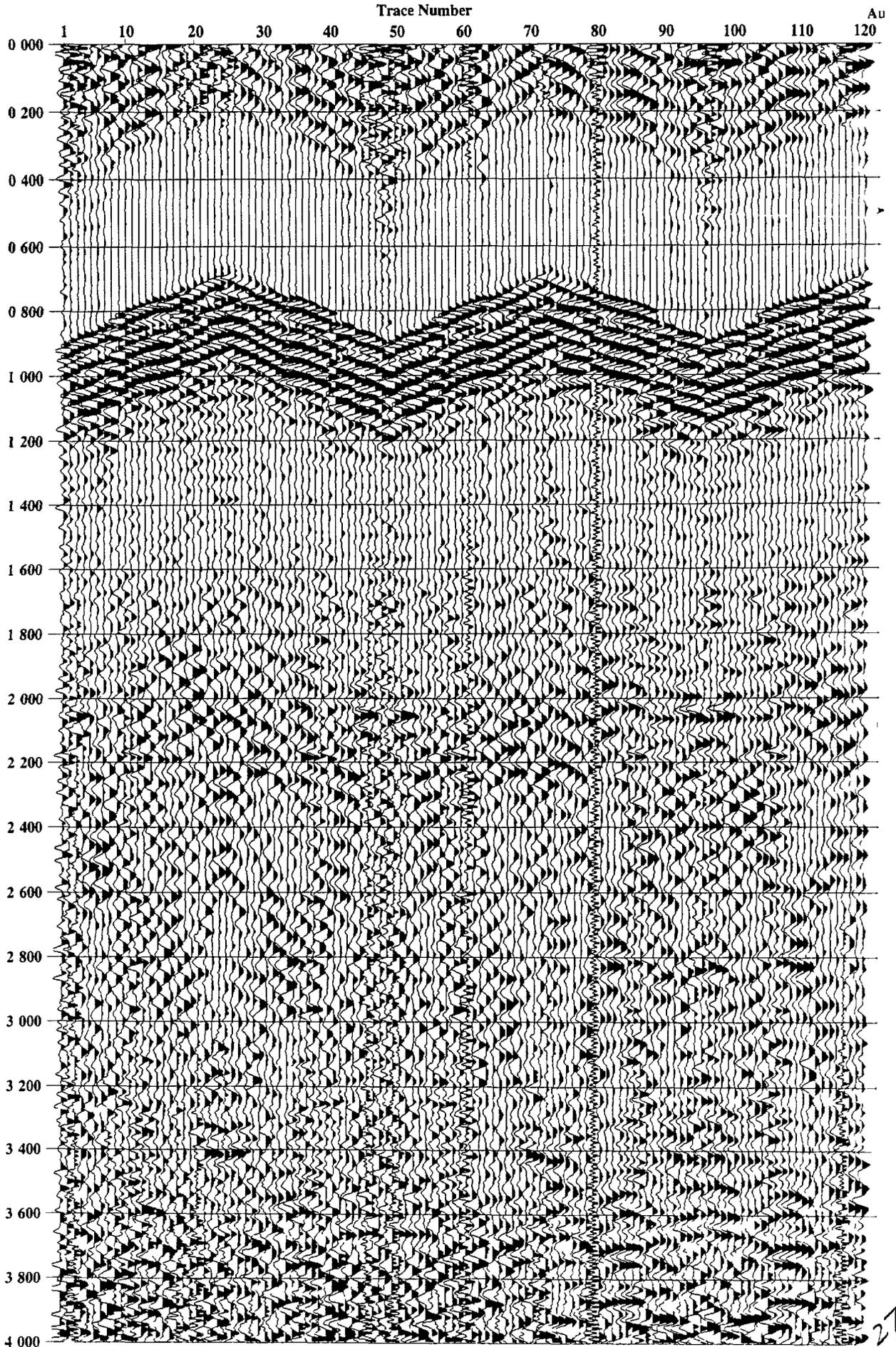
DATA CORRELATED AFTER STACK

FN 174

Prospect Field Test & Training
Crew Armenian Seismic Inst Pty #01
Area Shorakhpur
Line TEST LINE

Client USAID SEIMIC PROJECT DO 26
Date Wed Jun 18 17 06 59 1997
Highcut Frequency NONE
Lowcut Frequency NONE

Notch Frequency 50 000000
AGC Oper 1 000000
Polarity NORMAL
12db/sec Gam Applied NO



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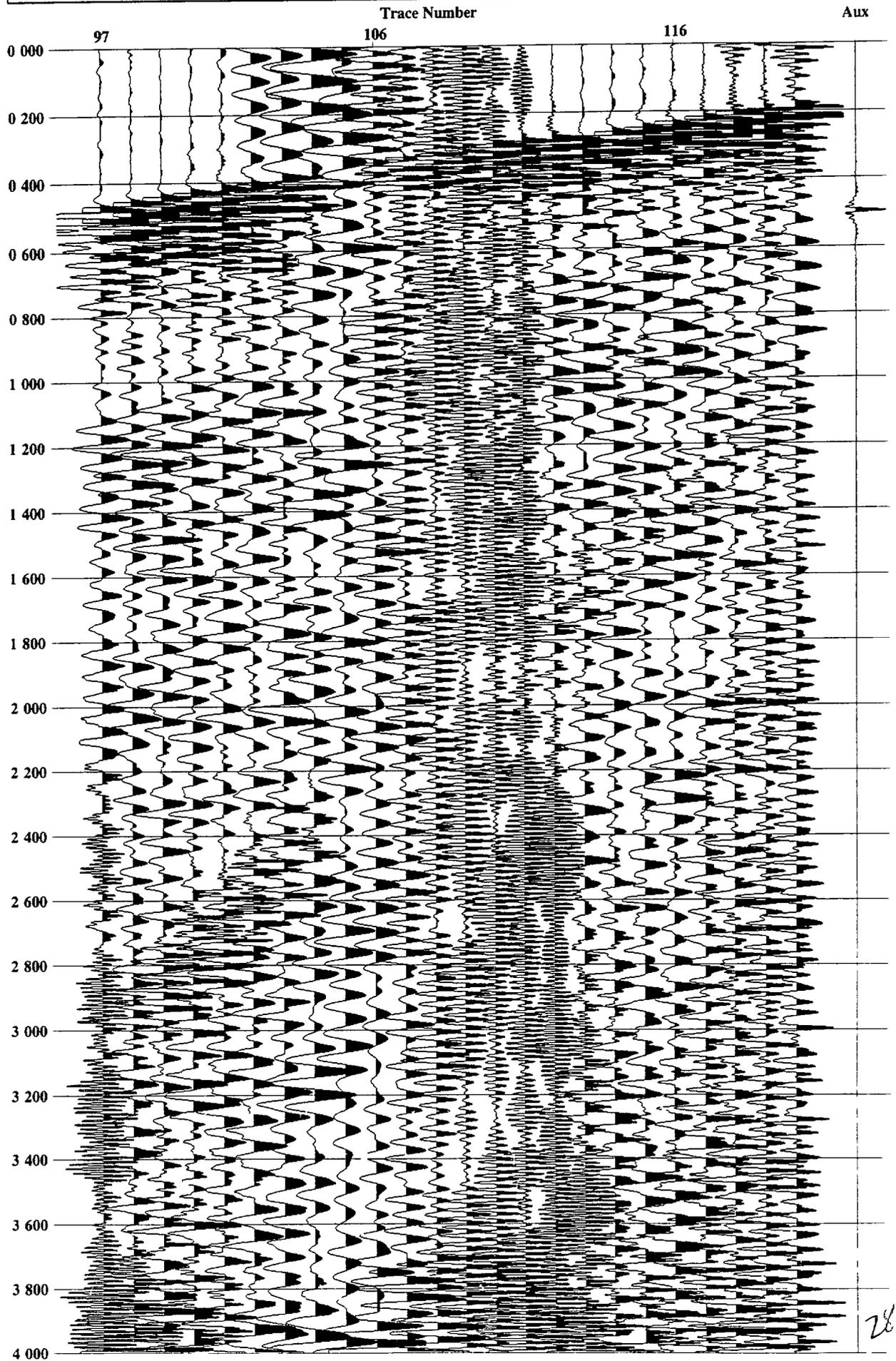
27

DATA CORRELATED AFTER STACK

Prospect USAID/S I
Crew S I # 001
Area LAKE SEVAN
Line TEST LINE

Client USAID
Date Mon Jun 16 19 40 36 1997
Highcut Frequency NONE
Lowcut Frequency NONE

Notch Frequency 50 000000
AGC Oper 1 100000
Polarity NORMAL
12db/sec Gam Applied NO



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28



Burns and Roe Enterprises, Inc.

52 Dzhrashat Street, Yerevan, Republic of Armenia
AT&T Fax and Phone (3742) 151 819 or 151 7 92
Local Phones (7 8852) 58 74 45

June 26, 1997

Frederick Arakelian, Director
"ARMENERGYSEISMICPROJECTS" Institute
Hrazdan Canyon
Yerevan
Republic of Armenia

Cc Dr Garen Galustian, Deputy Minister of Energy
Cc Dr Andre Agabalyan, Petroleum Projects Implementation Unit
Cc Mr Douglas Tuckhorn, Burns and Roe Enterprises, Inc
Cc Dale Gray, Gray and Associates

RE COMPLETION OF FIELD TESTING AND TRAINING PHASE OF THE USAID PROJECT

To Frederick,

On Monday, June 16, 1997 at 11 00 a.m , after all vehicles had been fueled up, we drove them in convoy from Ashatarak to the field testing site near the Shorakhpur well After a slight delay due to GAZ-66 #2 truck accident, the Surveyor, under the direction of Dale Gray and Robert Hinson, started chaining out the test noise spread.

During the next three days we were able to train the cable and geophone workers on how to lay various geophone arrays necessary to implement the test noise spread During the same period Vibrator Operators were able to get back in the habit of operating vibrators after a long period of inactivity We finished the noise spread and were able, due to testing, pick the optimum geophone array and vibrator sweep and length to obtain good energy and data for this area

Our next objective was to lay out 120 stations in line down the test site and record 120 V P's of data using 24 geophones layed out in line over 60 meters The optimum vibrator sweep was a 10 hz up to 80 hz for 14 seconds sweep and listen for 4 seconds The Vibrator taper was 62 5 m s

Over the next several days the S.I Operators, Ashot, Arthur, and David learned how to set up the Seiscam Stacker/Correlator to run daily Vibrator Similarities and DFS V Tests, and how to verify that

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the equipment is operating at Manufacturer's specifications And during the daily operation of Data Recording was able to check all Geophone Inputs and repair bad stations where necessary, and to recognize noisy stations, and have them corrected We are very pleased with the co-operation of all the Operators and their willingness to learn new American technology

As of today, June 27, 1997, we have finished with the test line and have verified that all of the S I vehicles and electronic equipment is operating properly and we are satisfied that the S I personnel can take the vehicles and the equipment and start the Project with the AAEC and do a very adequate and professional job of Data Acquisition

We are therefore declaring that the "Field Testing and Training" phase of the USAID Project will end on June 27, 1997, after all the equipment has been picked up from the test site and all men and vehicles have been driven back to Ashtarak

Submitted by

Accepted by

Robert A Hinson
Seismic Field Operator Engineer
and Representative of Gray & Associates

Frederick Arakelian
Director
"ARMENERGYSEISMICPROJECTS"

Gagik S Danielian
Authorized Representative
Burns and Roe Enterprises, Inc
Yerevan Office

Levon Egjev
Chief of the Party

Hrant Hakobian
Chief Engineer

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6/26/97

11"

Кому Фридриху Аракелян, Директору Института "Армэнергосейсмопроект"

Относительно Завершение стадии испытания и обучения Проект UASID полевых условиях

Копии Г-ну К Галстяну, Зам министра Энергетики
Г-ну А Агабяну, Подразделение по Осуществлению Проекта по Нефтепродуктам
Г-ну Д Такхорну, Директор Проекта, компания "Burns and Roe"
Г-ну Д Грейю, компания "Gray and Associates"

Фридрих,

В понедельник, 16 июня 1997 года в 1100 после того, как все транспортные средства, заправленные топливом, были успешно мобилизованы, с соответствующей охраной из Аштарака на опытный участок (рядом с Шорахпюр) для проведения испытаний в полевых условиях. После небольшого опоздания, вызванного аварией, произошедшей с автомашиной ГАЗ-66 # 2, топограф под руководством Д Грейя и Р Хинсона начали наладку диапазона колебаний для проведения испытаний.

В течение последних трех дней мы имели возможность обучить рабочего по кося и прокладке сейсмических линий, установке геофонов рядами, что необходимо для осуществления испытаний при различном диапазоне колебаний. В течение этого периода операторы вибраторов смогли привести вибраторы в рабочее состояние после долгого простоя. Мы завершили испытания при различных амплитудах колебаний и получили возможность, благодаря испытаниям, установить оптимальное количество рядов геофонов, получить соответствующие величины частоты и длины колебаний вибраторов для получения оптимальных величин по расходу энергии, а также оптимальные данные для данного участка.

Наша следующая цель - установить станцию (120 каналов) на опытном участке и зарегистрировать 120 V P's информации, используя 24 геофона, установленные на участке длиной в 60 м. Оптимальная частота вибратора от 10 до 80 Г в течение 14 секунд колебаний при переде прослушивания 4 секунд. Уклон вибратора 62.5 m/s. В течение последующих нескольких дней операторы (Апот, Артур, Давид) научились установке сейсмического стакера/коррелятора для осуществления испытаний функционирования вибратора и DFS-V, проверке функционирования оборудования в соответствии спецификациями производителя.

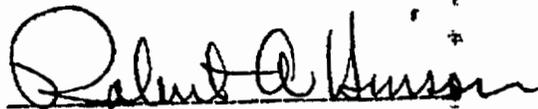
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В процессе ежедневного функционирования рекордер в состоянии проверить геофоны и провести ремонтные работы на станции, распознать помехи и устранить их

Мы удовлетворены работой операторов и их желанием изучить новые американские технологии

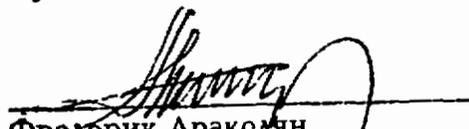
Сегодня, 27 июня 1997 года, мы закончили испытания на опытном участке, и пришли к заключению, что все транспортные средства и электрооборудование функционирует нормально и мы рады, что персонал Института "Армэнергосейсмопроект" может мобилизовать все транспортные средства и оборудование для выполнения Проекта с компанией ААЕС, осуществив работы по сбору информации на высоком профессиональном уровне Мы хотим сообщить, что "Период обучения и испытания в полевых условиях" по Программе USAID завершён 27 июня 1997 года, когда все оборудование, транспортные средства и персонал мобилируются с опытного участка в Аштарах

Представлено



Роберт Хинсон
Инженер по проведению
Сейсмических работ

Принято



Фредерик Аракелян
Директор Института
"Армэнергосейсмопроект"



Гагик Даниелян
Представитель компании
"Burns and Roe"



Левон Егисв
Начальник Партии



Грант Акопян
Главный Инженер

ՀՀ Էներգետիկայի և վառելիքի
Նախարարություն

Էներգետիկայի
սեյսմակայունության նախկին
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Republic of Armenia
Ministry of Energy and Fuel

"Armenian Energy
Complex Seismic Stability
Scientific and Projecting Institute
ARMENERGYSEISMICPROJECTS

6/30/97

To Mr D Tuckhorn, Director of Project
"Burns and Roe" Company

Dear Mr Tuckhorn,

I would like to inform You, that on 27 06 97 we complete USAID Project training-
preparation period, which includes SI equipment, transportation means repair, testing.
During two months "Armenergoseismicproject" Institute and "Burns and Roe" company
employees have been working in cooperation for performance of USAID Project,
connecting with seismic equipment preparation, SI personal training and vehicles testing
in field conditions.

Connecting with Project completion I would like to mention Mr Hinson, American
Seismic Equipment Engineer, and "Burns and Roe" Company employees (under
supervision of Mr G Danielian) fruitful, successful activity I would like to mention also
Mr Grey intensive activity in equipment field testing. I would like to express my
thankfulness again for Your assistance in promotion of this Project performance.

With best regards

F Arakelian,
Director of "Armenergoseismicproject" Institute

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Republic of Armenia
Ministry of Energy and Fuel

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Armenian Energy
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Yer. 002-2, Razhda Casyan, Yerevan, 375015
Phone: 7 (3832) 58 05 05 58 03 05
Tele. Yerevan, Yerevan 242852
c/o No. 220206 Arshakbank, Yerevan

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Компании "Бернс и Роэ"

г-ну Дугласу Таксору

Уважаемый господин Таксор !

Имею удовольствие сообщить Вам, что 27 июня 1997 г. завершена подготовка и испытание сейсморазведочной аппаратуры, оборудования и транспортных средств. В течение 2-х месяцев сотрудники института "Арменергосейсмомонопроект" и представители фирмы "Бернс и Роэ" тесно сотрудничали и осуществляли выполнение программы подготовки аппаратуры, ее испытаний в полевых условиях и обучение персонала.

В связи с успешным завершением этого этапа хотелось бы отметить плодотворную работу инженера по проведению сейсмических работ господина Роберта Хенсона и сотрудников представительства компании "Бернс и Роэ" во главе с господином Евгением Даниеляном.

Хочу отметить также интенсивную помощь, в осуществлении полевых испытаний, со стороны господина Д.Грек.

Еще раз хочу поблагодарить Вас за оказанную помощь и поддержку.

Директор

Փ.Օ.Արակеляն

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BURNS AND ROE ENTERPRISES, INC.

DELIVERY ORDER No. 26

**SEISMIC OIL & GAS EXPLORATION PROJECT
Training Plan**

ARMENIA

JULY 2, 1997

Prepared by: Gray & Associates

Submitted to: U S Agency for International Development

Contract No. CCN-0002-Q-00-3154-00
Energy Efficiency and Market Reform Project
Delivery Order No 26,
Seismic Oil & Gas Exploration Project
Training Plan

INTRODUCTION

The seismic field training, as revised by the Republic of Armenia Ministry of Energy and Fuels and agreed to by USAID is to be completed after of 10-12 days of field testing. This testing commenced on Tuesday, June 17, 1997 and was completed on June 27, 1997. This completed the field training portion of the seismic exploration technology transfer project. The Seismic Institute (SI) is now under contract to the AAEC to implement a 90 campaign for seismic oil & gas exploration in Armenia. This work will collect the same amount of data as envisioned by the USAID program, but it will not provide training to the Armenians in the area of interpretation and processing of the seismic data. Therefore, it is proposed to expand the training specifically addressing the interpretation and processing of seismic data. By expansion of training we mean that instead of 1 or 2 Armenians being sent to the USA 5 or 6 will be trained and instead of 1 or 2 weeks training a comprehensive 8 week training course will be implemented. The cost of this expansion to the Armenian training will be offset by not performing additional data collection after AAEC/SI work is completed.

This document provides a detailed description of proposed training.

PROCESS TRAINING

The next phase of the project will be training for the Armenian geophysical staff in data processing using PC based software and mainframe based software. The capabilities in the Republic of Armenia are limited so the training will be done in Denver, Colorado, USA, a major regional oil and gas center. The training will include formal training in using PC based software ProMax. ProMax is a US company produced software, as opposed to VISTA, which is a Canadian software package. A DOS version of VISTA was provided to the Republic of Armenia in 1993 with a 486 PC. This computer system, using an older version of Windows 3.1 and DOS based software are obsolete. The original proposal was to upgrade the software with the modern VISTA for Windows and to upgrade the computer for use with the processing and interpretation software.

A superior software package is ProMax is more common in the market, indeed will be even used by AAEC for their work, but was significantly more expensive for the original acquisition. The training in ProMax can be accomplished in Denver but in addition the training can include VISTA, VISTA for Windows and Mainframe processing of seismic data without have to purchase any software. The acquisition of software can then be resolved at a later date, possibly by other entities. The recommendation, at this time, would be to provide training in ProMax seismic data processing. Upon completion of the processing, USAID could recommend purchase of a license for the Republic of Armenia with a Pentium 200 PC using Windows NT as the operating system with an exabyte tape drive for data transfer from the recorder.

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Delivery Order #26, Seismic Oil & Gas Exploration Project

The training in Denver will include use of VISTA - DOS version VISTA for Windows ProMax extensive training and mainframe processing of existing Armenian data. The Seismic Institute has access to some of the existing data that was acquired by Simon/Partex during the EU funded study of the hydrocarbon potential of Armenia. This data could be processed by the Armenian geophysical students using the various systems. It has been my experience that students deal better with examples from their work area than just teaching examples that do not always apply to their particular processing problems. The training will commence with simple teaching examples and progress to use of the real Armenian data.

The training will include three geophysicists from Armenia, one fluent in English that can provide translation services during the training period. Attached are the resumes of the three candidates selected by the Seismic Institute, interviewed and accepted by Dale Gray in Yerevan. Training will be provided by Dale Gray starting with introductory level processing, followed by the training by two software providers so their representatives for their respective software packages and finally by a major US geophysics processing center that will also provide computer usage for processing of the Armenian data and the Field Test results. The Field Test result processing will allow the Armenian geophysics staff to learn how to process data to evaluate the optimum field parameters. This will be important when the field crew moves to different areas of the country that will require new experiments. The trainees will also be trained in advanced techniques such as 3D processing to develop state of the art processing skills that can in turn be implemented in the Republic of Armenia. The total training period is 20 days in Denver, Colorado, USA.

INTERPRETATION TRAINING

The next phase of the training for the Armenian geophysical staff is interpretation of the seismic data. Previous investigations have demonstrated that the seismic interpretation techniques used by the Seismic Institute are limited to manual methods of interpretation of paper copy of a seismic survey map ("picking the data"). The values are then hand contoured and the map is then hand drafted. Using these techniques, the seismic interpretation is limited to structural mapping and stratigraphic information is lost.

Modern interpretation techniques take seismic data from the processing center in a standardized format (SEGY) and is imported directly into the PC that has interpretation software. One of the best software packages in the industry, SeisVision, has been purchased for the Republic of Armenia. The seismic software package contains modules for computer assisted interpretation. These modules include time interpretation and time picking. The computer also allows stratigraphic information to be evaluated. The seismic data has three aspects, a time value (used in the manual method), amplitude and phase. The amplitude of the seismic data contains valuable information regarding the porosity and possibly the fluid content. For example, in

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turbidite sands, similar to what is found in the Tertiary sediments in Armenia, the presence of gas is observed as "bright spots" of high amplitude. The interpretation, using color monitors and color printers allow the evaluation of the stratigraphic section using direct detection techniques. These techniques, combined with computer automation of the structural mapping will be taught to the Armenian geophysics students. This software has already been acquired for the Seismic Institute and the manual is being translated into Armenian.

The interpretation training will overlap the final processing training of the Armenian data field test and existing Armenian seismic data to allow the interpreters of the data to learn the fundamentals of data processing to assist them to interpret the data.

The interpretation training will include the techniques of 3D interpretation using example data since there is no existing 3D Armenian data. This sequence will provide a complete training of state of the art techniques to complement their state of the art software.

SITE VISITS

Arrangements have been made to tour the Western Geophysical Processing Center in Denver, one of the largest in the World. Western has agreed to provide a Russian speaking tour guide for the day in the Data Center. Final date for the tour will be selected based on the final course arrangements.

Additional tours are planned for visiting a major oil company office to review typical operations for interpretation and the Colorado School of Mines to work on sample data for interpretation projects.

CANDIDATES FOR TRAINING

On June 24, 1997, Mr. Frederick Arakelian, Director of the Seismic Institute presented to Mr. Dale Gray, Senior Project Geophysicist for the Armenia Seismic Training Project, a list of candidates for the second phase of the Training Mission. It was Mr. Arakelian's suggestion to train the geophysicists for the entire training course of data processing and interpretation of seismic data. The original proposal was to have two groups of four candidates. One additional candidate, recommended by the USGS - USAID coal project chief geologist, Ms. Brenda Pierce, and working with the Armenia seismic project for the last two months, Mr. Georgy Aslanian, was selected as a person from training outside the Seismic Institute for a future joint scientific project with the UAFA for "Geophysical application of seismic data for coal studies".

The candidates were interviewed and accepted by Mr. Dale Gray as having an acceptable level of previous geophysical experience to qualify for further training. The nature of this training is

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Delivery Order #26, Seismic Oil & Gas Exploration Project

intensive, high technology training in specific geophysical software packages with application for subsurface exploration this level of training requires previous experience in geophysical exploration to avoid delays in the class by starting at an entry level

The five candidates recommended and accepted are

- 1) **Gevorg Manaseryan** - Fluent in English, Russian, Armenian, Masters in Geophysics, will also double as the interpreter
- 2) **Abrek Mousalarian** - Chief Geophysicists - Seismic Institute
- 3) **Vardan Andriasian** - Seismic Institute staff geophysicists for data processing and interpretation
- 4) **Mariam Sarkisian** - Lead seismic data processor - Seismic Institute
- 5) **Georgy Aslanian** - Geophysicists with 16 years experience in Oil & Gas and Coal

SCHEDULE FOR TRAINING

The training is scheduled as follows

Burns and Roe will make the appropriate arrangements for the geophysicists to travel from Yerevan, Armenia through Amsterdam to Denver, Colorado on Tuesday, July 15, 1997 and return on Saturday, August 30, 1997 The Visa applications for the Seismic Institute employees has already been started by Mr Frederick Arakelian, the Director of the Seismic Institute Mr Georgy Aslanian's Visa application should be submitted by Mr Gagik Danielian with Burns and Roe Yerevan

The geophysicists will arrive in the afternoon on Tuesday, July 15, 1997

The three week course in Seismic Data Processing training will start at noon on Wednesday, July 16, 1997 and continue until Wednesday August 6, 1997 The course will start with simple data processing and advance to ProMax data processing - advanced level training

The three week course in Seismic Data Interpretation will start on Thursday, August 7, 1997 and continue until Friday, August 29, 1997

The geophysicists will return to Yerevan on Saturday, August 30, 1997 through Amsterdam

HOUSING FOR CANDIDATES

The recommendation for the housing arrangements is to rent apartments for the visiting geophysicists and Mr Dale Gray with Gray & Associates This is a combination of cost

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Delivery Order #26, Seismic Oil & Gas Exploration Project

effective and improved living conditions. An attached list summarizes the available furnished apartments for short term rental. The course location will be in downtown Denver, so a location near downtown is recommended but not necessary. The Armenian geophysicists will not be able to drive but Gray & Associates will rent a car for transportation for the team while in Denver. Burns and Roe will need to make the necessary arrangements for apartment deposits and payment for the stay in Denver for the Armenian staff (2 two bedroom apartments). Mr Gray will make his arrangements for an apartment in the same facility but Burns and Roe must make sure there are three apartments available for the course time frame.

DELIVERY ORDER #26
Seismic Oil & Gas Exploration Project

ID	Task Name	Duration	April			May				June					July			August				September							
			13	20	27	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	31	7	14	21			
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2	Equipment Preparation	44d	[Task bar]																										
3	Field Testing and Training	15d	[Task bar]																										
4	Processing Training	20d	[Task bar]																										
5	Interpretation Training	20d	[Task bar]																										
6	Final Report	10d	[Task bar]																										
7	Present of Final Report	10d	[Task bar]																										

Project
Date 7/2/97

Task



Summary



Rolled Up Progress



Progress



Rolled Up Task



Milestone



Rolled Up Milestone



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Gray & Associates
International Geophysical Consultants

15982 N 78th Street, Suite B Scottsdale AZ 85260 (602) 905-8689 (602) 905 8818 fax

Burns and Roe Enterprises, Inc
1400 K Street N W , Suite 1050
Washington, D C 20005

Attn Mr Douglas Tuckhorn

RE: STATUS REPORT 9/10/1997

Summary of Training Program and Evaluation of the Project

REPUBLIC OF ARMENIA PROJECT

CCN-0002-Q-00-3154-00

Burns and Roe Contract No 5826-051

DO-26

Mr Dale Gray, Project Geophysicist, met the Armenian Specialists upon their arrival in Denver at 5 30 pm on July 22, 1997 The participants in the course were Abrek Musaelian, Chief Geophysicist, Gevork Manaseryan, Georgi Aslanyan, Mariam Sargasyan and Vardan Andriasyan They were transported by van to the corporate apartments, the base of operations during the six weeks of training

The five individuals involved in the seismic processing and interpretation training were selected by the Seismic Institute and interviewed by Dale Gray with Gray & Associates for technical qualifications and language skills One specialist, Gevork Manaserian, was fluent in English and has a degree in geophysics and training in Earthquake Seismology Mr Manaserian was the team interpreter as well as a class participant Two other specialist, Mariam Sargasyan and Georgi Anslanian had basic English skills and improved dramatically with constant exposure to the language The remaining two students, Abrek Musaelian, the Chief Geophysicist, and Vardan Andriasian had no previous English training Both were, however, well trained in the conventional Soviet style of processing and interpretation They were useful in the reprocessing of the older data by providing the translation of the Russian observer reports and insight on Russian styles of shooting seismic data With the use of Gevork Manaserian as the primary interpreter and Mariam Sargasyan as the secondary interpreter, the course proceeded relatively smoothly and efficiently

Housing was provided by USAID at the Oakwood Apartments in SE Denver The apartments were selected by the representatives of Burns and Roe's Washington office,

particularly Ms Gabrielle Koscielski. The decision was to use corporate apartments since the length of stay was six weeks. The room arrangement also allow the Armenian team to share food preparation costs and efforts. This process is recommended for future training procedure.

The Armenian staff is staying in corporate apartments located in SE Denver. The apartments are moderate but include several amenities including swimming pool, weight room and tennis courts. The specialists are active in their use of the facilities. They have been provided health insurance information for unexpected medical problems during their trip. Transportation is provided by an AVIS Dodge caravan, which carries the full insurance package. Mr Gray is providing driving.

The classes started on July 23, 1997 with training in VISTA for Windows seismic data processing at the offices of Vector Seismic Data Processing in downtown Denver. The first portion of the course was an overview of seismic processing taught by Mr Curt Moran with Vector Seismic Data. Mr Mike Galbraith, President of Seismic Image Software, the company that developed VISTA, presented three days of training for the Armenian specialists in the VECTOR office. The VISTA training was completed on August 1, 1997 and training commenced on general processing training on August 4, 1997. The training was conducted on the Seismic Field Test and Seismic Profile #1. This was the seismic line acquired by the USAID / Burns and Roe / Gray & Associates using the Republic of Armenia Seismic Institute staff and equipment in June, 1997.

OVERVIEW OF PROCESSING AND INTERPRETATION COURSE SCHEDULE

JULY 22 – SEPTEMBER 6, 1997
DENVER, COLORADO, USA

		22 Travel Day – Arrive from Yerevan	23 VISTA Training (Vector)	24 VISTA Training (Vector)	25 VISTA Training (Vector)	26 VISTA Training (Vector)
27 Picnic Armenian Of Colorado	28 VISTA Training (Vector)	29 VISTA Training (Vector)	30 VISTA Training (Vector)	31 VISTA Training (Vector)	1 Theory Training (Connelly)	2 Air Force Academy / Royal Gorge
3	4 Promax Training (Pulsonix)	5 USGS Tour - Coal	6 Promax Training (Pulsonix)	7 Promax Training (Pulsonix)	8 Promax Training (Pulsonix)	9 Water World
10 Rocky Mtn National Park	11 Promax Training (Pulsonix)	12 Promax Training (Rockies Game PM)	13 Promax Training (Pulsonix)	14 Promax Training (Pulsonix)	15 Promax Training (Pulsonix)	16 Picnic Pulsonix
17	18 Promax Training (Pulsonix)	19 USGS Tour Geo- physics	20 Inter- Pretation (G&A)	21 Inter- Pretation (G&A)	22 Theory Training (Connelly)	23
24	25 Inter- Pretation (G&A)	26 Inter- Pretation (G&A)	27 Inter- Pretation (G&A)	28 CSM Tour	29 Newmont Mining Geo- Physics	30 Inter- Pretation (G&A)
31 BRONCO GAME / AOC DINNER	1 LABOR DAY HOLIDAY	2 Geo graphix – Seisvision / GES	3 Seisvision (G&A)	4 Seisvision (G&A)	5 Seisvision (G&A) / Travel	6 Travel Day Amsterdam / Yerevan

SEISMIC DATA PROCESSING TRAINING

Two companies, Vector Seismic Data (VISTA) and Pulsonix (Promax), were selected for the processing training. They both had existing staff experienced in use of their selected software, experience in training and conference room facilities. They were available on short notice and had previous international processing experience. Western Geophysical did not have the ability or the two software packages (VISTA or Promax) to provide the training. Vector is a joint venture partner with VISTA in software development and was the only company available for VISTA software training. Vector was also involved with the original VISTA software purchase and was familiar with the project and had previously met the senior Armenian geophysicists. Pulsonix was selected since they were available on a short time frame notice and were also familiar with the Promax system operations. Pulsonix has provided training for other international projects and can provide the Armenian staff in-country training if the project acquires a Promax license for the Republic of Armenia. Additionally, Darrell Connally, a Denver based geophysical consultant, was used to teach two classes in the mathematics of seismic processing theory.

The purpose of the VISTA and Promax training was to allow the geophysical specialists from Armenia to evaluate the software packages, while developing proficiency in use of the processing software packages. There is currently a Promax system in operation in Yerevan for the Armenian American Exploration Company. This system, using expatriate British operators was leased for four months and will return to London in October.

The original VISTA software was one of the first interactive DOS based, PC platform seismic processing systems. VISTA ran on small personal computers, had good geometry functionality, strong field testing capabilities and efficient screen / hardcopy display abilities. It was considered a leader in seismic data processing. With the increase in PC computing capabilities and the dominance of Windows NT operating system, VISTA developed the VISTA for Windows version. The software, unfortunately is early in its development cycle but with maturity it will become one of the NT based leaders in the 2D / 3D processing systems. The DOS version was purchased for the Republic of Armenia by Armoil in 1993 and is resident in Yerevan, but was never installed or used since the Armenian specialists were not trained. VISTA is a Canadian (Calgary) based company.

Promax, a Denver based subsidiary of Landmark Graphics, is a well established, universal seismic data processing system that is recognized and used by most major oil companies and national geophysical laboratories throughout the world. In fact, USAID has previously acquired Promax systems for Russia (Tyumen) and the Ukraine (Kiev) in the past two years. It has a proven reputation of being one of the best interactive 2D processing systems with an intuitive user interface. It is quickly becoming a solid 3D system with the potential of being the leader in fully integrated processing systems. By being a Landmark company, the output from Promax is fully compatible with Geographix SeisVision, another Landmark division. The main negative feature to Promax is the cost. Promax is one of the most expensive 2D

and 3D software processing systems. Another negative issue is the UNIX operating system that has an uncertain future competing with Windows NT.

There are hardware issues that are related to the two different operating systems. VISTA runs on high end personal computers (Pentium Pro, etc) while Promax runs on IBM, Sun or Silicon Graphics workstations. The cost differences for the two systems is approximately \$25,000 mainly in hardware for the workstation. Both systems support a variety of peripheral hardware, however, Promax with its ten plus years of development has more flexibility and choices.

The Republic of Armenia has acquired approximately 120 profiles consisting of an estimated 5000 kilometers of seismic data acquired during the former Soviet Union time period of 1984 – 1993. These old seismic lines will need reprocessing using current state of the art seismic data processing techniques and software to allow the Republic of Armenia to evaluate the hydrocarbon potential of the various Armenian basins. The cost to reprocess just five of the 120 profiles at US based seismic data processing centers, selected on a competitive bid basis, will be approximately \$26,250 US at \$15 / record. The estimated cost to reprocess all 120 profiles would therefore be approximately \$630,000. The cost of a Promax system and related hardware/software that would allow the Republic of Armenia to reprocess their own data is estimated at less than \$200,000 US. The USAID trained geophysical specialists can then provide the reprocessing and interpretation in Yerevan using the new Promax / Geographix software and hardware.

The preliminary results of the reprocessing of five seismic lines provided by the Republic of Armenia for the Seismic Data Processing and Interpretation Training indicate a significant improvement over the existing data. The Republic of Armenia has been requested to provide clean copies of the existing, older processed data so that we can provide a direct comparison of the modern technical capabilities versus the older technology previously available.

INTERPRETATION TRAINING

In addition to Seismic Data Processing training, the Republic of Armenia geophysical specialists were provided training in Seismic Data Interpretation. The software package, Geographix SeisVISION, is a state of the art PC based seismic interpretation software package. This software was previously acquired by USAID / Burns and Roe as part of this project.

The training included two weeks of general seismic interpretation training using conventional paper copy interpretation, conversion from time to depth, geologic interpretation of seismic data, direct hydrocarbon indicators, contour exercises for geologic and structural traps, seismic stratigraphy and basin analysis. The USGS Denver based Geophysical Group, under the direction of Dr. Dave Taylor, demonstrated the SeisVISION, Geographix GES contouring and presentation software and the USGS Promax seismic data processing software system. This group is the equivalent of the function intended for the Seismic Institute in Armenia. He recommended that the Republic of Armenia procure the GES software as part of their interpretation package since the SeisVISION software does not have 2D mapping or

contouring capabilities. Following this recommendation, an appointment was made with Geographix in Denver for a demonstration of the software packages. Mr. Vince Molliconi with Geographix gave a demonstration of the integrated SeisVision and GES software packages for the entire Armenian team. The GES software allows the maps and seismic data to have values posted, contoured and to make presentation quality displays of potential prospects generated by the Republic of Armenia for meetings with oil companies interested in investing in the drilling of wells in Armenia. It is recommended that procurement of the GES software, a vital portion of the interpretation capabilities be included as part of the Project DO-26. Mr. Jay Workman, with Geographix, provided pricing information for the software. The pricing from Geographix is attached to this report. The GES Licenses should be acquired prior to the November meetings to allow training in Yerevan to be completed at that time.

The training in SeisVision was done initially with public domain data provided by previous grants for the US Department of Energy (DOE) and Gas Research Institute (GRI) and the University of Texas Bureau of Economic Geology (the Stratton data set). Vector Seismic Data, Interpretation Division, provided Landmark support and plotter support (HP650C) in generation of paper copies of the data for the initial interpretation training. These lines were used by the students for classical seismic interpretation using colored pencils and rulers. The same data sets were then interpreted using SeisVision, a PC based seismic interpretation software package. The interpretation with SeisVision took less than an hour to accomplish. The same products took two days work with manual systems. The structural contour mapping and presentation of the final product could not be accomplished until the GES software package is acquired. The training for this software package will be done prior to the final project report presentation in November in Yerevan. The course continued into 3D mapping and interpretation using the Stratton and Moosehead data sets. The 3D workstation interpretation is the current advanced technology for seismic interpretation. This was included in the course curriculum in the event that hydrocarbon deposits are discovered within the next year in the Republic of Armenia and there is a need to acquire, process and interpret 3D surveys for enhancing additional drilling locations and production evaluation. The 3D technique may also have some application in the Hrazdan salt cavern area for improved imaging to evaluate future strategic petroleum reserves needed with improved pipeline capacity. The methodology would allow reservoir mapping and evaluation of structural integrity of the salt domes prior to investment in drilling and leaching for storage development.

The final interpretation efforts will use the five reprocessed seismic lines acquired from the ROA and currently being reprocessed using Promax systems in Denver by Vector and Pulsonix. Several of the seismic lines, even at preliminary stage of reprocessing, demonstrate significant improvements over the previous work done by the Belorussian geophysical expeditions from 1984 to 1993. This training will be done prior to the final project report presentation in November in Yerevan. It is anticipated that the Republic of Armenia will reprocess several additional seismic lines during the upcoming month if they have a Promax system.

CONTINUED TRAINING NEEDS

The initial training in Denver was developed to create an immediate capability within the Republic of Armenia for seismic data processing and interpretation skills. The training schedule was six weeks and covered two processing systems, some processing theory and interpretation software training. The volume of information being presented required that the training be intensive, "hands on" rather than in depth theoretical and application related. The nature of the geophysical processing is to apply mathematically intensive computer solutions of model based algorithms to attempt to image the subsurface of the earth. The training was based upon the use of computer processing sequences for displaying the data. Very little time was available for development of background in the mathematical models and the assumptions that are inherent in the model. This lack of theoretical knowledge can only be provided by more exposure to trained professional geophysicist and formal college training. The short term need for the Armenian geophysical specialists continued training can be provided by "on-the-job" training at one of the data processing centers. The training could essentially be self funded with the exception of the initial cost of airfare, visa expenses, one month rent for an apartment and one month per diem assistance. The concept would be to provide six months training at one of the processing centers in a paid position. The specialist selected for the training would after one month have generated income to cover additional expenses during the training. The advantage to "on-the-job" training would be an increased exposure to a variety of projects, close support by trained professionals and improved processing skills developed by repetition. The following companies would be suggested for the "on-the-job" training: Pulsonix, Vector or Western Geophysical in Denver, Vector or Western in Houston or Western in California. Mariam Sargasyan would be the first candidate since she has the best developed language skills following Gevork Manaserian. She is single and developed several new Armenian friends in Denver that would create a potential roommate relationship. The second candidate for the training would be Georgi Ansylianian. While not a fluent in English, his geophysical skills are very good and he will, no doubt, become one of the leading geophysical influences in the Republic of Armenia. He demonstrated throughout the training exceptional background knowledge, computer skills and practical field experience. I think with minimal exposure, his English skills would be sufficient for the training.

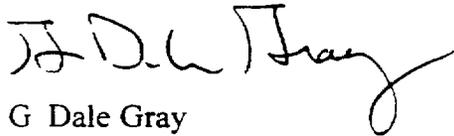
The more significant training, theoretical and application based, would require training at a university such as the Colorado School of Mines. The training needed would be a Masters in Geophysics (ME degree). This is a one year school / one year employment with supervised project curriculum. The student would be trained on state of the art equipment supported with classes in geophysical theory. The training includes acquisition, processing and interpretation classes. The result of the Masters program would be a capable staff scientist that would be respected at the international level for presentations, negotiations and new ventures. The secondary mission of the training of a staff scientist would be to provide an Armenian teacher in Yerevan to provide an on going supply of geophysicists for the future energy needs.

The concept would be to supplement the initial training phase with on the job training to provide a person in six months who would be more capable of providing the technical support necessary for processing and interpretation operations. This in turn would be supplemented by a person that would be trained at a US university that could provide the foundation of theoretical and application training required to understand the theory behind the software packages. This person would provide future training at the Yerevan universities for the continued supply of geophysicists that the Republic of Armenia will need in coming years.

My recommendation for the ME training would be Gevork Manaserian because of his knowledge of the English language (that would be an admissions requirement at any university) combined with his degree in geophysics, which would require minimal remedial course work. This combination should allow him to return the Republic of Armenia in approximately two years as a staff scientist with extensive geophysical training.

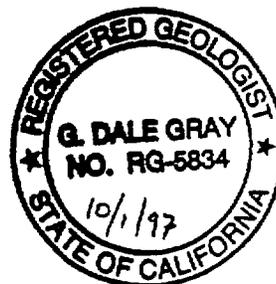
While it is beyond the scope of this mission to provide this level of training, I felt that it would be prudent to at least advise a course of action for further training. There are undoubtedly a number of financing options available for providing the training required for the long term solutions to the energy needs of the Republic of Armenia.

Submitted by

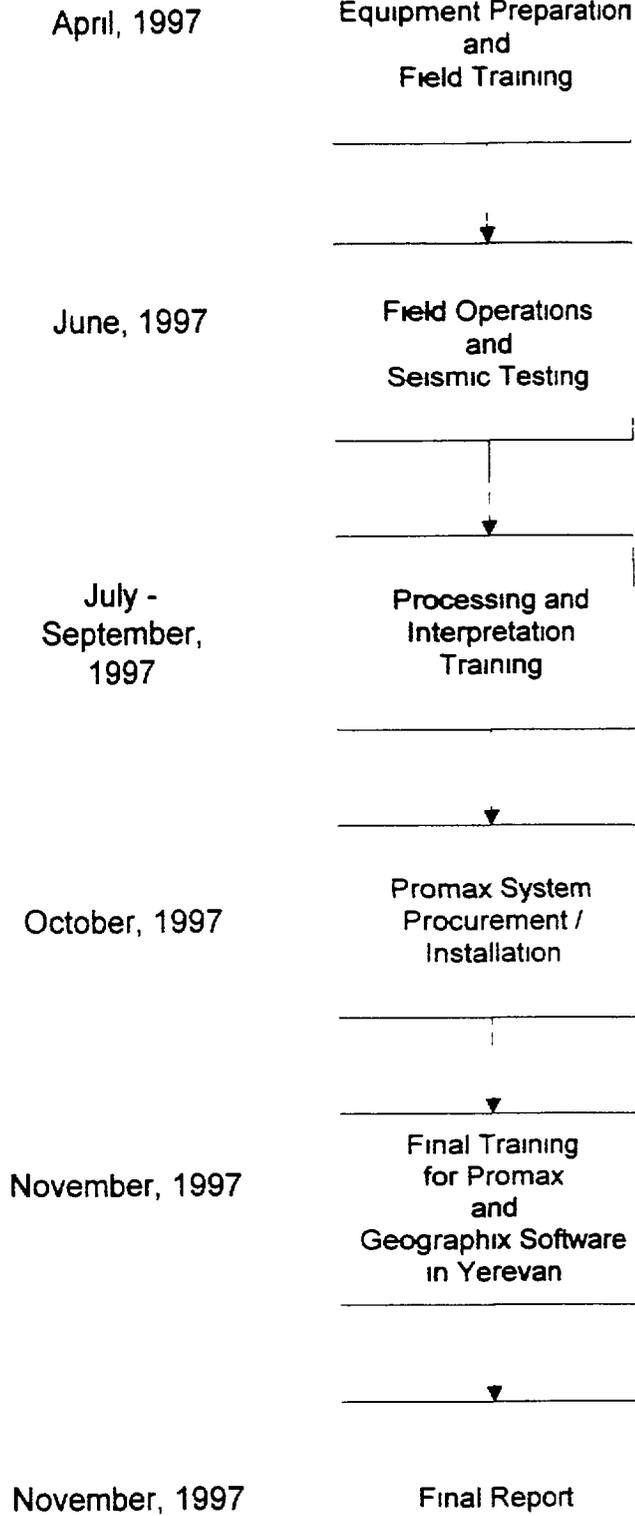


G Dale Gray
Project Geophysicist

October 1, 1997

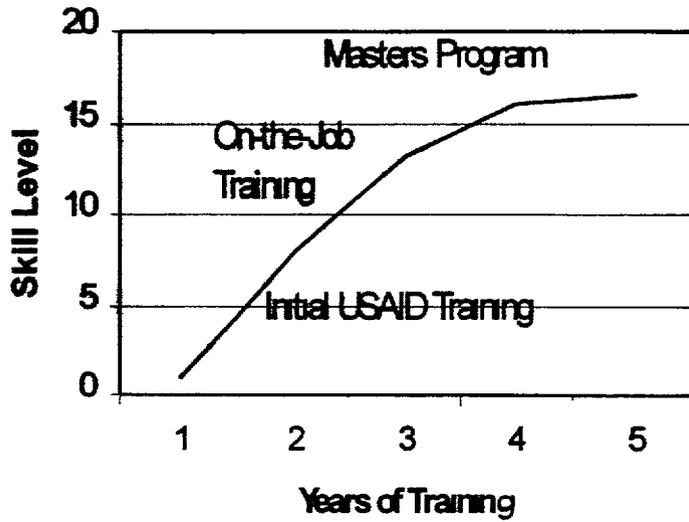


DO-26 Flowchart



Summary of Future Training Needs

Geophysical Skills vs. Time



Geophysical Skills vs. Time

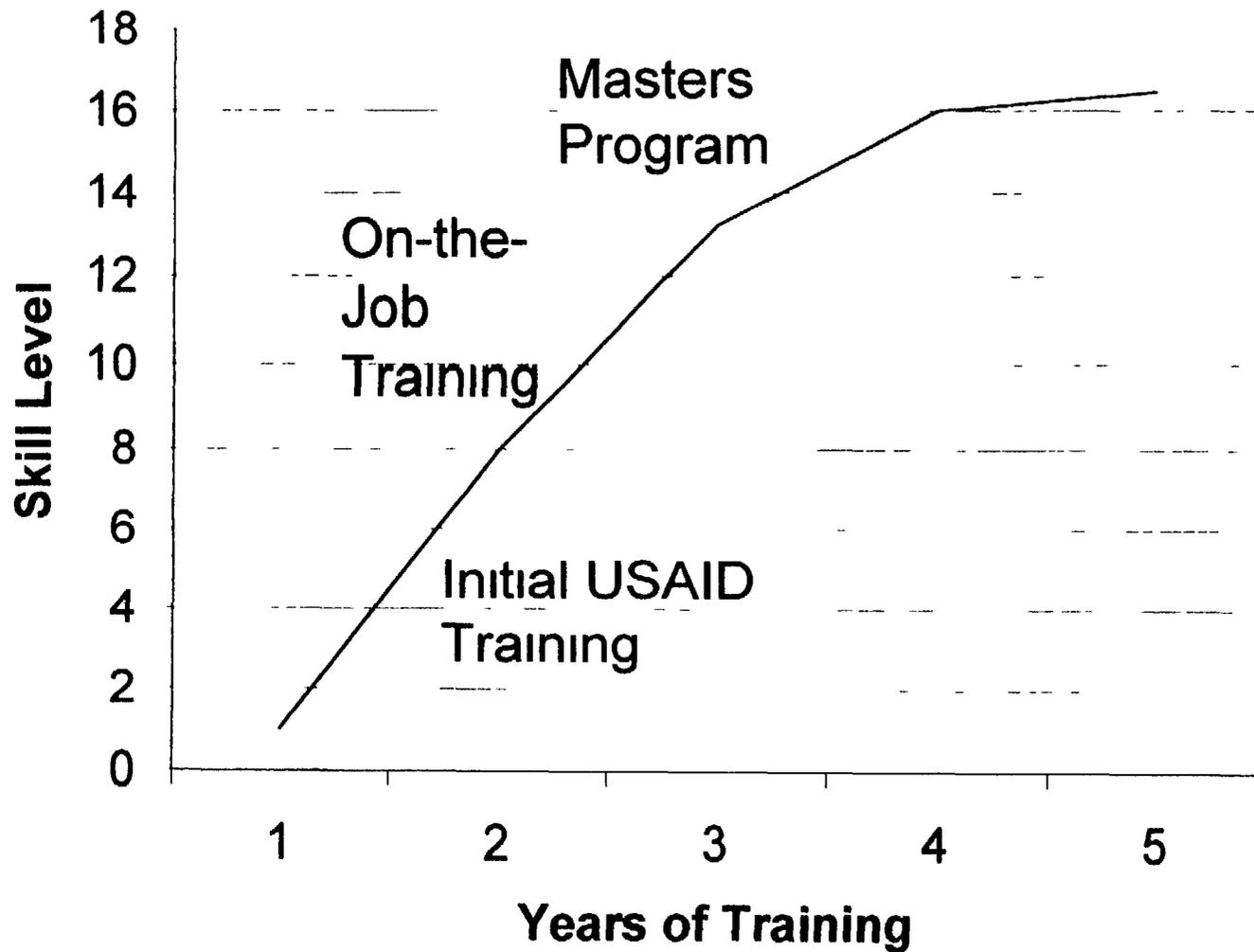


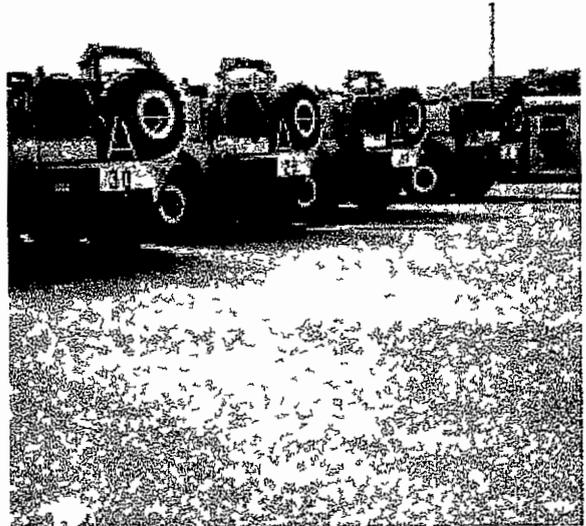
EXHIBIT #8 PHOTOS

INSPECTION OF EQUIPMENT, JUNE 13, 1997

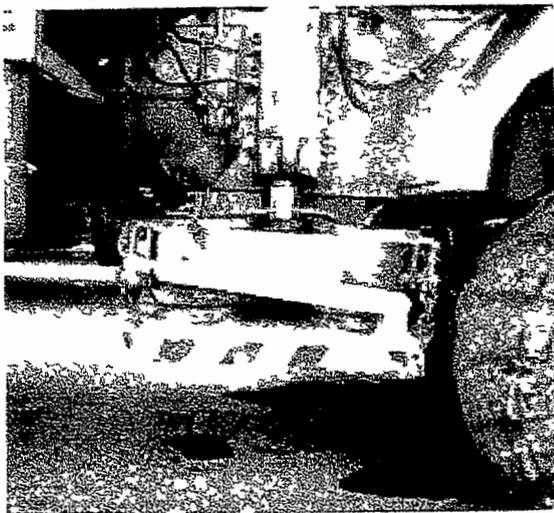
VIBRATORS



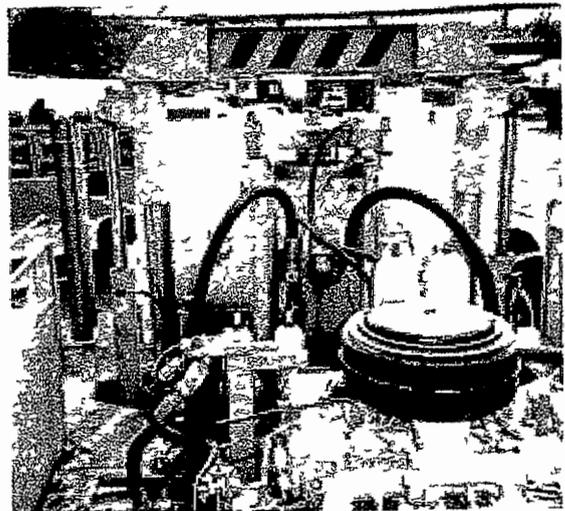
Vibrators Front View



Vibrators Rear View



Vibrator Pad

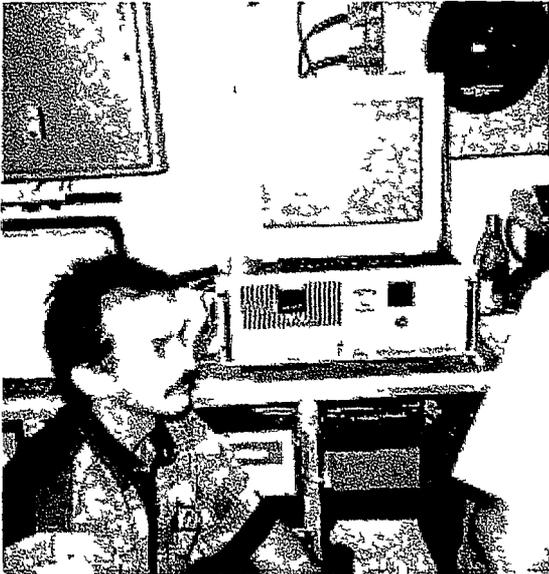


Vibrator Top View

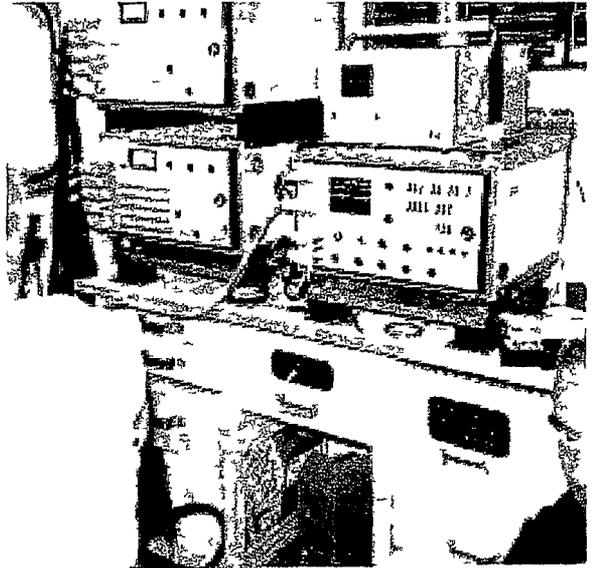
EXHIBIT #8 PHOTOS

INSPECTION OF EQUIPMENT, JUNE 13, 1997

SEISMIC STATION



Stacker Correlator - Seismic Station



DFSV - Seismic Station



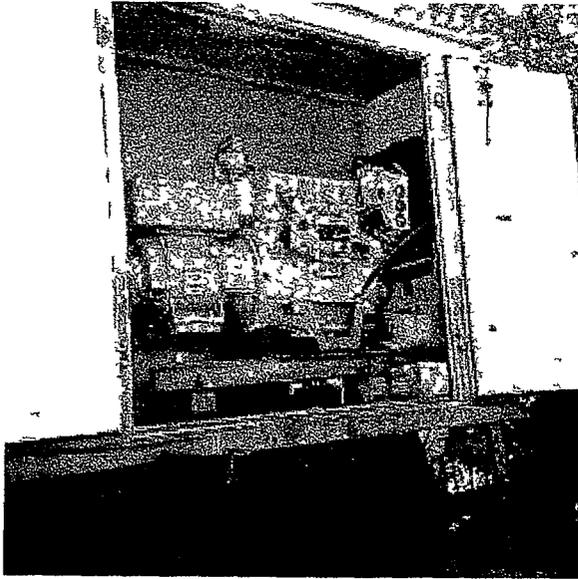
Seismic Station

50

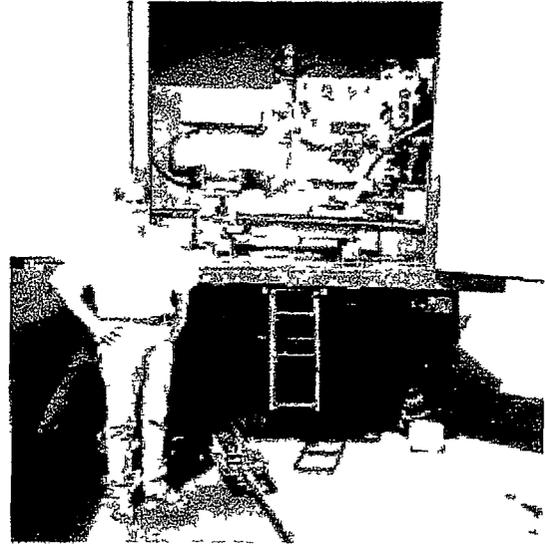
EXHIBIT #8 PHOTOS

INSPECTION OF EQUIPMENT, JUNE 13, 1997

SEISMIC STATION



Diesel Generator



Diesel Generator - Seismic Station

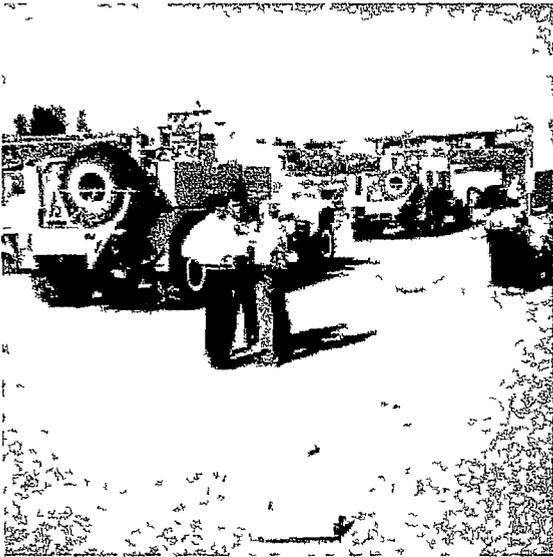


Robert/Ashort/ Dale - Seismic Station

5

EXHIBIT #8 PHOTOS

DEPARTING ASHTARAK, JUNE 16, 1997



Vibrators Leaving Camp



Convoy into Village



Convoy Ready to Leave Ashtarak



Convoy Leaving Ashtarak

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EXHIBIT #8 PHOTOS

DEPARTING ASHTARAK, JUNE 16, 1997



Convoy Ready to Leave Ashtarak



Reviewing Plan



Fueling Vibrators 2600 l Diesel



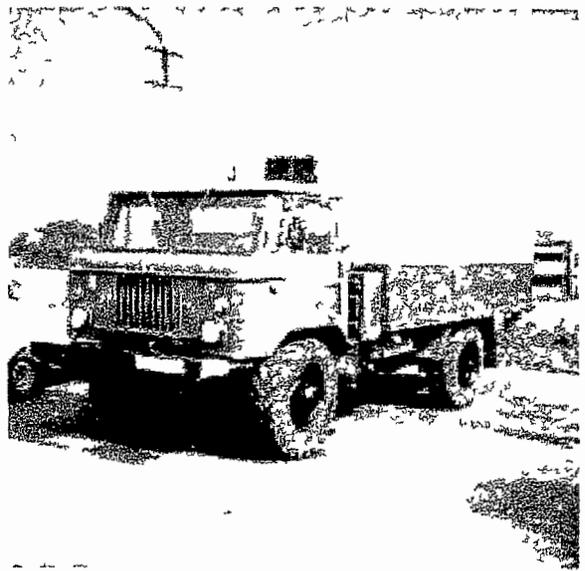
Fueling Vibrators 2600 l Diesel

EXHIBIT #8 PHOTOS

DEPARTING ASHTARAK, JUNE 16, 1997



660 l of Gasoline for Truck



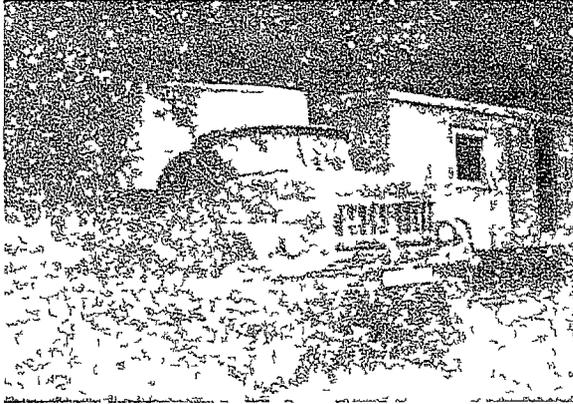
Supply Truck



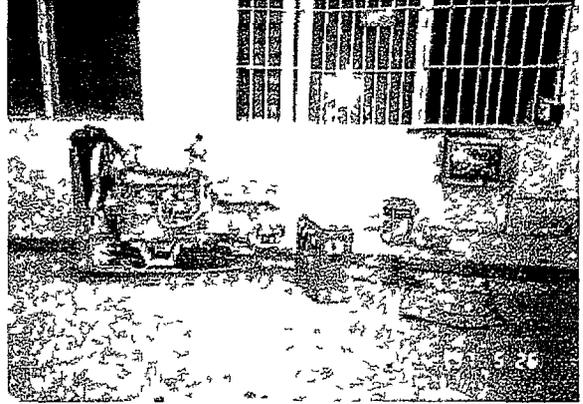
Supply Truck

EXHIBIT #8 PHOTOS

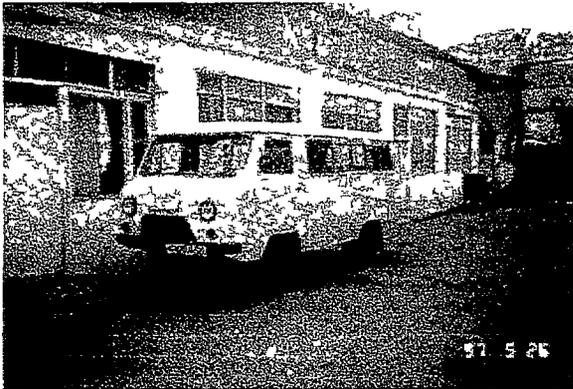
VARIOUS TRUCK/EQUIPMENT DURING REHAB



Seismic Station Truck



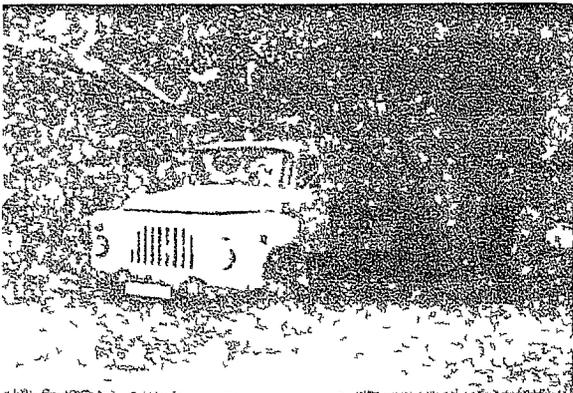
Diesel Generator for Seismic Station



Van



Jeep



Gas Truck



Supply Truck

5^m