

# REPORT NO

02-90



NVE  
NORWEGIAN  
WATER RESOURCES AND  
ENERGY ADMINISTRATION

## SMALL HYDRO-ELECTRICAL POWER DEVELOPMENT IN THE NORTHERN AREAS, PAKISTAN

MISSION REPORT NO.3

T.O.R. FOR CONSULTANCY SERVICES

ORGANIZATION

PROJECT COMMISSIONING DOCUMENTS



By  
Torodd Jensen

NVE  
NORWEGIAN  
WATER RESOURCES AND  
ENERGY ADMINISTRATION  
*Division of development  
assistance*

NORWEGIAN AGENCY  
FOR DEVELOPMENT  
COOPERATION

WAPDA  
WATER & POWER  
DEVELOPMENT  
AUTHORITY  
PAKISTAN



NVE  
NORWEGIAN  
WATER RESOURCES AND  
ENERGY ADMINISTRATION

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#### Sammendrag/Abstract

This report follows from recommendations of previous NVE missions to Pakistan (reports 04.88 and 02.89) which recommended the establishment of a mech/el-workshop for improved maintenance of existing power plants in the Northern Areas, Pakistan. They also gave recommendations on uprating of small hydel plants, refurbishment of mech/el-equipment in small hydel plants, the construction of a new small hydel plant and planning of medium scaled hydel plants. The total budget for the programme is NOK 120 mill (1988).

This report contains information about the Terms of Reference for Norwegian consultancy services approved by the Pakistani Authorities. It also provides more background information on each project in the programme from the Planning Commissioning Documents which were prepared for approval by the Pakistani Authorities.

#### Emneord/Subject Terms

Pakistan, the Northern Area  
Small Hydel Plants  
Maintenance  
Development  
Training

#### Ansvarlig underskrift/ Project Co-ordinator

  
Egil Skofteland  
NORAD-Coordinator

**PICTURE FRONT COVER**

**THE SOURCE OF POWER GENERATION IN THE NORTHERN AREAS IS PRIMARILY HYDRO. THE POWER DEMAND FAR EXCEEDS THE POSSIBLE PRODUCTION. IN ADDITION THE PRODUCTION IS REDUCED DURING WINTERTIME DUE TO LOW FLOW IN THE TRIBUTARIES TO THE MAIN RIVERS WHERE THE SMALL HYDEL PLANTS ARE LOCATED, AND DURING SUMMERTIME WHEN THE WATER CARRIES SILT AND MUD WHICH OFTEN CLOG THE TURBINES.**

**THE ENERGY CRISIS CAUSES CONSTANT DEMANDS ON THE STAFF OF THE NORTHERN AREAS PUBLIC WORKS DEPARTMENT WHO OFTEN FACE TROUBLE FROM ANGRY CONSUMERS. THE NORWEGIAN ASSISTANCE WILL IMPROVE ELECTRICITY PRODUCTION IN THE AREA AND IMPROVE LOCAL KNOWLEDGE ON THE CONSTRUCTION AND MAINTENANCE OF POWER PLANTS.**

**THE GROUP WORKING WITH THE PLANNING COMMISSIONING DOCUMENTS THEREFORE MADE EVERY EFFORT TO COMPLETE THE DOCUMENTS IN TIME FOR EARLY APPROVAL BY THE PAKISTANI AUTHORITIES.**

Contents	PAGE
1. EXECUTIVE SUMMARY	4
2. INTRODUCTION	8
2.1 Background	8
2.2 Hydel situation in the Northern Areas	9
3 NVE MISSION NO. 3	10
3.1 Objectives of the mission	10
3.2 Summary of notes of meetings and site visits	10
3.2.1 Summary of notes of meeting	10
3.2.2 Summary of sitevisits	12
3.3 Summary of Planning Commissioning (PC) documents	15
3.3.1 General	15
3.3.2 Establishment of workshop	15
3.3.3 Training for operation of the workshop	16
3.3.4 Uprating Kargah ph.5	16
3.3.5 Uprating Hassanabad ph.2	17
3.3.6 Planning of Tangir, Gilgit river, Nomal, Parri.	18
3.3.7 Construction of Tangir	18
APPENDIX 1 Terms of Reference for the NVE mission no.3	
APPENDIX 2 Terms of References for Norwegian consultancy services.	
A2.1 Consultancy services for the imple- mentation of SHP plants	
A2.2 Consultancy services for the electro/- mechanical workshop	
A2.3 Comments on the TOR from WAPDA and NAPWD	
APPENDIX 3 Notes of meetings	
APPENDIX 4 Sitevisits	
Kargah river	
Danyor hydro electric powerstation	



**SMALL HYDROELECTRIC POWER DEVELOPMENT IN THE NORTHERN AREAS,  
PAKISTAN, MISSION REPORT JANUARY 1990**

**1 EXECUTIVE SUMMARY**

This report summarizes the findings of a mission to Pakistan and discussions with The Ministry of Kashmir and Northern Areas Affairs, Water and Power Development Authority (WAPDA) and Northern Areas Public Works Department (NAPWD).

The purpose of this mission was to prepare documents for final approval by Pakistani Authorities regarding each project in the Norwegian hydro electric programme in The Northern Areas mentioned in the previous mission reports NVE 04.88 and NVE 02.89. Another task was to obtain approval for the Terms of Reference (TOR) for Norwegian consultancy services.

The summary of conclusions is as follows:

- \* The Norwegian assistance programme should be divided into 6 separate projects.
  - 1: Establishment of an el/mech workshop  
Budget: NOK 19 mill (RS 59.7 mill)  
Implementation period: 15 months
  - 2: Training of personnel for the workshop  
Budget: NOK 19 mill (RS 59.9 mill)  
Training period: 36 months
  - 3: Upgrading of Kargah ph.5 (1000 kW)  
Budget: NOK 17 mill (RS 53.6 mill)  
Implementation period: 36 months
  - 4: Upgrading of Hassanabad ph.2 (1000 kW)  
Budget: NOK 19 mill (RS 59.9 mill)  
Implementation period: 36 months
  - 5: Planning of Tangir and Nomal SHP (2000 kW) and Parri and Gilgit river medium plants (10-20 MW)  
Budget: NOK 6 mill (RS 19 mill)  
Planning period: 15 months
  - 6: Construction of Tangir (2000 kW)  
Budget: NOK 40 mill (RS 126 mill)  
Implementation period: 36 months

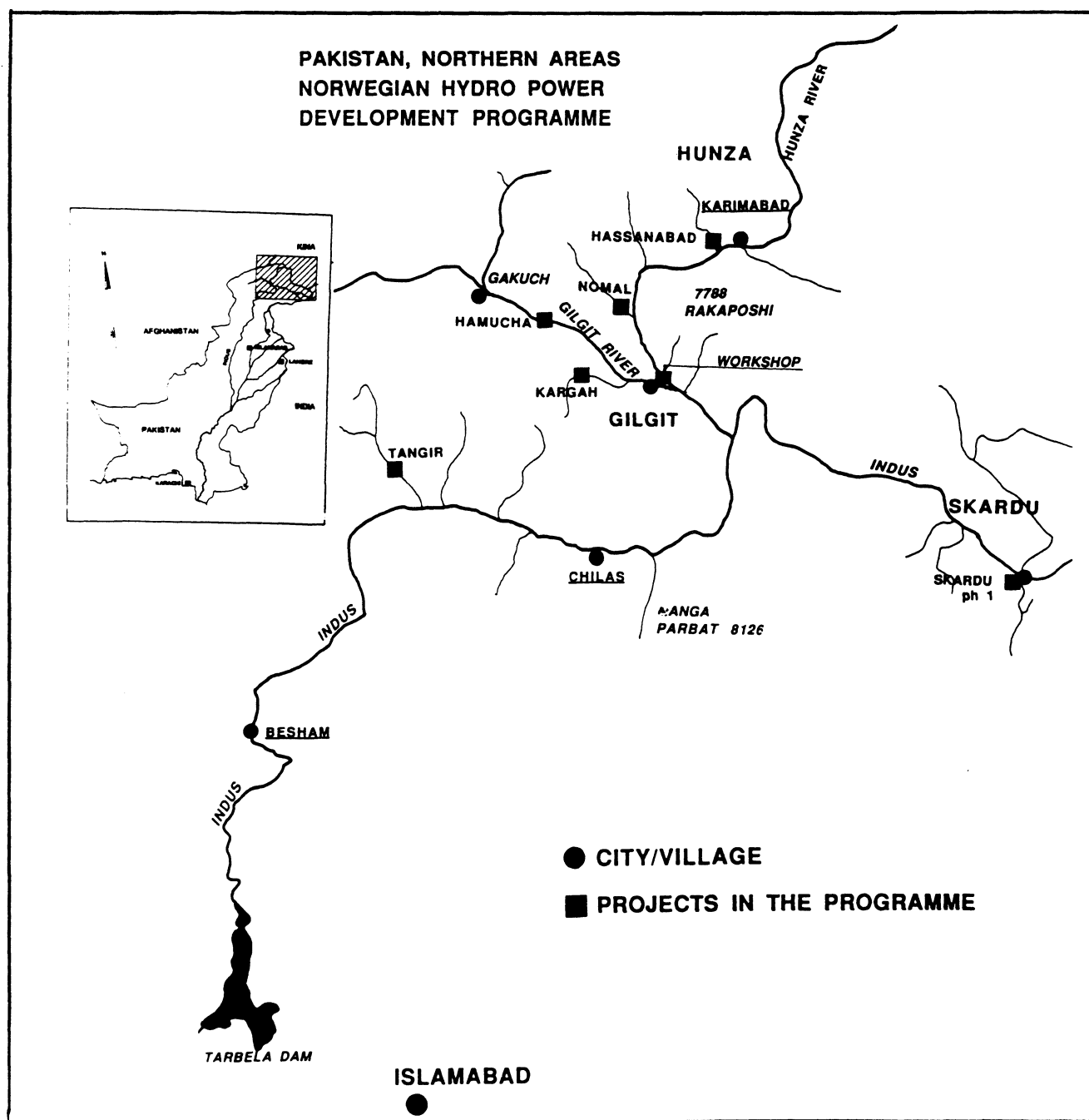
Times schedule see fig. 3

- \* As part of the training programme for the workshop the refurbishing of the existing electro/mechanical-equipment in the following plants will be carried out:

Kargah ph.5 (200 kW)  
 Hassanabad ph.1 (160 kW)  
 Skardu ph.1 (440 kW)

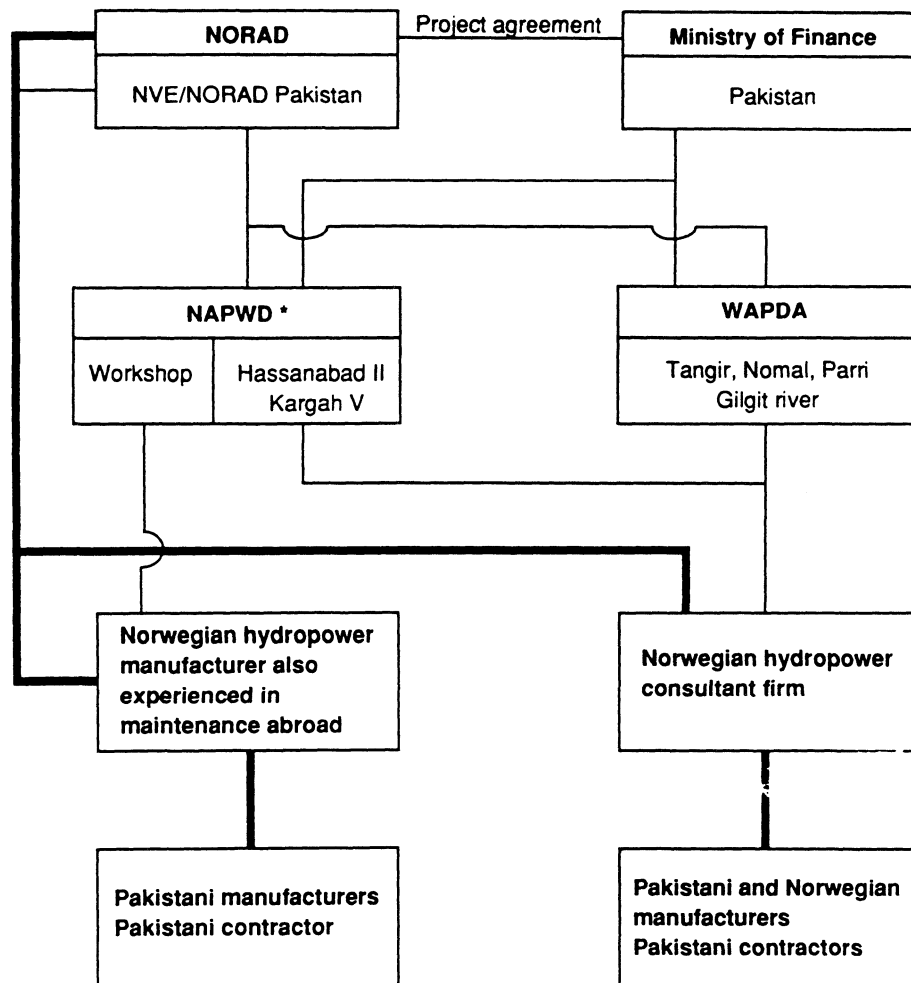
There is a desperate need for electricity in The Northern Areas and as time passes new information might come to light which means that the refurbishing programme mentioned above should be changed.

Fig 1: Location map for projects in the Norwegian Hydro electric programme:



- \* WAPDA stated that they would not be responsible for the construction and operation of Tangir. As The Ministry of Kashmir and Northern Areas Affairs is of another opinion there has to be negotiations between The Ministry and WAPDA to solve this problem this year. If not, the construction will be delayed.
- \* The organization chart has been changed by WAPDA. They agree about the two working groups mentioned in NVE report no 02.89, but they will follow their own practice regarding the signing of contracts. This means that NORAD has to sign the contracts with the consultants. WAPDA and NAPWD will, however, participate in the contract negotiations.

Fig 2: Organization chart:



— Contracts

— Control/following up

\* Note: NAPWD falls administrately under  
The Ministry of Kashmir and Northern Areas Affairs

- \* The actual cost of different components may differ from the above estimates. It is therefore important that the agreement between Norway and Pakistan states that the budget shall be used for the successful implementation of the different projects following the priority given above, and that funds may be reallocated between projects if necessary.
- \* The TOR documents prepared by NVE/NORAD were approved with organization changes just described. Issues arising from the comments of WAPDA and NAPWD (Appendix3) were solved.
- \* The programme of Norwegian assistance is planned to last for 3-4 years and the budget sum is NOK 120 mill (RS 380 mill) cost level 1988.

The implementation period for the whole programme will require approximately 500 Pakistani workers (skilled and unskilled). The operation of the different schemes will give job opportunities for approximately 100 persons from The Northern Areas. Depending on the project stages there will be 6-10 Norwegian expatriates attached to the programme in Pakistan.

Fig.1: Tentative time/cost schedule for the different projects in the programme.

PROJECT	YEAR 1 1-12 mnths	YEAR 2 12-24 mnths	YEAR 3 24-36 mnths	YEAR 4 36-48 mnths	NOK million
Maintenance workshop Construction, equipment	9 mill	10 mill			19
Maintenance workshop. Training. Revision Hassanabad I, Kargah V, Skardu I	1 mill	8 mill	5 mill	5 mill	19
Hassanabad II, uprating (planning, construction)	4 mill	8 mill	7 mill		19
Kargah V, uprating (planning construction)	3 mill	8 mill	6 mill		17
Tangir, Nomal, Parri, Gilgit river (planning)	4 mill	2 mill			6
Tangir (construction)		4 mill	21 mill	15 mill	40
Sum budget <sup>1)</sup>	21 mill	40 mill	39 mill	20 mill	120

<sup>1)</sup> At the present stage Norwegian gross prices for all material are quoted in the budget. Pakistani industry can and will supply a substantial part. The construction of Nomal depends on savings made in the rest of the programme, or on the success of the project so that an expansion of the programme may be considered.

Milestones:

—————▽ Planning stage completed

—————▽ Project completed

## 2 INTRODUCTION

### 2.1 Background

In 1986, NORAD proposed that aid to Pakistan should include energy supply projects, with special emphasis on technical solutions where Norway has special knowledge; and Pakistan subsequently applied for support for such projects.

In two missions to Pakistan and in co-operation with the relevant Pakistan authorities, The Ministry of Kashmir and Northern Areas, Pakistan Water and Power Development Authority (WAPDA) and Northern Area Public Works Department (NAPWD), projects have been identified which will improve and increase energy production in the Northern Area - Gilgit, Baltistan and Diamar districts (Fig.4).

The following is based on information given in NVE-reports 04-88 and 02-89 and discussions with relevant Pakistani Authorities during this mission.

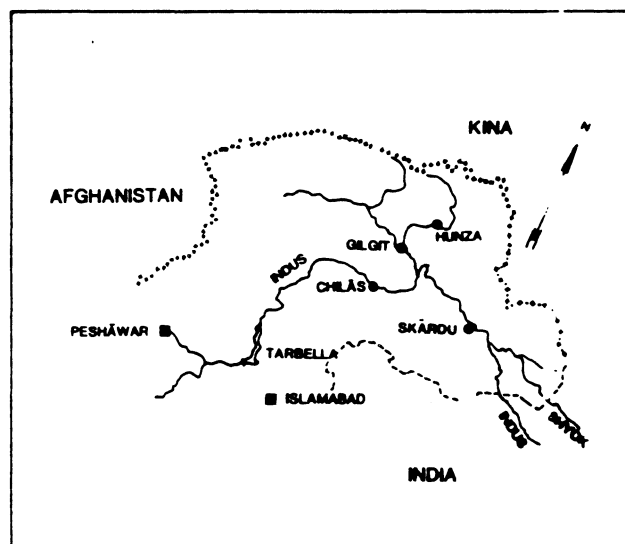
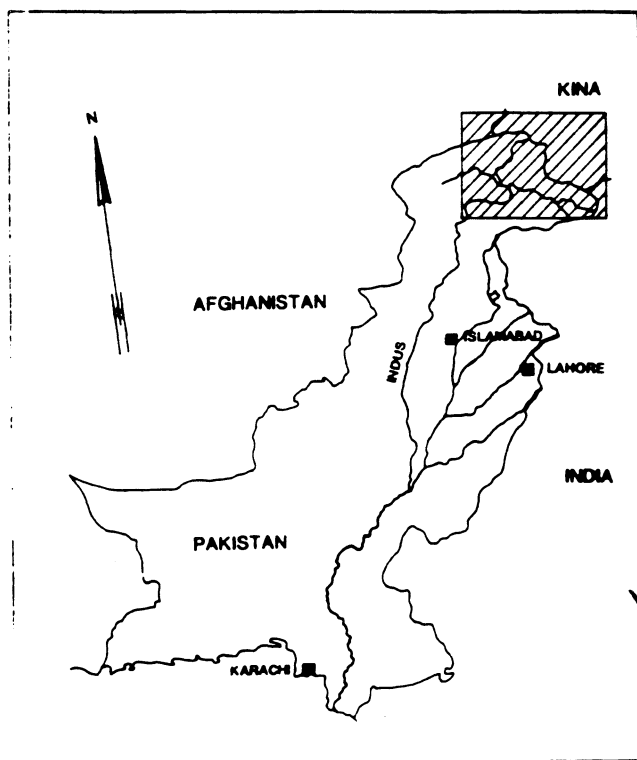


Fig. 1

## 2.2 Hydel situation in The Northern Areas.

The mountainous terrain and major water resources makes the Northern Areas suitable for hydroelectric generation of small, medium and large scale production. Since the population is located in the valleys, the development efforts so far have concentrated on building small hydel stations to serve the villages. Except for power stations situated in the same river, very few power plants are interconnected in a grid. The existing transmission lines are built to deliver the power over short distances. They therefore normally are 11 KV lines leading the power to a distribution grid.

The estimate of present demand in the Northern Areas in 1988 was according to NAPWD 78 MW which far exceeds what can be produced by constructing small hydro power plants, and areas presently without electricity are pressing to be able to join in. The conclusion is that small hydroelectric power plants (100-5,000 kW) should be built in rural and sparsely populated areas, while medium scale hydroelectric power plants (5,000-20,000 kW) should be built to meet the demand in heavily populated areas and town centres like Gilgit. The planning of medium scale power plants has started. The implementation of these plants will make the construction of high voltage transmission lines more feasible, which is a necessity for the development of an interconnected grid system. An interconnected grid system which also includes the small hydro power plants will improve the quality of electric production and allow the electrification of more villages.

In the Northern Areas, 75 small hydroelectric power plants will be in operation in the near future (appendix 2, page 28) producing approximately 30 MW. Some of the existing 40 power plants lack proper maintenance and daily operation is difficult. The frequent occurrence of power failures and load shedding lead to increased strain for the employees of NAPWD. There are no local facilities for even the smallest maintenance work on el/mech equipment, and they have to wait for weeks to get even the simplest repair work done.

### 3 NVE MISSION NO.3

#### 3.1 Objectives of the mission

The purpose of the mission was in cooperation with NAPWD and WAPDA to produce the necessary Project Commissioning (PC) documents for the different projects in the Norwegian hydro-electric assistance programme to The Northern Areas. These documents are required for approval by Pakistani Authorities which is a necessity before any signing of agreement between NORAD and The Ministry of Finance and Economic Affairs can take place. After this agreement is signed the Norwegian consultants can sign their contracts and start the work.

The Terms of Reference (TOR) for the Norwegian consultancy works on hydel schemes and the workshop have been prepared by NVE/-NORAD, and they were handed over to the Pakistani authorities in November 1989. Another task of this mission was to clear the way for approval of the TOR documents.

#### 3.2 Summary from notes of meetings and site visits

##### 3.2.1 Summary from notes of meetings

To ensure the necessary evaluation of the programme a splitting in six different projects is proposed. The different projects will be approved by different authorities after the following:

A project with investment cost of more than RS 60 mill. will be a subject of approval by the Executive Committee of the National Economic Council (ECNEC) which only meets a few times a year. Approval time not less than 6 months. For projects with cost between RS 20 mill. and RS 60 mill. the approval time will be approximately 2 months, and it will be subject to approval by The Northern Areas Council (NAC). Projects with cost less than RS 20 mill. will be approved by the Development Working Party Northern Areas (DWPNAS).

The following splitting of projects was proposed.:

- |        |  |
|--------|--|
| NAPWD: | 1: Workshop; planning/construction   |
|        | 2: Workshop; training/refurbishing el/mech units<br>in Skardu 1, Hassanabad 1, Kargah 5. |
|        | 5: Kargah 5 uprating; planning/construction  |
|        | 4: Hassanabad 2 uprating; planning/construction  |
| WAPDA: | 5: Tangir, Nomal, Parri, Hamucha; planning   |
|        | 6: Tangir; construction  |

The construction of the Tangir scheme will far exceed RS 60 mill. and will need approval from ECNEC. WAPDA stated that they would not be responsible for the construction and operation of Tangir. As The Ministry of Kashmir and Northern Areas Affairs is of another opinion there has to be negotiations between The Ministry and WAPDA to solve this problem this year. If not, the construction will be delayed. This delay may result in the Tangir scheme not being constructed.

All projects will have their own Planning Commissioning 1 (PC I) document and the consultant will have to sign a contract for each of them.

The budget for the whole programme is approximately RS 380 mill (NOK 120 mill) which is a Norwegian grant. The budget sum is based on 1988 prices to fit the proposed project in NVE-report nos. 4-88 and 02.89 and it cannot be expected that this will be raised in order to compensate for inflation.

The actual cost of different components may differ from the above estimates. It is therefore important that the agreement between Norway and Pakistan states that the budget shall be used for the successful implementation of the different projects following the priority given above, and that funds may be reallocated between projects if necessary.

It should also be stated that other possible schemes, like the construction of Nomal, detailed studies of a medium scheme in Gilgit river etc., may be discussed later, especially if cost savings in the whole programme are achieved.

NAPWD and WAPDA had some comments on the TOR documents, but these were solved (Appendix 3). Some of the comments are relevant for the contract negotiations between the consultant and the client.

NAPWD is looking forward to have the electro/mechanical maintenance workshop in operation. They have already started the discussion of recruitment of skilled people. The workshop site has been settled close to the 3 MW diesel plant constructed by WAPDA because this area has room for expansion, storeplace, construction of house for the operation personnel etc. Equipment for the workshop purchased before the construction is completed can be stored in the old existing workshop.

NAPWD will prepare a proposal for the accommodation of the Norwegian expatriates who will stay and work in Gilgit. Among the alternatives are renting of houses, accommodation in governmental guest houses or constructing houses close to the workshop which can be used by the workshop employees after the projects have been commissioned. There is also the alternative of using caravans.



### 3.2.2 Summary of site visits

The site visit to Kargah showed that Kargah phase 7 was in operation, and that improvements regarding the sediment chamber as proposed in the NVE-report 02.89 had been carried out. Kargah phase 6, which is being constructed by a contractor from Islamabad ("Down country contractor") with WAPDA having the executive responsibility, was still under construction and was expected to be commissioned late this year.

A site visit to another small plant, Danyor hydel plant, with output 118 kW showed the possibilities for utilizing the available head from the tailrace channel to the river, giving an additional 100 kW. A lot of the hydel schemes in The Northern Areas have similar possibilities for improved electricity production. As the intake, headrace channel and forebay are already paid for, the additional cost of utilizing the remaining head can be very feasible. Because the construction of hydel stations is normally paid by local funds, it is the purchasing of the electro/mechanical equipment for the power station which is a problem. The workshop can here play an important role, because there is already old equipment stored at the old workshop and more is coming. After being replaced by new Chinese turbines the equipment from powerplants in Kargah will be stored here. They will be protected against weather for the possible refurbishment which will enable use of these units in new schemes with the same possibilities as Danyor.

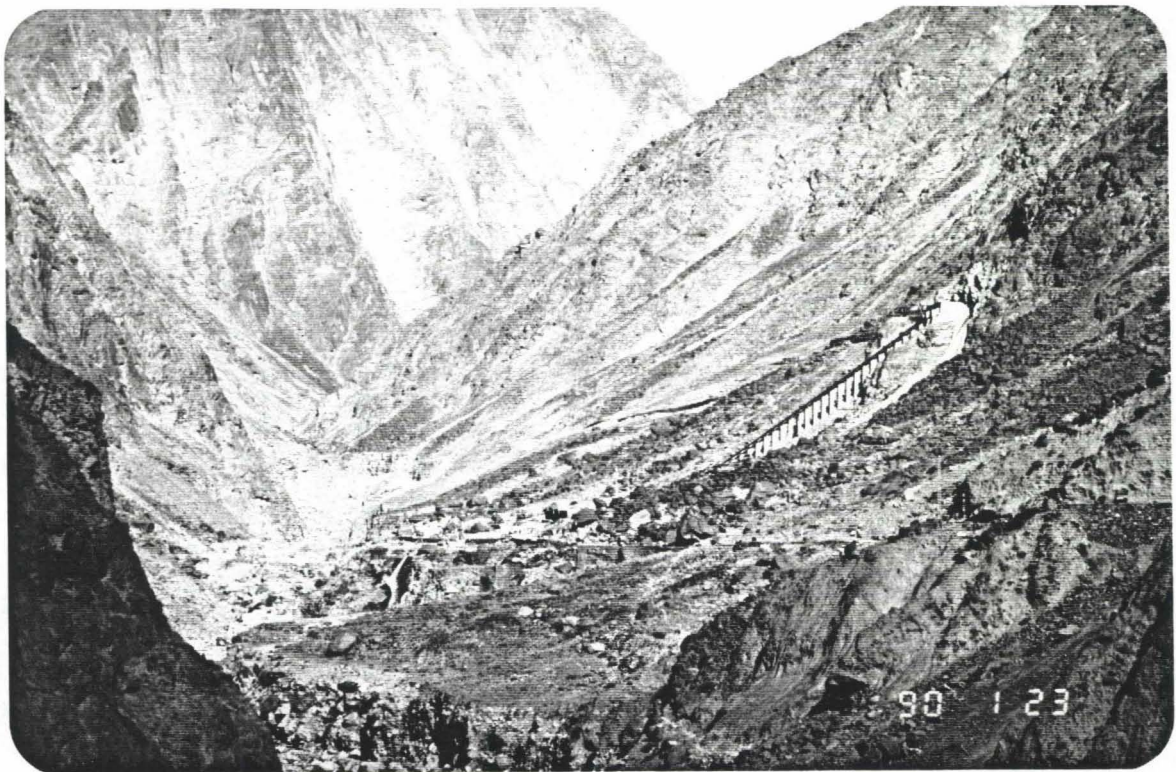


WORKSHOP SITE CLOSE TO THE 3 MW DIESEL PLANT



FUEL WOOD FROM MOUNTAIN FOREST CARRIED TO GILGIT TOWN  
ELECTRICITY IS WANTED FOR HEATING; NOT ONLY FOR ILLUMINATION.  
THE WORKSHOP IS IMPORTANT FOR IMPROVED HYDRO ELECTRIC PRODUCTION





DANYOR HYDRO ELECTRIC POWER PLANT : 118 KW  
THE AVAILABLE HEAD FROM THE TAILRACE CHANNEL TO THE RIVER CAN BE  
UTILIZED GIVING MORE ELECTRICITY AT LOW COST.



OLD TURBINES FROM KARGAH CAN BE REFURBISHED IN THE PLANNED  
WORKSHOP AND USED IN SCHEMES AS DANYOR PH.2

### 3.3 Summary of Planning Commissioning (PC) documents

#### 3.3.1 General

The PC-I documents refer to the NVE report no.2.89 on small hydro power development in the Northern Areas and to information given by NVE/NORAD and NAPWD in January 1990. The detailed PC-I documents are not included in this report. They are, however, obtainable from NVE or NAPWD.

The documents will be used in obtaining approval from the Pakistani authorities of the projects and the final signing of the agreement between NORAD and The Ministry of Finance and Economic Affairs.

It should be noted that the cost figures given on each project are rough, since they have been prepared without detailed planning including bills of quantities etc. The cost estimates are, however, based on experience from similar projects under construction in The Northern Areas and from costs given by Norwegian manufacturers of electro/mechanical equipment.

The PC-I documents have been prepared for the following projects where NAPWD has executive responsibility:

- \* Establishment of the workshop
- \* Training of personnel
- \* Uprating Kargah ph.5
- \* Uprating Hassanabad ph.2

#### 3.3.2 Establishment of the workshop

The planning and construction of a workshop building and purchasing of the necessary machinery, tools and stock hold for the improvement of maintenance of hydel stations in The Northern Areas.

After commissioning of this project components/parts of 44 already completed Hydel stations and 31 stations under construction will be manufactured/repaired in this workshop.

#### Cost estimate:

Construction cost RS	5.3 mill	(NOK	1.7 mill)
Tools/stock hold			
equipment.....	" 48.2 "	( "	15.3 " )
Consultant/-			
contingencies...	" 6.2 "	( "	2.0 " )

Total budget sum: RS 59.7 mill (NOK 19.0 mill)

Implementation period: 15 months  
Pakistani manmonths required: 1000

### 3.3.3 Training for operation of the workshop

3 years training of educated Pakistani personnel according to NVE-report no.2-89. These 3 years, corresponding to phase 1 of the workshop, include the employment of 12 skilled persons and 13 unskilled. It also includes the refurbishment of the electro/-mechanical equipment in Skardu ph.1, Kargah ph.5 and Hassanabad ph.1. This work will as far as possible be carried out in the workshop as part of the training programme.

Benefit of the project:

Spare parts for various Hydro electric plants of Northern Areas will be manufactured and old stations will be refurbished. Funds will be saved which are presently being spent on procurement/-import of spares. Local people will get employment.

Cost estimate:

Norwegian consultant	RS 37.8 mill	(NOK 12.0 mill)
Pakistani employees	" 2.5 "	( " 0.8 " )
Travelling/Accommodation (Norwegian/Pakistani)	" 12.6 "	( " 4.0 " )
<u>Contingencies</u>	<u>" 7.0 "</u>	<u>( " 2.2 " )</u>

Total budget sum: .....RS 59.9 mill (NOK 19.0 MILL)

### 3.3.4 Uprating Kargah ph.5

The uprating of Kargah ph.5 from currently 200 kW to approximately 1200 kW by the installation of a new 1 MW unit. The uprating also includes the construction of a new channel and increasing the head.

This project will also provide the following benefits:

- \* Electricity for a hospital
- \* Additional electricity for small industries
- \* Additional electricity for lift irrigation schemes
- \* Supply the el/mech-workshop with the necessary electric power (approximately 500 kW) which is not available today.

Cost estimate:

Construction cost...	RS 16.0 mill	(NOK 5.1 mill)
El/mech cost including penstock.....	" 22.2 "	( " 7.0 " )
Consultant/contingency/ <u>land compensation.....</u>	<u>" 15.4 "</u>	<u>( " 4.9 " )</u>
<u>Total budget cost:.....</u>	<u>RS 53.6 mill</u>	<u>(NOK 17.0 mill)</u>

Implementation periode 36 months.

Pakistani manmonths required for construction: 2300

The 20 NAPWD employees operating the existing  
Kargah ph.5 will also operate the plant in the future.

### 3.3.5 Uprating Hassanabad ph.2

The uprating of Hassanabad ph.2 from currently 400 kW (theoretical- operation today gives approximately 150 kW) to approximately 1000 kW by the installation of new units instead of the existing ones. The uprating also includes the enlarging of the headrace channel and increasing of available head.

The benefits of the project are:

- \* 2720 consumers who for the moment are sharing approximately 300 kW from two hydro power plants in bad condition and diesel generating sets generating approximately 210 kW will have more electricity and more reliable electricity. The diesel generating set is very expensive and operates therefore only between 1700 hrs and 2200 hrs. This is the only electricity source when the hydro power plants are out of operation, which often happens.
- \* Additional 800 consumers will have electricity in their homes. Altogether 25,000 people of Hunza will be provided with electricity.
- \* Industries such as welding plants, saw mills, flour mills, fruit dehydration plants will be developed.
- \* On completion of this project people will use electricity for lighting which will result in reduction of consumption of kerosene oil which the Government is supplying at subsidized rates.

## Cost estimate:

Construction.....	RS 28.5 mill	(NOK 9.1 mill)
Electro/mechanical equip. incl. penstock.....	" 20.9 "	( " 6.6 " )
Consultant/contingencies/ <u>land compensation.....</u>	<u>" 10.5 "</u>	<u>( " 3.3 " )</u>
<u>Total budget sum:.....</u>	<u>RS 59.9 mill</u>	<u>(NOK 19.0 mill)</u>

Implementation period: 36 months

Pakistani manmonths needed for construction: 8100 (1400 skilled). The operation of the plant will be carried out by the existing staff.

## 3.3.6 Planning of Tangir, Nomal, Gilgit river, Parri.

Carry out a feasibility study for Tangir and Nomal small hydro power schemes (output approximately 2 MW each). Carry out a pre-feasibility study for a medium sized hydro power scheme (10-20 MW) in Gilgit river near the village Hamucha. Undertake a review of the plans for the Parry multipurpose scheme. WAPDA will have the executive responsibility for this work.

Total budget sum: RS 19 mill (NOK 6 mill).

This is primarily consultant expenditures. The contract negotiations between the consultant and the client shall allow the use of Pakistani engineers as stressed in the TOR for the consultancy services.

## 3.3.7 Construction of Tangir

Construction of the small hydro power plant in Tangir including the necessary local transmission and distribution lines. Executive responsibility to be decided.

## Cost estimate:

Construction.....	RS 34.4 mill	NOK 10.8 mill)
El/mech-equipment/Penstock "	42.3 "	( " 13.5 " )
Transmission/distribution- lines etc....	" 23.7 "	( " 7.5 " )
Consultant/contingencies/ <u>jeep/land compensation etc."</u>	<u>25.6 "</u>	<u>( " 8.2 " )</u>
<u>Total budget sum .....</u>	<u>RS 126.0 mill</u>	<u>(NOK 40.0 mill)</u>



**A P P E N D I X   1**

**TERMS OF REFERENCE FOR NVE MISSION NO 3**

**P A K I S T A N**



## APPENDIX 1      TERMS OF REFERENCE FOR NVE MISSION NO 3, PAKISTAN

### SMALL HYDRO POWER DEVELOPMENT IN THE NORTHERN AREA, PAKISTAN

MISSION JANUARY 1990

#### TERMS OF REFERENCE, FOR TORODD JENSEN

##### Background

In October 1988 and February 1989 NORAD sent a delegation of professionals in hydro power planning to Pakistan to improve NORAD's background for decisionmaking concerning planning and implementation of small hydro power plants in the Northern Area. These missions concluded that some of the existing hydro power plants in the area were in poor condition and that the Northern Area Public Works Department (NAPWD) urgently needed a workshop to carry out regular maintenance on el/mech equipment in the power plants. Furthermore it was concluded that two powerstations in operation should be uprated, two powerstations should be refurbished and two new power plants should be planned, and at least one of them constructed and used as demonstrations for other plants with similar potential for improvement. The output for the plants range from 500 kW to 2000 kW.

Later discussions in NORAD and the annual consultations between the Government of Pakistan and the Government of Norway have focused on this project proposal and defined it as priority for Norwegian contribution to the rural electrification programme in the Northern Area.

NVE has written the background documents for decisionmaking within NORAD concerning the proposed project and Terms of Reference or consultancy services have been prepared for the various components of the project. The project documents and the Terms of Reference have been sent to Pakistan for approval.

NAPWD has asked NORAD for assistance to prepare documents describing the different projects (PC 1-Documents) to be presented to the Pakistani authorities.

##### General Scope of Work

T. Jensen shall during the stay in Pakistan:

1. In collaboration with NAPWD and WAPDA collect data and prepare PC-1 Documents for the Pakistani authorities.
2. Present to the relevant Pakistani authorities the proposed Terms of Reference for Norwegian consultancy services and try to obtain approval for these before returning from Pakistan.

He shall work in full cooperation with WAPDA and NAPWD. The October 88 and February 89 Mission Reports shall serve as general reference and guideline for the Mission.

## APPENDIX 2

### TERMS OF REFERENCE FOR NORWEGIAN CONSULTANCY SERVICES

A2.1 Consultancy services for the implementation of SHP plants

A2.2 Consultancy services for the electro-/mechanical workshop

A2.3 Comments on the TOR from WAPDA and NAPWD

# **SMALL HYDRO-ELECTRIC POWER DEVELOPMENT IN THE NORTHERN AREA, PAKISTAN.**

## **TERMS OF REFERENCE FOR CONSULTANCY SERVICES ON SMALL HYDROPOWER PROJECTS**

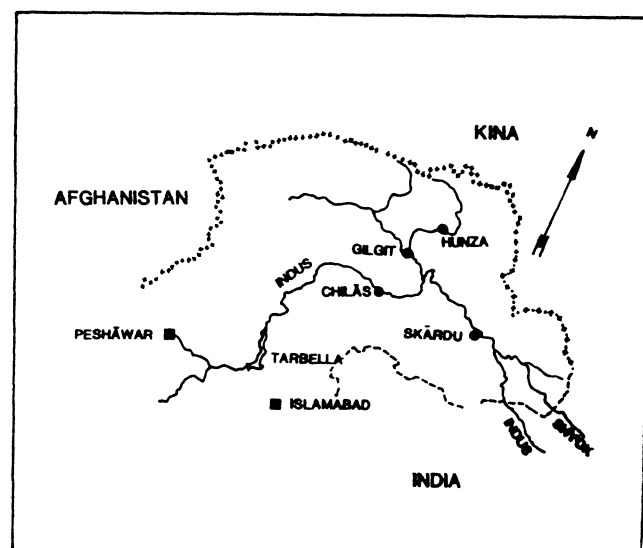
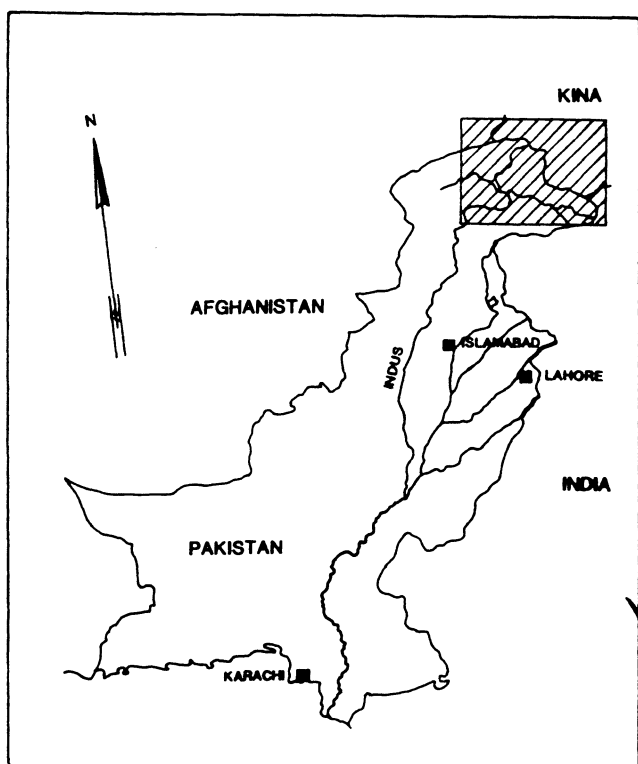
### **1 INTRODUCTION: SMALL HYDRO POWER DEVELOPMENT IN NORTHERN AREA.**

#### **1.1 Background**

In 1986, NORAD proposed that aid to Pakistan should include energy supply projects, with special emphasis on technical solutions where Norway has special knowledge; and Pakistan subsequently applied for support for such projects.

In two missions to Pakistan and in co-operation with the relevant Pakistan authorities, the Ministry of Kashmir and Northern Area, Pakistan Water and Power Development Authority (WAPDA) and Northern Area Public Works Department (NAPWD) projects have been identified which will improve and increase energy production in the Northern Area - Gilgit, Baltistan and Diamar districts (Fig.1).

The following Terms of Reference are based on information given in NVE-reports 04-88 and 02-89, which should be referred to for further details.



*Fig 1*

### 1.2 Present Hydro Electric Situation in the Northern Area.

The mountainous terrain and major water resources makes the Northern Area suitable for hydro electric generation of small, medium and large scale production. Since the population is located in the valleys, the development efforts so far have concentrated on building small hydel stations to serve the villages. Except for powerstations situated in the same river, very few powerplants are interconnected in a grid. The existing transmission lines are built to deliver the power over short distances. They therefore normally are 11 KV lines leading the power to a distribution grid.

The estimate of present demand in the Northern Area in 1988 was according to NAPWD 78 MW which far exceeds what can be produced by constructing small hydro power plants, and areas presently without electricity are pressing to be able to join in. The conclusion is that small hydro-electric power plants (100-5,000 kW) should be built in rural and sparsely populated areas, while medium scaled hydro-electric power plants (5,000-20,000 kW) should be built to meet the demand in heavily populated areas and town centres like Gilgit. The planning of medium scaled power plants has started. The implementation of these plants will make the construction of high voltage transmission lines more feasible, which is a necessity for the development of an interconnected grid system. An interconnected grid system which also includes the small hydro power plants will improve the quality of electric production and ease the electrification of more villages.

In the Northern Area, 75 small hydro electric power plants will be in operation in the near future (Appendix 1) producing approximately 30 MW. Some of the existing 40 power plants lack proper maintenance and daily operation is difficult. The frequent occurrence of power failures and load shedding lead to increased strain for the employees of NAPWD. There are no local facilities for even the smallest maintenance work on el/mech equipment, and they have to wait for weeks to get even the simplest repair work done.

## **2 CONSULTANCY SERVICES FOR HYDROPOWER PROJECTS**

### **2.1 Objectives**

A number of the existing power plants can be uprated or rehabilitated. This is important not only to increase the energy production in this area, but also to introduce improvements regarding intake, sediment chamber, channel, forebay, penstock and electro/mechanical equipment in the powerhouse. These improvements must be technically and financially feasible, given the situation in the area so that they can be included in the construction of other small hydro electric power plants which do not receive development assistance.

### **2.2 Scope of activities of the consultant**

#### **2.2.1 General**

The consultant shall assist WAPDA/NAPWD in preparation of conceptual and detailed design and specifications for civil works, including bills of quantities, as well as the preparation of specifications and contract documents for the electromechanical equipment of the power plants, supervision of civil construction works, supervision of erection of the electromechanical equipment and commissioning of the plants.

An integral part of the tasks of the consultant shall be to train Pakistan counterparts in the design, supervision and erection of all elements of these projects.

To complete the above tasks the consultant shall assign competent personnel to perform the services required. In the conduct of the work, the consultant shall co-operate fully with WAPDA/NAPWD.

The expenditure of resources on this planning phase of the programme must be kept at a level which is appropriate in relation to the expected cost of the implementation phase. The

consultant shall therefore ensure that the scale and cost of the various components of their work programme are commensurate with their expected benefits.

To the extent possible, equipment of local manufacture shall be used for this programme. Sub-consultant and contractors shall be from Pakistan, preferably from Northern Area.

The specifications for electro/mechanical equipment shall be limited in scope, such as to allow the manufactures to propose their own solution for obtaining the desired quality and output given the available head and flow.

The consultant shall also cooperate fully with a socioanthropologist carrying out the specified tasks, including the training of Pakistani counterparts. (See TOR Socio-economic Studies for a more detailed description of the duties and role of the anthropologist).

### 2.3 Mobilization phase

The consultant shall assign expatriate engineers to work together with WAPDA regarding the following projects:

- \* Review of existing plans for the Parri scheme
- \* Pre-feasibility study for a low head tunnel scheme in Gilgit river.
- \* Feasibility study with technical data sufficient for concession for SHP schemes at Tangir and Nomal.
- \* After concession is granted, preparation of tender documents for the implementation of the Tangir scheme, supervision of the construction works and commissioning of the plant.

The consultant shall assign expatriate engineers to work together with NAPWD regarding the following projects:

- \* Feasibility study with technical/economical data sufficient for concession for the uprating of Kargah ph.5 and Hassanabad ph. 2 power plants.
- \* After concession is granted, preparation of tender documents for the implementation of the schemes, supervision of construction works and commissioning of the plants.

The mobilization phase shall include the scheduling of the implementation programme for the agreed project. In addition the consultant shall:

- Prepare any additional topographic maps that are required for the detailed design phase.
- Undertake any additional geological and geotechnical field required to finalize the designs.

## 2.4 Detailed design phase

### 2.4.1 General

Together with WAPDA or NAPWD (decision still perding) the consultant shall carry out detailed design for the Tangir scheme. Together with NAPWD the consultant shall carry out detailed design for Kargah ph.5 and Hassanabad ph. 2.

### 2.4.2 Civil works-general.

The consultant shall carry out the design of civil works including temporary works. For this purpose, the consultant shall prepare specifications and bills of quantities. This shall be carried out in Lahore for projects under WAPDA responsibility and in Gilgit for projects under NAPWD responsibility. The activities shall include the design of:

- diversion weir
- intake and sediment chamber (see TOR Sediment)
- headrace channel including crossings
- forebay
- penstock intake and penstock foundation
- powerhouse including access road to the powerhouse
- tailrace channel
- switch yard
- transmission lines and distribution network (Tangir)

Supplementary working drawings shall be prepared as the project progresses. Tender documents shall be prepared in close cooperation with the relevant Pakistan Authority to secure the use of local contractors as far as possible.

#### 2.4.3 Electromechanical equipment

Together with WAPDA/NAPWD the consultant shall prepare functional specifications and tender documents for all the electromechanical components including the following:

- gates for intake, forebay, penstock, tailrace including trashracks
- turbines including governors
- synchronous generators including excitation and voltage system control panels.
- crane for the powerhouse, ventilation, lighting and dewatering facilities.
- penstock and manifolds including anchors, joints, slide rails
- transmission lines and distribution network including transformers

The work shall be carried out in Gilgit for Kargah ph.5 and Hassanabad ph.2 and Gilgit or Lahore for Tangir. The consultant shall prepare bidding documents for turbines, generators and control panels as a package for competitive bidding within Norway. The bidding documents for the rest of the items outlined



above shall preferably be a package for competitive bidding within Pakistan.

#### 2.5 Implementation phase

The consultant shall assign to the project site supervising engineers to assist NAPWD/WAPDA in the civil work construction. During this phase additional working drawings shall be prepared jointly by the consultant's supervising engineers and local consultants or WAPDA/NAPWD.

#### 2.6 Bid clarification

The consultant shall provide services for the clarification of possible issues that may be raised by the bidders on the tender documents. The consultant together with WAPDA/NAPWD shall evaluate the bids and submit their recommendations to NORAD/NVE.

#### 2.7 Erection and commissioning phase

The consultant shall ensure the co-ordination of civil works with the electromechanical works and the commencement of the erection works.

The consultant will inspect the essential parts during manufacturing phase and if WAPDA/NAPWD wish, they may join in these inspections.

The consultant shall supervise the erection of electromechanical works and commissioning of the plants.

A commissioning report shall be prepared by the consultant at project completion

## 2.8 Training of Pakistani Counterparts.

The consultant shall ensure that the Pakistani counterparts are satisfactorily trained during all phases of the project activity. In particular during the design phase of the civil works the consultant's experts shall work closely with Pakistani counterparts and ensure the appropriate technology transfer so that NAPWD will be able to carry out similar projects in the future without calling on the assistance of expatriates. To this effect the consultant shall also conduct seminars on the planning, design and implementation phases with the project experience as a case.

The Pakistan personnel shall also directly participate in erection and commissioning.

At the completion of the project the consultant, in cooperation with NAPWD, shall write an evaluation report on the technology transfer in general and in particular on the Pakistani engineers attached to the project.

### 3 DETAILS OF INDIVIDUAL SCHEMES

#### 3.1 Kargah phase 5

The existing small hydropower plants in Kargah watercourse are the only ones which serve the capital of the area, Gilgit.

Data on existing power plants:

Name of station	head m	discharge M3/s	installed units number	output(KW)	commissioned year
Kargah phase 1	37	1,47	2 Francis	320	1965
Kargah phase 2A	61	0,57	2 Cross Flow	180	?
Kargah phase 2B	61	0,76	2 Cross Flow	324	1978
Kargah phase 3	43	1,20	3 Francis	300	1980
Kargah phase 4	43	1,20	3 Francis	300	1980
Kargah phase 5	43	0,79	2 Francis	200	1984

Firm power from these power plants varies from 50% to 70% depending on the efficiency and available water during low flow season. Hence the available power production during winter time from Kargah watercourse to day is 1,12 MW.

The turbines in phase 1, 3 and 4 will be replaced by Chinese turbines. Phase 2 (A,B) will be replaced by a new scheme presently under construction (Phase 6), with the installation of four units of 1 MW each. Bywater (GB) will deliver the turbines. Phase 6 will utilize the head between phase 3 and 5 (Fig 2). The discharge will be approximately 1,6 M3/s. The old power plants will be operated during the high flow season.

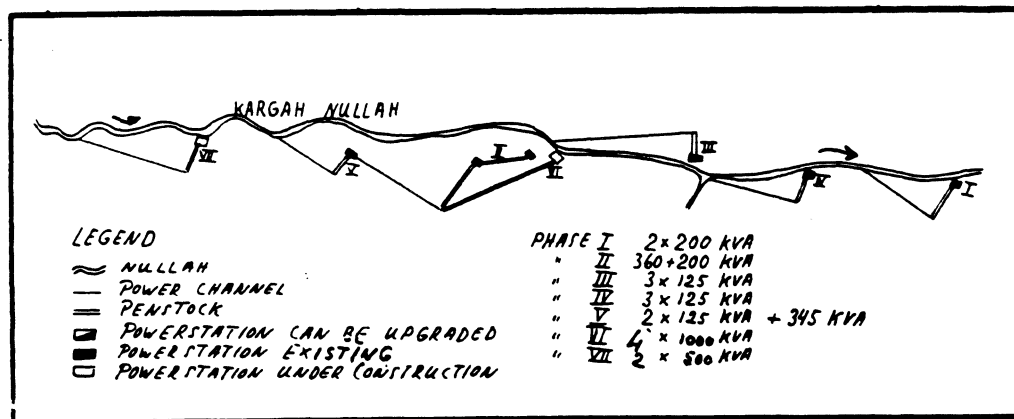


Fig 2

Kargah phase 6 will use the same intake as Kargah phase 5 (Fig 3). The intake for phase 5 is reconstructed and there is a plan for enlarging the headrace channel of phase 5 to cater for the necessary discharge. Because the turbines in ph.5 has less capacity than ph.6 a bypass tapping construction is planned. The existing sediment chamber will be used. For improvement of sediment chambers see TOR Sediment.

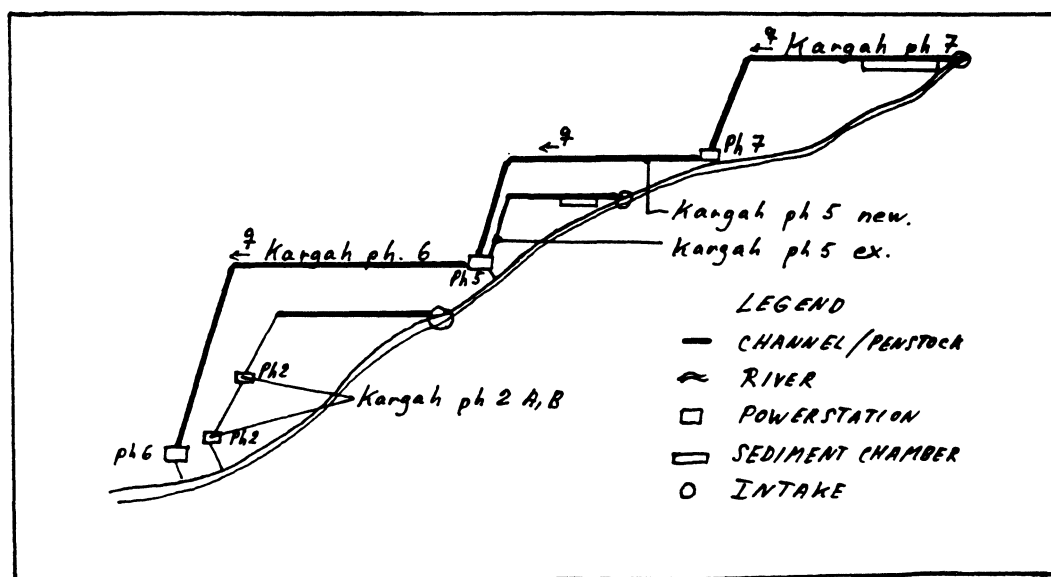


Fig 3. The head between tailrace water phase 7 and headrace water phase 6 should be fully utilized in Kargah ph. 5.

Upstream from the intake of phase 5 power plant there is a new scheme under construction with maximum output of 1 MW (Kargah Phase 7).

This plant is planned with approximately the same discharge as Kargah ph.6. The sediment chamber and intake solution in Kargah ph. 7 is proposed to be improved (NVE-report 02-89). Therefore Kargah ph. 5 should be uprated to utilize the full head between the tailrace channel of Kargah ph.7 and the headrace channel of Kargah ph. 6. The clean water from Kargah ph. 7 will then be utilized in Kargah ph. 5 and 6. The old turbines in Kargah ph.5 can be operated during high flow season summertime (April-October) and the old intake will also have to be a security intake for Kargah ph.6, the most important plant in the Kargah system in the future.

The uprating of Kargah ph.5 will include the following construction work:

- \* Construction of an open flow channel, designed for a discharge of 1,6 M<sup>3</sup>/s, from the tailrace channel of Kargah ph.7 to the forebay for the new kargah ph.5
- \* Construction of a new forebay and by-pass channel to the head race channel of ph 6.
- \* Construction of a penstock and a power house, or an extension of the old house for a 1 MW Francis unit operating on approximately 60 m head.
- \* Installation of the necessary mechanical and electrical equipment (Turbine approximately 1 MW, transformed 11 KV) (NVE-report 02-89).

The consultant shall in close cooperation with NAPWD carry out a selection study of alternatives for utilizing the head between tailwater Kargah ph.7 and headwater Kargah ph.6. The discharge shall be similar to ph.7. Furthermore the consultant shall

prepare technical documents for concession; and after concession is given prepare tender documents for the selected alternative; and later supervise the construction and the commissioning of the plant.

### 3.2 HASSANABAD phase 2

#### General

Hassanabad Phases 1 and 2 provide the only source of electrical supply for the west bank of the Hunza valley, i.e. the former kingdom of Hunza.

The hydro power plants are constructed in a river where analysis of flow sediments carried out (NVE report 04-88, 02-89) show that the possibility of turbine wear is great. When planning sedimentation chambers the accumulation of these particles must be considered. The chambers and the channel have to be constructed with this in mind.

#### The Hassanabad ph.2 project

This is a new scheme commissioned in 1986 with two crossflow turbines manufactured in Japan. The power plant is operating with less than 50% efficiency because the silty water in combination with high runner speed has destroyed the runners (NVE-report 02-89).

Fig 4 gives an overall view of the project where intake, sedimentchambers, penstock and power plants are located.

A new plant (Hassanabad ph.2B) utilizing the head from the tailrace channel of Hassanabad ph 2 to the river will be constructed in the near future. The turbines (Chinese) have already been purchased. This scheme is planned with a maximum discharge of approximately 1 M<sup>3</sup>/s to produce 270 kW. This plant will require an enlargement of the headrace channel and the sediment chambers of Hassanabad ph.2. Proposals for enlargement and improvements are made in NVE report 02-89. The enlargement of the headrace channel of Hassanabad ph.2 will make it feasible to

uprate the existing plant. In addition it is possible to increase the head by approximately 18 m, hence Hassanabad ph.2 could produce approximately 1,000 kW.

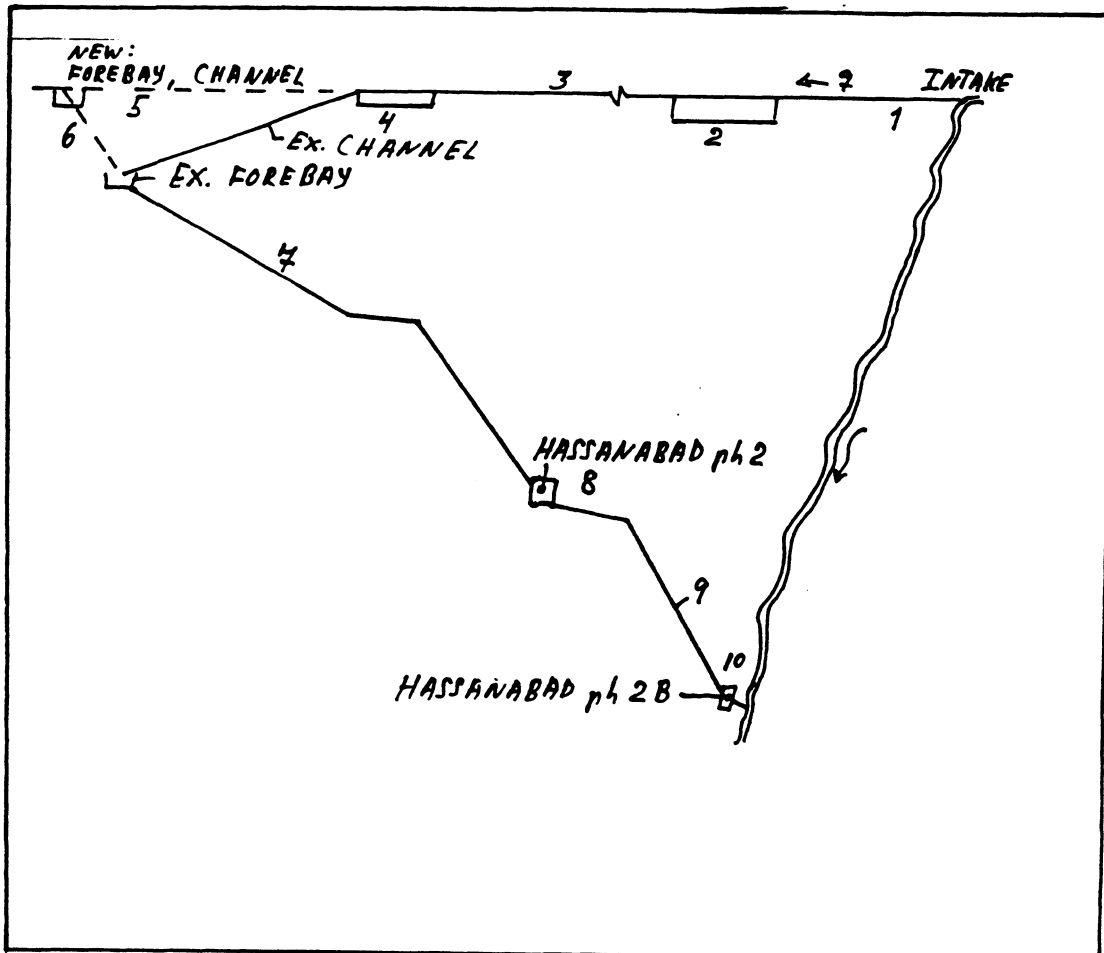


Fig.4 Hassanabad ph.2 and 2B system.

Legend

- 1 Intake could be improved to utilize more water from small tributaries in the flow season
- 2,3,4 Water channel and sediment chambers are proposed to be enlarged and improved to cater for 30+5 cusec, where 5 cusec is irrigation water.
- 5,6,7,8 Extension and enlarged penstock for increased head and flow and uprating the existing plant from 400 kW to 1,000 kW is proposed.
- 9,10 Penstock and powerhouse Hassanabad ph. 2B

Parts 9 and 10 are the responsibility of NAPWD as regards planning, construction and financing. It is proposed that work on 1-8 should be financed by NORAD and planned and constructed in close cooperation with NAPWD.

Name of plant	head m	discharge M3/s	turbine units	output KW	commissioned year
Old:					
Hassanabad ph.2	114	0.57	2 Cross Flow	400	1986
New:					
Hassanabad ph.2	132	0.95	1 Francis	1000	1992
Hassanabad ph.2B	45	0.95	2 Francis	270	?

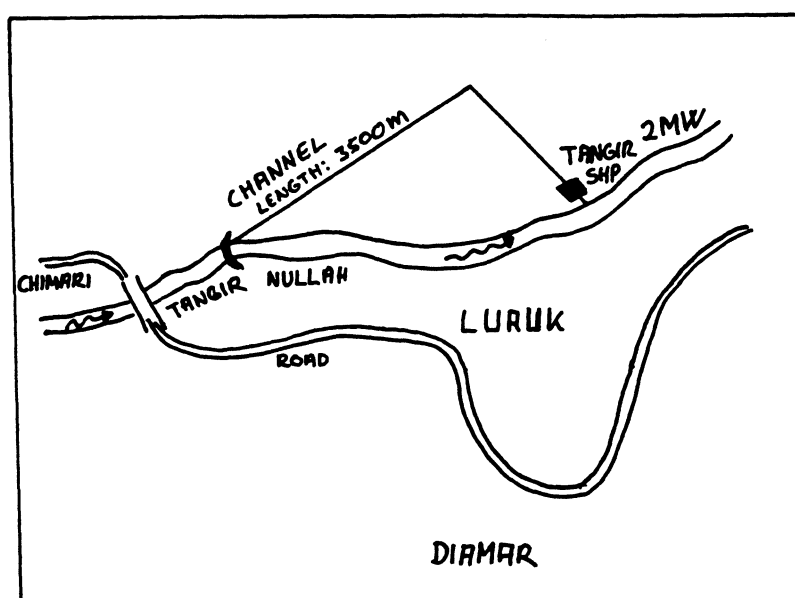
The consultant shall optimize the output of Hassanabad ph.2 which includes increasing the head and the discharge. When increasing the discharge the consultant shall take account of the need for irrigation water. (NVE report 02-89). The consultant shall prepare the technical/economical papers for concession, and after concession tender documents for the construction of the scheme. The consultant shall also supervise the construction work and the commissioning of the plant.

### 3.3 TANGIR small hydro electric power scheme

The project site is located downstream from Chimari village (Fig 5) and the power plant will be close to the village of Shearkh. NVE-report 2-89 describes sediment and hydrology issues. It is clear that the minimum discharge in the river will at least allow a 4 MW plant to be constructed if the total head is utilized.

The hydro power resource in this part of the river can be utilized by constructing one power plant utilizing the total head and allowing for later extension, or one plant utilizing the minimum discharge in the river and the necessary head to obtain 2 MW which will cover the demand in near future. The scheme will also have to include transmission lines (33 kV) and a distribution network.





Data on the proposed scheme (Including the existing hydro power plant in the valley):

Name	head dis- charge	turbine length	channel length	output mission	trans- line 11KV	distrib- ution line
	m	M3/s	m	KW	km	km
TANGIR PH1	42	0.84	3416	160	19	34 (ext.)
TANGIR PH2A	180	1.5	3500	2000	?	? (plan)
TANGIR PH2B	180	1.5	"	2000	?	? (plan)

Phase 2 B is not a part of the programme, but its future implementation will be made easier by preparing for it as part of the Phase 2 A.

The development of Tangir SHP will include the following construction work:

- Intake dam (weir)
- Intake and sediment chamber
- Headrace channel
- Forebay
- Penstock

- Powerhouse
- Transmission lines

The consultant shall optimize the alternatives downstream from Chimari village and prepare the scheme for later expansion if viable.

The consultant shall prepare the technical/economical papers for concession and after concession tender documents for the construction of the scheme. The consultant shall also supervise the construction work and the commissioning of the plant.

#### 3.4 NOMAL hydro electric power scheme

The NVE report 04-88 describes the socio cultural and environmental effects. There is presently pressure on land in Nomal, and a reluctance on the part of established owners to sell land to recent settlers. The proposed hydel scheme will require the purchase of a small cultivated area as site for the powerhouse and penstock. There is also a potential conflict of interest between hydrogenerating use and irrigation use of water from the river in the low flow months of February and March, when sowing and irrigation have started but melting has not set in the Nomal nullah watershed. A division of these water resources must be such as to secure the irrigation interests.

An existing hydro electric powerplant of 108 KW is hardly sufficient to meet the power requirement of about 500 consumers. This plant utilizes a head of 33m and a flow of 522 l/s in Cross flow turbines.

In the Nomal nullah watercourse studies have also been carried out on a medium scaled high head hydropower scheme. According to WAPDA this has not proved to be feasible. A high head scheme could also be in conflict with the environment in the catchment area.

The proposed scheme utilizes the existing feeder channel to the old power plant. The channel must be enlarged to cater for approximately 2 M3/s. (hydrology NVE-report 2-89). The existing intake and silting basin must be improved and a new forebay constructed upstream from one existing in the channel (NVE-report 2-89). With a discharge of 2 M3/s the output is estimated at 2000 KW.

The development of Nomal with necessary transmission lines will far exceed the concession limit of RS 60 mill., hence the concession procedure and local responsibility will be similar to Tangir. Because of the increased programme on uprating Kargah ph.5 and Hassanabad ph.2 it is not expected to be possible to construct Nomal within the proposed budget of NOK 120 mill, unless there are costsavings in the proposed programme.

The consultant shall in close cooperation with WAPDA carry out technical/economical plans sufficient for concession.

Data on existing and planned power plants:

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Name	Head	Turbine	discharge	Output	Transmission	line
NOMAL PH1	33m	522 l/s	(1 unit)	108 KW	11 KV	(exist.)
NOMAL PH2	120m	2000 l/s	(2 units)	2000KW	11/33 KV	(plan)

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### 3.5 The Parri Multi Purpose scheme

The project is described in NVE report 04-88. Currently WAPDA is working with a new plan which may also include more reservoirs in the catchment area. The scheme is a combination of irrigation and electric production. Thousands of acres of dry land can be irrigated by this scheme (20,-40,000) and 10-20 MW power can be produced. WAPDA has expressed interest in receiving assistance from Norway for this scheme, and it is proposed that a review of the new plans should be carried out. This review shall be limited

to technical and environmental comments. The budget for this review will be limited, but include a site visit by technical and environmental experts. This visit is expected to be combined with site visits to the low head scheme in Gilgit river.

### 3.6 Hydro Electric Power Scheme in Gilgit River.

The Hamucha Hydro-Electric Power Scheme is located 45 km upstream from Gilgit town in Gilgit River near Sher Qila and close to the village Hamucha (Fig 6). This scheme can give 10-20 MW power, by constructing a small dam (weir) in the river, a tunnel and an underground power plant. The power station will utilize rapids in an oxbow in the river. The scheme will introduce Norwegian tunnel technology in Pakistan and will also allow cooperation between Norwegian experts on environmental issues and the environmental department which probably will be established in WAPDA in near future.

The consultant shall in close cooperation with WAPDA carry out a pre-feasibility study in order to outline the projects viability related to technical, economic and environmental issues. (For details on environment see TOR Environment).

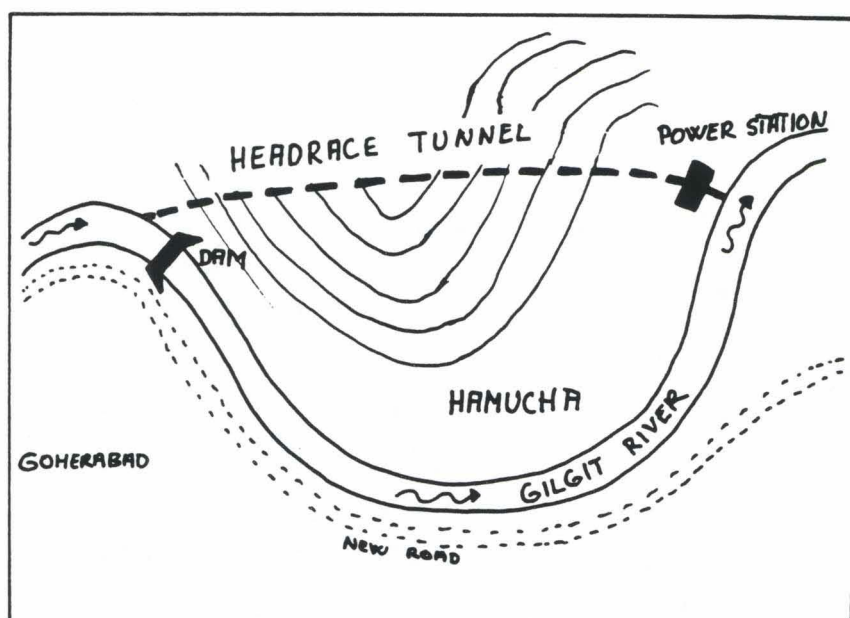


Fig 6

## 4.

**TERMS OF REFERENCE****Small Hydro-Electric Power Development  
in Northern Area, Pakistan****Socio-Economic Studies****4.1 Background**

Norwegian assistance is to be provided to Pakistan over a four year period to 1993, to rehabilitate and augment small hydropower projects in the Northern Area, and to set up a workshop. This will include provision of technical assistance and training.

It has been agreed that anthropological expertise is required to contribute to the success of the project. In order to undertake the studies listed below, the social anthropologist should collaborate with a suitable local institution. The tasks to be undertaken by the consultant are as follows.

**4.2 Scope of Work**

The consultant shall undertake three separate but related tasks:

**1. Baseline and Impact Study**

The consultant shall evaluate the socio-economic effects of the increased availability of energy on the local population. (Note: for the purposes of this study, the focus should be on the three localities of Tangir, Nomal, and Gilgit Town).

First, the consultant shall establish a socio-economic and cultural data base. Data will be collected with respect to everyday domestic and community life and production, social services such as health conditions and facilities, educational activities, and welfare. Such information will be based on primary data (i.e. information from the population directly involved) as well as such public records as are available. The scope and nature of the data to be collected will be specified in an Inception Report.

This report will:

- indicate what are the likely significant effects of the project on the local population - how electricity is absorbed into the socio-economic system and gives impetus for changes in socio-economic organization (Note: possible unintended deleterious effects of the project should also be considered).

social, e.g. changes in the patterns of social interaction and encounters; time savings; impact on settlement patterns and migration; impact on productive activities in

agriculture, industry, commerce and communication; changes in domestic organization; changes in standards of health and education; changes in the pattern of women's activities.

economic, e.g changes in the agricultural and industrial structure of the area; changes in supply/ demand balance of energy in relevant sectors; conversion of other types of energy use to electricity; balance of water use between irrigation, domestic use, and hydel use, with special attention to conflicts of interest in low water season; new economic activities established by electricity, and their effects on employment among men, women and children; changes in household budgets and in community stratification.

- set out a methodology for evaluating the nature and magnitude of such effects.
- specify what kind of data - both quantitative and qualitative - will be required in order to carry out such an evaluation. This should include, but not be limited to, participant observation and open-ended interviews among the local population.

In the Inception Report the consultant shall also identify major socio-economic factors which may constrain or prejudice the success of the project.

Next, the consultant shall collect the necessary baseline data as specified in the Inception report, with assistance as required from local personnel and/or students from Norway. (Subject to the agreement of NORAD and to Pakistan authorities). These data shall be processed and submitted as an Interim Report.

Near the end of the project period, the consultant shall return and carry out a new data collection exercise, to allow comparison between the "before" and "after" situations. The consultant shall then submit a Final Report presenting the findings of the impact study.

## 2. Monitoring

In addition to evaluating the impact of the project in the manner just described, the consultant shall also monitor the project through regular visits. The purpose of this is not so much to report on the progress of physical works, as to monitor the effects of the project. This has three major purposes:

- to provide information which may improve the implementation of the project as it progresses; to overcome constraints to implementation, to maximise the benefits and minimise any possible detrimental effects;

- to provide information of relevance for the evaluation exercise, e.g. by identifying unforeseen effects, or noting anticipated effects which are not in fact realised;
- to give preliminary findings which may be of relevance in the design of a follow-up phase of the project.

### 3. Liaison

In addition to the above tasks, the consultant shall:

- facilitate communication and cooperation between expatriates, local counterpart staff and the local population;
- participate in the design and execution of training schemes;
- participate in the design of the implementation phase of the programme with regard to the involvement of local labour.
- assist in recruitment of local staff for the workshop.

## 5.

## TERMS OF REFERENCE

**SMALL HYDRO-ELECTRICAL POWER DEVELOPMENT  
IN NORTHERN AREA, PAKISTAN**

**INTAKES, CHANNELS, SEDIMENT CHAMBERS**

5.1. General

Based on available information in the two mission reports, NVE no 04-88 and 02-89 and possible supplementary material the consultant shall

- a. Review and comment on existing headwork, canals and sediment excluding facilities relevant to the upgrading plans for Hassanabad II, Kharga 5 and Nomal power plants.
- b. Propose improvements or additions needed to sufficiently reduce sediment intrusion to the upgraded power plants.
- c. propose canal and sediment excluding facilities for the proposed new power plant in Tangir.
- d. Produce design drawings and work instructions suitable for tendering for the four above mentioned power plants according to priorities and work programme outlined in other parts of this terms of reference.

The following principles should be adhered to as far as possible:

- local knowledge and skills should be used where applicable in order to make relevant use of local manpower, materials and manufactured products, and prepare for local firms participation in the implementation.
- sediment excluders should primarily be based on manual rather than automatic control and operation, unless it can be shown that automatic excluders will function even for the maximum expected sediment load and provide a better solution for the plant.
- local maintenance of canals and sediment excluders should be facilitated.

The consultant shall include in the proposal time and capacity for control calculations and qualified advice to local contractors e.g. in cases where the dimensions or complexity of new structures exceed those normally found in traditional irrigation canal design. Examples are construction of deep channels and sediment traps, consequences of leaks and failures and prevention of damage from flushing discharge.



## 5.2. Special factors regarding the various sites

### 5.2.1. Hassanabad II

- The existing canal has a complicated and inefficient sediment trapping and flushing system. The canal is partly covered, but large remaining open reaches receive lateral influx of sediments from landslides and tributaries. The consultant shall evaluate the feasibility of various solutions to the sediment problem viz:
  - \* cover major parts of the canal, and rely on one main sediment excluder near the headworks.
  - \* apply an improved version of the existing solution with a series of secondary sediment traps along the canal.
  - \* use one secondary sediment trap near the forebay as the only supplement to the main trap.
  - \* possible other solutions.
- The consultant shall investigate and select a suitable location and design for the main sediment trap and determine whether it may be combined with certain permanent or semipermanent intake structures e.g. guide walls or sills, in order to reduce the influx of gravel to the canal.
- Given the existing canal route, the consultant shall investigate the feasible range of discharges versus improved canal cross section, seen from the viewpoint of sediment problems.

### 5.2.2 Kharga 5/5B

- The solution to Kharga 5/5B is linked to the ongoing construction of Kharga 7. A proposal to redesign the partly completed sediment trap for Kharga 7 was presented at site by the sediment specialist during the mission in February 1989. It is necessary for the consultant to review the actual design of Kharga 7 and evaluate whether the discharge from Kharga 7 will be sufficiently free from sediments to be utilized without further treatment in Kharga 5B/6. If not additional measures must be included in the design of Kharga 5/5B.
- Construction of an improved sediment trap for the old Kharga 5 intake and canal, and an increased canal section are needed for water supply to Kharga 5 + 6 during temporary closure of Kharga 7.

### 5.2.3 Nomal

- Increased discharge requires relocation and redesign of the canal intake, and increased cross section for the canal.

- A new sediment trap has been proposed by the sediment specialist. The consultant shall review and select a suitable location and design.
- The need for a secondary sediment excluder near the forebay is to be evaluated.

#### 5.2.4 Tangir

the feasibility of the proposed Tangir plant depends on many uncertain conditions, which it is the primary task for the consultant to investigate and conclude on:

- The intake location and design.
- The design of a gravel trap and its operation.
- The risk of slides along the canal route and measures to prevent slide damages.
- The need for and the location of sediment excluders at the lower part of the canal.
- Efficient sharing of water for irrigation and power production.
- Consequences of leaks from the canal, and measures for avoiding damage to village property.

#### 5.2.5 Power plant in the Gilgit river

A possible plant near Goherabad/Japuka may include:

- A threshold across Gilgit river, guiding water into
- A tunnel through the oxbow formed by the river
- A forebay in direct connection to the tunnel
- The powerplant may discharge directly back into the river.

The consultant shall investigate the site for threshold and tunnel entrance and propose solutions that minimize the sediment intrusion to the tunnel and sediment traps/flushing systems to prevent harmful sediments from reaching the turbine.

6.

## TERMS OF REFERENCE

**SMALL HYDRO-ELECTRIC POWER DEVELOPMENT  
IN NORTHERN AREA, PAKISTAN****ENVIRONMENTAL STUDIES****6.1 General Introduction**

Development of hydropower cannot be accomplished without encroachments on nature and the environment. It is important to reduce the possible negative impacts of hydropower development as far as possible.

In the following a survey of the environmental impacts related to the implementation of the suggested projects (NVE-report 04-88) will be given. To avoid or reduce negative impacts in the future, it is important to point out the possible short- and long term consequences of the implementation of the projects.

Experience has shown that the cost of repairing later "unexpected" environmental damages are usually much greater than the costs required to avoid them.

The necessary environmental studies as outlined here shall be carried out in close cooperation with employees at the proposed new environmental department in WAPDA.

**6.2 Possible conflicts related to the available water**

Conflicts may occur if water supply for domestic use and irrigation are dependent on surplus water from the power plant. In this case the plans must include solutions which make the water for supply independent of the water used in the power production (This applies only to Hassanabad 2.). Hassanabad ph. 2 and Nomal may during the dry months of February-April be in conflict with the need for irrigation water.

**6.3 Damages caused by accidents**

Mass movement and erosion in the hill sides are very common all over the Northern area. Additionally the area is situated in a seismically unstable zone. These are all elements indicating the danger of bursts in penstocks and channels. The increase in discharge and head will increase the consequences if an accident should occur. Because the hillsides are quite unstable and easily erodible an accident could lead to serious damage.

To avoid or reduce the consequences, different measures against erosion should be taken during the planning process.

#### 6.4 Deposition of sediments

During construction of the sediment chambers attention must be paid to the process of emptying and storing the sediments. The sediments which mainly consist of sand, gravel and pebbles, are easily transported by running water. If the necessary precautions are not made, this may lead to an increase in downstream sediment transport and aggradation in the channels. Further the natural landscape and domestic use of the environment are important factors not to be forgotten when planning the deposition area.

#### 6.5 Hydrology and sediment transport

The actual projects are run of river hydro power plants. Usually, implementation of this kind of plants has minor negative effects on the river systems and only along a limited reach. However, the reduction in discharge along the reach may affect the sediment transport processes due to reduced competence and capacity. Further, if the stream becomes dry in periods of the year, then it is important to evaluate the effects on the natural biological life, the recipient capacity and the domestic use of water along the reach. The Hamucha project in Gilgit river will require the above mentioned evaluation.

#### 6.6 The construction site

If a construction site is established, the location has to be chosen in keeping with the natural and cultural environment. When the construction period is finished, the site area has to be cleaned up in a manner dependent on the subsequent use to which the site area will be put.

#### 6.7 Transmission lines

The 11 kv transmission lines for small hydro power plants in Northern Area distributing the power to local villages are likely to have minor effect on the environment. Transmission lines from the Parri and the Hamucha scheme, which will be constructed as 33 or 66 kv-line leading the power to Gilgit town, have negative environmental effects. When planning these lines the natural and cultural environment has to be considered. Similarly, the effect on bird and animal life must be evaluated.

#### 6.8 Tangir: Special considerations

In Chimari village, the bridges, road, houses along the river and the river itself constitute a special cultural environment. The planning of the small hydro power project in Tangir must avoid encroachments and damages in the Chimari area. The design of the project should take account of local fishing interest.

## 6.9 Medium scaled hydropower plants

### 6.9.1 General

Generally, medium scale power plants lead to more severe environmental consequences than small ones. For the projects in Gilgit River and Parri, close cooperation with the Environmental Section in WAPDA should be maintained, and maximum use made of local knowledge.

The two projects are quite different. The Hamucha scheme in Gilgit River is a run of the river project, while Parri is a high head project. Further, the Parri project only involves a review of existing plans. The Hamucha scheme includes a prefeasibility study.

### 6.9.2 The Hamucha Scheme in Gilgit river

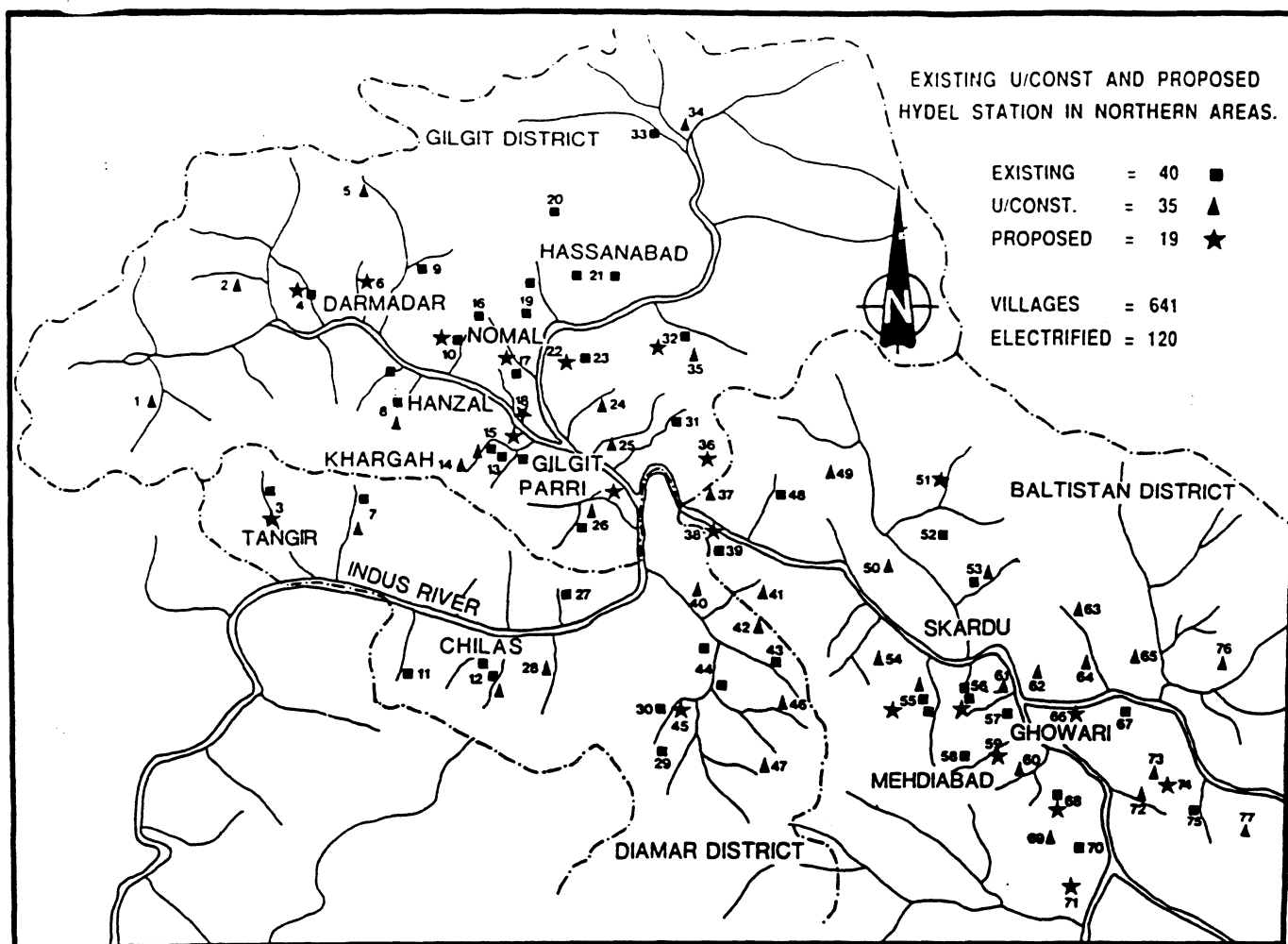
The pre-feasibility study shall include environmental studies to establish whether the project is environmentally feasible. Further, an evaluation of this project in relation to other alternatives to meet the power demand in the area has to be included.

### 6.9.3 The Parri high head project

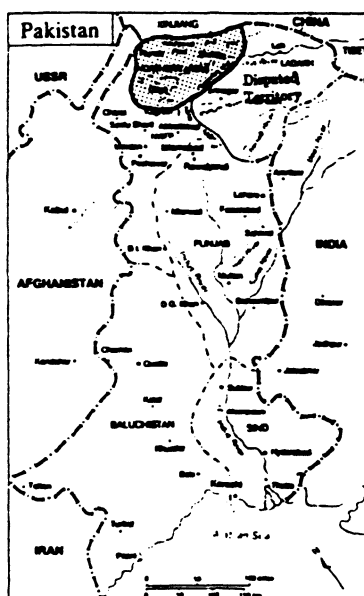
This project includes only a review of the content and background of existing plans. Major issues related to the environmental evaluation are as follows:

- \* Reservoir area: Erosion, human settlement, agriculture, animal husbandry, animal life, historical or cultural remains, and landscape elements of importance to the local population, increased risk of water-borne diseases, fish and other biological life and changes in the nutrients and chemical composition.
- \* Drain of Parri river: Changes in hydrology and the effect on people and environment along the river, changes in fluvial processes and recipient, effect on animals, birds and the biological life in the stream.
- \* Security of the outlet in Gilgit river against erosion.





	KVA
1. PHANDAR	1250
2. NAZBAR	1250
3. TANGIR	2500; 200
4. GUPIS	2000; 750
5. ISHKOMAN	1250
6. DARMADAR	750
7. DAREL	1250; 250
8. SINGLE	125; 250
9. CHATORKHAND	200
10. SHERQILLAH	1250 ; 250
11. THOR	200
12. CHILAS	1250; 500; 2000
13. KHARGA N	4000
14. DORMUSHKO	250; 1250
15. HANZAL N	6250
16. NALTAR	100
17. NOMAL	250; 135
18. BARGO	200
19. CHALT	125
20. BODALAS	750
21. HASSANABAD	200; 500
22. PISAN	500
23. MINAPIN	125
24. DAYOUR	250
25. JALALABAD	1250
26. JAGLOTE	250; 135
27. GOHARABAD	200
28. BUNAR	1250
29. RATTU	200
30. GORIKOTE	250
31. BAGROTE	800
32. SUMAYAR	250; 125
33. KHYBER	500



	KVA
34. MISGAR	200
35. NAGAR	250
36. HARAMOSH	500
37. TURMIK	1000
38. GANJI	500
39. MENDI	200
40. HARCHO	800
41. HARPO	500
42. LOUS	1850
43. PARISHING	200
44. ASRORE	135; 135
45. BULSHBAR	800

	KVA
46. GUDAI	250
47. SHANKORGARH	250
48. STAK	200
49. NIALSO	250
50. KAYO	125
51. BARALDO	500
52. HASHOPI	100
53. SHIGAR	1000
54. BASHO	1000
55. KACHURA	250; 2000
56. SKARDU	2500; 250
57. SIRMIK	3000; 800
58. PARKUTA	125
59. MEHDIABAD	135
60. MANTHAKA	1000
61. GOL	250
62. KIRS	500
63. THALY	200
64. BALAYGOND	200
65. KHARKOO	1500
66. GHOWARI	1000
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68. TOLTI	135
69. SHIRTING	250; 250
70. OLDING	1000
71. HERGOSIL	125
72. GUNDAS	1000
73. GARBUCHING	200
74. HASANABAD	250
75. SIKSA	500
76. DANSAM	200
77. PION	1500
	1000

**SMALL HYDRO-ELECTRIC POWER DEVELOPMENT IN THE NORTHERN AREA,  
PAKISTAN.**

**TERMS OF REFERENCE FOR SERVICES ON ELECTRO/MECHANICAL WORKSHOP  
AND THE REHABILITATION OF THE EQUIPMENT IN THREE SMALL HYDROPOWER  
PLANTS.**

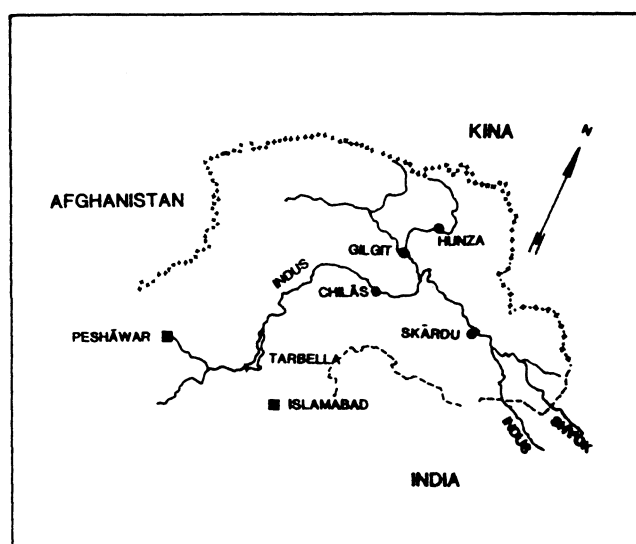
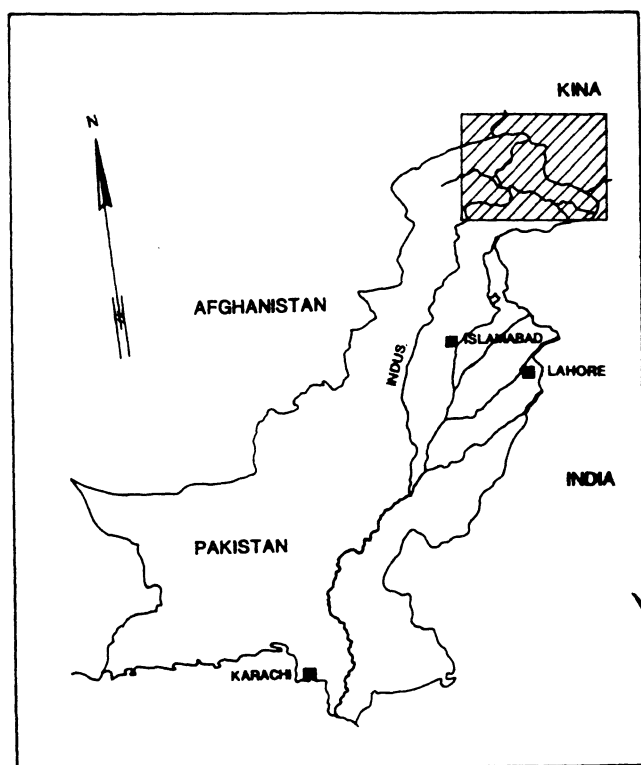
**1 INTRODUCTION: SMALL HYDRO POWER DEVELOPMENT IN NORTHERN AREA.**

**1.1 Background**

In 1986, NORAD proposed that aid to Pakistan should include energy supply projects, with special emphasis on technical solutions where Norway has special knowledge; and Pakistan subsequently applied for support for such projects.

In two missions to Pakistan and in co-operation with the relevant Pakistan authorities, the Ministry of Kashmir and Northern Area, Pakistan Water and Power Development Authority (WAPDA) and Northern Area Public Works Department (NAPWD) projects have been identified which will improve and increase energy production in the Northern Area - Gilgit, Baltistan and Diamar districts (Fig.1).

The following Terms of Reference are based on information given in NVE-reports 04-88 and 02-89, which should be referred to for further details.



### 1.2 Present Hydro Electric Situation in the Northern Area.

The mountainous terrain and major water resources makes the Northern Area suitable for hydro electric generation of small, medium and large scale production. Since the population is located in the valleys, the development efforts so far have concentrated on building small hydel stations to serve the villages. Except for powerstations situated in the same river, very few powerplants are interconnected in a grid. The existing transmission lines are built to deliver the power over short distances. They therefore normally are 11 KV lines leading the power to a distribution grid.

The estimate of present demand in the Northern Area in 1988 was according to NAPWD 78 MW which far exceeds what can be produced by constructing small hydro power plants, and areas presently without electricity are pressing to be able to join in. The conclusion is that small hydro-electric power plants (100-5,000 kW) should be built in rural and sparsely populated areas, while medium scaled hydro-electric power plants (5,000-20,000 kW) should be built to meet the demand in heavily populated areas and town centres like Gilgit. The planning of medium scaled power plants has started. The implementation of these plants will make the construction of high voltage transmission lines more feasible, which is a necessity for the development of an interconnected grid system. An interconnected grid system which also includes the small hydro power plants will improve the quality of electric production and ease the electrification of more villages.

In the Northern Area, 75 small hydro electric power plants will be in operation in the near future (Appendix 1) producing approximately 30 MW. Some of the existing 40 power plants lack proper maintenance and daily operation is difficult. The frequent occurrence of power failures and load shedding lead to increased strain for the employees of NAPWD. There are no local facilities for even the smallest maintenance work on el/mech equipment, and



they have to wait for weeks to get even the simplest repair work done.

The implementation of a maintenance workshop with trained workforce will improve NAPWD's capability to produce high quality electricity. It will reduce the shut down time of the power plants which is of great importance in this area with a desperate need for electric power.

The rehabilitation of three power plants is necessary for the training of employees at the workshop. In addition it will lead to increased production in these power plants.

The trained employees at the workshop will be valuable for NAPWD when new plants are constructed. The workshop will have facilities for production of different components regarding power plants and the employees will be trained in mounting of different types of equipment.

## **2. SCOPE OF WORK OF THE CONSULTANT**

### **2.1 General**

The consultant shall assist NAPWD in preparation of conceptual and detailed design and specifications for civil works, including bills of quantities, as well as the preparation of specifications and purchasing of tools and accessories needed for a workshop which shall be designed to service both mechanical and electrical needs.

The expenditure of resources on this planning phase of the programme must be kept at a level which is appropriate in relation to the expected cost of the implementation phase. The consultant shall therefore ensure that the scale of the various components of their work programme are commensurate with their expected benefits.

To the extent possible, equipment of local manufacture shall be

used for this programme. Contractors shall be from Pakistan, preferably from Northern Area.

The main task of the consultant is to train Pakistani counterparts in operation of the workshop tools, management of the workshop, preparing rehabilitation programme for small hydro electric power plants and how to carry out the plans.

To complete the above tasks the consultant shall assign competent personnel to perform services required. In the conduct of the work, which shall be carried out in Gilgit, the consultant shall co-operate fully with NAPWD.

## 2.2 Mobilization phase

The consultant shall assign expatriates to work together with NAPWD regarding the following:

- \* Planning and construction of the workshop
- \* Purchasing equipment and recruitment and training of personnel for the workshop
- \* Planning of the rehabilitation of electro/mechanical equipment in the following small hydropower plants:  
Kargah phase 5, Hassanabad phase 1, Skardu phase 1.
- \* Refurbishment programme in the workshop

The mobilization phase shall include the scheduling of the implementation programme for the agreed project.

## 2.3 Detailed design phase

### 2.3.1 The workshop-building

Together with NAPWD the consultant shall carry out detailed design for the building regarding civil works. This design shall be similar to the diesel plant building which already is constructed close to the site for the workshop. Erosion is an important factor in this area, and the workshop must be located so that river erosion (Gilgit and Hunza rivers) is not a threat to the building in the foreseeable future.

The operation of the workshop will produce different kinds of waste which could pollute the local environment. The plan shall include solutions for recirculation or trapping of oil and other effluents.

#### 2.3.2 The workshop-equipment

Tools and accessories for the workshop shall be purchased in order to meet the requirement in stage 1 in the workshop programme (NVE-report 02-89). The different machines shall not be automatic. The tools shall be purchased in Pakistan, or second hand machines shall be purchased from other countries if price and quality is satisfactory for the operation of the workshop. As a rule equipment should be chosen such that spare parts are obtainable in Pakistan.

The consultant shall assist NAPWD in purchasing adequate material stock to allow the rehabilitation of power plants in the area.

#### 2.3.3 The workshop-training

The training of personell shall be based on stage 1 for the implementation of the workshop (NVE-report 02-89) which include 7 skilled workers and in addition necessary educated personnel for the management of the workshop. In the recruitment of these people the consultant shall fully cooperate with NAPWD and the socioanthropologist who will be attached to the project.

#### 2.3.4 The rehabilitation projects

The rehabilitation programme is focused on the electro/mechanical equipment in the following power plants:

- \* Kargah phase 5 (200kW)
- \* Hassanabad phase 1 (160kW)
- \* Skardu phase 1 (320 kW)

Necessary improvements regarding intake, sediment chamber,

channel, penstock and power house i.e. all civil works are the responsibility of NAPWD.

Details on each plant is described in NVE-report 02-89.

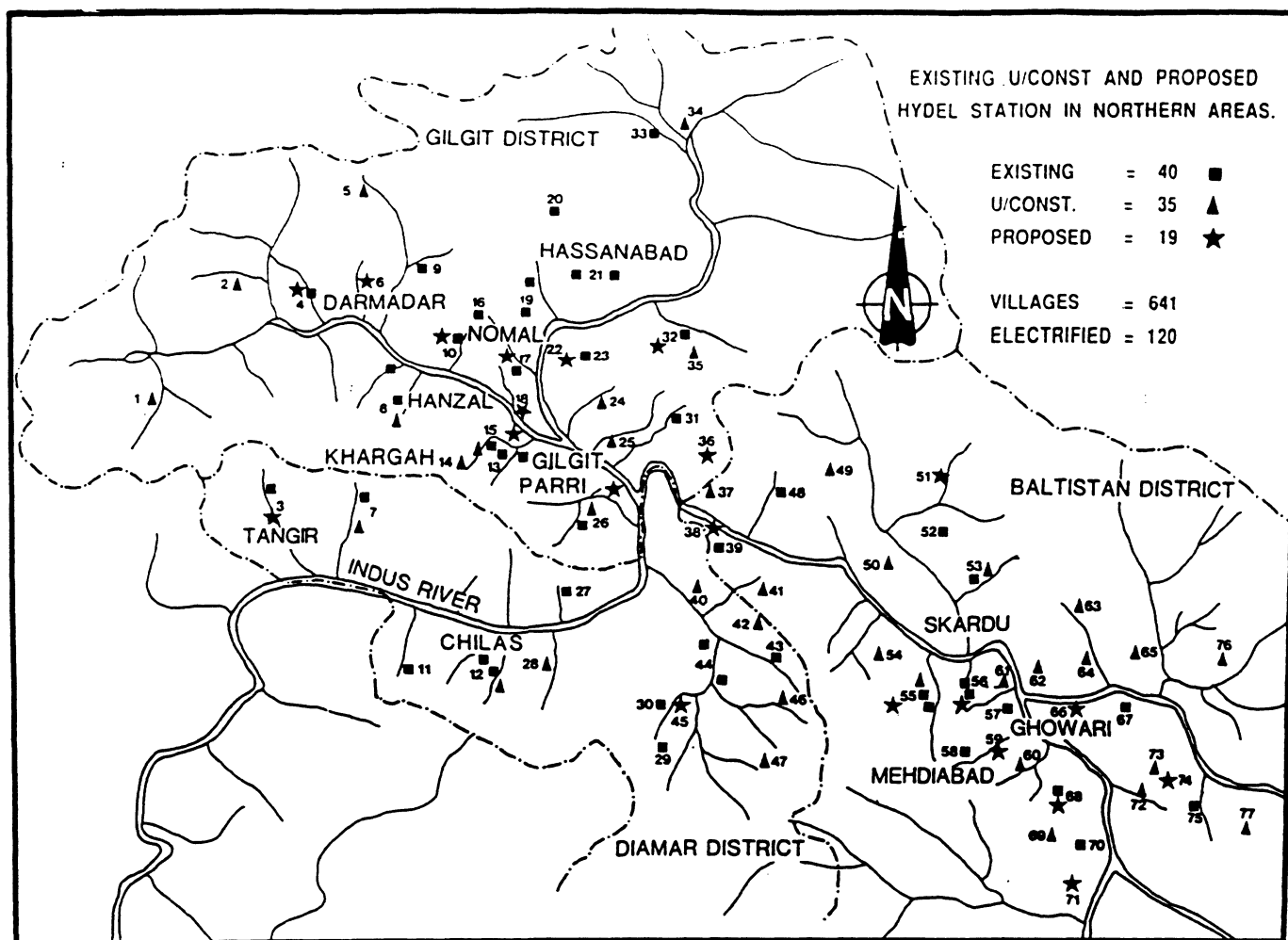
#### 2.4 Implementation phase

The consultant shall assign to the project site supervising engineers to assist NAPWD in the civil work construction of the workshop and the mounting of the different machines.

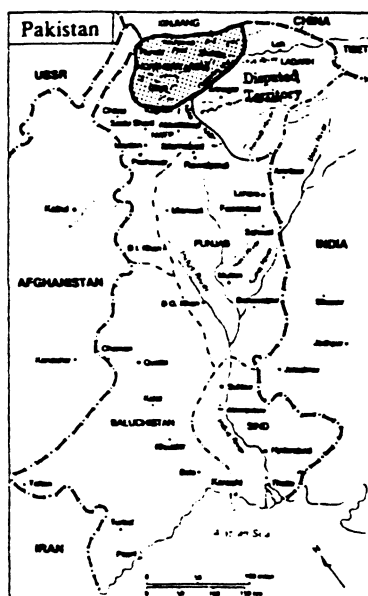
As noted in to NVE-report 02-89 the consultant shall assign to the project the necessary expatriates to ensure that the Pakistani employees are a selfsufficient unit after 3-4 years.

It is emphasised that the rehabilitation works shall be carried out at the workshop to give sufficient training for the employees. The consultant shall seek solutions to include as much work as possible at the workshop so that the dependence of manufactures outside Pakistan is reduced.

At the completion of the project the consultant, in cooperation with NAPWD, shall write an evaluation report on the technology transfer in general and in particular on the skilled labours attached to the project.



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2. NAZBAR	1250
3. TANGIR	2500; 200
4. GUPIS	2000; 750
5. ISHKOMAN	1250
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74. HASANABAD	500
75. SIKSA	200
76. DANSAM	1500
77. PION	1000



Telegram : ECONOMIC  
Telex : ECDIV No. 05-634

SECTION OFFICER  
~~822759~~ 822269

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Innkomet NORAD ISLAMABAD J.nr.: 1500 Dato: 11.1.90 Arkiv: 333.2.2
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No. 3(1)CM-II/89  
Government of Pakistan  
MINISTRY OF FINANCE AND  
ECONOMIC AFFAIRS  
(ECONOMIC AFFAIRS DIVISION)

Islamabad, the 7th Jan., 19 90

Subject:-SMALL HYDRO ELECTRIC POWER DEVELOPMENT IN THE  
NORTHERN AREA., PAKISTAN

Dear Mr.Skogstad,

Please refer to your letter of 7th November, 1989 regarding subject referred above and the views of Ministry of Water & Power, WAPDA and Kashmir Affairs & Northern Affairs Division are enclosed.

With regards,

Yours sincerely

  
( Hamid Ahmad Ghouri )

Mr.Thormod Skogstad  
Counsellor (Development)  
Royal Norwegian Embassy  
Islamabad

No. P.III-4(18)/89  
Government of Pakistan  
Ministry of Water and Power

SECRET

Islamabad, the 7th November, 1989.

OFFICE MEMORANDUM

Subject : RURAL ELECTRIFICATION IN NORTHERN AREAS  
THROUGH SMALL HYDEL STATIONS-M/S. NORAD'S  
PARTICIPATION.

The undersigned is directed to say that under an agreement of Development Co-operation between Governments of Pakistan and Norway, M/s NORAD of Norway visited Pakistan and agreed to take up the feasibility studies and construction work of Nomal and Tangir Hydel Stations in the first instance in association with WAPDA.

2. Economic Affairs Division is requested that NORAD (Norwegian) may be requested to provide details of programme of the consultants appointed for the execution of work to enable WAPDA to arrange local staff and requisite funds as per Protocol signed between the two Governments.

3. PC-II for "Rural Electrification in Northern Area through Small Hydel Schemes" which included the above two Hydel Stations stands approved.

*Farooq Ijaz Khan*  
( Farooq Ijaz Khan )  
Section Officer  
November, 1989.

Economic Affairs Division,  
(Mr. Badrul Hasan,  
Deputy Secretary),  
Government of Pakistan,  
ISLAMABAD.

NORTHERN AREAS  
M/S. NORAD'S

to say that  
agreed between  
M of Norway  
feasibility  
Tangir Hydel  
with WAPDA.

*and today at 13.30 hrs*  
*7/11/89*

NORWEGIAN ASSISTANCE FOR SMALL HYDRO ELECTRIC PLANTS  
IN NORTHERN AREAS

SCOPE OF WORK DESCRIBED IN VARIOUS REPORTS & T.O.R.

Protocol / Agreed Minutes of Meeting Dec. 1, 1988	Report 4 - 88 Jan. 1989	Report 2-89 Sept. 1989	T.O.R. Nov. 1989	Comments
a) As the first priority, Norway would recommend the refurbishing of turbines and electric equipment of certain plants in operation, (Kargah Phase 5, Hassanabad Phase 2 and Skardu Phase I). It could be followed by construction of a maintenance mechanical workshop in Gilgit to improve the operational efficiency of existing small hydro - electric plants.	No change in scope of work.	Upgrading of Kargah Phase 5 has been added to agreed scope of work.	<p>i. Planning and construction of the workshop.</p> <p>ii. Purchasing equipment and recruitment and training of personnel for the workshop.</p> <p>iii. Planning of the rehabilitation of electro/mechanical equipment in the following small hydropower plants: Kargah Phase 5, Hassanabad Phase 1, Skardu Phase 1.</p> <p>iv. Refurbishment programme in the workshop.</p> <p>v. Feasibility study with technical/economical data sufficient for approval for upgrading of Kargah ph.5 and Hassanabad ph.2 power plants.</p> <p>After approval is granted preparation of tender documents for the implementation of the scheme, supervision of construction works and commissioning of the plants.</p> <p>Prepare any additional topographic maps that are required for the detailed design phase.</p>	NA, PWD is dealing with these works.



b) As a possible second priority the Norwegian delegation would recommend the planning and construction of small hydro electric plants in Tangir and Nomal.	No change in scope of work.	Construction of Nomal hydel scheme has been dropped from the agreed scope of work.	Undertake any additional geological & geotechnical field requirement to finalize the designs.
c) As a third priority the Norwegian delegation would recommend a review of the existing feasibility scheme for the Parri-multipurpose scheme & Hanzel scheme.	No change in scope of work.	No change of scope of work.	<p data-bbox="1256 496 1700 520">i. Feasibility study with <u>b &amp; c</u></p> <p data-bbox="1308 536 1610 624">technical data sufficient for approval for hydel schemes at Tangir and Nomal.</p> <p data-bbox="1240 639 1648 847">ii. After approval is granted, preparation of tender documents for the implementation of the Tangir scheme, supervision of construction works and commissioning of the plant.</p> <p data-bbox="1301 879 1570 1086">Review of existing plans for the Parri scheme with Pre-feasibility study of a low head tunnel scheme as an alternative in Gilgit river.</p> <p data-bbox="1632 536 2051 791">i. Construction of Nomal SHP has been dropped due to more expenditure being expected in refurbishment and uprating of the existing power plants. In our view they may propose to their Govt. to increase the grant for energy sector or divert some funds from other sectors of support.</p> <p data-bbox="1621 815 2029 1023">ii. It has been mentioned that expatriats to execute/design different aspects of project will be provided but there is no mentioned of number of expatriats and the months for which they will be deployed.</p> <p data-bbox="1599 1038 2051 1214">iii. The review of the project report and progress reporting alongwith actual contribution both in terms of material &amp; funds by both the Govts. have not been specifically discussed for each project.</p> <p data-bbox="1621 1230 2051 1334">iv. While calculating the total cost of the project, the break up of civil works costs have not been separately shown.</p>

however, cost of engineering design have been given. These costs do not indicate the local and foreign components.

- v. The actual start up of studies have also not been indicated in the TOR. The absence of this makes it a general TOR although it should have been more specific & elaborate.
- vi. The preparation of civil works specifications and tender documents have not been discussed except the BOQ and detailed drawing and supervision of civil works. These may be included alongwith bid scrutiny for civil works.

A specimen of PC-I porforma has also been handed over to NORAD for collection of required data at their own end. It was confirmed by the delegation that an Engineer representative of NORAD will visit Pakistan to finally prepare the document. NA PWD will provide the cost effect of materials/labour etc the NORAD team require for incorporation from Pakistan.

b. PROVISION OF FUNDS. It was agreed by the delegation that 100% financing for the project will be done by the Norwegian Government with exception to some ongoing schemes where partial financing for construction works will be possible by NA PWD through normal annual development programme i.e Hassan Abad Phase-I & II.

6. Consultancy Services. As regards feasibility studies of Parri, Hanzel, Nomal and Tangir schemes, comments/ views of WAPDA should be sought as they are going to be sponsors.

COPY

Annexure-A

To CE letter No.E4(103)/89

Dated. 05.12.1989.

Norwegian Assistance for Small Hydro-Electric Plants in Northern Areas. Departmental comments on Terms of reference for services on Electro/Mechanical Workshop and Rehabilitation of the Equipment in Three Small Hydro Power Plants.

General.

1. A four member Norwegian delegation visited Northern Areas from 15 to 17 November, 1989 to have further discussions with Administrator Northern Areas and NA PWD Engineers on Norwegian Assistance programme. Development programme in general and Terms of reference for services on Electro/Mechanical Workshop and The Rehabilitation of equipment in three small Hydro Power plants, in particular, were discussed. The delegation also visited proposed site for Electro/Mechanical Workshop and existing Hydro power stations at Kargah phase-5, Hassan Abad Phase-1/2.

Comments on Terms of Reference.

2. Although the entire project is to be financed 100% by NORAD yet the mode of employment of Norwegian consultants/Contractors need to be clarified especially in areas where NA PWD is required to provide assistance.

3. The rehabilitation of Hassan Abad Phase-II was included in the final report but does not figure out in TOR. This should also be included in the programme.

4. Ref page 5 para 2.3.4: Responsibility for improvement regarding intake, sediment chamber, channel, penstock pipe of power House i.e Civil works should not be entrusted to NA PWD as the same has not been catered for, in the annual development programme. However NA PWD can execute this job provided funds are made available in time. Preferably this should be included in NORAD programme.

Miscellaneous Points.

5. During discussion with Norwegian delegation following was mutually agreed:-

- a. PC-I PREPARATION..PC-I form mainly deals with cost effect of the project. As the above assistance programme mainly involves foreign aid in the form of machinery and services therefore, it was not considered appropriate for NA PWD to prepare this document due to lack of information about cost effect of different items in Norway/international market. Keeping in view the foregoing, it was decided that PC-I form will be prepared by NA NORAD.

Cont./2...

## APPENDIX 3

### NOTES OF MEETINGS

## APPENDIX 3

## NOTES OF MEETINGS

### 3.1 MEETING WITH THE MINISTRY OF KASHMIR AFFAIRS AND NORTHERN AFFAIRS, 20.01.90.

Place/time: Ministry/9-12 AM

Participants: Joint Secretary, Mr. Wazir Farman Ali  
Assistant Chief, Mr. Muham Ashraf  
Planning Officer, Mr. Abdul Hafeez Khan

NORAD	Mr. Thormod Skogstad
NORAD/NVE	Mr. Torodd Jensen

#### 3.1.1 Terms of Reference for consultancy services

The objectives for the meeting were to clear the way for approval of the two Terms of Reference for consultancy services and to discuss the preparation of the PC I documents for the different projects.

The ministry had no comments on the TOR, and an official approval was promised within 5 days.

#### 3.1.2 Planning Commissioning (PC) documents

To ensure the necessary evaluation of the programme a splitting in six different projects was proposed. The different projects will be approved by different authorities after the following:

A project with investment cost of more than RS 60 mill. will be a subject of approval by the Executive Committee of the National Economic Council (ECNEC) which only meets a few times a year. Approval time not less than 6 months. For projects with cost between RS 20 mill. and RS 60 mill. the approval time will be approximately 2 months, and it will be subject to approval by The Northern Areas Council (NAC). Projects with cost less than RS 20 mill. will be approved by the Development Working Party Northern Areas (DWPNA's).

The following splitting of projects were proposed.:

- NAPWD:
- \* Kargah 5 uprating; planning/construction
  - \* Hassanabad 2 uprating; planning/construction
  - \* Workshop; planning/construction
  - \* Workshop; training/refurbishing el/mech units in Skardu 1, Hassanabad 1, Kargah 5.

WAPDA:       \* Tangir, Nomal, Parri, Hamucha; planning  
              \* Tangir; construction

The construction of the Tangir scheme will far exceed RS 60 mill. and will need approval from ECNEC. These projects will each have their own PC I document and the consultant will have to sign a contract for each of them.

The questionnaire for the PC I document requires detailed information on each project, such as bills of quantities, expected amount of labour etc. At this stage of the project a lot of these questions cannot be answered. It was therefore proposed to prepare a simple PC I document (so-called Umbrella PC) so that the planning of the different projects could start.

The following is a short description of the different PC-documents:

PC-I documents:       Planning documents for approval, normally based on PC-II documents.

PC-II documents:      Pre-Feasibility study, always needed for projects like Tangir, Nomal, Gilgit River or larger projects.

PC-III documents:     Progress reports during construction.

PC-IV documents:      Completion report.

### 3.2 MEETING WITH SUPERINTENDING ENGINEER, COLONEL MUNIR AFGAL 21.01.90.

Place/time:       Chilas/12-2 PM

PC I document for Tangir was discussed as well as PC I documents in general. The PC I documents are supposed to be written after detailed planning of the different schemes. This detailed planning is supposed to include land survey, preparation of bills of quantities for excavation, concrete works, reinforcement etc. as well as detailed information on equipment in the powerhouse, pipeline etc. For the preparation of a simple PC I document the experience from a SHP plant under construction (1.5 MW, head 125m) could be used especially for rough cost figures.

**3.3 MEETING WITH SUPERINTENDING ENGINEER, PLANNING & DESIGN,  
MR. FARUQUI, GILGIT 21.01.90.**

Place/time: Gilgit/6-9 PM

Mr. Faruqui has replaced Lt. Colonel Javed Akhtar. He reported that he had already started the work to give as much information as possible for the preparation of the PC documents.

**3.4 MEETING WITH NAPWD 22.01.90:**

Place/time: Gilgit/9 AM-5 PM

Participants NAPWD: CHIEF ENGINEER MR. RIAZ AHMAD RIAZ  
LT.COLONEL MR. FARUQUI  
LT.COLONEL MR. RASHID AHMAD

**3.4.1 General**

Mr. Ahmad Riaz has replaced Brigadier Najeeb Ullah Khan. The histories of the different projects were summed up. A short report from the meeting with the ministry was given which stressed the need for the PC documents to be written, and the need to split the different projects for later evaluation.

The different schemes were discussed and some misunderstandings were solved. The programme financed by NORAD will include the following projects:

- \* Planning and construction of a workshop with equipment, tools, material to allow the desired improvement of the maintenance of the hydro power plants in the Northern Areas.
- \* Training of the required manpower needed for the first phase of the workshop. As part of this training the electro/mechanical units in Kargah 5, Hassanabad 1 and Skardu 1 will be refurbished in the workshop.
- \* Planning and construction for uprating (expansion) of Kargah 5 to utilize the total head between Kargah 7 and 6 with the same discharge as Kargah 7.
- \* Planning and construction for uprating (expansion) of Hassanabad 2 to utilize the maximum obtainable head and discharge so that the discharge is similar to Hassanabad 2B currently under construction with intake in the tailwater of Hassanabad 2.



For Hassanabad 1 and Skardu 1 NAPWD has worked out PC-1 documents for uprating of each plant. NAPWD had thought that this also could be included in the NORAD programme because the possibility is mentioned in NVE - report 02.89. But these have not been included in the agreed programme. If cost savings in the programme are achieved, however, assistance to other projects like these may be discussed.

Cost estimate for Skardu ph.1 prepared by NAPWD:

Civil works (Power- channel/house etc.	NOK	1.8 mill
<u>Electro/mechanical equipment/penstock etc...</u>	<u>"</u>	<u>14.2 mill</u>
<u>Total sum.....</u>	<u>NOK</u>	<u>16.0 mill</u>

The Exec. Eng. Hunza division, Mr. Darvesali and the Exec. Eng. electrical/mechanical, Chief Eng. office, Mr. Mohammad Nabi participated in the discussion of the PC-I documents and wrote the final document for each project together with other staff-members in NAPWD.

#### 3.4.2 Hunza, Hassanabad 1 hydro power station

In accordance with the recommendations of the February 89 mission the sediment chamber and feeder channel for Hassanabad 1 have been improved. Also work is in progress with an extension of the channel to be used in the new Hassanabad 1 scheme. The request for assistance from NORAD for this scheme will therefore cover the purchase of necessary equipment for the power station. The head will be approximately 70 m giving an output of 500 kW. A unit purchased in China will cost approximately RS 4 mill (NOK 1,3 mill). When the work with the program has started it should be clarified if there still is a need for the refurbishment of the old power station Hassanabad 1. If not, the savings from this project should be used for the benefit of the new Hassanabad 1. There are today 3520 consumers in Hunza asking for electricity, of which 2720 are connected to the grid. The current hydro power production is approximately 300 kW because of the bad situation in the old Hassanabad 1 power station and the sediment problems in the new Hassanabad 2 power station.

## HAFSANABAD PHASE-I

Head = 220ft - 250 ft

Discharges 30 Cusecs

Capacity = 500 KW

Capacity = 500 KW		F.F		Local		Metal
S.No.	Items	Unit	Rate	Amount	Rate	Amount (Millions)
1.	Power House 25 X 30'	750 sq ft	-	-	0.00053	0.40
2.	Tail race/Gen Foundation	-	-	-	0.25	0.25
3.	Pen stock pipe 30" dia & 600 Rft i/e pillars	600 Rft	-	-	0.001	0.60
4.	Forebay 16X20X10	3200 sq ft	-	-	0.0005	0.16
5.	Silt basin 160 X20X10'	3200 sq ft	-	-	0.0005	1.60
6.	Waste way 700 Rft	700 Rft	-	-	0.001	0.700
7.	Const of Power channel					
a)	Raising of existing side/retaining walls	5000 Rft	-	-	0.0002	1.00
b)	Cost of 1200 Rft new channel	1200 Rft	-	-	0.0002	0.24
c)	R.C.C. lining of power channel	6200 Rft	-	-	0.0003	1.86
8.	Transmission/ Distribution lines	40 KM	-	-	0.15	6.00
9.	Cost of turbine, inlet valve, Governor set of appertenances & spare etc	2 sets	9.30	18.60	-	18.60
10.	Cost of electrical equipment	2 sets	8.52	17.04	-	17.04
Total				35.64		13.53
11. Add for contingencies						3.440
G.Total						52.610

#### 3.4.3 Accommodation and local assistance to the consultant

The consultant who will stay for several months in Gilgit can discuss with NAPWD about using one of the governmental rest-houses or renting a house for accommodation and office the first months. The purchasing of caravans is also possible. Workshop staff houses can be built near the workshop site. The construction of a three-bedroom house costs approximately NOK 250,000,-. Such a house can be built within 6 months time. For later use there should not be more than two three-room houses and two two-room houses. One of the three-room houses can be used as an office. **These houses have so far not been included in the programme.**

The consultant cannot expect NAPWD to carry out any planning regarding the different schemes except for the help that will be given for employing of local people, contractors etc. If local experienced people are not available in the Northern Areas, it is possible to engage people from Pakistani consultant companies down country.

#### 3.5 MEETING WITH CHIEF ENGINEER NAPWD AND HIS STAFF 23.10.90

Place/time: Gilgit/8 AM-9 PM

##### 3.5.1 The Workshop

The site for the workshop will most likely be near the 3 MW diesel plant in Gilgit. An alternative is to develop the site for the existing workshop, but this site is small and will give little room for future activities. The site is also close to private houses which will be disturbed by the noise from the workshop. This site will also make it more difficult to carry out maintenance on the generators in the diesel plant which require use of maintenance in the workshop.

The recruitment of educated personnel for the workshop has started. Mr. Tawahar Ali now working within NAPWD in their small workshop has been appointed to be included in the staff for the proposed workshop financed by NORAD.

### 3.6 MEETING WITH THE MINISTRY OF KASHMIR AFFAIRS AND NORTHERN AFFAIRS, 25.01.90.

Place/time: Ministry/2-4 PM

Participants:	Joint Secretary,	Mr. Wazir Farman Ali
	Chief Eng. NAPWD	Mr. Riaz Ahmed Riaz
	Assistant Chief,	Mr. Muham Ashraf
	Deputy Chief	Mr. Rafiq Ahmed Chaudhary
	NORAD	Mr. Thormod Skogstad
	NORAD/NVE	Mr. Torodd Jensen

Results from the meetings and preparation of PC-I documents for projects concerning NAPWD were summed up. NORAD complimented the hardworking employees at NAPWD who managed to prepare the detailed documents for the workshop, Hassanabad ph.2 and Kargah ph.5 within a very limited time. The Chief Engineer, NAPWD was handed over copies of the PC-I documents with some minor corrections from NVE/NORAD. NAPWD undertook to include the corrections into the final documents before they were handed over, hopefully for early approval by the Authorities. The approval time was expected to take not more than three months. Within this time the Norwegian consultant should be selected and ready for contract negotiations.

As the TOR for consultancy services were cleared the Ministry and NAPWD stated that they had no objections to the proposed visit by the Norwegian consultants who were invited to bid for the job.

### 3.7 Meeting with WAPDA, Lahore 27.01.90

Participants:	Chief Engineer, planning & design,	Mr. Zakria
	Deputy Director,	Mr. Shahid Lobal
	NORAD	Mr. Thormod Skogstad
	NORAD/NVE	Mr. Torodd Jensen

The WAPDA comments on the TOR were discussed and clarified. Some of these comments are relevant for the contract negotiations. WAPDA has no objections to a visit by the Norwegian consultants to improve their background knowledge before bidding.

After bidding, the selection of the Norwegian consultant can be carried out by NORAD without any approval from WAPDA/NAPWD.

WAPDA/NAPWD will, however, participate in the contract negotiations to be sure the different projects will be adapted to the local technology. Sophisticated solutions and equipment beyond reach of local knowledge are not wanted. WAPDA proposed another

responsible party for the signing of contracts than proposed by NORAD. The WAPDA proposal is consistent with their practice with all foreign donors.

WAPDA agreed on the proposed two working groups, but stated that they would not be responsible for the construction and operation of Tangir. As The Ministry of Kashmir and Northern Areas Affairs is of another opinion there has to be negotiations between The Ministry and WAPDA to solve this problem this year. If not, the construction will be delayed. This delay may result in the Tangir scheme not being constructed.

The PC-II documents for the planning of Tangir, Nomal, Gilgit River (Hamucha) and the review of Parri have been approved long time ago. The PC-I document for the construction of Tangir will be prepared as soon as the detailed study by the Norwegian consultant has been completed and approved by WAPDA/NORAD.

The one year training course on hydro power development in Norway was discussed. Last year WAPDA had one person selected but there was some delay within the bureaucracy. WAPDA will receive another application form and NVE will make the necessary arrangements to reserve one place for a Pakistani student to start this year.

Facing financial troubles with large schemes like the Basha scheme, WAPDA is looking for medium scale schemes (10-150 MW) in the tributaries to the big rivers and also in the big rivers themselves. These schemes will normally be tunnel schemes. A site investigation will take place in Indus upstream of Tarbella Dam. This work will be carried out by WAPDA's own engineers. In this context, the medium tunnel scheme in Gilgit river can play an important role for transferring of knowledge.

## APPENDIX 4

### SITE VISITS

## **APPENDIX 4        SITE VISITS**

### **4.1    GENERAL**

There was little time for site visits due to the priority of writing the PC-I documents. The proposed workshop site and the site for the existing workshop were visited as well as power stations in Kargah and the power station in Danyor Nullah.

### **4.2    POWER STATIONS IN KARGAH**

The Kargah 1 power station is now in operation after the installation of two new Chinese Francis turbines which replaced two old Francis turbines from Drees Company, W. Germany. The output of each unit is 160 kW with a discharge of 0.7 m<sup>3</sup>/s and available head of 36.7m. Similarly the Kargah 4 power station has been renewed with two Chinese units each with the following data: kW 320, discharge 1.2 m<sup>3</sup>/s, head 43.3m. The installation of unit no. 2 was in progress. Work was in progress in Kargah 3 which also will have old units replaced by Chinese ones.

Kargah 7 was in operation, but one of the turbines delivered from Bywater (two Crossflow turbines 500 kW each) was not commissioned due to difficulties with operation. The sediment chamber had been improved almost according to the proposals in NVE- report no.2-89.

Kargah 6 was still under construction. Scheduled time for commissioning is December 1990. Turbines for the 4 MW plant will be delivered by Bywater.

### **4.3    DANYOR POWER PLANT**

The Danyor power plant in Danyor Nullah has its catchment area from the Rakaposhi mountains. The power plant utilizes a head of 45m, and produces 118 kW with a discharge of 0.5 m<sup>3</sup>/s. The turbine is a Chinese Crossflow turbine with RPM 750. The plant is built to fit the turbine, hence it is possible to utilize another 40-50m from the power station to the river.

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