OSHPC BARKI TOJIK

# TECHNO-ECONOMIC ASSESSMENT STUDY FOR ROGUN HYDROELECTRIC CONSTRUCTION PROJECT

## COST ESTIMATE – PHASE II

## GENERAL INTRODUCTION

P002378. RP49_revD

August 2014

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# TECHNO-ECONOMIC ASSESSMENT STUDY FOR ROGUN HYDROELECTRIC CONSTRUCTION PROJECT

## VOLUME 4: IMPLEMENTATION STUDIES

## CHAPTER 2: COST ESTIMATE

## GENERAL INTRODUCTION

**August 2014**

Report No. P002378. RP49_revD

| Revision | Date | Subject of revision | Drafted | Checked | Approved |
|---|---|---|---|---|---|
| D | 05/08/2014 | Final version | FPI | VLI | LBO |
| C | 26/03/2014 | Third revision | FPI | VLI | NSA |
| B | 02/12/2013 | Second revision | FPI | VLI | NSA |
| A | 06/11/2013 | First revision | FPI | VLI | NSA |
| | 24/06/2013 | First Emission | FPI | VLI | NSA |

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# Foreword

This volume encloses the project definition cost estimate of each alternative option for Rogun HPP, as defined in Volume 3 Engineering and Design of Phase II report. They consist basically in three dam heights and three installed capacities per height. The main focus has been to accurately estimate the cost of the highest height alternative, for which a maximum of documentation was available and use it as a basis to derive the costs of the lower height dams. The purpose of this estimate is to derive estimates at a relevant level of precision to compare each alternative and feed the economic assessment of the project alternatives. The report is a major input in the Economic and Financial analysis which is dealt with in Volume 5 of Phase II report.

In accordance with the Terms of Reference and the approved Methodology which was inserted in Phase I report, this Phase II cost covers all costs to completion of each alternatives. It includes estimates for remedial measures to strengthen existing structures as recommended in Phase I report but mitigation measures for salt dissolution specified in Phase 0 report.

Cost of resettlement and environment as estimated by the ESIA Consultant were duly incorporated in the overall estimate.

The cost estimate has been carried out during the time spanning from June 2012 to August 2014 on the ground of basic costs (labour, materials and construction equipment) which have been investigated in Tajikistan and in other countries during the early stage of the study.

The unit price analyses and the cost summaries have been elaborated in United States of America Dollars (US$), with break down into local and foreign currency. In order to simplify the calculations for obtaining the unit prices, the local component has been converted into US$ equivalent.

The details related to the cost estimate methodology are given in the eight parts composing this Volume.

# PART I: INTRODUCTION AND COST SUMMARY

# 1 INTRODUCTION

## 1.1 Structure of the Cost Estimate

The structure of the cost estimate is as follows:

| Part | Description |
|---|---|
| Part I | Introduction and cost summary |
| Part II | Basic costs of labour and materials, civil works |
| Part III | Construction equipment rates, civil works |
| **ALTERNATIVE 1 – FSL=1290 m.a.s.l** | |
| Part IV- Alt.1 | Calculation Assumptions (Civil Works – Dam) |
| Part V- Alt.1 | Price list, civil works |
| Part VI- Alt.1 | Priced bill of quantities, civil works |
| Part VII- Alt.1 | Priced bill of quantities, permanent equipment. |
| **ALTERNATIVE 2 – FSL=1255 m.a.s.l** | |
| Part IV- Alt.2 | Calculation Assumptions (Civil Works – Dam) |
| Part V- Alt.2 | Price list, civil works |
| Part VI- Alt.2 | Priced bill of quantities, civil works |
| Part VII- Alt.2 | Priced bill of quantities, permanent equipment. |
| **ALTERNATIVE 3 – FSL=1220 m.a.s.l** | |
| Part IV- Alt.3 | Calculation Assumptions (Civil Works – Dam) |
| Part V- Alt.3 | Price list, civil works |
| Part VI- Alt.3 | Priced bill of quantities, civil works |
| Part VII- Alt.3 | Priced bill of quantities, permanent equipment. |
| **APPENDICES** | |

The Cost Estimate is separated in three volumes corresponding to each dam alternative of F.S.L= [1290; 1255; 1220] m.a.s.l.

A separated annexes volume gives all the details about unit prices, and figures quoted in the reports.

## 1.2 Project Costs

The project costs related to the civil works and permanent equipment are detailed in the priced Bill of Quantities organized as follow:

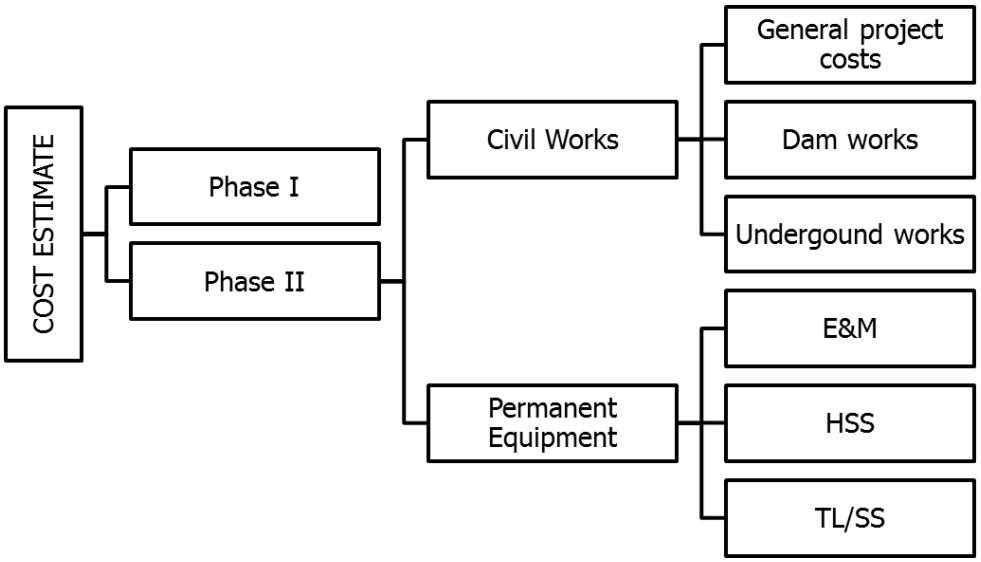



**Figure 1-1: Cost estimate – diagram**

*(*) Phase I: Existing Works; Phase II: Works to be achieved; E&M: Electro and Mechanical Equipment; HSS: Hydro Mechanical Equipment; TL/SS: Transmission lines and Substation bay.*

The total amount of the project (use as input data for Economic and Financial Analysis) is calculated as follow:

(1) [Civil Works + Permanent Equipment] * (2) [Physical Contingencies] = (3)

+ (4) [Administration and Engineering Cost]

+ (5) [Resettlement Cost]

= TOTAL AMOUNT OF THE PROJECT

Administration and Engineering Costs are calculated as percentages of “(3)”: Administration (3%) and Engineering (2%).

## 1.3 Costs not Included in the Estimate

The cost estimate does not include the following costs:

- Land acquisition and rights of way (both permanent and temporary).
- Interests during construction;
- Taxes, duties and levies in Tajikistan, except for the Contractor’s Income Tax.

## 1.4 Physical Contingencies

Physical contingencies have been considered afterwards, according to an analysis for each specific item (Civil works, Permanent equipment).

The mean resulting value of physical contingencies is close to 11% of the cost without.

The following physical contingencies have been added to the construction costs of the Bill of Quantities:

| N° | Item | Contingencies |
|---|---|---|
| | | |
| **1** | **CIVIL WORKS** | |
| **1.1** | **General Costs** | |
| | a) Mobilization and demobilization | 10% |
| | b) Remaining works | 12% |
| | | |
| **1.2** | **Dam - Common works** | |
| | a) Grouting curtains | 15% |
| | b) Excavation works | 12% |
| | c) Remaining works | 12% |
| | | |
| **1.3** | **Dam - Phase 1** | |
| | a) Pre-coffer dam | 10% |
| | b) Impermeabilization diagram of pre-coffer dam | 15% |
| | c) Ionakhsh fault treatment | 25% |
| | d) Dam fills | 8% |
| | f) Remaining works | 12% |
| | | |
| **1.4** | **Dam - Phase 2 to 6** | |
| | a) Dam instrumentation | 12% |
| | b) Core | 10% |
| | c) Dam fills | 8% |
| | | |
| **1.5** | **Power system structures** | |
| | a) Surface works | 10% |
| | b) Power tunnels | 10% |
| | c) Powerhouse / Transformer chamber | 10% |
| | d) Draft tubes | 15% |
| | e) Switchyard | 15% |
| | f) Drainage and ventilation gallery | 20% |
| | g) Penstocks | 18% |

| | | |
|---|---|---|
| | h) Gate chamber and gate shaft | 15% |
| | i) Remaining works | 12% |
| | | |
| **1.6** | **Diversion tunnels - Remedial works** | 20% |
| | | |
| **1.7** | **Diversion tunnel 3** | |
| | a) Surface works | 10% |
| | b) Underground works | 15% |
| | | |
| **1.8** | **Middle outlet level 1** | |
| | a) Surface works | 10% |
| | b) Underground works | 15% |
| | | |
| **1.9** | **Middle outlet level 2** | |
| | a) Surface works | 10% |
| | b) Underground works | 15% |
| | | |
| **1.1** | **High level tunnels** | |
| | a) Surface works | 10% |
| | b) Underground works | 15% |
| | | |
| **1.11** | **Surface spillway** | |
| | a) Surface works | 10% |
| | b) Underground works | 15% |
| | | |
| **1.12** | **Flushing tunnel** | |
| | a) Surface works | 10% |
| | b) Underground works | 15% |
| | | |
| **1.13** | **Transportation tunnels** | |
| | a) Surface works | 10% |
| | b) Underground works | 15% |
| | c) Remaining works | 12% |
| | | |
| **2** | **PERMANENT EQUIPMENT** | |
| **2.1** | E&M | 10% |
| **2.2** | HSS | 8% |
| **2.3** | TL/SS | 10% |

## 1.5 Rates of Exchange

The local basic costs, mainly concerning labor and few materials, have been converted to US$ with a rate of exchange of 1.00 US$ = 4.764 Somoni.

The basic costs of imported materials, imported construction equipment and expatriate personnel which were quoted in Euro currency, have been converted to US$ with a rate of exchange of 1.00 € = 1.30 US$.

## 1.6 Construction Time Schedule

The conctruction time schedule is detailed in the report “Implementation Schedule” (RP44).

The report deals with the tentatibe implementation schedules of the 3 alternatives, assesses the overall construction period and the critical activites and present recommendations.

The implementation schedules of the three alternatives presented in the report have been used for preparing the cash flow of each of them which have been incorporated in the Financial Economic Analysis.

## 1.7 Civil Works General Information

### 1.7.1 Contract Conditions

The cost estimate has been elaborated envisaging that the future civil works contracts can be based on standard FIDIC Conditions which take the following key provisions into account:

- Amount of performance security: 10% of the Contract Price
- Advance payment: 15% of the Contract Price;
- Retention money: 10% of interim payment certificates;
- Release of retention money: against bank guarantee;
- Limit of liquidated damages:10% of Final Contract Price;
- Price escalation: specific provisions for price adjustment covering local labour, diesel fuel, wood, cement and reinforcing steel;
- Defect liability period: 365 days from the final acceptance of the Permanent Works.

### 1.7.2 Work Organization and Worker’s Supervision

The unit price analyses have been elaborated considering that:

- The surface works, in general, are organized with two shifts of 10 hours a day, 24 working days per month and 10.5 months per year.
- The underground works, in general, are organized with three-eight-hours shifts a day, 24 working days per month and 11 months per year.

The worker’s supervision is organized on two levels as normally foreseen when international contractors are involved in similar projects, i.e. a local foremen who manage gangs

composed of workers from eight to ten and an expatriate general foremen who manage several gang foremen.

### 1.7.3 Contractor

The costs have been estimated assuming that the works are carried out by international contractors having experience in similar hydropower projects with the possible participation of local subcontractor(s) for the execution of part of the construction activities such as the construction of camps, roads and other temporary facilities.

### 1.7.4 Analyses of Unit prices

The detailed analyses for establishing the unit prices have been concentrated on those items which represent the major portion of the total cost of the dam and have been elaborated on the ground of the investigated basic costs and productions that have been studied in detail according to the specific characteristics of each works to be carried out.

### 1.7.5 Estimating Methodology

The price analyses carried out take the following main components into account:

- Basic wages of labor;
- Basic costs of materials delivered to the Site;
- Owning and operating costs of the construction equipment;
- Site construction contingencies;
- Overheads and profit.

The basic wages of labor and the basic costs of materials are included in Part II of this volume.

The owning and operating costs of construction equipment are included in Part III of this volume.

The Site construction contingencies, overheads and profit are commented in the paragraph herein below.

A flow chart related to the cost estimate methodology is given in the annexed Figure 1.

### 1.7.6 Site Construction Contingencies

Site construction contingencies have been considered in the detailed analyses on a percentage basis and added to the total of the direct costs.

These contingencies include minor costs not included in the detailed analyses that are caused by recurring and unexpected events that can affect the production rates.

Such events mainly include: equipment breakdown during operation, unexpected work interruptions, equipment refueling, displacement from site to site of the resources, unexpected unfavorable weather conditions, on-spot construction equipment maintenance, etc..

### 1.7.7 General Construction Costs

The general construction costs related to mobilization and demobilization of construction equipment and construction facilities as well as those related to construction and maintenance of camps have been included in the lump sums of the priced BOQ.

### 1.7.8 Overheads and Profit

The overheads consist of costs that the Contractor incurs both at the job-site and at his headquarter for staff salaries, vehicles for personnel and general services, office expenses, bonds, insurance, camp running costs including maintenance of camps, tests, rents, travels, legal fees, medical and hospital care and other expenses that are not included in the direct costs.

The amount of overheads depends on a lot of variables which are strictly connected to the specific organization and to the country of origin of the contractor.

The overheads for Rogun Hydroelectric Power Plant have been established on the ground of data recorded during the construction of similar projects all over the world that have been awarded according to competitive bid procedures.

The percentages of the main overhead components and of the Contractor’s risks and profit considered are listed in the following table.

| N° | Description | % |
|---|---|---|
| **1** | Site running costs, personnel | **8.6%** |
| **2** | mobility | **3.7%** |
| **3** | construction facilities | **2.8%** |
| **4** | other | **2.0%** |
| **5** | Travels | **3.7%** |
| **6** | Head office and liason office | **2.8%** |
| **7** | Bonds, guarantees and insurances | **4.5%** |
| **8** | Financial costs | **4.7%** |
| **9** | General investigations and tests | **0.3%** |
| **10** | Defects repair | **0.6%** |
| **11** | Miscellaneous (income tax, consultancies, licenses, permits, vehicle taxes etc.) | **6.0%** |
| **12** | Contractor's risks | **3.0%** |
| **13** | Contractor's profit | **9.0%** |
| **Total ----------→** | | **51.7%** |
| **Rounded Total ----------→** | | **52.0%** |

The above percentage of indirect costs has been added to all direct costs analyzed excluding the supply of reinforcing steel, cement, bentonite and concrete admixtures because less indirect costs are born by contractors for these materials.

The percentage of 52% for indirect costs has been applied to the sum of the direct costs in local and foreign currency and then subdivided 10% in local currency and 90% in foreign currency.

## 1.8 Permanent Equipment General Information

### 1.8.1 Foreword

The TEAS for Rogun Hydropower Project has been carried out for the basic solution, i.e. the alternative with the higher dam as proposed in the original design of HPI, and for various alternative solutions.

The basic solution foresees a total maximum capacity of 3600 MW, maximum reservoir level at 1290 m a.s.l. with a corresponding head of 320 m and with six units, out of which two are to be used during the early generation phase.

The following table shows all possible alternatives which depend upon the installed capacity and the maximum normal reservoir level (Full Supply Level - FSL) selected for the study.

| | **ALTERNATIVES** | | |
|---|---|---|---|
| | **FSL 1220** | **FSL 1255** | **FSL 1290** |
| | **Installed capacity ( MW )** | | |
| High | 2800 | 3200 | 3600 |
| Medium | 2400 | 2800 | 3200 |
| Low | 2000 | 2400 | 2800 |

Regarding the electromechanical equipment, the four alternatives with total capacity of 2000, 2400, 2800 and 3200 MW) have been developed considering using the units and their components already available at site, as in the basic solution, except the two existing runners.

As explained in Volume 4: Implementation Studies - Chapter 1: Implementation Schedule and Construction Methods, for alternatives FSL 1290 and 1255 the early generation units are equipped with final runners and temporary generators, whilst for alternative FSL 1220 the units are commissioned under the final configuration, including permanent generators.

The costs of the E&M components (units, BOP) and HSS components, associated to the basic solution and the various alternatives, are described in the following paragraphs.

### 1.8.2 Summary

The following table summarizes the costs of the basic solution and of the various alternatives which have been considered:

| ROUNDED COSTS SUMMARY OF BASIC SOLUTION AND ALTERNATIVES, IN U$ | | | | | |
|---|---|---|---|---|---|
| | **2000 MW** | **2400 MW** | **2800 MW** | **3200 MW** | **3600 MW** |
| Generating Units | 298,070,955 | 356,649,248 | 386,102,763 | 417,316,900 | 469,209,000 |
| BOP | 196,287,000 | 229,975,200 | 263,718,000 | 293,966,400 | 328,939,200 |
| HSS (*) | 222,004,779 | 237,178,537 | 255,916,154 | 255,916,154 | 255,916,154 |
| TL/SS | 13,230,000 | 13,230,000 | 19,845,000 | 19,845,000 | 19,845,000 |
| Total | 729,592,734 | 837,032,985 | 925,581,917 | 987,044,454 | 1,073,909,354 |

Note: HSS costs shown in the table are those relevant to the highest dam alternative considered for the relevant installed capacity, i.e. FSL 1220 for 2000 MW, FSL 1255 for 2400 MW, FSL 1290 for 2800 to 3600 MW. The summary tables of the BoQ show all combination of capacity and dam height.

The details of the TL/SS costs are also provided in the BoQ.

The costs have been determined considering to utilize the items already available to the maximum possible extent.

It is to be underlined that the costs of units 1 to 4 have been determined assuming that the units have to be procured entirely by the future supplier, i.e. disregarding the components already at site, constituted basically by the draft tubes cones and some elbows.

In the Consultant opinion in fact it is not worthwhile to impose to a Contractor selected with an International Bid the utilization of components designed by others.

The reasons for this approach are basically two:

- the prospective Supplier may not be in condition to provide efficiency guarantees if he is obliged to make use of components not designed and constructed by him.

- the prospective Supplier would be obliged to carefully check such components; this may be time and cost demanding, having a negative impact on an International Bidding procedure.

In other words, the utilization of the existing components for units 1 to 4 would likely change the approach of the procurement from that of new units to that similar to the rehabilitation of a plant.

According to us, when preparing the Tender Documents for units 1 to 4 the possibility to have alternatives with and without the utilization of existing components could be considered, but in their cost evaluation we considered the most conservative approach.

### 1.8.3 General

Various approaches can be implemented to evaluate the costs of E&M equipment.

Apparently the most precise one would be that to evaluate in detail the cost of all major components estimating their manufacturing costs (the cost of an item in which steel is the prevailing component should be evaluated based on a cost per kg, variable depending upon the manufacture procedure - welded, forged, casted or mixed - and the cost of an item such as a transformer on a cost per kVA, variable depending upon transformer characteristics) and separately their transportation and erection costs.

At this stage of the project, considering that various technical decisions are still to be defined, and also taking into account that in Rogun the percentage of E&M cost on the total cost of the plant is quite limited, compared to the large cost of the civil works, a detailed analysis of the cost of all single main components would be unjustified and it could also lead to some cost evaluation errors which could be even larger than those made with the procedure the Consultant has adopted, which in his opinion is applicable when the installed capacity is large and various units are foreseen.

Therefore, the Consultant has calculated the E&M costs on the basis of cost per kW, evaluating separately turbine, generator and remaining equipment (Balance of Plant - BOP) costs.

The calculation of costs based on cost per kW installed is a procedure certainly justified for turbines and generators, while its application also to BOP, as the Consultant has done, is less evident. In fact, besides few exceptions, BOP is composed of systems which are standard and which are mainly dependent upon number and capacity of the generating units. The Consultant also remarks that the order of magnitude of BOP cost is the same of that of the generating units, i.e. it is lower than the 10% of the total cost of the plant.

The calculation of HSS cost (gates, penstock, linings), which is not strictly dependent from the installed capacity (for example the cost of spillway gates is much more related to the design flood), has been performed by evaluating separately the costs of the various main components.

Considerations on the utilization of existing items and impact of early generation on choices which have impact on costs are reported in a separate section.

### 1.8.4 E&M costs of the basic solution

In this section, considerations about the "basic solution", that is the solution considered in the original design, are given, while in the next one various alternatives with different installed capacities and maximum operating head have been analyzed.

As already indicated, the basic solution foresees a total maximum capacity rounded to 3600 MW, maximum reservoir level at 1290 m a.s.l. with a corresponding head of 320 m and with six units, out of which two are to be used during early generation phase.

The E&M cost have been evaluated on the basis of unit cost of the units capacity, that is the cost per kW installed.

In principle, the cost of a generating unit that is of turbine and generator is mainly dependent upon number of units, type, capacity and operating head. Given the flow and head involved, in the present case Francis type units have been adopted.

The following key aspects are taken into account in evaluating the equipment costs:

- the design head, which for a given capacity determines the size of turbine and also that of generator, depending upon its rotational speed which is in turn connected to the turbine head. For a given capacity the rotational speed increases with increasing the head, while the dimensions of the units decrease. An increment in the total capacity corresponds to the unit cost decrease, because the supply becomes more attractive and also because various costs, which are independent from the installed capacity, such as design, model testing, coordination and other factors conditioning the erection costs, reduce their impact on the unit cost.

- the number of units, which plays also an important role; when the unit capacity is very high, as in the present case, an increase of the installed capacity obtained by increasing the number of units may have the same, or even more favorable, impact on the unit cost than an increase of the unit capacity (this could be easily understood considering for example the unit cost of cast pieces which lowers by increasing the number of pieces, while it may increase by increasing dimensions which are already very large).

- BOP, with few exceptions, is composed of systems which are standard and which are mainly dependent upon the number and capacity of the generating units.

  The major exception to this rule relates to the components of the switchyard and the HV interconnections between main transformers and switchyard. The part of the switchyard which depends upon the number of transmission lines, even if conditioned by the plant capacity, may largely vary depending upon the number of outlet bays.

- the cost of the interconnection between the main transformers and the switchyard may largely vary depending upon their distance. When transformers and switchyards are far away, as in the present case where the distance is in the order of 1 km, the cost of the HV cable increases.

In any case, the impact of the switchyard and interconnection costs variation on the total E&M costs remain very limited, and may be neglected. Therefore the Consultant has decided to evaluate BOP cost on the same basis of cost per kW installed.

The **reference costs** have been taken from those of two very recent large plants under construction on which the Consultant is directly involved (the price of one is about 3 years old and that of the second and largest one is about one year old) where many Francis units of large capacity are installed. One plant has installed capacity of 1850 MW (10 x 185 MW units) and the other has an installed capacity of 5350 MW (15 x 357 MW units).

The unit prices of these two large projects have been compared with those of a recent smaller plant, proving that, reducing the total installed and unit capacities, the cost per kW largely increases. The comparison also proves that the impact on the cost per kW of the total installed capacity and number of units is much more important than other factors such as the turbine head.

In the present case, in spite of the much higher operating head (315 m of the small plant against the 120 m of the largest plant), factor which, as said above, should have positive impact on both turbine and generator cost per kW, the smallest plant has a cost per kW which is more than 30% higher than that of the largest plant.

From the diagram obtained with these data, a cost per kW has been deducted for Rogun HPP, assuming a margin of about 5% in respect to the curve. The total capacity considered for Rogun is that of 4 units, because as indicated in another section, a separate contract has been envisaged for the two units which components are available and which shall work during early generation.

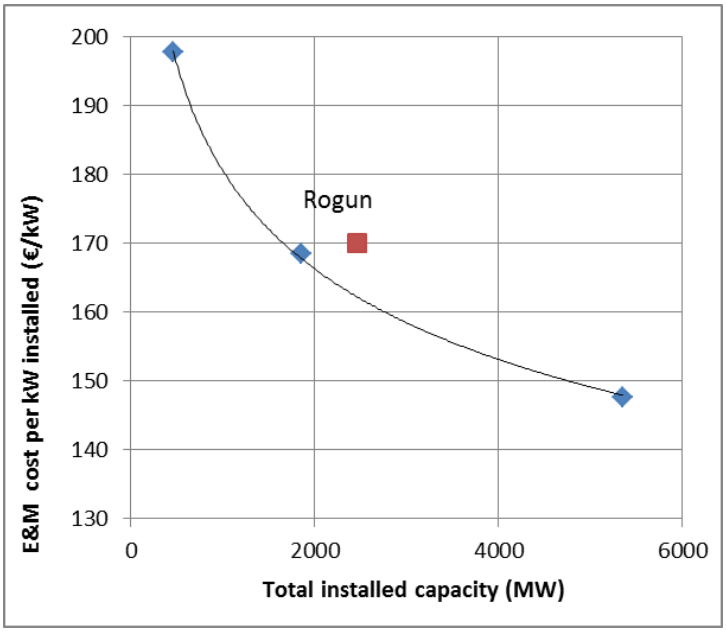
An increase of the capacity from 2400 (four units) to 3600 (six units) MW theoretically would allow to reduce by about 10 € the total cost per kW installed. The Consultant observes however that in the present case this cost reduction would not be applicable. In fact even bidding 6 new units instead of 4, in any case two of them should be different from the others, being designed for early generation.

The Table of reference costs and relevant diagram are the following:

**Table 1-1: Cost evaluation of E&M**

| Cost evaluation of E&M equipment | | | | |
|---|---|---|---|---|
| | **Plant 1** | **Plant 2** | **Plant 3** | **Rogun** |
| Total capacity (MW) | 460 | 1850 | 5350 | 2400 |
| Number of units | 4 | 10 | 15 | 6 |
| Head (m) | 315 | 193 | 120 | 245 |
| Revolution speed (rpm) | 375 | 272,7 | 125 | 166,7 |
| | **Unit cost (€/kW)** | | | |
| 1. Hydraulic Turbines and Governors | 39 | 37 | 44 | 50 |
| 2. Generators and Excitation Equipment | 70 | 61 | 46 | 50 |
| 3. Automation | 10 | 4 | 9 | 10 |

| Cost evaluation of E&M equipment | | | | |
|---|---|---|---|---|
| | **Plant 1** | **Plant 2** | **Plant 3** | **Rogun** |
| 4. BOP mechanical (include PH cranes) | 16 | 11 | 7 | 12 |
| 5. BOP electrical | 24 | 16 | 13 | 15 |
| 6. HV transformers | 17 | 21 | 20 | 20 |
| 7. Switchyard and links | 22 | 14 | 11 | 13 |
| 8. Inlet Valve | | 5 | | |
| Total unit | 109 | 98 | 90 | 100 |
| Total BOP | 89 | 70 | 60 | 70 |
| Total E&M cost | 198 | 168 | 148 | 170 |
| Notes:<br>1.The total capacity indicated here for Rogun is only that of 4 units (those to bid with a separate bid) | | | | |




The total E&M cost has been obtained by adding to the cost of new 4 units and relevant BOP the additional costs necessary to complete and install the first two units and relevant BOP equipment.

As explained in the table included in the following paragraph 1.8.7.1, the total cost required for the utilization of the existing units for the alternatives with FSL 1290 and 1255 is higher by about 26% than that needed in the case of FSL 1220. This is because for the higher dam alternatives on the first two units, in addition to some missing items, one additional erection step is required. On the contrary for the case of FSL 1220 the equipment is erected from the beginning in its final configuration. This point is discussed further here below.

The costs of E&M equipment are indicated in the summary table shown at the beginning of this chapter and are detailed in the annexed sheets, where the estimated value of the existing components is also shown.

Available data in Euro were converted to US$ with an exchange rate of 1.3 US$ = 1 €.

### 1.8.5 E&M costs of the other alternatives

Various alternatives of installed capacity for different dam heights have been considered and all of them have been quoted based on the same criteria, i.e. applying the cost per kW used to quote the basic solution. The following table shows all the alternatives which are depending upon the installed capacity and the maximum normal reservoir level (Full Supply Level - FSL).

| ALTERNATIVES | | | |
|---|---|---|---|
| **Full Supply Level m a.s.l.** | **1220** | **1255** | **1290** |
| | **Installed capacity ( MW )** | | |
| High | 2800 | 3200 | 3600 |
| Medium | 2400 | 2800 | 3200 |
| Low | 2000 | 2400 | 2800 |

In the cost estimate of the various project alternatives, the Consultant has not evaluated the impact of the head, which as shown in the above table may vary of about 70 m, on the cost per kW, while has duly considered the impact of the installed capacity, which as indicated in the previous paragraph is very important. Therefore the costs of four alternatives have been considered for the E&M equipment, corresponding to 3200, 2800, 2400 and 2000 MW installed capacity.

To determine the total costs the Consultant has assumed, for all the solutions, to install 6 units and to make use of the existing equipment of the first two units, except the runners.

In calculating the cost of the first two units, the Consultant has assumed that the cost of the turbines will remain unchanged for all the solutions, while the generator cost will change depending upon the unit capacity foreseen in the solution. This assumption is justified by the fact that most of the items to be supplied are relevant to generators (one of which is missing).

The E&M costs of the various alternatives are summarized in the table shown at the beginning of the chapter.

### 1.8.6 HSS Costs

As previously indicated, the HSS costs have been calculated evaluating the weights of the various items and applying to these weights different costs depending upon the specific item. In evaluating the cost of gates, also the weight of fixed parts and lifting equipment has been included.

The following unit costs have been considered:

| Unit cost | US$/kg |
|---|---|
| Stoplogs | 6.5 |
| Gates including operating system | 11.0 |
| Penstock and Linings | 6.5 |
| Cranes | 14.3 |
| Trash racks | 5.2 |

The details of weights and corresponding total costs of the different components are given in the annexed tables.

The total value of the existing HSS, which is that already procured in view of the early impounding, mostly already installed but partly stored and still to be installed, has been also calculated and is shown in the annexed sheets.

It is interesting to note that in the present case, referring to the basic solution with about 3600 MW, the cost per kW of HSS including the already existing components is similar to that of the two large plants which has been taken as reference for the calculation of E&M costs.

### 1.8.7 Existing equipment and their utilization

#### *1.8.7.1 E&M equipment*

In evaluating the costs of the generating equipment, it was taken into account that most of the components of the two generating units which will be used for early generation have been already procured and are stored at site.

For these existing items, erection costs have been evaluated keeping into due account the additional costs related to the utilization of the two existing units for early generation.

In fact the early commissioning procedure leads to the necessity to start the operation of these units in a provisional arrangement (for alt FSL 1290 and 1255), that is making use of the generators available at site and then, at higher head, modifying them by increasing the synchronous rotational speed of the generator through E&M modifications. The modification is not required for alt FSL 1220 which is erected since the beginning in its final configuration.

It is highlighted that, in consideration of the dam construction rate, which is now much higher than in the original works schedule, by the time of commissioning units 6 & 5 the head will be already enough high to avoid one of the modification steps foreseen by HPI. Therefore, only two steps are now envisaged for FSL 1290 and 1255, while for FSL 1220 the head at the time of commissioning unit 6 & 5 will be such to allow starting generation with the final configuration.

Remarkable are the additional costs linked with the above operation. In addition to the modification of number of poles of generator, one generator is almost completely missed and some adjustments of other components are required. For example, the generator rotor cooling system shall be modified from direct water winding cooling to conventional cooling. In addition, the generator modification requires duplicating its erection works.

An analysis of the costs for completing the two existing units is shown in the following table, detailing the various modification steps:

| **Additional cost for the first two units using existing components for FLS 1290 & 1255** | | | | | |
|---|---|---|---|---|---|
| | **1st step** | | **2nd step** | | **total E&M %** |
| **Item** | **supply and transport** | **install** | **supply and transport** | **install** | |
| Unit 6 | | | | | |
| turbine | 20% | 30% | 0% | 0% | 50% |
| generator | 20% | 35% | 10% | 35% | 100% |
| Unit 5 | | | | | |
| turbine | 20% | 30% | 0% | 0% | 50% |
| generator | 55% | 35% | 10% | 35% | 135% |
| Total | | | | | 335% |

Note: the % indicated above are referred to the total cost of new equipment

| **Additional cost for the first two units using existing components for FLS 1220** | | | | | |
|---|---|---|---|---|---|
| | **1st step** | | **2nd step** | | **total E&M %** |
| **Item** | **supply and transport** | **install** | **supply and transport** | **install** | |
| Unit 6 | | | | | |
| turbine | 20% | 30% | 0% | 0% | 50% |
| generator | 30% | 35% | 0% | 0% | 65% |
| Unit 5 | | | | | |
| turbine | 20% | 30% | 0% | 0% | 50% |
| generator | 65% | 35% | 0% | 0% | 100% |
| Total | | | | | 265% |

Note: the % indicated above are referred to the total cost of new equipment

The two first units, in their provisional arrangement, were designed about 25 years ago, manufactured in 1988, then supplied and stored at site about 20 years ago. One unit is almost complete, while the generator of the second is missing.

The existing components are listed in the following table:

| Main Item | Available | |
|---|---|---|
| | Unit 1 | Unit 2 |
| Spiral case and stay ring ( both available for three units plus some additional part of stay ring) | Yes | Yes |
| Draft tube cone (available for all the six units) | Yes | Yes |
| Draft tube elbow (not clear if available for three or six units) | Yes | Yes |
| Head cover | Yes | Yes |
| Bottom cover | Yes | Yes |
| Runner of preliminary arrangement | Yes | Yes |
| Runner of final arrangement | No | No |
| Guide vanes and servomotors | Yes | Yes |
| Ring gate and servomotors | Yes | Yes |
| Turbine Shaft | Yes | Yes |
| Turbine guide bearing | Yes | Yes |
| Turbine shaft seal | Yes | Yes |
| Cone supporting thrust bearing | Yes | Yes |
| Governor | Part | No |
| Stator | 92-93% | No |
| Rotor | Part | No |
| Excitation system and voltage regulator (to be replaced with new ones) | Part | Part |
| Generator shaft | Yes | No |
| Generator guide bearing and upper bracket | Yes | No |
| Generator lower bracket | Yes | No |

| Main Item | Available | |
|---|---|---|
| | Unit 1 | Unit 2 |
| Generator thrust bearing (pads and other elements also for first unit are missing) | Yes | No |
| Main transformer | No | No |
| Cooling systems | Part | Part |
| Other minor auxiliaries | Part | Part |

The Consultant must remark that:

- the existing parts of generator exciters and voltage regulators are of old design and shall be replaced with new ones, the same is valid for all the control system of the existing turbine governor;

- the two existing units, in addition to particular characteristics which are imposed by the early generation, show other special design characteristics which in the new units should not be imposed to their supplier. Due to this, the utilization of the two existing units will lead to accept the presence in the plant of units with different features.

The special design characteristics of the two existing units are the following:

- Both rotor and stator cores are directly cooled with distillate water; the generator shall be modified by eliminating the direct rotor core cooling, whilst the direct cooling of stator would probably remain.

- The existing turbines are protected by mean of a cylindrical gate, located in between stay-ring and guide vanes.

- The unit arrangement shows two guide bearings, the turbine guide bearing and a second bearing located above the generator. This arrangement with only two guide bearings may be changed in the other four units, depending also upon the available space, to an arrangement with three guide bearings, one of which combined with thrust bearing.

### *1.8.7.2 Existing Hydromechanical (HSS) equipment*

In evaluating the costs, the Consultant has considered that some hydromechanical equipments are available and already installed and some other are available but not yet installed, as indicated in the following table.

| | Total | Installed | To be installed |
|---|---|---|---|
| | t | t | t |
| Diversion tunnels repair gate chamber | | | |
| Sliding gates with embedded parts and drive | 882 | 882 | |
| Auxiliary items | 830 | 830 | |
| Cranes | 413 | 413 | |
| Diversion tunnels: emergency/ repair gate and main gate chamber | | | |
| Radial gates with embedded parts and drive | 1847 | 1847 | |
| Slide gates with embedded parts and drive | 840 | 840 | |
| Cranes | 212 | 212 | |
| Auxiliaries | 104 | 104 | |
| Lining in diversion tunnels | | | |
| Steel lining | 5460 | 5460 | |
| Power Outlet/draft tube | | | |
| Slide gate at power outlet with embedded parts | 180 | 0 | 180 |
| Sectional gate at draft tube with embedded parts | 492 | 0 | 492 |
| Cranes | 118 | 0 | 118 |
| Auxiliaries | 45 | 0 | 45 |
| Temporary Power Intake | | | |
| Trash racks and embedded parts | 426 | 0 | 426 |
| Gate Chamber of Temporary Waterways | | | |
| Slide gate with embedded parts | 434 | 106 | 328 |
| Slide gate with embedded parts | 410 | 0 | 410 |
| Cranes | 85 | 35 | 50 |
| Steel linings | 570 | 570 | |

| | Total | Installed | To be installed |
|---|---|---|---|
| | t | t | t |
| Auxiliaries | 215 | 215 | |
| Steel Lining | | | |
| Steel Lining | 2100 | 1500 | 600 |
| Salt Protection System | | | |
| Left Bank Lining | 1800 | 1450 | 350 |
| Right Bank Lining | 1800 | 0 | 18 |

Therefore, the cost of erection of the components “To be installed” has been evaluated and it is included in the BoQ.

### *1.8.7.3 The critical aspects of procurement*

Since the procedure for procuring the E&M and HSS equipment has a non negligible impact on its cost estimation, the possible options and the selected alternative are discussed here below.

As for the existing components of the first two units, in the Consultant’s opinion they shall be incorporated into the plant, completing and adjusting them as necessary.

This approach brings to the need of awarding the contract for their completion, installation and modification to the original manufacturer, or most likely to give the order to the firm who acquired the know-how of the original designer.

In fact it would not be possible to pretend that a contractor different from the original one utilizes the existing components of the first two units and at the same time to pretend guarantees on their efficiency and correct operation, in particular considering the two steps required for the early impounding and all the relevant constrains.

On the other hand, we deem that with a financing from an international lending agency it would not be possible to make a direct procurement of all the six units from the original manufacturer.

Thus, as a consequence of the decision of utilizing the existing components of the first two units, two separate contracts should be signed: one for the first two units and another for the remaining four.

Following this approach to procure under a separate contract the last four units, the decision whether to utilize their existing components (draft tube components and one spiral case) should be left under the full responsibility of the Contractor, who in any case shall provide four equal units and shall test them with a turbine model test.

In the cost estimate, the Consultant has not considered the value of the possible utilization of the existing components of the last four units.

It is ought to highlight that the need to have two separate contracts brings to the possibility to have two different suppliers: as a consequence it is likely that the design of the new units will be very different from that of the existing two units.

The only possible alternative to avoid this situation would be not to use the existing components of the first two units and to make a single package of all the six units, two of which should be designed also for early generation.

In the cost evaluations, the Consultant has discarded this alternative, even if a comparison between E&M total costs, with and without reutilization of the existing equipment, gives a very small difference in between the two prices. The difference increases concurrently with the increase of the installed capacity.

As far as HSS works are concerned, that is gates, penstock and linings, most of the components necessary for the early generation have been already installed and are partly available, as shown in the previous table. All remaining HSS, which is the substantial part of the HSS works, in the Consultant's opinion should be included in the contract of Civil Works which in Rogun are very demanding and may condition many of the HSS erection activities giving rise, in case of separate contracts, to litigations and claims.

Another important aspect is that related with the procurement of the BOP, that is all the E&M equipment with the exception of generating units and HSS equipment.

The possible alternative solutions are:

a. the supplier of the first two units supplies also all the whole BOP;
b. both the two suppliers supply part of the BOP, each for the respective units;
c. the supplier of the new units supply all the BOP, including that for the existing ones;
d. a separate order is made for the BOP.

Solution a. in the Consultant's opinion there is no strict requirement to add to the two units the whole BOP, thus an international lending agency may not accept this option. It should be noted that this procedure would imply that the “original” supplier would remain engaged in the project for its whole duration.

Solution b. would be the most reasonable one from the point of view of Contractors responsibilities, even though it may be complicate and can give rise to the possibility to have differences between items which, on the contrary, should be equal.

Solution c. does not seem attractive because of time constraints (it will be necessary, before finalization of BOP specifications, to obtain detailed information from the supplier of the first two units), because a large coordination works of the contractor of the new units would be required and because his time schedule should be extended with impact on costs.

Solution d. would require obtaining detailed information from the "Original" supplier about the need of the BOP for the first two units and to start the preparation of the tender at the soonest, when the supplier of other units is not selected yet.

Therefore, in the Consultant opinion the most adequate solution, which is directly linked to the decision of utilizing the existing components of the first two units, is that to require that each supplier provides the BOP for the respective units.

# 2 COST SUMMARY

## 2.1 Global Summary

A global summary of the total Construction Cost is given in Table 2-1, for each alternative in BUS$. These amounts have been considered for the Economic and Financial Analysis. The cost varies between 3.312 and 5.211 billion US$ (BUS$).

**Table 2-1 Construction Cost with Resettlement Cost, [BUS$]**

| | High Capacity | | | Intermediate Capacity | | | Low Capacity | | |
|---|---|---|---|---|---|---|---|---|---|
| | Local | Foreign | Total | Local | Foreign | Total | Local | Foreign | Total |
| Alt. 1290 | 0.684 | 4.527 | 5.211 | 0.664 | 4.446 | 5.111 | 0.650 | 4.389 | 5.039 |
| Alt. 1255 | 0.582 | 3.799 | 4.381 | 0.568 | 3.742 | 4.310 | 0.552 | 3.677 | 4.229 |
| Alt. 1220 | 0.471 | 2.997 | 3.467 | 0.455 | 2.932 | 3.386 | 0.440 | 2.873 | 3.312 |

Local and Foreign parts correspond respectively to 13% and 87% of the total cost (approximatively, based on:

- Regarding Civil works, Local and Foreign parts have been calculated with the breakdown of unit prices (cf. Volume 5 of Cost Estmate: Appendices);
- Regarding E&M, Local and Foreign parts correspond respectively to 20% and 80% of the cost;
- Regarding Administration and Engineering, Local and Foreign parts correspond respectively to 13% and 77% of the cost;
- Regarding Resettlement and Infrastructure Replacement, Local and Foreign parts correspond respectively to 11% and 89% of the cost.

## 2.2 Civil works

### 2.2.1 General description

Civil works are divided in three sections: General project costs, dam works, and underground works. The structure is detailed in Figure 2-1.

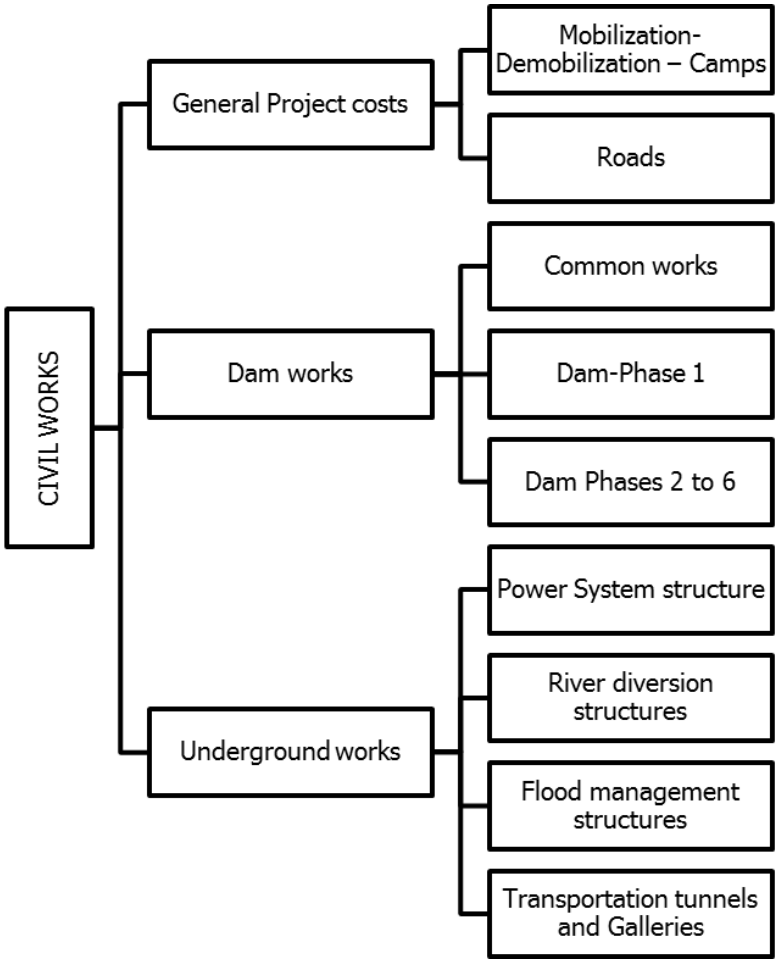



**Figure 2-1: Civil Works, diagram**

The total cost of civil works (excluding physical contingencies) is detailed in the table below. The amounts vary from 1.97 to 3.06 billion US$, according to the alternative taken into consideration.

## Table 2-2: Civil Works, without Physical Contingencies

| CIVIL WORKS | | Alt. 1290 | Alt. 1255 | Alt. 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A | General Project Costs | 195 | 169 | 140 |
| B | Dam Works | 1 546 | 1 133 | 740 |
| C | Underground Works | 1 321 | 1 283 | 1 088 |
| **Total Cost of Civil Works** | | **3 063** | **2 587** | **1 969** |
| **Difference with Alternative FSL 1290** | | **0** | **-476** | **-1 094** |

### 2.2.2 Summary - Without Physical Contingencies

| N° | DESCRIPTION | Alternative 1 – FSL=1290 m.a.s.l | | | Alternative 2 – FSL=1255 m.a.s.l | | | Alternative 3 – FSL=1220 m.a.s.l | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| | | (MUS$Eq.) | (MUS$) | (MUS$ Equiv.) | (MUS$Eq.) | (MUS$) | (MUS$ Equiv.) | (MUS$Eq.) | (MUS$) | (MUS$ Equiv.) |
| A | GENERAL PROJECT COSTS | 27 | 169 | 195 | 23 | 147 | 170 | 19 | 121 | 140 |
| B | DAM WORKS | 147 | 1 400 | 1 546 | 108 | 1 026 | 1 134 | 72 | 668 | 740 |
| C | UNDERGROUND WORKS | 160 | 1 162 | 1 322 | 156 | 1 128 | 1 284 | 132 | 957 | 1 089 |
| Total Civil Works | | 333 | 2 730 | 3 064 | 287 | 2 300 | 2 587 | 223 | 1 746 | 1 970 |

### 2.2.3 Summary - With Physical Contingencies

| N° | DESCRIPTION | Alternative 1 – FSL=1290 m.a.s.l | | | Alternative 2 – FSL=1255 m.a.s.l | | | Alternative 3 – FSL=1220 m.a.s.l | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| | | (MUS$Eq.) | (MUS$) | (MUS$ Equiv.) | (MUS$Eq.) | (MUS$) | (MUS$ Equiv.) | (MUS$Eq.) | (MUS$) | (MUS$ Equiv.) |
| A | GENERAL PROJECT COSTS | 30 | 188 | 218 | 26 | 164 | 190 | 22 | 135 | 156 |
| B | DAM WORKS | 160 | 1 525 | 1 686 | 118 | 1 120 | 1 238 | 79 | 733 | 812 |
| C | UNDERGROUND WORKS | 181 | 1 313 | 1 494 | 176 | 1 272 | 1 448 | 149 | 1 082 | 1 231 |
| Total Civil Works | | 371 | 3 027 | 3 398 | 320 | 2 556 | 2 876 | 250 | 1 949 | 2 199 |

### 2.2.4 Physical Contingencies Calculation (Cost in MUS$)

| ITEM | | | Alternative 1290 masl | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | % of Cont. | 1290 masl - 3600 MW | | 1290 masl - 3200 MW | | 1290 masl - 2800 MW | |
| | CONSTRUCTION COSTS | | *Without Ph.Cont* | *With Ph.Cont* | *Without Ph.Cont* | *With Ph.Cont* | *Without Ph.Cont* | *With Ph.Cont* |
| 1 | **CIVIL WORKS** | **cf. Analysis** | **3 064** | **3 398** | **3 064** | **3 398** | **3 064** | **3 398** |
| 2 | **E&M / HSS / TLSS** | | **1 074** | **1 176** | **987** | **1 081** | **926** | **1 013** |
| *2.1* | E&M | 10% | 798 | 878 | 711 | 782 | 650 | 715 |
| *2.2* | EXISTING HSS | 8% | 10 | 11 | 10 | 11 | 10 | 11 |
| *2.3* | NEW HSS | 8% | 246 | 266 | 246 | 266 | 246 | 266 |
| *2.4* | TL/SS | 10% | 20 | 22 | 20 | 22 | 20 | 22 |
| TOTAL COSTS | | | **4 137** | **4 574** | **4 051** | **4 478** | **3 989** | **4 411** |

| ITEM | | % of Cont. | Alternative 1255 masl | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1255 masl - 3200 MW | | 1255 masl - 2800 MW | | 1255 masl - 2400 MW | |
| | CONSTRUCTION COSTS | | *Without Ph.Cont* | *With Ph.Cont* | *Without Ph.Cont* | *With Ph.Cont* | *Without Ph.Cont* | *With Ph.Cont* |
| 1 | **CIVIL WORKS** | **cf. Analysis** | **2 587** | **2 876** | **2 587** | **2 876** | **2 587** | **2 876** |
| 2 | **E&M / HSS / TLSS** | | **968** | **1 060** | **907** | **993** | **837** | **916** |
| *2.1* | E&M | 10% | 711 | 782 | 650 | 715 | 587 | 645 |
| *2.2* | EXISTING HSS | 8% | 10 | 11 | 10 | 11 | 10 | 11 |
| *2.3* | NEW HSS | 8% | 227 | 245 | 227 | 245 | 227 | 245 |
| *2.4* | TL/SS | 10% | 20 | 22 | 20 | 22 | 13 | 15 |
| TOTAL COSTS | | | **3 556** | **3 936** | **3 494** | **3 869** | **3 425** | **3 792** |

| ITEM | | % of Cont. | Alternative 1220 masl | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 1220 masl - 2800 MW | | 1220 masl - 2400 MW | | 1220 masl - 2000 MW | |
| | CONSTRUCTION COSTS | | *Without Ph.Cont* | *With Ph.Cont* | *Without Ph.Cont* | *With Ph.Cont* | *Without Ph.Cont* | *With Ph.Cont* |
| 1 | **CIVIL WORKS** | **cf. Analysis** | **1 970** | **2 199** | **1 970** | **2 199** | **1 970** | **2 199** |
| 2 | **E&M / HSS / TLSS** | | **863** | **945** | **793** | **868** | **730** | **798** |
| *2.1* | E&M | 10% | 622 | 684 | 558 | 614 | 494 | 544 |
| *2.2* | EXISTING HSS | 8% | 10 | 11 | 10 | 11 | 10 | 11 |
| *2.3* | NEW HSS | 8% | 212 | 229 | 212 | 229 | 212 | 229 |
| *2.4* | TL/SS | 10% | 20 | 22 | 13 | 15 | 13 | 15 |
| TOTAL COSTS | | | **2 833** | **3 145** | **2 763** | **3 067** | **2 699** | **2 997** |

The Physical contingencies used for Civil works are detailed in the following tables.

Physical Contingencies

Alternative FSL=1290 m a.s.l

| ITEM No. | | CONSTRUCTION COSTS | | | CONTINGENCIES | | | | TOTAL AMOUNT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | % | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| **1** | **CIVIL WORKS** | | | | | | | | | | |
| **1.1** | **General Costs** | | | | | | | | | | |
| | a) Mobilization and demobilization | 4 409 307 | 39 683 764 | 44 093 071 | 10% | 440 931 | 3 968 376 | 4 409 307 | 4 850 238 | 43 652 140 | 48 502 378 |
| | b) Remaining works | 22 273 375 | 128 871 371 | 151 144 746 | 12% | 2 672 805 | 15 464 565 | 18 137 370 | 24 946 180 | 144 335 936 | 169 282 116 |
| | **Total ----------> ** | **26 682 682** | **168 555 135** | **195 237 817** | | **3 113 736** | **19 432 941** | **22 546 677** | **29 796 418** | **187 988 076** | **217 784 494** |
| **1.2** | **Dam - Common works** | | | | | | | | | | |
| | a) Grouting curtains | 5 122 036 | 29 992 720 | 35 114 755 | 15% | 768 305 | 4 498 908 | 5 267 213 | 5 890 341 | 34 491 628 | 40 381 969 |
| | b) Excavation works | 5 952 871 | 45 800 695 | 51 753 566 | 12% | 714 345 | 5 496 083 | 6 210 428 | 6 667 215 | 51 296 778 | 57 963 994 |
| | c) Remaining works | 5 932 889 | 58 162 648 | 64 095 536 | 12% | 711 947 | 6 979 518 | 7 691 464 | 6 644 835 | 65 142 166 | 71 787 001 |
| | **Total ----------> ** | **17 007 795** | **133 956 063** | **150 963 858** | | **2 194 596** | **16 974 509** | **19 169 106** | **19 202 392** | **150 930 572** | **170 132 963** |
| **1.3** | **Dam - Phase 1** | | | | | | | | | | |
| | a) Pre-coffer dam | 532 616 | 4 461 844 | 4 994 460 | 15% | 79 892 | 669 277 | 749 169 | 612 508 | 5 131 121 | 5 743 629 |
| | b) Impermeabilization diagram of pre-coffer dam | 77 096 | 586 760 | 663 856 | 15% | 11 564 | 88 014 | 99 578 | 88 660 | 674 774 | 763 434 |
| | c) Ionakhsh fault treatment | 2 953 959 | 22 696 346 | 25 650 305 | 25% | 738 490 | 5 674 086 | 6 412 576 | 3 692 448 | 28 370 432 | 32 062 881 |
| | d) Dam fills | 23 612 947 | 229 780 758 | 253 393 704 | 8% | 1 889 036 | 18 382 461 | 20 271 496 | 25 501 983 | 248 163 218 | 273 665 201 |
| | f) Remaining works | 1 685 517 | 16 200 623 | 17 886 140 | 12% | 202 262 | 1 944 075 | 2 146 337 | 1 887 779 | 18 144 697 | 20 032 477 |
| | **Total ----------> ** | **28 862 135** | **273 726 330** | **302 588 465** | | **2 921 244** | **26 757 912** | **29 679 157** | **31 783 379** | **300 484 242** | **332 267 621** |
| **1.4** | **Dam - Phase 2 to 6** | | | | | | | | | | |
| | a) Dam instrumentation | 1 522 755 | 14 997 862 | 16 520 618 | 12% | 182 731 | 1 799 743 | 1 982 474 | 1 705 486 | 16 797 606 | 18 503 092 |
| | b) Core | 12 745 851 | 100 734 516 | 113 480 367 | 10% | 1 274 585 | 10 073 452 | 11 348 037 | 14 020 436 | 110 807 968 | 124 828 404 |
| | c) Dam fills | 86 519 377 | 876 313 641 | 962 833 017 | 8% | 6 921 550 | 70 105 091 | 77 026 641 | 93 440 927 | 946 418 732 | 1 039 859 659 |
| | **Total ----------> ** | **100 787 983** | **992 046 019** | **1 092 834 002** | | **8 378 866** | **81 978 286** | **90 357 152** | **109 166 849** | **1 074 024 305** | **1 183 191 154** |
| **1.5** | **Powerhouse / Miscellaneaous / Remedial works** | | | | | | | | | | |
| | a) Surface works | 8 155 657 | 68 060 875 | 76 216 531 | 10% | 815 566 | 6 806 087 | 7 621 653 | 8 971 222 | 74 866 962 | 83 838 185 |
| | b) Power tunnels | 60 108 | 483 118 | 543 226 | 15% | 9 016 | 72 468 | 81 484 | 69 125 | 555 586 | 624 710 |
| | c) Powerhouse / Transformer chamber | 3 395 738 | 24 702 452 | 28 098 190 | 10% | 339 574 | 2 470 245 | 2 809 819 | 3 735 312 | 27 172 697 | 30 908 009 |
| | d) Bus Duc / Draft tubes / Cable Duc | 2 863 692 | 19 721 435 | 22 585 128 | 15% | 429 554 | 2 958 215 | 3 387 769 | 3 293 246 | 22 679 651 | 25 972 897 |
| | e) Switchyard | 1 134 946 | 7 394 502 | 8 529 448 | 15% | 170 242 | 1 109 175 | 1 279 417 | 1 305 188 | 8 503 678 | 9 808 866 |
| | f) Drainage and ventilation gallery | 1 658 800 | 9 419 383 | 11 078 183 | 20% | 331 760 | 1 883 877 | 2 215 637 | 1 990 560 | 11 303 259 | 13 293 819 |
| | g) Remaining works | 4 977 076 | 33 019 359 | 37 996 436 | 12% | 597 249 | 3 962 323 | 4 559 572 | 5 574 326 | 36 981 682 | 42 556 008 |
| | **Total ----------> ** | **22 246 017** | **162 801 124** | **185 047 142** | | **2 692 961** | **19 262 391** | **21 955 351** | **24 938 978** | **182 063 515** | **207 002 493** |
| **1.6** | **Upstream Waterways** | | | | | | | | | | |
| | a) Surface works | 10 113 159 | 73 533 391 | 83 646 550 | 10% | 1 011 316 | 7 353 339 | 8 364 655 | 11 124 475 | 80 886 730 | 92 011 205 |
| | b) Underground works | 10 433 980 | 66 108 845 | 76 542 825 | 15% | 1 565 097 | 9 916 327 | 11 481 424 | 11 999 077 | 76 025 172 | 88 024 249 |
| | **Total ----------> ** | **20 547 139** | **139 642 236** | **160 189 375** | | **2 576 413** | **17 269 666** | **19 846 079** | **23 123 552** | **156 911 902** | **180 035 454** |

Physical Contingencies

Alternative FSL=1290 m a.s.l

| ITEM No. | | CONSTRUCTION COSTS | | | CONTINGENCIES | | | | TOTAL AMOUNT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | % | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| **1.6** | **Diversion tunnels - Remedial works** | **3 334 539** | **22 994 642** | **26 329 181** | 20% | **666 908** | **4 598 928** | **5 265 836** | **4 001 447** | **27 593 571** | **31 595 017** |
| **1.7** | **Diversion tunnel 3** | | | | | | | | | | |
| | a) Surface works | 2 512 155 | 18 311 038 | 20 823 193 | 10% | 251 216 | 1 831 104 | 2 082 319 | 2 763 371 | 20 142 142 | 22 905 513 |
| | b) Underground works | 16 122 825 | 119 292 079 | 135 414 905 | 15% | 2 418 424 | 17 893 812 | 20 312 236 | 18 541 249 | 137 185 891 | 155 727 140 |
| | **Total ---------->** | **18 634 981** | **137 603 117** | **156 238 098** | | **2 669 639** | **19 724 916** | **22 394 555** | **21 304 620** | **157 328 033** | **178 632 653** |
| **1.8** | **Middle outlet level 1** | | | | | | | | | | |
| | a) Surface works | 8 270 670 | 63 601 782 | 71 872 452 | 10% | 827 067 | 6 360 178 | 7 187 245 | 9 097 737 | 69 961 960 | 79 059 697 |
| | b) Underground works | 12 513 214 | 90 909 973 | 103 423 187 | 15% | 1 876 982 | 13 636 496 | 15 513 478 | 14 390 196 | 104 546 469 | 118 936 665 |
| | **Total ---------->** | **20 783 884** | **154 511 755** | **175 295 639** | | **2 704 049** | **19 996 674** | **22 700 723** | **23 487 933** | **174 508 429** | **197 996 363** |
| **1.9** | **Middle outlet level 2** | | | | | | | | | | |
| | a) Surface works | 2 314 474 | 16 833 828 | 19 148 302 | 10% | 231 447 | 1 683 383 | 1 914 830 | 2 545 921 | 18 517 211 | 21 063 132 |
| | b) Underground works | 17 302 802 | 124 511 513 | 141 814 314 | 15% | 2 595 420 | 18 676 727 | 21 272 147 | 19 898 222 | 143 188 240 | 163 086 462 |
| | **Total ---------->** | **19 617 275** | **141 345 341** | **160 962 616** | | **2 826 868** | **20 360 110** | **23 186 977** | **22 444 143** | **161 705 450** | **184 149 593** |
| **1.10** | **High level tunnels** | | | | | | | | | | |
| | a) Surface works | 11 187 206 | 80 229 540 | 91 416 746 | 10% | 1 118 721 | 8 022 954 | 9 141 675 | 12 305 927 | 88 252 494 | 100 558 420 |
| | b) Underground works | 11 634 864 | 84 458 044 | 96 092 908 | 15% | 1 745 230 | 12 668 707 | 14 413 936 | 13 380 094 | 97 126 750 | 110 506 844 |
| | **Total ---------->** | **22 822 070** | **164 687 583** | **187 509 653** | | **2 863 950** | **20 691 660** | **23 555 611** | **25 686 020** | **185 379 244** | **211 065 264** |
| **1.11** | **Surface spillway** | | | | | | | | | | |
| | a) Surface works | 14 444 515 | 106 912 845 | 121 357 359 | 10% | 1 444 451 | 10 691 284 | 12 135 736 | 15 888 966 | 117 604 129 | 133 493 095 |
| | b) Underground works | 2 925 032 | 19 707 000 | 22 632 032 | 15% | 438 755 | 2 956 050 | 3 394 805 | 3 363 787 | 22 663 050 | 26 026 837 |
| | **Total ---------->** | **17 369 547** | **126 619 844** | **143 989 391** | | **1 883 206** | **13 647 334** | **15 530 541** | **19 252 753** | **140 267 179** | **159 519 932** |
| **1.13** | **Transportation tunnels** | | | | | | | | | | |
| | a) Surface works | 528 224 | 3 710 618 | 4 238 841 | 10% | 52 822 | 371 062 | 423 884 | 581 046 | 4 081 679 | 4 662 725 |
| | b) Underground works | 11 588 418 | 88 679 468 | 100 267 885 | 15% | 1 738 263 | 13 301 920 | 15 040 183 | 13 326 680 | 101 981 388 | 115 308 068 |
| | d) Remaining works | 2 623 391 | 19 271 195 | 21 894 586 | 12% | 314 807 | 2 312 543 | 2 627 350 | 2 938 198 | 21 583 738 | 24 521 936 |
| | **Total ---------->** | **14 740 032** | **111 661 280** | **126 401 313** | | **2 105 892** | **15 985 525** | **18 091 417** | **16 845 924** | **127 646 806** | **144 492 730** |
| **TOTAL COSTS OF CIVIL WORKS ---------->>** | | **333 436 080** | **2 730 150 470** | **3 063 586 550** | | **37 598 328** | **296 680 854** | **334 279 182** | **371 034 408** | **3 026 831 324** | **3 397 865 732** |

Physical Contingencies
Alternative FSL=1255 m a.s.l

| ITEM No. | | CONSTRUCTION COSTS | | | CONTINGENCIES | | | | TOTAL AMOUNT WITH CONTINGENCIES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | % | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| **1** | **CONSTRUCTION COSTS** | | | | | | | | | | |
| **1.1** | **General Costs** | | | | | | | | | | |
| | a) Mobilization and demobilization | 3 728 362 | 33 555 258 | 37 283 621 | 10% | 372 836 | 3 355 526 | 3 728 362 | 4 101 198 | 36 910 784 | 41 011 983 |
| | b) Remaining works | 19 563 242 | 113 071 351 | 132 634 592 | 12% | 2 347 589 | 13 568 562 | 15 916 151 | 21 910 831 | 126 639 913 | 148 550 743 |
| | **Total ----------> ** | **23 291 604** | **146 626 609** | **169 918 213** | | **2 720 425** | **16 924 088** | **19 644 513** | **26 012 029** | **163 550 697** | **189 562 726** |
| **1.2** | **Dam - Common works** | | | | | | | | | | |
| | a) Grouting curtains | 4 483 495 | 26 239 845 | 30 723 340 | 15% | 672 524 | 3 935 977 | 4 608 501 | 5 156 019 | 30 175 822 | 35 331 841 |
| | b) Excavation works | 4 120 732 | 32 571 645 | 36 692 377 | 12% | 494 488 | 3 908 597 | 4 403 085 | 4 615 220 | 36 480 243 | 41 095 462 |
| | c) Remaining works | 5 740 980 | 56 951 390 | 62 692 370 | 12% | 688 918 | 6 834 167 | 7 523 084 | 6 429 898 | 63 785 557 | 70 215 455 |
| | **Total ----------> ** | **14 345 207** | **115 762 881** | **130 108 088** | | **1 855 930** | **14 678 741** | **16 534 671** | **16 201 137** | **130 441 622** | **146 642 758** |
| **1.3** | **Dam - Phase 1** | | | | | | | | | | |
| | a) Pre-coffer dam | 532 616 | 4 461 844 | 4 994 460 | 15% | 79 892 | 669 277 | 749 169 | 612 508 | 5 131 121 | 5 743 629 |
| | b) Impermeabilization diagram of pre-coffer dam | 77 096 | 586 760 | 663 856 | 15% | 11 564 | 88 014 | 99 578 | 88 660 | 674 774 | 763 434 |
| | c) Ionakhsh fault treatment | 2 953 959 | 22 696 346 | 25 650 305 | 25% | 738 490 | 5 674 086 | 6 412 576 | 3 692 448 | 28 370 432 | 32 062 881 |
| | d) Dam fills | 18 416 024 | 177 852 412 | 196 268 436 | 8% | 1 473 282 | 14 228 193 | 15 701 475 | 19 889 306 | 192 080 605 | 211 969 911 |
| | f) Remaining works | 1 347 372 | 12 805 208 | 14 152 580 | 12% | 161 685 | 1 536 625 | 1 698 310 | 1 509 056 | 14 341 833 | 15 850 889 |
| | **Total ----------> ** | **23 327 066** | **218 402 570** | **241 729 637** | | **2 464 913** | **22 196 195** | **24 661 108** | **25 791 979** | **240 598 765** | **266 390 745** |
| **1.4** | **Dam - Phase 2 to 6** | | | | | | | | | | |
| | a) Dam instrumentation | 1 012 871 | 10 033 758 | 11 046 629 | 12% | 121 545 | 1 204 051 | 1 325 595 | 1 134 415 | 11 237 809 | 12 372 225 |
| | b) Core | 9 304 471 | 73 536 197 | 82 840 668 | 10% | 930 447 | 7 353 620 | 8 284 067 | 10 234 918 | 80 889 816 | 91 124 735 |
| | c) Dam fills | 59 909 671 | 608 065 423 | 667 975 094 | 8% | 4 792 774 | 48 645 234 | 53 438 008 | 64 702 445 | 656 710 657 | 721 413 101 |
| | **Total ----------> ** | **70 227 013** | **691 635 378** | **761 862 391** | | **5 844 765** | **57 202 904** | **63 047 670** | **76 071 779** | **748 838 282** | **824 910 061** |
| **1.5** | **Power system structures** | | | | | | | | | | |
| | a) Surface works | 8 155 657 | 68 060 875 | 76 216 531 | 10% | 815 566 | 6 806 087 | 7 621 653 | 8 971 222 | 74 866 962 | 83 838 185 |
| | b) Power tunnels | 60 108 | 483 118 | 543 226 | 15% | 9 016 | 72 468 | 81 484 | 69 125 | 555 586 | 624 710 |
| | c) Powerhouse / Transformer chamber | 3 395 738 | 24 702 452 | 28 098 190 | 10% | 339 574 | 2 470 245 | 2 809 819 | 3 735 312 | 27 172 697 | 30 908 009 |
| | d) Bus Duc / Draft tubes / Cable Duc | 2 863 692 | 19 721 435 | 22 585 128 | 15% | 429 554 | 2 958 215 | 3 387 769 | 3 293 246 | 22 679 651 | 25 972 897 |
| | e) Switchyard | 1 134 946 | 7 394 502 | 8 529 448 | 15% | 170 242 | 1 109 175 | 1 279 417 | 1 305 188 | 8 503 678 | 9 808 866 |
| | f) Drainage and ventilation gallery | 1 594 878 | 9 087 618 | 10 682 497 | 20% | 318 976 | 1 817 524 | 2 136 499 | 1 913 854 | 10 905 142 | 12 818 996 |
| | g) Remaining works | 4 977 076 | 33 019 359 | 37 996 436 | 12% | 597 249 | 3 962 323 | 4 559 572 | 5 574 326 | 36 981 682 | 42 556 008 |
| | **Total ----------> ** | **22 182 096** | **162 469 360** | **184 651 456** | | **2 680 176** | **19 196 038** | **21 876 214** | **24 862 272** | **181 665 398** | **206 527 670** |

Physical Contingencies
Alternative FSL=1255 m a.s.l

| ITEM No. | | CONSTRUCTION COSTS | | | CONTINGENCIES | | | | TOTAL AMOUNT WITH CONTINGENCIES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | % | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| **1.6** | **Upstream Waterways** | | | | | | | | | | |
| | a) Surface works | 8 427 632 | 61 277 826 | 69 705 458 | 10% | 842 763 | 6 127 783 | 6 970 546 | 9 270 396 | 67 405 608 | 76 676 004 |
| | b) Underground works | 10 433 980 | 66 108 845 | 76 542 825 | 15% | 1 565 097 | 9 916 327 | 11 481 424 | 11 999 077 | 76 025 172 | 88 024 249 |
| | **Total ----------> ** | **18 861 613** | **127 386 671** | **146 248 284** | | **2 407 860** | **16 044 109** | **18 451 970** | **21 269 473** | **143 430 780** | **164 700 253** |
| **1.7** | **Diversion tunnels - Remedial works** | **3 334 539** | **22 994 642** | **26 329 181** | 20% | **666 908** | **4 598 928** | **5 265 836** | **4 001 447** | **27 593 571** | **31 595 017** |
| **1.8** | **Diversion tunnel 3** | | | | | | | | | | |
| | a) Surface works | 2 512 155 | 18 311 038 | 20 823 193 | 10% | 251 216 | 1 831 104 | 2 082 319 | 2 763 371 | 20 142 142 | 22 905 513 |
| | b) Underground works | 16 122 825 | 119 292 079 | 135 414 905 | 15% | 2 418 424 | 17 893 812 | 20 312 236 | 18 541 249 | 137 185 891 | 155 727 140 |
| | **Total ----------> ** | **18 634 981** | **137 603 117** | **156 238 098** | | **2 669 639** | **19 724 916** | **22 394 555** | **21 304 620** | **157 328 033** | **178 632 653** |
| **1.9** | **Middle outlet level 1** | | | | | | | | | | |
| | a) Surface works | 7 118 857 | 55 749 284 | 62 868 141 | 10% | 711 886 | 5 574 928 | 6 286 814 | 7 830 743 | 61 324 212 | 69 154 955 |
| | b) Underground works | 12 016 736 | 87 399 566 | 99 416 302 | 15% | 1 802 510 | 13 109 935 | 14 912 445 | 13 819 246 | 100 509 501 | 114 328 748 |
| | **Total ----------> ** | **19 135 593** | **143 148 850** | **162 284 443** | | **2 514 396** | **18 684 863** | **21 199 259** | **21 649 989** | **161 833 713** | **183 483 703** |
| **1.10** | **High level tunnels 1,2,3** | | | | | | | | | | |
| | a) Surface works | 18 120 605 | 126 305 120 | 144 425 725 | 10% | 1 812 060 | 12 630 512 | 14 442 572 | 19 932 665 | 138 935 632 | 158 868 297 |
| | b) Underground works | 19 130 149 | 138 854 880 | 157 985 029 | 15% | 2 869 522 | 20 828 232 | 23 697 754 | 21 999 671 | 159 683 112 | 181 682 783 |
| | **Total ----------> ** | **37 250 753** | **265 160 001** | **302 410 754** | | **4 681 583** | **33 458 744** | **38 140 327** | **41 932 336** | **298 618 745** | **340 551 081** |
| **1.11** | **Surface spillway** | | | | | | | | | | |
| | a) Surface works | 17 710 618 | 129 629 572 | 147 340 190 | 10% | 1 771 062 | 12 962 957 | 14 734 019 | 19 481 680 | 142 592 529 | 162 074 209 |
| | b) Underground works | 3 602 609 | 24 448 489 | 28 051 098 | 15% | 540 391 | 3 667 273 | 4 207 665 | 4 143 000 | 28 115 763 | 32 258 763 |
| | **Total ----------> ** | **21 313 227** | **154 078 061** | **175 391 288** | | **2 311 453** | **16 630 231** | **18 941 684** | **23 624 680** | **170 708 292** | **194 332 972** |
| **1.13** | **Transportation tunnels** | | | | | | | | | | |
| | a) Surface works | 528 202 | 3 709 553 | 4 237 755 | 10% | 52 820 | 370 955 | 423 775 | 581 022 | 4 080 508 | 4 661 530 |
| | b) Underground works | 10 789 378 | 80 665 892 | 91 455 269 | 15% | 1 618 407 | 12 099 884 | 13 718 290 | 12 407 784 | 92 765 776 | 105 173 560 |
| | d) Remaining works | 3 880 108 | 30 738 303 | 34 618 410 | 12% | 465 613 | 3 688 596 | 4 154 209 | 4 345 721 | 34 426 899 | 38 772 619 |
| | **Total ----------> ** | **15 197 687** | **115 113 747** | **130 311 434** | | **2 136 840** | **16 159 435** | **18 296 275** | **17 334 527** | **131 273 182** | **148 607 709** |
| **TOTAL COSTS OF CIVIL WORKS ----------->>** | | **287 101 379** | **2 300 381 887** | **2 587 483 266** | | **32 954 889** | **255 499 193** | **288 454 082** | **320 056 268** | **2 555 881 080** | **2 875 937 348** |

Physical Contingencies
Alternative FSL=1220 m a.s.l

| ITEM No. | | CONSTRUCTION COSTS | | | CONTINGENCIES | | | | TOTAL AMOUNT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | % | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| **1** | **CONSTRUCTION COSTS** | | | | | | | | | | |
| **1.1** | **General Costs** | | | | | | | | | | |
| | a) Mobilization and demobilization | 2 841 221 | 25 570 991 | 28 412 212 | 10% | 284 122 | 2 557 099 | 2 841 221 | 3 125 343 | 28 128 090 | 31 253 433 |
| | b) Remaining works | 16 505 169 | 95 299 676 | 111 804 845 | 12% | 1 980 620 | 11 435 961 | 13 416 581 | 18 485 789 | 106 735 638 | 125 221 427 |
| | **Total ----------> ** | **19 346 390** | **120 870 667** | **140 217 057** | | **2 264 742** | **13 993 060** | **16 257 803** | **21 611 133** | **134 863 727** | **156 474 860** |
| **1.2** | **Dam - Common works** | | | | | | | | | | |
| | a) Grouting curtains | 2 397 830 | 14 169 755 | 16 567 586 | 15% | 359 675 | 2 125 463 | 2 485 138 | 2 757 505 | 16 295 219 | 19 052 724 |
| | b) Excavation works | 728 218 | 11 329 994 | 12 058 212 | 12% | 87 386 | 1 359 599 | 1 446 985 | 815 604 | 12 689 594 | 13 505 198 |
| | c) Remaining works | 10 242 494 | 84 406 411 | 94 648 905 | 12% | 1 229 099 | 10 128 769 | 11 357 869 | 11 471 594 | 94 535 180 | 106 006 774 |
| | **Total ----------> ** | **13 368 543** | **109 906 160** | **123 274 703** | | **1 676 160** | **13 613 832** | **15 289 992** | **15 044 703** | **123 519 992** | **138 564 695** |
| **1.3** | **Dam - Phase 1** | | | | | | | | | | |
| | a) Pre-coffer dam | 532 616 | 4 461 844 | 4 994 460 | 15% | 79 892 | 669 277 | 749 169 | 612 508 | 5 131 121 | 5 743 629 |
| | b) Impermeabilization diagram of pre-coffer dam | 77 096 | 586 760 | 663 856 | 15% | 11 564 | 88 014 | 99 578 | 88 660 | 674 774 | 763 434 |
| | c) Ionakhsh fault treatment | 2 953 959 | 22 696 346 | 25 650 305 | 25% | 738 490 | 5 674 086 | 6 412 576 | 3 692 448 | 28 370 432 | 32 062 881 |
| | d) Dam fills | 9 057 562 | 87 672 751 | 96 730 313 | 8% | 724 605 | 7 013 820 | 7 738 425 | 9 782 167 | 94 686 571 | 104 468 738 |
| | f) Remaining works | 1 918 660 | 14 181 093 | 16 099 753 | 12% | 230 239 | 1 701 731 | 1 931 970 | 2 148 899 | 15 882 824 | 18 031 723 |
| | **Total ----------> ** | **14 539 892** | **129 598 794** | **144 138 686** | | **1 784 791** | **15 146 928** | **16 931 719** | **16 324 683** | **144 745 722** | **161 070 405** |
| **1.4** | **Dam - Phase 2 to 6** | | | | | | | | | | |
| | a) Dam instrumentation | 843 419 | 8 206 982 | 9 050 401 | 12% | 101 210 | 984 838 | 1 086 048 | 944 629 | 9 191 820 | 10 136 449 |
| | b) Core | 6 771 175 | 53 514 746 | 60 285 921 | 10% | 677 117 | 5 351 475 | 6 028 592 | 7 448 292 | 58 866 221 | 66 314 513 |
| | c) Dam fills | 36 467 649 | 367 222 137 | 403 689 786 | 8% | 2 917 412 | 29 377 771 | 32 295 183 | 39 385 061 | 396 599 908 | 435 984 969 |
| | **Total ----------> ** | **44 082 243** | **428 943 865** | **473 026 108** | | **3 695 740** | **35 714 083** | **39 409 823** | **47 777 983** | **464 657 948** | **512 435 931** |
| **1.5** | **Power system structures** | | | | | | | | | | |
| | a) Surface works | 8 155 657 | 68 060 875 | 76 216 531 | 10% | 815 566 | 6 806 087 | 7 621 653 | 8 971 222 | 74 866 962 | 83 838 185 |
| | b) Power tunnels | 60 108 | 483 118 | 543 226 | 15% | 9 016 | 72 468 | 81 484 | 69 125 | 555 586 | 624 710 |
| | c) Powerhouse / Transformer chamber | 3 395 738 | 24 702 452 | 28 098 190 | 10% | 339 574 | 2 470 245 | 2 809 819 | 3 735 312 | 27 172 697 | 30 908 009 |
| | d) Bus Duc / Draft tubes / Cable Duc | 2 863 692 | 19 721 435 | 22 585 128 | 15% | 429 554 | 2 958 215 | 3 387 769 | 3 293 246 | 22 679 651 | 25 972 897 |
| | e) Switchyard | 1 134 946 | 7 394 502 | 8 529 448 | 15% | 170 242 | 1 109 175 | 1 279 417 | 1 305 188 | 8 503 678 | 9 808 866 |
| | f) Drainage and ventilation gallery | 1 521 368 | 8 706 089 | 10 227 457 | 20% | 304 274 | 1 741 218 | 2 045 491 | 1 825 642 | 10 447 307 | 12 272 949 |
| | g) Remaining works | 4 977 076 | 33 019 359 | 37 996 436 | 12% | 597 249 | 3 962 323 | 4 559 572 | 5 574 326 | 36 981 682 | 42 556 008 |
| | **Total ----------> ** | **22 108 586** | **162 087 831** | **184 196 417** | | **2 665 474** | **19 119 732** | **21 785 206** | **24 774 060** | **181 207 563** | **205 981 623** |

Physical Contingencies
Alternative FSL=1220 m a.s.l

| ITEM No. | | CONSTRUCTION COSTS | | | | CONTINGENCIES | | | TOTAL AMOUNT | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | L.C.P. | F.C.P. | TOTAL | % | L.C.P. | F.C.P. | TOTAL | L.C.P. | F.C.P. | TOTAL |
| **1.6** | **Upstream Waterways** | | | | | | | | | | |
| | a) Surface works | 6 742 106 | 49 022 261 | 55 764 367 | 10% | 674 211 | 4 902 226 | 5 576 437 | 7 416 317 | 53 924 487 | 61 340 803 |
| | b) Underground works | 10 433 980 | 66 108 845 | 76 542 825 | 15% | 1 565 097 | 9 916 327 | 11 481 424 | 11 999 077 | 76 025 172 | 88 024 249 |
| | **Total ---------->** | **17 176 086** | **115 131 106** | **132 307 192** | | **2 239 308** | **14 818 553** | **17 057 860** | **19 415 394** | **129 949 659** | **149 365 053** |
| **1.7** | **Diversion tunnels - Remedial works** | **3 334 539** | **22 994 642** | **26 329 181** | 20% | **666 908** | **4 598 928** | **5 265 836** | **4 001 447** | **27 593 571** | **31 595 017** |
| **1.8** | **Diversion tunnel 3** | | | | | | | | | | |
| | a) Surface works | 2 512 155 | 18 311 038 | 20 823 193 | 10% | 251 216 | 1 831 104 | 2 082 319 | 2 763 371 | 20 142 142 | 22 905 513 |
| | b) Underground works | 16 122 825 | 119 292 079 | 135 414 905 | 15% | 2 418 424 | 17 893 812 | 20 312 236 | 18 541 249 | 137 185 891 | 155 727 140 |
| | **Total ---------->** | **18 634 981** | **137 603 117** | **156 238 098** | | **2 669 639** | **19 724 916** | **22 394 555** | **21 304 620** | **157 328 033** | **178 632 653** |
| **1.9** | **Middle outlet level 1** | | | | | | | | | | |
| | a) Surface works | 8 094 975 | 62 258 763 | 70 353 738 | 10% | 809 497 | 6 225 876 | 7 035 374 | 8 904 472 | 68 484 639 | 77 389 111 |
| | b) Underground works | 11 818 042 | 85 890 580 | 97 708 623 | 15% | 1 772 706 | 12 883 587 | 14 656 293 | 13 590 749 | 98 774 167 | 112 364 916 |
| | **Total ---------->** | **19 913 017** | **148 149 343** | **168 062 360** | | **2 582 204** | **19 109 463** | **21 691 667** | **22 495 221** | **167 258 806** | **189 754 027** |
| **1.10** | **High level tunnels** | | | | | | | | | | |
| | a) Surface works | 5 614 557 | 39 751 180 | 45 365 737 | 10% | 561 456 | 3 975 118 | 4 536 574 | 6 176 012 | 43 726 298 | 49 902 311 |
| | b) Underground works | 6 720 521 | 48 785 856 | 55 506 377 | 15% | 1 008 078 | 7 317 878 | 8 325 957 | 7 728 599 | 56 103 735 | 63 832 334 |
| | **Total ---------->** | **12 335 078** | **88 537 036** | **100 872 114** | | **1 569 534** | **11 292 996** | **12 862 530** | **13 904 612** | **99 830 033** | **113 734 645** |
| **1.11** | **Surface spillway** | | | | | | | | | | |
| | a) Surface works | 13 755 096 | 106 532 927 | 120 288 023 | 10% | 1 375 510 | 10 653 293 | 12 028 802 | 15 130 605 | 117 186 220 | 132 316 826 |
| | b) Underground works | 9 327 413 | 60 718 573 | 70 045 986 | 15% | 1 399 112 | 9 107 786 | 10 506 898 | 10 726 525 | 69 826 359 | 80 552 884 |
| | **Total ---------->** | **23 082 509** | **167 251 501** | **190 334 009** | | **2 774 621** | **19 761 079** | **22 535 700** | **25 857 130** | **187 012 579** | **212 869 709** |
| **1.12** | **Transportation tunnels** | | | | | | | | | | |
| | a) Surface works | 528 224 | 3 710 618 | 4 238 841 | 10% | 52 822 | 371 062 | 423 884 | 581 046 | 4 081 679 | 4 662 725 |
| | b) Underground works | 10 813 512 | 80 867 828 | 91 681 340 | 15% | 1 622 027 | 12 130 174 | 13 752 201 | 12 435 539 | 92 998 002 | 105 433 541 |
| | d) Remaining works | 3 880 108 | 30 738 303 | 34 618 410 | 12% | 465 613 | 3 688 596 | 4 154 209 | 4 345 721 | 34 426 899 | 38 772 619 |
| | **Total ---------->** | **15 221 843** | **115 316 748** | **130 538 591** | | **2 140 462** | **16 189 832** | **18 330 294** | **17 362 305** | **131 506 580** | **148 868 885** |
| **TOTAL COSTS OF CIVIL WORKS ---------->>** | | **223 143 708** | **1 746 390 810** | **1 969 534 518** | | **26 729 583** | **203 083 403** | **229 812 987** | **249 873 291** | **1 949 474 214** | **2 199 347 504** |

### 1.1.1 General Project Costs

The General project costs are divided into two sections: Mobilization/Demobilization/Camps, and Roads. The structure is detailed in Figure 2-2.

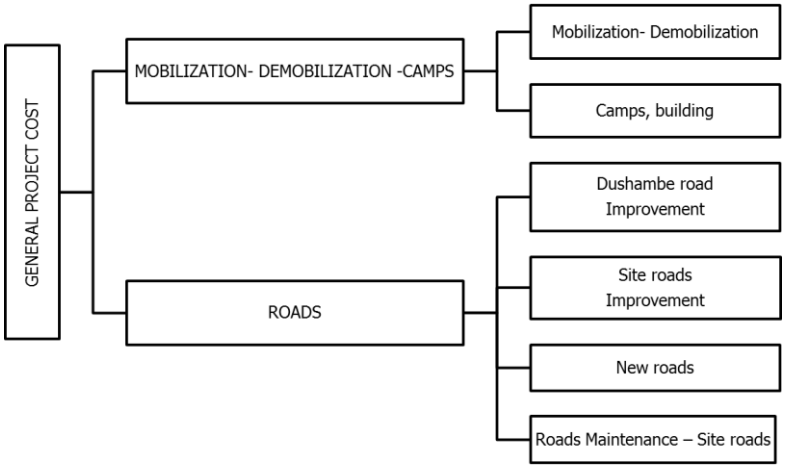



**Figure 2-2: General Project Cost, diagram**

The total costs of the general project cost (excluding physical contingencies) are detailed in the table below. The amounts vary from 140 to 195 MUS$ according to the alternative taken into consideration.

**Figure 2-3: General Project Cost, [MUS$]**

| A. GENERAL PROJECT COSTS | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A.I | **MOBILIZATION / DEMOBILIZATION / CAMPS** | **124.0** | **101.9** | **75.4** |
| A.I.1 | Mobilization demobilization | 44.1 | 37.3 | 28.4 |
| A.I.2 | Camp | 80.0 | 64.6 | 47.0 |
| A.II | **ROADS (CONSTRUCTION - IMPROVEMENT - MAINTENANCE)** | **71.2** | **68.0** | **64.8** |
| A.III.1 | ROAD IMPROVEMENT - ROAD FROM SITE TO DUSHANBE | 13.1 | | |
| A.III.2 | ROAD IMPROVEMENT – WITHOUT ENLARGMENT - SITE ROADS | 5.7 | | |
| A.III.3 | ROAD IMPROVEMENT - WITH ENLARGMENT - SITE ROADS | 16.1 | | |
| A.III.4 | NEW ROADS - SITE ROADS | 17.3 | | |
| A.III.5 | ROADS MAINTENANCE - SITE ROADS | 19.1 | 15.9 | 12.7 |
| Total General Project Cost | | **195.2** | **169.9** | **140.2** |
| Difference with Alternative FSL1290 | | 0.0 | -25.3 | -55.0 |

## 1.1.2 Dam Works

### *1.1.2.1 Diagram*

Dam works are divided into three sections: Common works, Dam phase 1 (equivalent to Stage 1 dam), and Dam Phases 2 to 6.

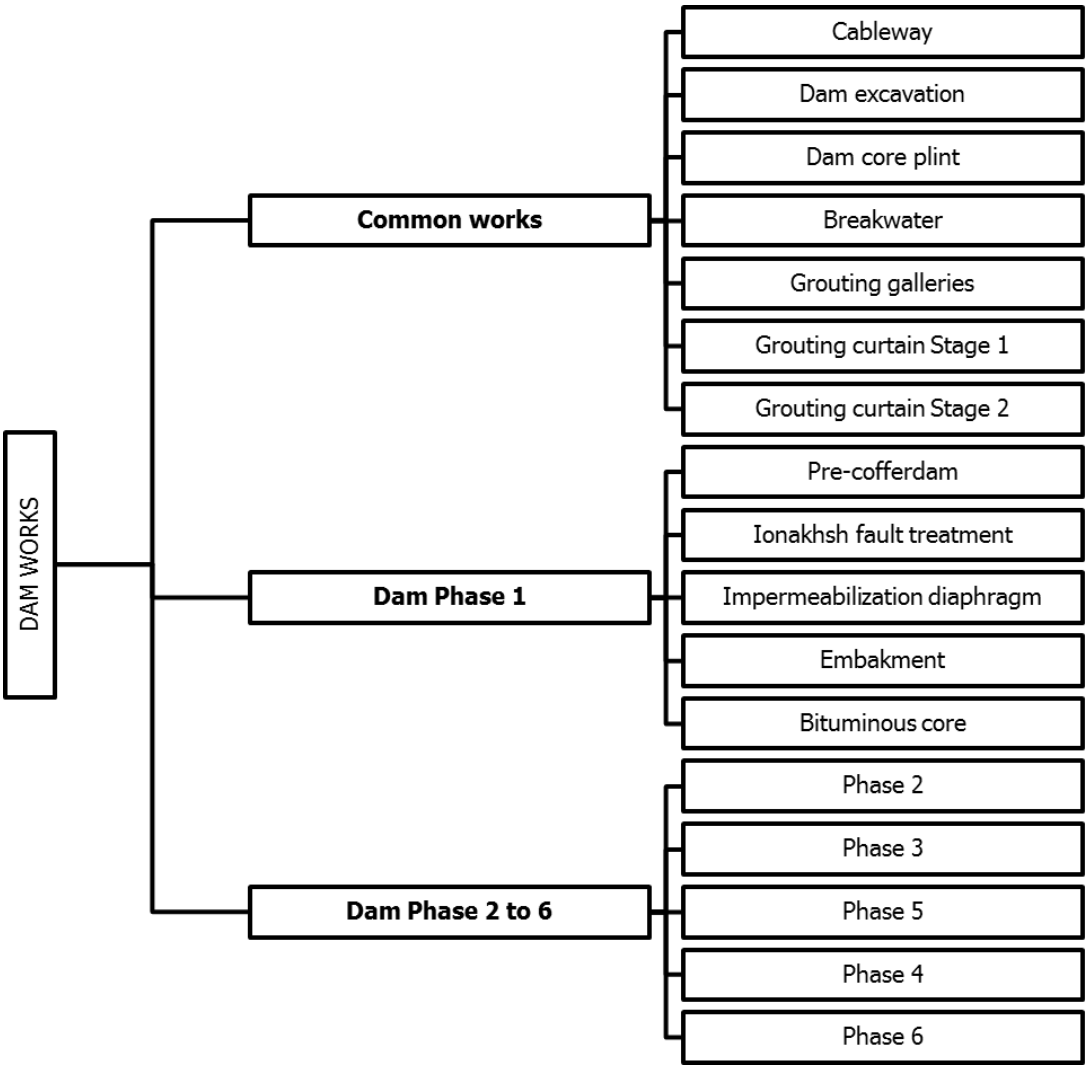



**Figure 2-4: Dam Works, diagram**

### *1.1.2.2 Common works*

The common works cost varies from 123 MUS$ (FSL=1220 mas) to 150 MUS$ (1290 m a.s.l). The main part of this section corresponds to the Dam excavation and the dam core plinth.

**Table 2-3: Common Works, [MUS$]**

| B.I COMMON WORKS FOR PHASE 1 TO 6 | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| **B.I.1** | Fix Type Cableway, 25 t Capacity | 4.7 | 4.7 | 4.7 |
| **B.I.2** | Dam Excavation | 35.8 | 24.6 | 23.2 |
| **B.I.3** | Protection of Dam Core Excavation Surfaces | 11.6 | 8.6 | 8.6 |
| **B.I.4** | Reinforcement of Dam Core Excavation Surfaces | 4.3 | 3.5 | 3.5 |
| **B.I.5** | Dam Core Plinth | 58.8 | 57.5 | 56.3 |
| **B.I.6** | Breakwater on Dam Crest | 0.6 | 0.5 | 0.4 |
| **B.I.7** | Grouting Galleries on Dam Abutments | 12.7 | 11.4 | 10.0 |
| **B.I.8** | Grouting Curtains - Stage 1 | 4.9 | 3.5 | 2.7 |
| **B.I.9** | Grouting Curtains - Stage 2 | 17.6 | 15.8 | 13.9 |
| **Total Cost of Common works** | | **151.0** | **130.1** | **123.3** |
| **Difference with Alternative FSL 1290** | | **0.0** | **-20.9** | **-27.7** |

### *1.1.2.3 Dam Phase 1*

The cost of dam phase 1 varies from 144 MUS$ (FSL=1220 m a.s.l) to 302 MUS$ (FSL=1290 m a.s.l).

**Table 2-4: Dam Phase 1, [MUS$]**

| B.II DAM PHASE 1 | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| B.II.1 | Pre-cofferdam | 5.0 | 5.0 | 5.0 |
| B.II.2 | Impermeabilization diaphgram of pre-cofferdam | 0.7 | 0.7 | 0.7 |
| B.II.3 | Ionakhsh fault treatment (grouting and hydraulic curtain) | 25.7 | 25.7 | 25.7 |
| B.II.4 | Embankment | 242.8 | 187.2 | 96.7 |
| B.II.5 | Bituminous inclined impermeabilization diaphragm | 10.6 | 9.1 | 8.0 |
| B.II.6 | Sundries | 17.9 | 14.2 | 8.1 |
| Total Cost of Dam Works | | **302.6** | **241.7** | **144.1** |
| Difference with Alternative FSL 1290 | | **0.0** | **-60.9** | **-158.4** |

### *1.1.2.4 Dam Phases 2 to 6*

The cost of dam phases 2 to 6 varies from 473 MUS$ (FSL=1220 m a.s.l) to 1,093 MUS$ (FSL=1290 m a.s.l).

**Table 2-5: Dam Phases 2 to 6, [MUS$]**

| B.III DAM PHASES 2 TO 6 | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| B.III.1 | DAM PHASE 2 | 58.4 | 28.6 | 20.4 |
| B.III.2 | DAM PHASE 3 | 196.8 | 104.7 | 64.8 |
| B.III.3 | DAM PHASE 4 | 391.8 | 293.9 | 174.7 |
| B.III.4 | DAM PHASE 5 | 229.4 | 184.5 | 106.5 |
| B.III.5 | DAM PHASE 6 | 216.4 | 150.1 | 106.6 |
| Total Cost of Dam Phase 2 to 6 | | **1 092.8** | **761.9** | **473.0** |
| Difference with Alternative FSL 1290 | | **0.0** | **-331.0** | **-619.8** |

## 1.1.3 Underground Works

### *1.1.3.1 General Description*

Underground works are divided into four sections: Power system structures, River diversion structure, Flood management structures, and Transportation tunnels and galleries.

The power system and river diversion structures are identical for all alternatives. However, the flood management and transportation structure differs.

Each underground structure has been estimated considering the following items: Excavation and supports, Concrete works, Drilling and grouting, Sundries.

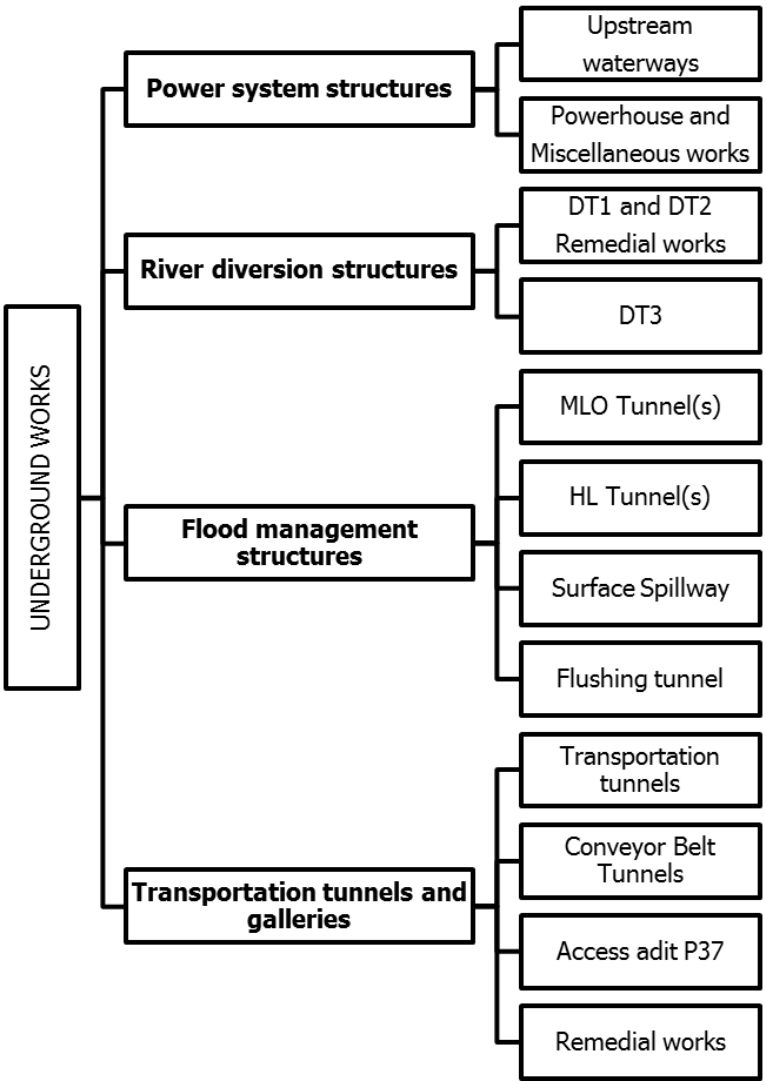



**Figure 2-5: Underground Works, diagram**

The total costs of underground works (excluding physical contingencies) are detailed in the table below. The amount varies bewteen 1.089 to 1.322 Billion of US$.

The cost of alternatives FSl=1290 m a.s.l and FSl=1255 m a.s.l is almost identical, whereas the smallest dam costs 233 million less.

**Figure 2-6: Underground Works, [MUS$]**

| C. UNDERGROUND WORKS | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| C.I | POWER SYSTEM STRUCTURES | 345.2 | 330.9 | 316.5 |
| C.II | RIVER DIVERSION STRUCTURES | 182.6 | 182.6 | 182.6 |
| C.III | FLOOD MANAGEMENT STRUCTURES | 667.8 | 640.1 | 459.3 |
| C.IV | TRANSPORTATION TUNNELS AND GALLERIES | 126.4 | 130.3 | 130.5 |
| Total Cost of Underground Works | | **1 322.0** | **1 283.9** | **1 088.9** |
| Difference with Alternative FSL 1290 | | **0.0** | **-38.1** | **-233.1** |

### *1.1.3.2 Power System Structures*

The total cost of the power system structures is between 316 and 345 MUS$.

**Table 2-6: Power System Structures, [MUS$]**

| C.I POWER SYSTEM STRUCTURES | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| C.I.1 | **POWERHOUSE AND MISCELLANEOUS WORKS** | **185.0** | **184.7** | **184.2** |
| C.I.1.1 | SURFACE WORKS OF UNDERGROUND STRUCTURES | 76.2 | 76.2 | 76.2 |
| C.I.1.2 | POWER FACILITIES | 59.8 | 59.8 | 59.8 |
| C.I.1.3 | DRAINAGE AND VENTILATION GALLERIES | 11.1 | 10.7 | 10.2 |
| C.I.1.4 | VARIOUS BUILDINGS | 10.0 | 10.0 | 10.0 |
| C.I.1.5 | REMEDIAL WORKS | 28.0 | 28.0 | 28.0 |
| C.I.2 | **UPSTREAM WATERWAYS** | **160.2** | **146.2** | **132.3** |
| C.I.2.1 | INTAKE STRUCTURES | 83.6 | 69.7 | 55.8 |
| C.I.2.2 | HEADRACE TUNNELS STRETCH UP TO GATE CHAMBER | 10.2 | 10.2 | 10.2 |
| C.I.2.3 | GATE CHAMBER AND GATE SHAFT | 22.9 | 22.9 | 22.9 |
| C.I.2.4 | PENSTOCK ERECTION CHAMBER | 11.5 | 11.5 | 11.5 |
| C.I.2.5 | HORIZONTAL PENSTOCK | 3.0 | 3.0 | 3.0 |
| C.I.2.6 | PENSTOCK SHAFT AND BLOCK | 29.0 | 29.0 | 29.0 |
| Total Cost of Power System Structures | | **345.2** | **330.9** | **316.5** |
| Difference with Alternative FSL 1290 | | **0.0** | **-14.3** | **-28.7** |

### *1.1.3.3 Diversion structures*

The total cost of the Diversion structures represents 182 MUS$ for all alternatives.

The rehabilitation of Diversion tunnels 1 and 2 has been included in this section. It represents 14% of the diversion structures cost.

**Table 2-7: Diversion structures, [MUS$]**

| C.II DIVERSION STRUCTURES | | TOTAL (MUS$ Equiv.) |
|---|---|---|
| C.II.1 | DIVERSION TUNNELS - REMEDIAL WORKS | 26.3 |
| C.II.2 | DIVERSION TUNNEL 3 | 156.2 |
| Total of Diversion structures | | **182.6** |

### *1.1.3.4 Flood Management Structures*

The total cost of the flood management structures varies bewteen 459 and 668 MUS$. It depends of the number/type of hydraulic structures considered for each.

**Table 2-8: Flood Management Structures, [MUS$]**

| C.III FLOOD MANAGEMENT STRUCTURES | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| C.III.1 | MIDDLE OUTLET LEVEL 1 | 175.3 | 162.3 | 168.1 |
| C.III.2 | MIDDLE OUTLET LEVEL 2 | 161.0 | | |
| C.III.3 | HIGH LEVEL TUNNELS SPILLWAYS | 187.5 | 302.4 | 100.9 |
| C.III.4 | SURFACE SPILLWAY | 144.0 | 175.4 | 190.3 |
| Total cost of Flood Management Structures | | **667.8** | **640.1** | **459.3** |
| Difference with Alternative FSL 1290 | | **0.0** | **-27.7** | **-208.5** |

### *1.1.3.5 Transportation Tunnels and Galleries*

The total cost of the transportation structures represents about 130 MUS$ for all alternatives.

**Table 2-9: Transportation Structures, [MUS$]**

| C.IV Transportation Structures | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| C.IV.1 | TUNNEL T-10 | 6.0 | 5.3 | 5.7 |
| C.IV.2 | TUNNEL T-18 | 14.0 | 14.1 | 13.7 |
| C.IV.3 | TUNNEL T-39 | 35.9 | 40.4 | 40.0 |
| C.IV.4 | TUNNEL T-22 | 2.6 | 2.6 | 2.6 |
| C.IV.5 | TUNNEL T-10a | 3.5 | 3.5 | 3.5 |
| C.IV.6 | TUNNEL T-3a | 9.7 | 9.7 | 9.7 |
| C.IV.7 | TUNNEL T-50 | 7.7 | 7.7 | 8.3 |
| C.IV.8 | TUNNEL T-2 | 4.3 | 4.3 | 4.3 |
| C.IV.9 | TUNNEL T-8 | 1.2 | 1.2 | 1.2 |
| C.IV.10 | TUNNEL T-8 | 7.5 | 7.5 | 7.5 |
| C.IV.11 | CONVEYOR BELT | 5.0 | 5.0 | 5.0 |
| C.IV.12 | ACCESS ADIT P-37 | 2.2 | 2.2 | 2.2 |
| C.IV.13 | PROVISIONAL SUM FOR TUNNELS PLUGGING | 5.0 | 5.0 | 5.0 |
| C.IV.14 | REMEDIAL WORKS | 21.9 | 21.9 | 21.9 |
| Total cost of Transportation structures | | **126.4** | **130.3** | **130.5** |
| Difference with Alternative FSL 1290 | | **0.0** | **3.9** | **4.1** |

## 2.3 Permanent Equipment

### 2.3.1 General Description

Permanent Equipment are divided into three sections: E&M (Electro-Mechanical Equipment), HSS (Hydro Mechanical Equipment) and TL/SS (Transmission lines). The structure is detailed in Figure 2-7.

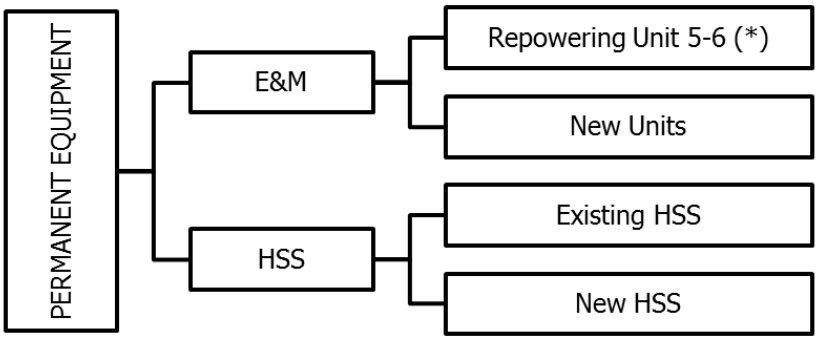



**Figure 2-7: Permanent Equipment, diagram**

The costs of permanent equipment excluding the physical contingencies are given in the following tables:

**Alternative 1 – FSL=1290 m.a.s.l**

| N° | DESCRIPTION | 3600 MW | 3200 MW | 2800 MW |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A | E&M | 798 | 711 | 650 |
| B | HSS | 256 | | |
| C | TL/SS | 20 | 20 | 20 |
| TOTAL PERMANENT EQUIPMENT | | **1 074** | **987** | **926** |
| *Difference with upper installed capacity* | | | *-87* | *-61* |

**Alternative 2 – FSL=1255 m.a.s.l**

| N° | DESCRIPTION | 3200 MW | 2800 MW | 2400 MW |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A | E&M | 711 | 650 | 587 |
| B | HSS | 237 | | |
| C | TL/SS | 20 | 20 | 13 |
| TOTAL PERMANENT EQUIPMENT | | **968** | **907** | **837** |
| *Difference with upper installed capacity* | | | *-61* | *-70* |

**Alternative 3 – FSL=1220 m.a.s.l**

| N° | DESCRIPTION | 2800 MW | 2400 MW | 2000 MW |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A | E&M | 622 | 558 | 494 |
| B | HSS | 222 | | |
| C | TL/SS | 20 | 13 | 13 |
| TOTAL PERMANENT EQUIPMENT | | **863** | **793** | **730** |
| *Difference with upper installed capacity* | | | *-70* | *-64* |

### 1.1.4 E&M Equipment

The E&M equipment includes the repowering of units 5 and 6, and four new units (Units 1 to 4).

**Table 2-10: E&M Equipment, Alternative 1290 m a.s.l, [MUS$]**

| A. E&M EQUIPMENT (1290) | | 3600 MW | 3200 MW | 2800 MW |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A.1 | REPOWERING OF UNIT 6 | **110** | **59** | **58** |
| | *UNIT* | *59* | *59* | *58* |
| | *BOP* | *52* | | |
| A.2 | REPOWERING OF UNIT 5 | **124** | **72** | **71** |
| | *UNIT* | *72* | *72* | *71* |
| | *BOP* | *52* | | |
| A.3 | FOUR NEW UNITS | **519** | **547** | **490** |
| | *UNIT* | *312* | *267* | *239* |
| | *BOP* | *207* | *280* | *251* |

| | | | | |
|---|---|---|---|---|
| A.4 | MISCELLANEA | **45** | **34** | **31** |
| Total cost of New HSS Equipment | | **798** | **711** | **650** |
| *Difference with upper installed capacity* | | | *-87* | *-61* |

**Table 2-11: E&M Equipment, Alternative 1255 m a.s.l, [MUS$]**

| A. E&M EQUIPMENT (1255) | | 3200 MW | 2800 MW | 2400 MW |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A.1 | REPOWERING OF UNIT 6 | **59** | **58** | **0** |
| | *UNIT* | *59* | *58* | *59* |
| | *BOP* | *0* | *0* | |
| A.2 | REPOWERING OF UNIT 5 | **72** | **71** | **0** |
| | *UNIT* | *72* | *71* | *72* |
| | *BOP* | *0* | *0* | |
| A.3 | FOUR NEW UNITS | **547** | **490** | **0** |
| | *UNIT* | *267* | *239* | *209* |
| | *BOP* | *280* | *251* | *219* |
| A.4 | MISCELLANEA | **34** | **31** | **28** |
| Total cost of New HSS Equipment | | **711** | **650** | **28** |
| *Difference with upper installed capacity* | | | *-61* | *-622* |

**Table 2-12: E&M Equipment, Alternative 1220 m a.s.l, [MUS$]**

| A. E&M EQUIPMENT (1220) | | 2800 MW | 2400 MW | 2000 MW |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| A.1 | REPOWERING OF UNIT 6 | **44** | **45** | **46** |
| | *UNIT* | *44* | *45* | *46* |
| | *BOP* | | | |
| A.2 | REPOWERING OF UNIT 5 | **58** | **59** | **60** |
| | *UNIT* | *58* | *59* | *60* |
| | *BOP* | | | |
| A.3 | FOUR NEW UNITS | **490** | **428** | **365** |
| | *UNIT* | *239* | *209* | *178* |
| | *BOP* | *251* | *219* | *187* |
| A.4 | MISCELLANEA | **30** | **27** | **24** |
| Total cost of New HSS Equipment | | **622** | **558** | **494** |
| *Difference with upper installed capacity* | | | *-64* | *-64* |

### 1.1.5 HSS Equipment

Part of HSS equipment has already been manufactured (power outlet/draft tube, temporary power intake, gate chamber of temporary power intake, penstock) so that only the supply, transport and installation have been considered for the estimation (which corresponds to 10 MUS$).

The rest of HSS equipment includes manufacture, transport and installation.

**Table 2-13: New HSS Costs, [MUS$]**

| B. NEW HSS COSTS | | FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|---|---|
| | | TOTAL (MUS$ Equiv.) | | |
| B.1 | DIVERSION TUNNEL 3RD LEVEL (DT3) | 22 | 22 | 22 |
| B.2 | MIDDLE LEVEL OUTLET N.1 (MLO1) | 23 | 23 | 23 |
| B.3 | MIDDLE LEVEL OUTLET N.2 (MLO2) | 24 | | |
| B.4 | HIGH LEVEL SPILLWAY TUNNEL 1 (HLST1) | 8 | 8 | 8 |
| B.5 | HIGH LEVEL SPILLWAY TUNNEL 2 (HLST2) | 8 | 8 | |
| B.6 | HIGH LEVEL SPILLWAY TUNNEL 2 (HLST3) | | 8 | |
| B.7 | SURFACE SPILLWAY | 4 | 7 | 15 |
| B.8 | PERMANENT POWER INTAKES | 72 | 66 | 60 |
| B.9 | PENSTOCKS | 74 | 74 | 74 |
| B.10 | MISCELLANEA | 9 | 9 | 8 |
| Total cost of New HSS Equipment | | **246** | **227** | **212** |
| Difference with Alternative FSL 1290 | | **0** | **-19** | **-34** |

## 1.2 Administration and Engineering

The percentages considered for administration and engineering costs is based on the total construction cost with contingencies (excluding resettlement and replacement costs) are as follows:

- Administration: 3%
- Engineering: 2%

The total cost varies bewteen 150 and 228 millions of US$ .

**Table 2-14: Administration and Engineering, [MUS$]**

| | High Capacity | Intermediate Capacity | Low Capacity |
|---|---|---|---|
| **FSL 1290** | 228 | 223 | 220 |
| **FSL 1255** | 197 | 193 | 190 |
| **FSL 1220** | 157 | 153 | 150 |

## 1.3 Infrastructure Replacement and Resettlement Costs

In order to calculate the total amount for each alternative, used as input data for the economic and financial analysis, resettlement and replacement costs have been included.

**Table 2-15: Resettlement and Replacement Cost, [MUS$]**

| FSL 1290 | FSL 1255 | FSL 1220 |
|---|---|---|
| 408 | 247 | 165 |

## 2.4 Futher Analysis

### 2.4.1 Pareto

The Pareto principle (also known as the 80–20 rule, the law of the vital few, and the principle of factor sparsity) states that, for many events, roughly 80% of the effects come from 20% of the causes.

The applications of this principle are various (business, economic, environmental, sociology, etc.) and very effective to check the quality of a defined work.

This analysis has been proposed for the cost estimate of Phase II – alternative FSL=1290 m a.s.l, in order to check if 20% of included items represent 80% of the total cost.

The Pareto principle can also be used to identify the main components of the cost estimate, i.e. components that have a significant influence on the total amount. In order to evaluate the sensitivity of this analysis, the Pareto principle has been applied by considering three levels of details, as defined below:

| Level | (a) Total number of items | (b) Number of items required to obtain 80% of Total Cost | Percentage (b/a) |
|---|---|---|---|
| 1 | 27 | 8 | 30% |
| 2 | 73 | 19 | 26% |
| 3 | 120 | 29 | 24% |

The **Figure 2-8** corresponds to the three levels defined are presented.

The figure below  bring out the items with the higher percentages of the total amount, sorted from largest to smallest.

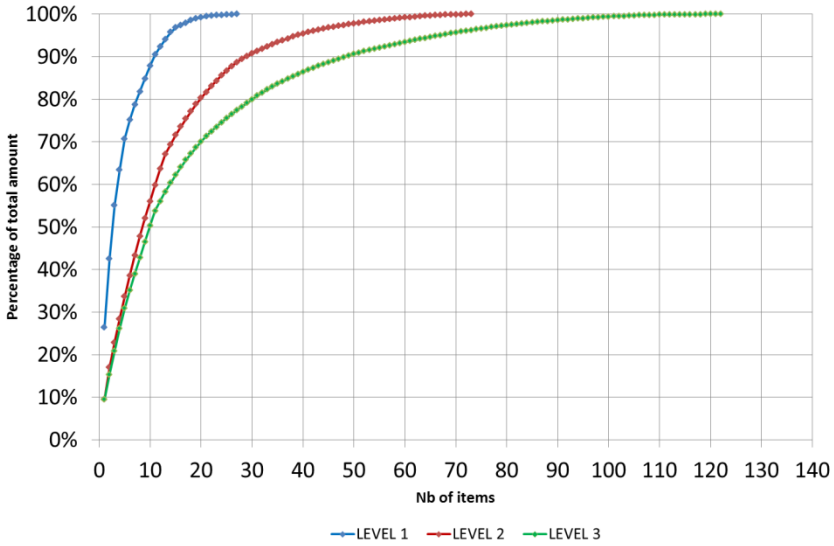



**Figure 2-8: Pareto Principle Applied with three Levels of Definitions**

### 2.4.2 Dam analysis

The **Figure 2-9** shows that a global unit price for the dam (amount includes dam embankment and common works) is approx. 20 US$/m3 for each alternative.

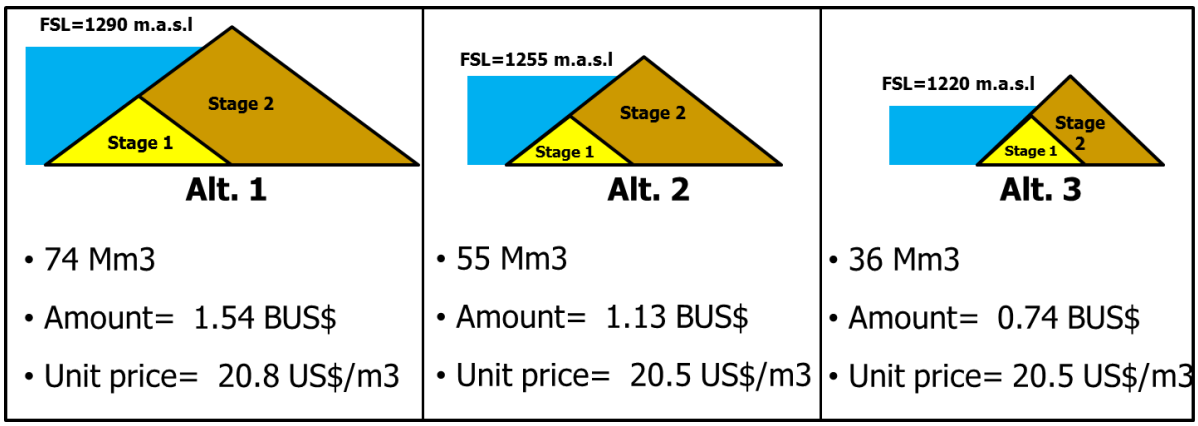



**Figure 2-9: Dam Fills Analysis, Including Common Works (1)**

The **Figure 2-10**, shows that a global unit price for the dam (amount includes dam embankment only) ranges from 14 to 18 US$/m3 according to the alternative considered.

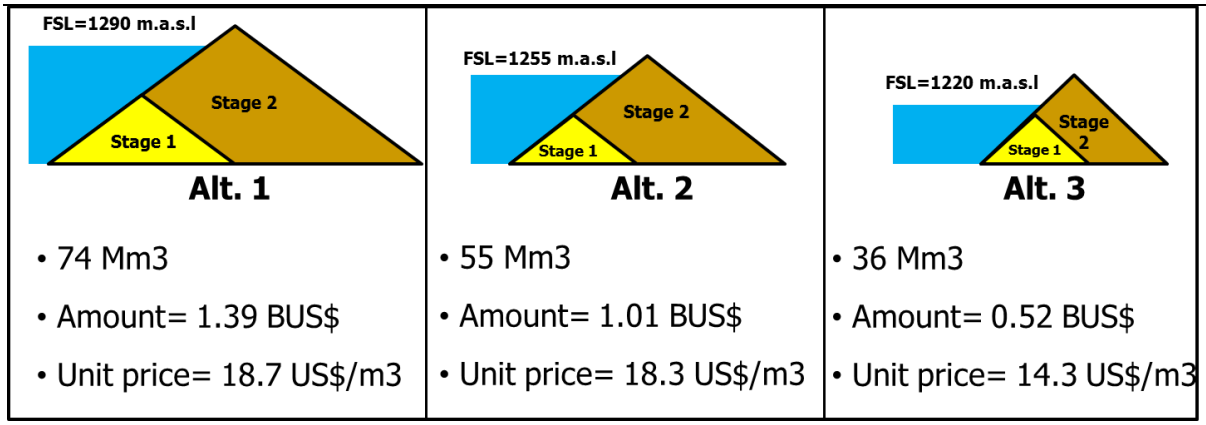



**Figure 2-10: Dam Fills Analysis, Excluding Common Works (2)**

## 2.5 Disbursment curves

The Capex disbursement curve gives the repartition of the total amount year by year. At this stage of the study, it is not possible to establish a precise Capex disbursement curve, but the Consultant proposed its own cost distribution based on its experience of large hydro project and the analysis of the implementation schedule.

The methodology is to determine the amount spent by year from the beginning to the end of the works. In this way, the main items of the Cost Estimate have been identified. The amount of these items is thereafter distributed considering the starting and the ending date.

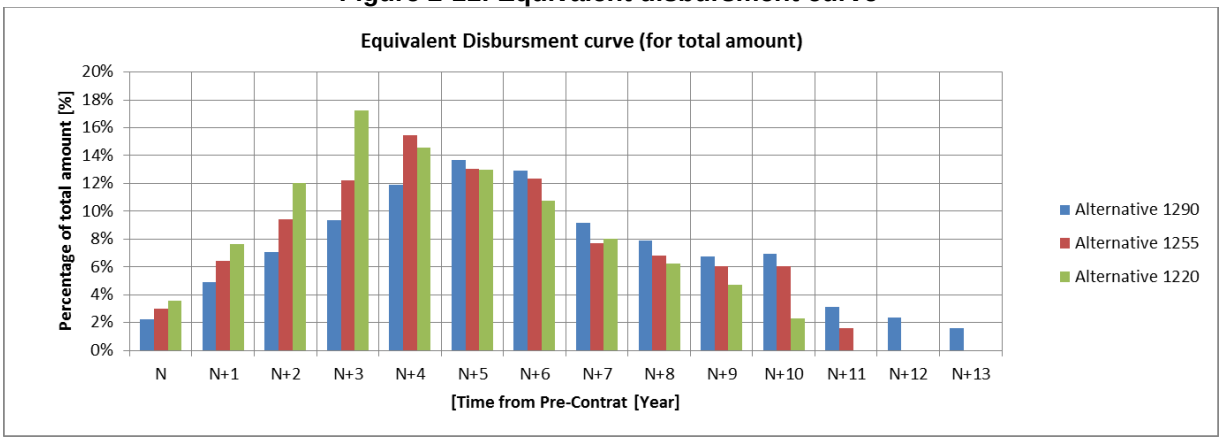
It has been decided to calculate the Equivalent disbursement curve based on disbursement curves derived for the following items:

- Civil Works (General project Cost, Dam works, Underground Works)
- Permanent Equipment (E&M, HSS, TL/SS)
- Administration and Engineering
- Infrastructure Replacement and Resettlement Costs (ESIA Report)

**Table 2-16: Equivalent disbursment curve**

| | N | N+1 | N+2 | N+3 | N+4 | N+5 | N+6 | N+7 | N+8 | N+9 | N+10 | N+11 | N+12 | N+13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
| **Alternative 1290** | | | | | | | | | | | | | | |
| *3600 MW* | 2.3% | 4.9% | 7.1% | 9.4% | 11.9% | 13.7% | 12.9% | 9.2% | 7.9% | 6.7% | 7.0% | 3.1% | 2.4% | 1.6% |
| *3200 MW* | 2.3% | 5.0% | 7.2% | 9.3% | 11.9% | 13.6% | 12.8% | 9.2% | 7.9% | 6.7% | 6.9% | 3.2% | 2.4% | 1.6% |
| *2800 MW* | 2.3% | 5.0% | 7.2% | 9.2% | 11.9% | 13.7% | 12.8% | 9.3% | 7.9% | 6.6% | 6.8% | 3.2% | 2.4% | 1.7% |
| **Alternative 1255** | | | | | | | | | | | | | | |
| *3200 MW* | 3.0% | 6.4% | 9.4% | 12.2% | 15.5% | 13.1% | 12.4% | 7.7% | 6.8% | 6.0% | 6.0% | 1.6% | | |
| *2800 MW* | 3.0% | 6.4% | 9.5% | 12.2% | 15.5% | 13.0% | 12.3% | 7.7% | 6.7% | 6.0% | 6.0% | 1.6% | | |
| *2400 MW* | 3.1% | 6.5% | 9.6% | 12.2% | 15.6% | 12.9% | 12.1% | 7.8% | 6.7% | 5.9% | 6.0% | 1.6% | | |
| **Alternative 1220** | | | | | | | | | | | | | | |
| *2800 MW* | 3.6% | 7.6% | 12.0% | 17.2% | 14.6% | 13.0% | 10.7% | 8.0% | 6.2% | 4.7% | 2.3% | | | |
| *2400 MW* | 3.7% | 7.7% | 12.3% | 17.4% | 14.5% | 12.8% | 10.5% | 8.1% | 6.2% | 4.7% | 2.2% | | | |
| *2000 MW* | 3.7% | 7.8% | 12.4% | 17.4% | 14.5% | 12.8% | 10.4% | 8.1% | 6.1% | 4.5% | 2.2% | | | |

**Figure 2-11: Equivalent disbursment curve**



## Table 2-17: Disbursment curve - Civil Works

| | N | N+1 | N+2 | N+3 | N+4 | N+5 | N+6 | N+7 | N+8 | N+9 | N+10 | N+11 | N+12 | N+13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
| **Alternative 1290** | | | | | | | | | | | | | | |
| *3600 MW* | 3.0% | 5.0% | 7.0% | 9.0% | 12.0% | 14.0% | 12.0% | 10.0% | 8.0% | 6.0% | 5.0% | 4.0% | 3.0% | 2.0% |
| *3200 MW* | 3.0% | 5.0% | 7.0% | 9.0% | 12.0% | 14.0% | 12.0% | 10.0% | 8.0% | 6.0% | 5.0% | 4.0% | 3.0% | 2.0% |
| *2800 MW* | 3.0% | 5.0% | 7.0% | 9.0% | 12.0% | 14.0% | 12.0% | 10.0% | 8.0% | 6.0% | 5.0% | 4.0% | 3.0% | 2.0% |
| **Alternative 1255** | | | | | | | | | | | | | | |
| *3200 MW* | 4.0% | 7.0% | 10.0% | 13.0% | 17.0% | 13.0% | 11.0% | 8.0% | 6.0% | 5.0% | 4.0% | 2.0% | | |
| *2800 MW* | 4.0% | 7.0% | 10.0% | 13.0% | 17.0% | 13.0% | 11.0% | 8.0% | 6.0% | 5.0% | 4.0% | 2.0% | | |
| *2400 MW* | 4.0% | 7.0% | 10.0% | 13.0% | 17.0% | 13.0% | 11.0% | 8.0% | 6.0% | 5.0% | 4.0% | 2.0% | | |
| **Alternative 1220** | | | | | | | | | | | | | | |
| *2800 MW* | 5.0% | 9.0% | 14.0% | 20.0% | 15.0% | 12.0% | 9.0% | 7.0% | 5.0% | 3.0% | 1.0% | | | |
| *2400 MW* | 5.0% | 9.0% | 14.0% | 20.0% | 15.0% | 12.0% | 9.0% | 7.0% | 5.0% | 3.0% | 1.0% | | | |
| *2000 MW* | 5.0% | 9.0% | 14.0% | 20.0% | 15.0% | 12.0% | 9.0% | 7.0% | 5.0% | 3.0% | 1.0% | | | |

## Figure 2-12: Disbursment curve - Civil Works

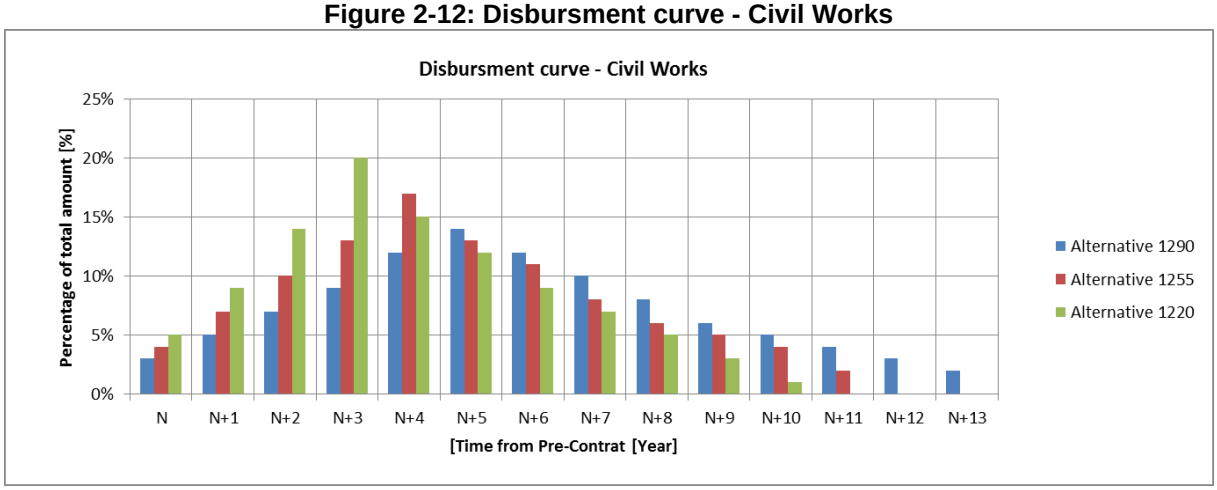


**Table 2-18: Disbursment curve – Permanent Equipmentt**

| | N | N+1 | N+2 | N+3 | N+4 | N+5 | N+6 | N+7 | N+8 | N+9 | N+10 | N+11 | N+12 | N+13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
| **Alternative 1290** | | | | | | | | | | | | | | |
| *3600 MW* | | 4.6% | 7.6% | 10.7% | 12.3% | 13.4% | 16.2% | 6.6% | 7.4% | 8.6% | 12.6% | | | |
| *3200 MW* | | 4.8% | 8.0% | 10.4% | 12.2% | 13.3% | 16.0% | 6.6% | 7.3% | 8.5% | 12.8% | | | |
| *2800 MW* | | 4.8% | 8.3% | 10.2% | 12.1% | 13.3% | 15.9% | 6.6% | 7.3% | 8.5% | 12.9% | | | |
| **Alternative 1255** | | | | | | | | | | | | | | |
| *3200 MW* | | 4.9% | 8.0% | 10.5% | 12.2% | 13.4% | 16.1% | 6.5% | 8.5% | 8.5% | 11.6% | | | |
| *2800 MW* | | 4.9% | 8.3% | 10.3% | 12.1% | 13.3% | 16.0% | 6.5% | 8.4% | 8.4% | 11.8% | | | |
| *2400 MW* | | 5.1% | 8.8% | 10.1% | 12.0% | 12.9% | 15.6% | 6.6% | 8.4% | 8.4% | 12.2% | | | |
| **Alternative 1220** | | | | | | | | | | | | | | |
| *2800 MW* | | 4.5% | 7.9% | 11.7% | 13.6% | 15.0% | 14.4% | 10.0% | 8.6% | 8.6% | 5.7% | | | |
| *2400 MW* | | 4.7% | 8.4% | 11.6% | 13.5% | 14.7% | 14.0% | 10.2% | 8.6% | 8.6% | 5.8% | | | |
| *2000 MW* | | 4.8% | 8.8% | 11.3% | 13.4% | 14.6% | 13.7% | 10.4% | 8.5% | 8.5% | 6.0% | | | |

**Figure 2-13: Disbursment curve - Permanent Equipment**

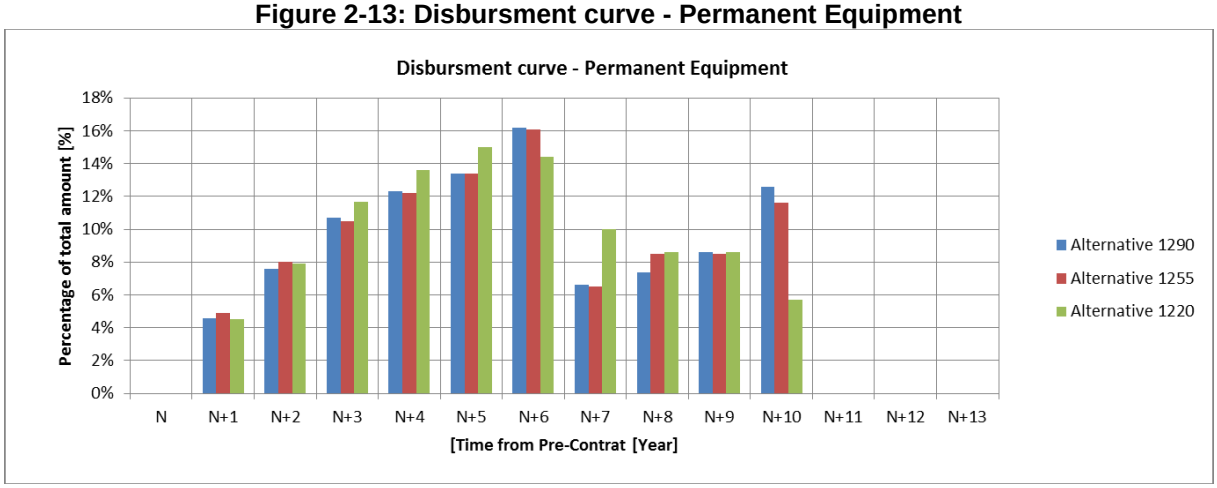


**Table 2-19: Disbursment curve – Administration and Engineering**

| | N | N+1 | N+2 | N+3 | N+4 | N+5 | N+6 | N+7 | N+8 | N+9 | N+10 | N+11 | N+12 | N+13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
| **Alternative 1290** | | | | | | | | | | | | | | |
| *3600 MW* | 3.0% | 5.0% | 6.0% | 8.0% | 9.0% | 10.0% | 10.0% | 10.0% | 9.0% | 8.0% | 7.0% | 6.0% | 5.0% | 4.0% |
| *3200 MW* | 3.0% | 5.0% | 6.0% | 8.0% | 9.0% | 10.0% | 10.0% | 10.0% | 9.0% | 8.0% | 7.0% | 6.0% | 5.0% | 4.0% |
| *2800 MW* | 3.0% | 5.0% | 6.0% | 8.0% | 9.0% | 10.0% | 10.0% | 10.0% | 9.0% | 8.0% | 7.0% | 6.0% | 5.0% | 4.0% |
| **Alternative 1255** | | | | | | | | | | | | | | |
| *3200 MW* | 4.0% | 6.0% | 8.0% | 10.0% | 11.0% | 12.0% | 12.0% | 10.0% | 9.0% | 8.0% | 6.0% | 4.0% | | |
| *2800 MW* | 4.0% | 6.0% | 8.0% | 10.0% | 11.0% | 12.0% | 12.0% | 10.0% | 9.0% | 8.0% | 6.0% | 4.0% | | |
| *2400 MW* | 4.0% | 6.0% | 8.0% | 10.0% | 11.0% | 12.0% | 12.0% | 10.0% | 9.0% | 8.0% | 6.0% | 4.0% | | |
| **Alternative 1220** | | | | | | | | | | | | | | |
| *2800 MW* | 5.0% | 7.0% | 9.0% | 12.0% | 14.0% | 14.0% | 13.0% | 11.0% | 9.0% | 6.0% | | | | |
| *2400 MW* | 5.0% | 7.0% | 9.0% | 12.0% | 14.0% | 14.0% | 13.0% | 11.0% | 9.0% | 6.0% | | | | |
| *2000 MW* | 5.0% | 7.0% | 9.0% | 12.0% | 14.0% | 14.0% | 13.0% | 11.0% | 9.0% | 6.0% | | | | |

**Figure 2-14: Disbursment curve - Administration and Engineering**

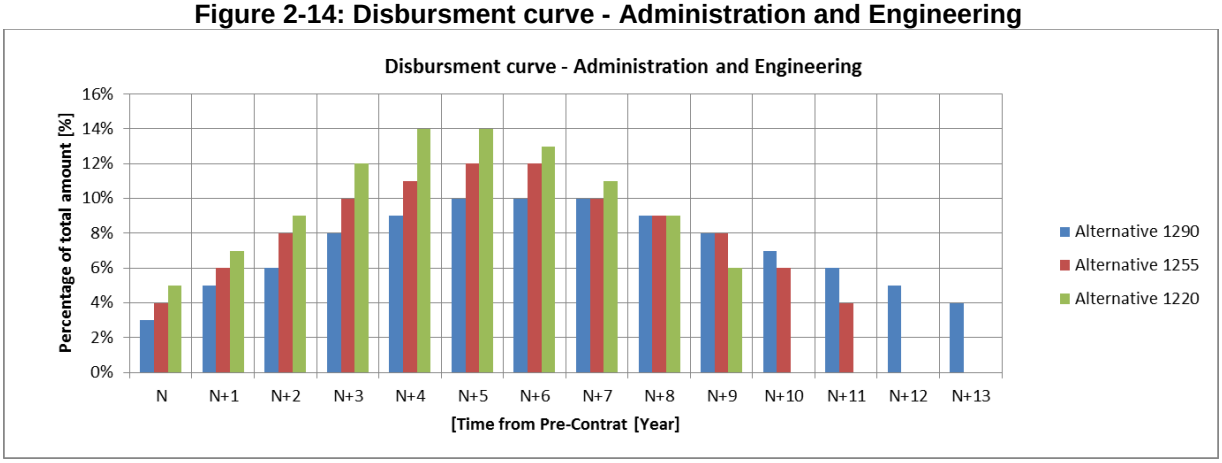
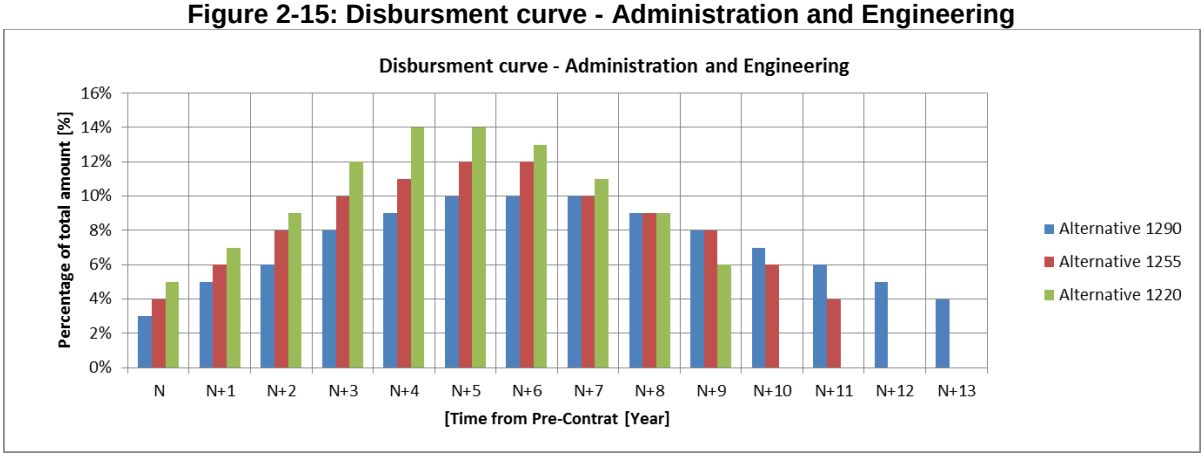


**Table 2-20: Disbursment curve – Administration and Engineering**

| | N | N+1 | N+2 | N+3 | N+4 | N+5 | N+6 | N+7 | N+8 | N+9 | N+10 | N+11 | N+12 | N+13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 |
| **Alternative 1290** | | | | | | | | | | | | | | |
| *3600 MW* | 7.8% | 7.8% | 7.8% | 5.2% | 5.2% | 5.2% | 5.2% | 5.9% | 8.0% | 8.0% | 8.0% | 8.9% | 8.0% | 9.0% |
| *3200 MW* | 7.8% | 7.8% | 7.8% | 5.2% | 5.2% | 5.2% | 5.2% | 5.9% | 8.0% | 8.0% | 8.0% | 8.9% | 8.0% | 9.0% |
| *2800 MW* | 7.8% | 7.8% | 7.8% | 5.2% | 5.2% | 5.2% | 5.2% | 5.9% | 8.0% | 8.0% | 8.0% | 8.9% | 8.0% | 9.0% |
| **Alternative 1255** | | | | | | | | | | | | | | |
| *3200 MW* | 9.9% | 9.9% | 9.9% | 6.1% | 6.1% | 6.1% | 8.5% | 8.5% | 8.5% | 8.5% | 8.5% | 9.5% | | |
| *2800 MW* | 9.9% | 9.9% | 9.9% | 6.1% | 6.1% | 6.1% | 8.5% | 8.5% | 8.5% | 8.5% | 8.5% | 9.5% | | |
| *2400 MW* | 9.9% | 9.9% | 9.9% | 6.1% | 6.1% | 6.1% | 8.5% | 8.5% | 8.5% | 8.5% | 8.5% | 9.5% | | |
| **Alternative 1220** | | | | | | | | | | | | | | |
| *2800 MW* | 12.4% | 12.4% | 12.4% | 6.8% | 6.8% | 9.5% | 9.5% | 9.7% | 9.5% | 11.0% | | | | |
| *2400 MW* | 12.4% | 12.4% | 12.4% | 6.8% | 6.8% | 9.5% | 9.5% | 9.7% | 9.5% | 11.0% | | | | |
| *2000 MW* | 12.4% | 12.4% | 12.4% | 6.8% | 6.8% | 9.5% | 9.5% | 9.7% | 9.5% | 11.0% | | | | |

**Figure 2-15: Disbursment curve - Administration and Engineering**




The note “Specification for Economic and Financial Analysis” included in Volume 5, gives more details about the Input Data necessary for the Economic and Financial analysis.

# PART II: BASIC COSTS – LABOUR AND MATERIALS (CIVILWORKS)

## 1 General

The Part II of this volume includes the labour wages for the surface and underground works and the costs of local and imported materials.

## 3 Labor Wages

The local labor wages are those investigated in Tajikistan during the month of June 2012 and are the average in force in the Country for the construction of civil works.

The expatriate labor wages are those that currently international contractors who work abroad for large civil works projects can assume for preparing a tender for Rogun power plant.

The wages include all the retributions according to the lows in force and the additional burdens such as overtime, night shift differential, site allowance, bonuses and extra compensations.

The cost estimate has been assumed that the labor necessary for the construction activities will be mainly local. However foreign personnel, such as general foremen and specialists have been taken into account for the execution of the works.

The times considered for the workers in the analyses are in general a little more than that established for the construction equipment involved in each specific activity in order to take the time losses that normally occur during the execution of the works into account.

## 4 Materials

The construction materials have been considered procured mainly from foreign countries because not available or not in sufficient quantity in the Country.

The main imported materials include: Portland cement, gasoline, diesel oil, lubricants, part of the explosives, woods, steel items including the bars for concrete reinforcement and, welded wire fabric, rock bolts, tendons, drilling tools (shanks, rods, couplings, rock bits, integral drill steels, breaker tools and other similar consumable goods), panel type steel formworks, telescopic type formworks for tunnels, climbing type formworks, steel scaffoldings, water stops and concrete admixtures.

The local materials include only part of the explosive.

The prices of the imported materials have been obtained from the prevailing quotations in force at the time of the investigation in US$. The quotation in Euros have been converted to

US$ with the prevailing rate of exchange at the time of the investigation i.e. 1 Euro = 1.30 US$. No custom duties and taxes have been added to the cost of imported materials.

The cost of loading, ocean freight, inland transportation to the Site, insurance premium and storage have been added to the ex-factory cost of each item in order to establish the on Site cost.

The burden for losses during transport and handling of some good has been considered in percentage of the supply plus transport cost and included in the material price list.

# 5 Tables of Labor and Materials

The labor wages for the surface and the underground works have been listed in Table BC1 which follows.

The costs of materials have been listed in Table BC2 - BC3 which follows.

**ROGUN HYDROELECTRIC POWER PLANT** **TABLE BC 1**
**CIVIL WORKS COST ESTIMATE - PHASE II**
**BASIC COSTS - LABOUR WAGES**

| Item | Description | Currency | Wage Daily Wage | Hourly Wage | Hourly Wage in US$ Equivalent |
|---|---|---|---|---|---|
| | | | | | |
| **1** | **LOCAL LABOUR** | | | | |
| | | | | | |
| **1.1** | **Surface Works** | | | | |
| | | | | | |
| 1.1.1 | Foreman | Somoni | 232.86 | 29.11 | 6.11 |
| | | | | | |
| 1.1.2 | Heavy equipment operator | do | 205.42 | 25.68 | 5.39 |
| | | | | | |
| 1.1.3 | Specialist (welder, rigger, powder o. etc) | do | 130.34 | 16.29 | 3.42 |
| | | | | | |
| 1.1.4 | Skilled | do | 105.57 | 13.20 | 2.77 |
| | | | | | |
| 1.1.5 | Semiskilled | do | 83.85 | 10.48 | 2.20 |
| | | | | | |
| 1.1.6 | Unskilled | do | 62.50 | 7.81 | 1.64 |
| | | | | | |
| **1.2** | **Underground Works** | | | | |
| | | | | | |
| 1.2.1 | Foreman | Somoni | 251.54 | 31.44 | 6.60 |
| | | | | | |

| Item | Description | Currency | Wage Daily Wage | Hourly Wage | Hourly Wage in US$ Equivalent |
|---|---|---|---|---|---|
| 1.2.2 | Heavy equipment operator | do | 221.81 | 27.73 | 5.82 |
| | | | | | |
| 1.2.3 | Specialist (welder, rigger, powder o. etc) | do | 140.63 | 17.58 | 3.69 |
| | | | | | |
| 1.2.4 | Skilled | do | 113.95 | 14.24 | 2.99 |
| | | | | | |
| 1.2.5 | Semiskilled | do | 90.71 | 11.34 | 2.38 |
| | | | | | |
| 1.2.6 | Unskilled | do | 67.46 | 8.43 | 1.77 |
| | | | | | |
| **2** | **EXPATRIATE LABOUR** | | | | |
| | | | | | |
| **2.1** | **Surface Works** | | | | |
| | | | | | |
| 2.1.1 | Foreman | US$ | 350.00 | 43.75 | ---- |
| | | | | | |
| 2.1.2 | Specialist | do | 330.00 | 41.25 | ---- |
| | | | | | |
| 2.1.3 | Skilled | do | 290.00 | 36.25 | ---- |
| | | | | | |
| **2.2** | **Underground Works** | | | | |
| | | | | | |
| 2.2.1 | Foreman | US$ | 378.00 | 47.25 | ---- |
| | | | | | |
| 2.2.2 | Specialist | do | 363.00 | 45.38 | ---- |
| | | | | | |

| Item | Description | | Wage | | Hourly |
|---|---|---|---|---|---|
| | | Currency | Daily | Hourly | Wage in US$ |
| | | | Wage | Wage | Equivalent |
| 2.2.3 | Skilled | do | 319.00 | 39.88 | ---- |
| | | | | | |

**ROGUN HYDROELECTRIC POWER PLANT** **TABLE BC-2**

**CIVIL WORKS COST ESTIMATE - PHASE II**

**BASIC COSTS - MATERIALS**

| Item | Description | Unit | Source | (Somoni) | | | | Cost in US$ Equivalent |
|---|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Trans-port | T. & H. Losses | Total Cost | |
| | | | | | | | | |
| | **LOCAL MATERIALS** | | | | | | | |
| | | | | | | | | |
| **1** | **Explosives** | | | | | | | |
| 1.01 | Explosive, amonite type | kg | CIF Site | 11.00 | 0.00 | 0.00 | 0.00 | 2.31 |
| | | | | | | | | |
| 1.02 | Explosive, gramonite type | kg | ditto | 9.81 | 0.00 | 0.00 | 0.00 | 2.06 |
| | | | | | | | | |
| 1.03 | Explosive, ammonium nitrate | kg | ditto | 3.53 | 0.00 | 0.00 | 0.00 | 0.74 |
| | | | | | | | | |
| | **Steel items** | | | | | | | |
| 1.04 | Steel tyloop for formworks | ea. | CIF Site | 17.87 | 0.00 | 0.00 | 0.00 | 3.75 |
| | | | | | | | | |

**ROGUN HYDROELECTRIC POWER PLANT** **TABLE BC3**
**CIVIL WORKS COST ESTIMATE - PHASE II**
**BASIC COSTS - IMPORTED MATERIALS**

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| | | | | | | | |
| **1** | **Expansion anchor rock bolts 22.0 mm dia.** | | | | | | |
| 1.01 | Rock bolt, 22 mm dia., length 3.0 m | ea | Europe | 34.10 | 2.59 | 0.00 | 36.69 |
| | | | | | | | |
| 1.02 | Rock bolt, 22 mm dia., length 3.5 m | ea | Ditto | 36.58 | 3.02 | 0.00 | 39.60 |
| | | | | | | | |
| 1.03 | Rock bolt, 22 mm dia., length 4.0 m | ea | Ditto | 39.06 | 3.46 | 0.00 | 42.52 |
| | | | | | | | |
| 1.04 | Rock bolt, 22 mm dia., length 4.5 m | ea | Ditto | 41.54 | 3.89 | 0.00 | 45.43 |
| | | | | | | | |
| 1.05 | Rock bolt, 22 mm dia., length 5.0 m | ea | Ditto | 44.02 | 4.32 | 0.00 | 48.34 |
| | | | | | | | |
| 1.06 | Rock bolt, 22 mm dia., length 5.5 m | ea | Ditto | 46.50 | 4.75 | 0.00 | 51.25 |
| | | | | | | | |
| 1.07 | Rock bolt, 22 mm dia., length 6.0 m | ea | Ditto | 48.98 | 5.18 | 0.00 | 54.16 |
| | | | | | | | |
| **2** | **Expansion anchor rock bolts 26.5 mm dia.** | | | | | | |
| 2.01 | Rock bolt, 26.5 mm dia., length 3.0 m | ea | Europe | 49.58 | 3.65 | 0.00 | 53.23 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 2.02 | Rock bolt, 26.5 mm dia., length 3.5 m | ea | Ditto | 53.28 | 4.27 | 0.00 | 57.55 |
| | | | | | | | |
| 2.03 | Rock bolt, 26.5 mm dia., length 4.0 m | ea | Ditto | 56.98 | 4.86 | 0.00 | 61.84 |
| | | | | | | | |
| 2.04 | Rock bolt, 26.5 mm dia., length 4.5 m | ea | Ditto | 60.68 | 5.48 | 0.00 | 66.16 |
| | | | | | | | |
| 2.05 | Rock bolt, 26.5 mm dia., length 5.0 m | ea | Ditto | 64.38 | 6.08 | 0.00 | 70.46 |
| | | | | | | | |
| 2.06 | Rock bolt, 26.5 mm dia., length 5.5 m | ea | Ditto | 68.08 | 6.70 | 0.00 | 74.78 |
| | | | | | | | |
| 2.07 | Rock bolt, 26.5 mm dia., length 6.0 m | ea | Ditto | 71.78 | 7.29 | 0.00 | 79.07 |
| | | | | | | | |
| **3** | **Resin anchor rock bolts 32 mm dia.** | | | | | | |
| 3.01 | Rock bolt, 32.0 mm dia., length 3.0 m | ea | Europe | 68.84 | 5.35 | 0.00 | 74.19 |
| | | | | | | | |
| 3.02 | Rock bolt, 32.0 mm dia., length 3.5 m | ea | Ditto | 74.24 | 6.24 | 0.00 | 80.48 |
| | | | | | | | |
| 3.03 | Rock bolt, 32.0 mm dia., length 4.0 m | ea | Ditto | 79.64 | 7.13 | 0.00 | 86.77 |
| | | | | | | | |
| 3.04 | Rock bolt, 32.0 mm dia., length 4.5 m | ea | Ditto | 85.04 | 8.02 | 0.00 | 93.06 |
| | | | | | | | |
| 3.05 | Rock bolt, 32.0 mm dia., length 5.0 m | ea | Ditto | 90.44 | 8.91 | 0.00 | 99.35 |
| | | | | | | | |
| 3.06 | Rock bolt, 32.0 mm dia., length 5.5 m | ea | Ditto | 95.84 | 9.80 | 0.00 | 105.64 |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| | | | | | | | |
| 3.07 | Rock bolt, 32.0 mm dia., length 6.0 m | ea | Ditto | 101.24 | 10.69 | 0.00 | 111.93 |
| | | | | | | | |
| 3.08 | Rock bolt, 32.0 mm dia., length 6.5 m | ea | Ditto | 126.80 | 11.58 | 0.00 | 138.38 |
| | | | | | | | |
| 3.09 | Rock bolt, 32.0 mm dia., length 7.0 m | ea | Ditto | 132.20 | 12.47 | 0.00 | 144.67 |
| | | | | | | | |
| 3.10 | Rock bolt, 32.0 mm dia., length 7.5 m | ea | Europe | 137.60 | 13.37 | 0.00 | 150.97 |
| | | | | | | | |
| 3.11 | Rock bolt, 32.0 mm dia., length 8.0 m | ea | Ditto | 143.00 | 14.26 | 0.00 | 157.26 |
| | | | | | | | |
| 3.12 | Rock bolt, 32.0 mm dia., length 8.5 m | ea | Ditto | 148.40 | 15.15 | 0.00 | 163.55 |
| | | | | | | | |
| 3.13 | Rock bolt, 32.0 mm dia., length 9.0 m | ea | Ditto | 153.80 | 16.04 | 0.00 | 169.84 |
| | | | | | | | |
| **4** | **Permanent tendons, 50 t capacity** | | | | | | |
| 4.01 | Tendon, capacity 50 t, length 10 m | ea | Europe | 257.90 | 12.15 | 0.00 | 270.05 |
| | | | | | | | |
| 4.02 | Tendon, capacity 50 t, length 15 m | ea | Ditto | 321.70 | 18.23 | 0.00 | 339.93 |
| | | | | | | | |
| 4.03 | Tendon, capacity 50 t, length 20 m | ea | Ditto | 385.60 | 24.30 | 0.00 | 409.90 |
| | | | | | | | |
| 4.04 | Tendon, capacity 50 t, length 25 m | ea | Ditto | 449.40 | 30.38 | 0.00 | 479.78 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 4.05 | Tendon, capacity 50 t, length 30 m | ea | Ditto | 513.20 | 36.45 | 0.00 | 549.65 |
| | | | | | | | |
| **5** | **Permanent tendons, 70 t capacity** | | | | | | |
| 5.01 | Tendon, capacity 70 t, length 10 m | ea | Europe | 307.00 | 15.93 | 0.00 | 322.93 |
| | | | | | | | |
| 5.02 | Tendon, capacity 70 t, length 15 m | ea | Ditto | 383.00 | 23.90 | 0.00 | 406.90 |
| | | | | | | | |
| 5.03 | Tendon, capacity 70 t, length 20 m | ea | Ditto | 459.00 | 31.86 | 0.00 | 490.86 |
| | | | | | | | |
| 5.04 | Tendon, capacity 70 t, length 25 m | ea | Ditto | 535.00 | 39.83 | 0.00 | 574.83 |
| | | | | | | | |
| 5.05 | Tendon, capacity 70 t, length 30 m | ea | Ditto | 611.00 | 47.79 | 0.00 | 658.79 |
| | | | | | | | |
| **6** | **Integral drill steels and breaker point** | | | | | | |
| 6.01 | Integral drill steel, 22 mm size, length 800 mm | ea | Sweden | 131.00 | 1.65 | 0.00 | 132.65 |
| | | | | | | | |
| 6.02 | Integral drill steel, 22 mm size, length 1600 mm | ea | Ditto | 151.00 | 2.97 | 0.00 | 153.97 |
| | | | | | | | |
| 6.03 | Integral drill steel, 22 mm size, length 2400 mm | ea | Ditto | 170.00 | 4.35 | 0.00 | 174.35 |
| | | | | | | | |
| 6.04 | Integral drill steel, 22 mm size, length 3200 mm | ea | Ditto | 197.00 | 5.78 | 0.00 | 202.78 |
| | | | | | | | |
| 6.05 | Integral drill steel, 22 mm size, length 4000 mm | ea | Ditto | 230.00 | 6.93 | 0.00 | 236.93 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 6.06 | Integral drill steel, 22 mm size, length 4800 mm | ea | Ditto | 278.00 | 8.31 | 0.00 | 286.31 |
| | | | | | | | |
| 6.07 | Hand held breaker moil point, length 440 mm | ea | Ditto | 30.50 | 1.87 | 0.00 | 32.37 |
| | | | | | | | |
| **7** | **Truck drill steels** | | | | | | |
| 7.01 | Track drill rod R32, length 3660 mm | ea | Sweden | 471.80 | 11.44 | 0.00 | 483.24 |
| | | | | | | | |
| 7.02 | Shank adaptor for ditto | ea | Ditto | 275.40 | 1.71 | 0.00 | 277.11 |
| | | | | | | | |
| 7.03 | Coupling for ditto | ea | Sweden | 53.60 | 0.55 | 0.00 | 54.15 |
| | | | | | | | |
| 7.04 | Track drill rod T38, lenght 3660 mm | ea | Ditto | 522.00 | 16.94 | 0.00 | 538.94 |
| | | | | | | | |
| 7.05 | Shank adapter for ditto | ea | Ditto | 282.30 | 2.37 | 0.00 | 284.67 |
| | | | | | | | |
| 7.06 | Coupling for ditto | ea | Ditto | 76.30 | 0.94 | 0.00 | 77.24 |
| | | | | | | | |
| 7.07 | Track drill rod T45, lenght 3660 mm | ea | Ditto | 701.65 | 22.77 | 0.00 | 724.42 |
| | | | | | | | |
| 7.08 | Shank adapter for ditto | ea | Ditto | 294.70 | 3.36 | 0.00 | 298.06 |
| | | | | | | | |
| 7.09 | Coupling for ditto | ea | Ditto | 114.80 | 1.76 | 0.00 | 116.56 |
| | | | | | | | |
| **8** | **Tunnelling jumbo drill steels** | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 8.01 | Tunnel jumbo rod R 32, length 3090 mm | ea | Sweden | 449.10 | 10.89 | 0.00 | 459.99 |
| | | | | | | | |
| 8.02 | Tunnel jumbo rod R 32, length 4310 mm | ea | Ditto | 623.70 | 15.13 | 0.00 | 638.83 |
| | | | | | | | |
| 8.03 | Tunnel jumbo rod R 32, length 5530 mm | ea | Ditto | 789.30 | 19.14 | 0.00 | 808.44 |
| | | | | | | | |
| 8.04 | Shank adapter for ditto | ea | Ditto | 300.50 | 1.87 | 0.00 | 302.37 |
| | | | | | | | |
| 8.05 | Coupling for ditto | ea | Ditto | 76.00 | 1.05 | 0.00 | 77.05 |
| | | | | | | | |
| **9** | **Percussion drill bits** | | | | | | |
| 9.01 | Button type rock bit, 35 mm dia. | ea | Sweden | 79.30 | 0.28 | 0.00 | 79.58 |
| | | | | | | | |
| 9.02 | Button type rock bit, 45 mm dia. | ea | Ditto | 136.80 | 0.44 | 0.00 | 137.24 |
| | | | | | | | |
| 9.03 | Button type rock bit, 48 mm dia. | ea | Ditto | 150.00 | 0.50 | 0.00 | 150.50 |
| | | | | | | | |
| 9.04 | Button type rock bit, 51 mm dia. | ea | Ditto | 163.80 | 0.55 | 0.00 | 164.35 |
| | | | | | | | |
| 9.05 | Button type rock bit, 64 mm dia. | ea | Ditto | 291.10 | 0.88 | 0.00 | 291.98 |
| | | | | | | | |
| 9.06 | Button type rock bit, 76 mm dia. | ea | Ditto | 393.00 | 1.21 | 0.00 | 394.21 |
| | | | | | | | |
| 9.07 | Button type rock bit, 89 mm dia. | ea | Ditto | 466.30 | 1.76 | 0.00 | 468.06 |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| | | | | | | | |
| 9.08 | Button type rock bit, 102 mm dia. | ea | Ditto | 584.70 | 2.15 | 0.00 | 586.85 |
| | | | | | | | |
| 9.09 | Reamer rock bit, 102 mm dia. | ea | Ditto | 416.00 | 1.16 | 0.00 | 417.16 |
| | | | | | | | |
| **10** | **Rods, barrels & bits for rotary drilling** | | | | | | |
| 10.01 | Drill rod for rotary drilling, 42 x 1500 mm | ea | Sweden | 90.00 | 3.96 | 0.00 | 93.96 |
| | | | | | | | |
| 10.02 | Drill rod for rotary drilling, 50 x 1500 mm | ea | Ditto | 124.00 | 6.35 | 0.00 | 130.35 |
| | | | | | | | |
| 10.03 | Drill rod for rotary drilling, 60 x 1500 mm | ea | Ditto | 167 | 9.68 | 0 | 176.68 |
| | | | | | | | |
| | **Rods, barrels & bits for rotary drilling (cont.)** | | | | | | |
| 10.04 | Drill rod for rotary drilling, 42 x 3000 mm | ea | Sweden | 165.00 | 7.21 | 0.00 | 172.21 |
| | | | | | | | |
| 10.05 | Drill rod for rotary drilling, 50 x 3000 mm | ea | Ditto | 225.00 | 11.55 | 0.00 | 236.55 |
| | | | | | | | |
| 10.06 | Drill rod for rotary drilling, 60 x 3000 mm | ea | Ditto | 302.00 | 17.60 | 0.00 | 319.60 |
| | | | | | | | |
| 10.07 | Simple core barrel, 56 mm dia., length 1500 mm | ea | Ditto | 574.00 | 8.25 | 0.00 | 582.25 |
| | | | | | | | |
| 10.08 | Simple core barrel, 56 mm dia., length 3000 mm | ea | Ditto | 696.00 | 16.50 | 0.00 | 712.50 |
| | | | | | | | |
| 10.09 | Doble core barrel, 56 mm dia., length 1500 mm | ea | Ditto | 869.00 | 13.75 | 0.00 | 882.75 |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| | | | | | | | |
| 10.10 | Double core barrel, 56 mm dia., length 3000 mm | ea | Ditto | 1,054.00 | 28.05 | 0.00 | 1082.05 |
| | | | | | | | |
| 10.11 | Diamond core bit, 76/56 mm diameter | ea | Ditto | 766.00 | 0.83 | 0.00 | 766.83 |
| | | | | | | | |
| 10.12 | Diamond impregnated type plug bit, 36 mm diameter | ea | Ditto | 507.00 | 0.28 | 0.00 | 507.28 |
| | | | | | | | |
| 10.13 | Diamond impregnated type plug bit, 46 mm diameter | ea | Ditto | 610.00 | 0.72 | 0.00 | 610.72 |
| | | | | | | | |
| 10.14 | Diamond impregnated type plug bit, 56 mm diameter | ea | Ditto | 793.00 | 1.05 | 0.00 | 794.05 |
| | | | | | | | |
| 10.15 | Diamond impregnated type plug bit, 66 mm diameter | ea | Ditto | 1,071.00 | 1.38 | 0.00 | 1072.38 |
| | | | | | | | |
| 10.16 | Diamond impregnated type plug bit, 76 mm diameter | ea | Ditto | 1,390.00 | 1.65 | 0.00 | 1391.65 |
| | | | | | | | |
| **11** | **Pakers** | | | | | | |
| 11.01 | Top type mecanically expanded packer, Ø 43.5 mm | ea | Sweden | 514.00 | 2.75 | 0.00 | 516.75 |
| | | | | | | | |
| 11.02 | Single type inflatable paker, 30-55 mm dia., L 500 | ea | Ditto | 956.00 | 2.20 | 0.00 | 958.20 |
| | | | | | | | |
| 11.03 | Single type inflatable paker, 42-98 mm dia., L 500 | ea | Ditto | 1,019.00 | 3.30 | 0.00 | 1022.30 |
| | | | | | | | |
| 11.04 | Double type inflatable paker, 42-98 mm dia., L 500x2 | ea | Ditto | 1,332.00 | 5.50 | 0.00 | 1337.50 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| **12** | **Waterstops** | | | | | | |
| 12.01 | PVC waterstop, width 220 mm | m | Europe | 6.50 | 0.56 | 0.00 | 7.06 |
| | | | | | | | |
| 12.02 | PVC waterstop, width 2500 mm | m | Ditto | 7.20 | 0.66 | 0.00 | 7.86 |
| | | | | | | | |
| 12.03 | PVC waterstop, width 320 mm | m | Ditto | 7.82 | 0.86 | 0.00 | 8.68 |
| | | | | | | | |
| **13** | **Cement and bentonite** | | | | | | |
| 13.01 | Portland cement ASTM type I or II, bulk | t | CIF Site | 0.00 | 0.00 | 0.00 | 206.20 |
| | | | | | | | |
| 13.02 | Portland cement ASTM type I or II, bagged | t | Ditto | 0.00 | 0.00 | 0.00 | 216.10 |
| | | | | | | | |
| 13.03 | Portland cement ASTM type V (sulfate resistant), | t | Ditto | 0.00 | 0.00 | 0.00 | 242.20 |
| | bulk | | | | | | |
| | | | | | | | |
| 13.04 | Silica fume | t | CIF Site | 0.00 | 0.00 | 0.00 | 468.00 |
| | | | | | | | |
| 13.05 | Bentonite | t | Ditto | 0.00 | 0.00 | 0.00 | 357.00 |
| | | | | | | | |
| **14** | **Concrete admixtures & form break bond** | | | | | | |
| 14.01 | Water-reducing admixture | kg | Turkey | 1.16 | 0.26 | 0.02 | 1.44 |
| | | | | | | | |
| 14.02 | Superplasticizer admixture | kg | Ditto | 1.68 | 0.26 | 0.03 | 1.97 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 14.03 | Air entraining | kg | Ditto | 1.59 | 0.26 | 0.03 | 1.88 |
| | | | | | | | |
| 14.04 | Shotcrete quick set admixture | kg | Ditto | 0.52 | 0.26 | 0.01 | 0.79 |
| | | | | | | | |
| 14.05 | Formworks break-bond emulsion | kg | Ditto | 2.91 | 0.26 | 0.06 | 3.23 |
| | | | | | | | |
| **15** | **Wooden items** | | | | | | |
| 15.01 | Lumber for formworks, planks sawn | $m^3$ | CIF Site | 0.00 | 0.00 | 0.00 | 350.00 |
| | | | | | | | |
| 15.02 | Lumber for formworks, planks planed | $m^3$ | Ditto | 0.00 | 0.00 | 0.00 | 420.00 |
| | | | | | | | |
| 15.03 | Lumber for formworks, square sawn | $m^3$ | Ditto | 0.00 | 0.00 | 0.00 | 310.00 |
| | | | | | | | |
| 15.04 | Plywood for formworks, 12 mm thick | $m^2$ | Ditto | 0.00 | 0.00 | 0.00 | 11.45 |
| | | | | | | | |
| 15.05 | Plywood for formworks, 25 mm thick | $m^2$ | Ditto | 0.00 | 0.00 | 0.00 | 20.27 |
| | | | | | | | |
| **16** | **Fuels and lubricants** | | | | | | |
| 16.01 | Diesel oil | Lit | Russia | 0.60 | 0.37 | 0.02 | 0.99 |
| | | | | | | | |
| 16.02 | Gasoline (petrol) | Lit | Ditto | 0.65 | 0.37 | 0.02 | 1.04 |
| | | | | | | | |
| 16.03 | Lubricant for diesel engine | kg | Ditto | 4.20 | 0.40 | 0.00 | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| | | | | | | | 4.60 |
| | | | | | | | |
| 16.04 | Lubricant for gasoline engine | kg | Ditto | 4.60 | 0.40 | 0.00 | 5.00 |
| | | | | | | | |
| 16.05 | Lubricant for transmissions and gears | kg | Ditto | 3.70 | 0.40 | 0.00 | 4.10 |
| | | | | | | | |
| 16.06 | Hydraulic oil | kg | Ditto | 3.60 | 0.40 | 0.00 | 4.00 |
| | | | | | | | |
| 16.07 | Grease, litium type | kg | Ditto | 4.40 | 0.40 | 0.00 | 4.80 |
| | | | | | | | |
| **17** | **Explosives and related materials** | | | | | | |
| 17.01 | Explosive, emulsion type | kg | CIF Site | 2.28 | 0.00 | 0.00 | 2.28 |
| | | | | | | | |
| 17.02 | Electric detonators, 3.0 m leading wires | ea | Ditto | 1.98 | 0.00 | 0.00 | 1.98 |
| | | | | | | | |
| 17.03 | Plain detonator | m | Ditto | 0.78 | 0.00 | 0.00 | 0.78 |
| | | | | | | | |
| 17.04 | Detonating fuse (cord) | m | CIF Site | 0.82 | 0.00 | 0.00 | 0.82 |
| | | | | | | | |
| 17.05 | Slow burning fuse | m | Ditto | 0.51 | 0.00 | 0.00 | 0.51 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 17.06 | Copper type firing cable | m | Ditto | 0.56 | 0.00 | 0.00 | 0.56 |
| | | | | | | | |
| 17.07 | Copper type shotfiring wire | m | Ditto | 0.13 | 0.00 | 0.00 | 0.13 |
| | | | | | | | |
| **18** | **Steel items** | | | | | | |
| 18.01 | Reinforcing steel Ø 10-20 mm, plain | kg | Russia | 0.42 | 0.41 | 0.00 | 0.83 |
| | | | | | | | |
| 18.02 | Reinforcing steel Ø 16-32 mm, deformed | kg | Ditto | 0.43 | 0.41 | 0.00 | 0.84 |
| | | | | | | | |
| 18.03 | Welded wire fabric | kg | Ditto | 0.46 | 0.41 | 0.00 | 0.87 |
| | | | | | | | |
| 18.04 | Reinforcing steel, prestress type | kg | Ditto | 1.19 | 0.41 | 0.00 | 1.60 |
| | | | | | | | |
| 18.05 | Steel plates, from 10 to 25 mm thickness | kg | Ditto | 0.43 | 0.41 | 0.00 | 0.84 |
| | | | | | | | |
| 18.06 | Steel beams, H shape 150 to 300 mm | kg | Ditto | 0.60 | 0.41 | 0.00 | 1.01 |
| | | | | | | | |
| 18.07 | Steel conventional shapes (L, T, Z, Π and similar) | kg | Ditto | 0.65 | 0.41 | 0.00 | 1.06 |
| | | | | | | | |
| 18.08 | Black steel pipes, from 25 mm to 76 mm dia. | kg | Ditto | 1.20 | 0.41 | 0.00 | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| | | | | | | | 1.61 |
| | | | | | | | |
| 18.09 | Black steel pipes, from 76 mm to 200 mm dia. | kg | Ditto | 1.00 | 0.41 | 0.00 | 1.41 |
| | | | | | | | |
| 18.10 | Galvanized steel pipes, from 25 mm to 50 mm dia. | kg | Ditto | 1.56 | 0.41 | 0.00 | 1.97 |
| | | | | | | | |
| 18.11 | Galvanized steel pipes, from 50 mm to 100 mm dia. | kg | Ditto | 1.50 | 0.41 | 0.00 | 1.91 |
| | | | | | | | |
| 18.12 | Black wire (0.8-1.5 mm dia) | kg | Ditto | 0.75 | 0.41 | 0.00 | 1.16 |
| | | | | | | | |
| 18.13 | Nails for wooden forworks | kg | Ditto | 0.70 | 0.41 | 0.00 | 1.11 |
| | | | | | | | |
| **19** | **Galvanized steel scaffoldings** | | | | | | |
| 19.01 | Steel scaffolding, pipe | m | Europe | 8.91 | 1.34 | 0.00 | 10.25 |
| | | | | | | | |
| 19.02 | Steel scaffolding, joint (average of 3 types) | ea | Ditto | 10.08 | 0.50 | 0.00 | 10.58 |
| | | | | | | | |
| 19.03 | Steel scaffolding, connection | ea | Ditto | 4.19 | 0.23 | 0.00 | 4.42 |
| | | | | | | | |
| 19.04 | Steel scaffolding, base | ea | Ditto | 4.59 | 0.36 | 0.00 | 4.95 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 19.05 | Fast assembly wall type scaffolding | m2 | Ditto | 47.50 | 2.88 | 0.00 | 50.38 |
| | (steel component only) | | | | | | |
| | | | | | | | |
| **20** | **Wall type steel formworks** | | | | | | |
| 20.01 | Single panel type steel formwork with anchoring truss | $m^2$ | Europe | 754.40 | 66.24 | 0.00 | 820.64 |
| | | | | | | | |
| 20.02 | Anchor bolt for ditto | ea. | Ditto | 53.25 | 5.40 | 0.00 | 58.65 |
| | | | | | | | |
| 20.03 | Multipanels type steel formworks with clamps | $m^2$ | Ditto | 222.75 | 16.20 | 0.00 | 238.95 |
| | | | | | | | |
| **21** | **Steel formworks for underground concrete** | | | | | | |
| 21.01 | Full round formwork, 3.75 m diameter | $m^2$ | Europe | 589.00 | 55.80 | 0.00 | 644.80 |
| | | | | | | | |
| 21.02 | Traveller on rail for Ø 3.75 m form shifting | unit | Ditto | 40,000.00 | 3,600.00 | 0.00 | 43,600.00 |
| | | | | | | | |
| 21.03 | Full round formwork, 8.00 m diameter | $m^2$ | Ditto | 665.00 | 64.80 | 0.00 | 729.80 |
| | | | | | | | |
| 21.04 | Traveller on rail for Ø 8.00 m form shifting | unit | Ditto | 54,960.00 | 5,040.00 | 0.00 | 60,000.00 |
| | | | | | | | |
| 21.05 | Arch and sidewalls formwork, 3-4 m span | $m^2$ | Ditto | 418.00 | 39.60 | 0.00 | 457.60 |
| | | | | | | | |
| 21.06 | Arch and sidewalls formwork, 4-6 m span | $m^2$ | Ditto | 456.00 | 43.20 | 0.00 | 499.20 |
| | | | | | | | |
| 21.07 | Arch and sidewalls formwork, 6-8 m span | $m^2$ | Ditto | 532.00 | 50.40 | 0.00 | 582.40 |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| | | | | | | | |
| 21.08 | Arch and sidewalls formwork, 8-10 m span | $m^2$ | Ditto | 627.00 | 59.40 | 0.00 | 686.40 |
| | | | | | | | |
| 21.09 | Arch and sidewalls formwork, 10-12 m span | $m^2$ | Ditto | 722.00 | 68.40 | 0.00 | 790.40 |
| | | | | | | | |
| 21.10 | Arch formwork, 11-13 m span | $m^2$ | Ditto | 738.00 | 64.80 | 0.00 | 802.80 |
| | | | | | | | |
| 21.11 | Arch formwork, 13.14 m span | $m^2$ | Ditto | 861.00 | 75.60 | 0.00 | 936.60 |
| | | | | | | | |
| 21.12 | Arch formwork, 19.00 m span with shifting trolley | $m^2$ | Ditto | 1,081.00 | 82.80 | 0.00 | 1,163.80 |
| | | | | | | | |
| 21.13 | Arch formwork, 20.50 m span with shifting trolley | $m^2$ | Ditto | 1,222.00 | 93.60 | 0.00 | 1,315.60 |
| | | | | | | | |
| 21.14 | Arch formwork, 24.00 m span with shifting trolley | $m^2$ | Ditto | 1,410.00 | 108.00 | 0.00 | 1,518.00 |
| | | | | | | | |
| 21.15 | Side closure of tunnel formworks | $m^2$ | Ditto | 380.00 | 36.00 | 0.00 | 416.00 |
| | | | | | | | |
| 21.16 | Formwork for tunnel side curbs, type 1 | $m^2$ | Ditto | 410.00 | 36.00 | 0.00 | 446.00 |
| | | | | | | | |
| 21.17 | Formwork for tunnel side curbs, type 2 | $m^2$ | Ditto | 492.00 | 43.20 | 0.00 | 535.20 |
| | | | | | | | |
| **22** | **Rubber hoses, 12 bar pressure** | | | | | | |
| 22.01 | Rubber hoses 19 mm (3/4") diameter with fittings | m | Europe | 10.64 | 0.59 | 0.00 | 11.23 |
| | | | | | | | |

| Item | Description | Unit | Source | Cost (US$) | | | |
|---|---|---|---|---|---|---|---|
| | | | | Basic Cost | Transport Cost | T&H Losses | Total Cost |
| 22.02 | Rubber hoses 25 mm (1") diameter with fittings | m | Ditto | 14.30 | 0.86 | 0.00 | 15.16 |
| | | | | | | | |
| 22.03 | Rubber hoses 37 mm (1-1/2") diameter with fittings | m | Ditto | 19.40 | 1.27 | 0.00 | 20.67 |
| | | | | | | | |
| 22.04 | Rubber hoses 50 mm (2") diameter with fittings | m | Ditto | 24.70 | 1.98 | 0 | 26.68 |
| | | | | | | | |
| **23** | **Miscellaneous** | | | | | | |
| 23.01 | Steel rib supports | kg | Europe | 1.60 | 0.55 | 0.00 | 2.15 |
| | | | | | | | |
| 23.02 | Ribbed galvanized steel sheet, 3/10 mm thickness | m2 | Ditto | 3.25 | 0.33 | 0.00 | 3.58 |
| | | | | | | | |
| 23.03 | Ribbed galvanized steel sheet, 5/10 mm thickness | m2 | Ditto | 4.29 | 1.38 | 0.00 | 5.67 |
| | | | | | | | |
| 23.04 | Galvanized gabions, 8x10 cm mesh, Ø 2.7 mm wire | kg | Ditto | 4.19 | 0.77 | 0.00 | 4.96 |
| | | | | | | | |
| | *Note: "T&H" Losses = Transport & handling losses* | | | | | | |

# PART III: CONSTRUCTION EQUIPMENT RATES

## 1 Estimate of the Rates

The rates of the main construction equipment have been established by means of a computerized program.

The program takes several basic data of each unit into account such as: delivered price to the customer including attachments, residual value at replacement, net value to be recovered through work, estimated ownership period, estimated usage time, repairs carried out at the Site workshop, mechanical availability, condition of roads, abrasion degree of the soil and other specific data which can affect the cost of each equipment.

The rates include the owning and the operating costs. The owning costs include: depreciation, interest cost, insurance, installation and dismantling. The operating costs include: repairs, fuel, lubricants, electric power, specific wear items and other minor items such as filters, batteries, grease, tires, and other minor costs.

The depreciation has been calculated according to the straight- line method for the economic life of the different machines, leaving a residual amount (i.e. resale salvage value) for some units according to the total life established for the depreciation.

Interest and insurance, applied against owner's average capital cost, have been calculated with an annual rate equal to 6.5% and 1.5% respectively.

The rates of equipment have been divided into two groups, i.e. rates for mobile units and rates for stationary/dedicated units. The first group includes the units that in general can be used in several sections of works; the second group includes the units that in general are dedicated to specific works for several months.

The owning cost of the mobile units has been tabulated separately and utilized in the price analyses for taking the cost of the reserve units that the contractor has to keep at the Site in order to perform the construction activities according to the time schedule in force.

The rates of stationary/dedicated units have been separated into owning costs (per month) and operating costs (per hour). In the owning rates have been also included the cost for the basic spare parts that the contractor have to keep on Site in order to assure an uninterrupted service of the units.

The rate of some unit has been calculated both for average working conditions and severe working conditions.

## 2 Table of Rates

The construction equipment rates are listed in Table CE1 which follows.

**ROGUN HYDROELECTRIC POWER PROJECT** **TABLE CE1**
**CIVIL WORKS COST ESTIMATE - PHASE II**
**CONSTRUCTION EQUIPMENT - HOURLY COSTS**

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| | | (1) | (2) | | | |
| **A** | **MOBILE EQUIPMENT** | | | | | |
| | | | | | | |
| **1** | **Bulldozers** | | | | | |
| 1.01 | Bulldozer with universal type blade, 72 kW | Op. | A | 0.63 | 48.81 | 49.44 |
| | | s.b. | ---- | 0.00 | 20.84 | 20.84 |
| 1.02 | Bulldozer with universal type blade, 153 kW | Op. | A | 0.96 | 79.55 | 80.51 |
| | | s.b. | ---- | 0.00 | 30.76 | 30.76 |
| 1.03 | Bulldozer with universal type blade, 179 kW | Op. | A | 1.29 | 97.19 | 98.48 |
| | | s.b. | ---- | 0.00 | 36.66 | 36.66 |
| 1.04 | Bulldozer with universal type blade, 231 kW | Op. | A | 1.64 | 121.99 | 123.63 |
| | | s.b. | ---- | 0.00 | 45.46 | 45.46 |
| 1.05 | Bulldozer with universal type blade, 306 kW | Op. | A | 2.29 | 161.65 | 163.94 |
| | | s.b. | ---- | 0.00 | 58.03 | 58.03 |
| 1.06 | Bulldozer with universal b. & parall. type ripper, 179 kW | Op. | S | 1.98 | 131.75 | 133.73 |
| | | s.b. | ---- | 0.00 | 47.53 | 47.53 |
| 1.07 | Bulldozer with universal b. & single-shank ripper, 231 kW | Op. | S | 3.19 | 171.52 | 174.71 |
| | | s.b. | ---- | 0.00 | 59.83 | 59.83 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 1.08 | Bulldozer with universal b. & single-shank ripper, 306 kW | Op. | S | 2.90 | 303.48 | 306.38 |
| | | s.b. | ---- | 0.00 | 69.83 | 69.83 |
| **2** | **Wheel loaders** | | | | | |
| 2.01 | Wheel loader, 72 kW, 1.30 m3 heaped bucket | Op. | A | 0.35 | 31.09 | 31.44 |
| | | s.b. | ---- | 0.00 | 13.33 | 13.33 |
| 2.02 | Wheel loader, 115 kW, 2.10 - 2.40 m3 heaped bucket | Op. | A | 0.49 | 44.61 | 45.10 |
| | | s.b. | ---- | 0.00 | 18.74 | 18.74 |
| 2.03 | Wheel loader, 157 kW, 2.95-3.30 m3 heaped bucket | Op. | A | 0.60 | 54.76 | 55.36 |
| | | s.b. | ---- | 0.00 | 21.07 | 21.07 |
| 2.04 | Wheel loader, 157 kW, 3.10 m3 heaped rock bucket | Op. | S | 0.75 | 70.52 | 71.27 |
| | | s.b. | ---- | 0.00 | 26.87 | 26.87 |
| 2.05 | Wheel loader, 199 kW, 3.70 - 4.30 m3 heaped bucket | Op. | A | 0.83 | 73.62 | 74.45 |
| | | s.b. | ---- | 0.00 | 28.96 | 28.96 |
| 2.06 | Wheel loader, 199 kW, 4.0 m3 heaped rock bucket | Op. | S | 0.83 | 73.62 | 74.45 |
| | | s.b. | ---- | 0.00 | 28.96 | 28.96 |
| 2.07 | Wheel loader, 275 kW, 5.20 - 5.80 m3 heaped bucket | Op. | A | 1.03 | 97.91 | 98.94 |
| | | s.b. | ---- | 0.00 | 35.81 | 35.81 |
| 2.08 | Wheel loader, 275 kW, 5.50 m3 heaped rock bucket | Op. | S | 1.35 | 135.08 | 136.43 |
| | | s.b. | ---- | 0.00 | 44.63 | 44.63 |
| 2.09 | Wheel loader, 373 kW, 6.40 - 7.30 m3 heaped bucket | Op. | A | 1.56 | 142.03 | 143.59 |
| | | s.b. | ---- | 0.00 | 53.94 | 53.94 |
| **3** | **Track type hydraulic excavators (backhoes)** | | | | | |
| 3.01 | Hydraulic backhoe, 41 kW, 0.37 m3 g. p. heaped bucket | Op. | A | 0.27 | 23.93 | 24.20 |
| | | s.b. | ---- | 0.00 | 12.03 | 12.03 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 3.02 | Hydraulic backhoe, 130 kW, 1.80 m3 g. p.heaped bucket | Op. | A | 0.58 | 56.52 | 57.10 |
| | | s.b. | ---- | 0.00 | 23.56 | 23.56 |
| 3.03 | Hydraulic backhoe, 161 kW, 2.35 m3 g. p.heaped bucketd | Op. | A | 0.63 | 66.88 | 67.51 |
| | | s.b. | ---- | 0.00 | 25.76 | 25.76 |
| 3.04 | Hydraulic backhoe, 200 kW, 2.60 m3 g. p. heaped bucketd | Op. | A | 0.67 | 81.94 | 82.61 |
| | | s.b. | ---- | 0.00 | 27.32 | 27.32 |
| 3.05 | Hydraulic backhoe, 239 kW, 3.50 m3 g. p. heaped bucket | Op. | A | 0.95 | 99.42 | 100.37 |
| | | s.b. | ---- | 0.00 | 38.33 | 38.33 |
| 3.06 | Hydraulic backhoe, 354 kW, 5.10 m3 g. p. heaped bucket | Op. | A | 1.44 | 149.70 | 151.14 |
| | | s.b. | ---- | 0.00 | 58.35 | 58.35 |
| 3.07 | Hydraulic backhoe used for y.vibrators, 41 kW, 8.5 t oper. weigth | Op. | A | 0.23 | 15.23 | 15.46 |
| | | | | | | |
| 3.08 | Hydraulic front shovel, 301 kW, 4.10 m3 heaped bucket | Op. | A | 1.37 | 123.22 | 124.59 |
| | | s.b. | ---- | 0.00 | 53.08 | 53.08 |
| 3.09 | Hydraulic front shovel, 390 kW, 5.70 m3 heaped bucket | Op. | A | 1.80 | 163.89 | 165.69 |
| | | s.b. | ---- | 0.00 | 72.58 | 72.58 |
| **4** | **Trucks, tippers and water tanks** | | | | | |
| 4.01 | Flat bed truck, 10 t pay load with 7.0 t/m capacity crane | Op. | A | 0.32 | 29.23 | 29.55 |
| | | s.b. | ---- | 0.00 | 12.36 | 12.36 |
| 4.02 | Flat bed truck, 15 t pay load | Op. | A | 0.35 | 43.67 | 44.02 |
| | | s.b. | ---- | 0.00 | 13.61 | 13.61 |
| 4.03 | Tractor and semi-trailer, 25 t pay load | Op. | A | 0.50 | 57.86 | 58.36 |
| | | s.b. | ---- | 0.00 | 19.01 | 19.01 |
| 4.04 | Rear tipper with semi-rock type body, 24.0 t pay load | Op. | A | 0.44 | 55.14 | 55.58 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| | | s.b. | ---- | 0.00 | 16.94 | 16.94 |
| 4.05 | Truck mounted water tank, 24 000 liters capacity | Op. | A | 0.42 | 47.56 | 47.98 |
| | | s.b. | ---- | 0.00 | 16.67 | 16.67 |
| 4.06 | Heavy duty trailer water tank, 38000 liters capacity | Op. | A | 1.79 | 75.58 | 77.37 |
| | | s.b. | ---- | 0.00 | 19.36 | 19.36 |
| **5** | **Off-highway dumpers** | | | | | |
| 5.01 | Rear dump truck, 36.60 ton pay load., 25.10 m3 heaped | Op. | A | 1.32 | 98.59 | 99.91 |
| | | s.b. | ---- | 0.00 | 33.74 | 33.74 |
| 5.02 | Rear dump truck, 46.20 ton pay load., 31.30 m3 heaped | Op. | A | 1.61 | 116.24 | 117.85 |
| | | s.b. | ---- | 0.00 | 39.01 | 39.01 |
| 5.03 | Rear dump truck, 55.60 ton pay load., 35.60 m3 heaped | Op. | A | 1.86 | 133.53 | 135.39 |
| | | s.b. | ---- | 0.00 | 41.34 | 41.34 |
| 5.04 | 4WD reversible steering dumper, 10 t pay load | Op. | A | 0.20 | 21.98 | 22.18 |
| | | s.b. | ---- | 0.00 | 9.08 | 9.08 |
| 5.05 | Self loading 4WD reversible steering mini-dumper, 2.5 t pay load | Op. | A | 0.06 | 7.75 | 7.81 |
| | | s.b. | ---- | 0.00 | 5.08 | 5.08 |
| **6** | **Motorgraders** | | | | | |
| 6.01 | Motorgrader with ripper, 103 kW, 3.66 m blade width | Op. | A | 0.79 | 66.33 | 67.12 |
| | | s.b. | ---- | 0.00 | 32.25 | 32.25 |
| 6.02 | Motorgrader with ripper, 136 kW, 3.66 m blade width | Op. | A | 0.90 | 78.21 | 79.11 |
| | | s.b. | ---- | 0.00 | 36.56 | 36.56 |
| 6.03 | Motorgrader with ripper, 193 kW, 4.29 m blade width | Op. | A | 0.94 | 89.25 | 90.19 |
| | | s.b. | ---- | 0.00 | 37.24 | 37.24 |
| **7** | **Rollers and compactors** | | | | | |

| Item | Description | Op. & s.b. | Oper. condit. (A/S) | Hourly Cost L.C.P (US$ Eq.) | Hourly Cost F.C.P. (US$) | Aggregate Cost (US$) |
|---|---|---|---|---|---|---|
| 7.01 | Smooth single drum vibrating roller, 22.1 kg/cm s. linear load | Op. | A | 0.19 | 25.10 | 25.29 |
| | | s.b. | ---- | 0.00 | 7.29 | 7.29 |
| 7.02 | Smooth single drum vibrating roller, 38.0 kg/cm s. linear load | Op. | A | 0.23 | 31.18 | 31.41 |
| | | s.b. | ---- | 0.00 | 8.92 | 8.92 |
| 7.03 | Smooth single drum vibrating roller, 50.0 kg/cm s. linear load | Op. | A | 0.27 | 43.87 | 44.14 |
| | | s.b. | ---- | 0.00 | 9.89 | 9.89 |
| 7.04 | Pad-foot single drum vibrating roller, 38 kg/cm s. linear load | Op. | A | 0.23 | 31.08 | 31.31 |
| | | s.b. | ---- | 0.00 | 8.85 | 8.85 |
| 7.05 | Pad-foot single drum vibrating roller, 44.0 kg/cm s. linear load | Op. | A | 0.28 | 43.95 | 44.23 |
| | | s.b. | ---- | 0.00 | 10.46 | 10.46 |
| 7.06 | Tyred roller, 27 t operating weight with ballast, width 2.30 m | Op. | A | 0.50 | 48.14 | 48.64 |
| | | s.b. | ---- | 0.00 | 17.49 | 17.49 |
| 7.07 | Vibrating plate compactor, 7.5 kW, 490 kg operating weigth | Op. | A | 0.07 | 5.39 | 5.46 |
| | | s.b. | ---- | 0.00 | 2.85 | 2.85 |
| 7.08 | Vibrating rammer (tamper), 70 kg operating weight | Op. | A | 0.03 | 2.61 | 2.64 |
| | | s.b. | ---- | 0.00 | 1.13 | 1.13 |
| **8** | **Rock drill rigs and breakers** | | | | | |
| 8.01 | Diesel powered tyred rock drill, 61 kW, holes 38-64 mm dia. | Op. | A | 0.54 | 46.87 | 47.41 |
| | | s.b. | ---- | 0.00 | 26.85 | 26.85 |
| 8.02 | Diesel powered crawler rock drill, 116 kW, holes 64-89 mm dia. | Op. | A | 0.68 | 66.30 | 66.98 |
| | | s.b. | ---- | 0.00 | 34.44 | 34.44 |
| 8.03 | Diesel powered crawler rock drill, 149 kW, holes 76-102 mm dia. | Op. | A | 0.73 | 77.76 | 78.49 |
| | | s.b. | ---- | 0.00 | 38.96 | 38.96 |
| 8.04 | Diesel powered crawler rock drill, 194 kW, holes 89-115. mm dia. | Op. | A | 0.77 | 84.86 | 85.63 |

| Item | Description | Op. & s.b. | Oper. condit. (A/S) | Hourly Cost L.C.P (US$ Eq.) | Hourly Cost F.C.P. (US$) | Aggregate Cost (US$) |
|---|---|---|---|---|---|---|
| | | s.b. | ---- | 0.00 | 38.83 | 38.83 |
| 8.05 | Air powered crawler rock drill, holes 51-76 mm diameter | Op. | A | 0.39 | 24.56 | 24.95 |
| | | s.b. | ---- | 0.00 | 16.40 | 16.40 |
| 8.06 | Electro-hydraulic rock drill, 52 kW, holes 38-64 mm dia. | Op. | A | 0.49 | 36.48 | 36.97 |
| | | s.b. | ---- | 0.00 | 18.26 | 18.26 |
| 8.07 | Air powered wagon-drill with 3029 mm feed, hole dia. 38/64 mm | Op. | A | 0.22 | 15.05 | 15.27 |
| | | s.b. | ---- | 0.00 | 10.05 | 10.05 |
| 8.08 | Hand-held rock drill, medium weight type | Op. | A | 0.04 | 2.03 | 2.07 |
| | | s.b. | ---- | 0.00 | 1.21 | 1.21 |
| 8.09 | Hand-held rock drill, heavy weight type | Op. | A | 0.05 | 2.71 | 2.76 |
| | | s.b. | ---- | 0.00 | 1.60 | 1.60 |
| 8.10 | Hand-held paving breaker, medium weigth type | Op. | A | 0.03 | 1.98 | 2.01 |
| | | s.b. | ---- | 0.00 | 1.07 | 1.07 |
| 8.11 | Hand-held paving breaker, heavy weigth type | Op. | A | 0.04 | 2.61 | 2.65 |
| | | s.b. | ---- | 0.00 | 1.41 | 1.41 |
| **9** | **Diesel powered air compressors** | | | | | |
| 9.01 | Motorcompressor, 5.0 m3/min capacity, 7.5 bar pressure | Op. | A | 0.08 | 11.32 | 11.40 |
| | | s.b. | ---- | 0.00 | 2.99 | 2.99 |
| 9.02 | Motorcompressor, 10.0 m3/min capacity, 7.5 bar pressure | Op. | A | 0.15 | 24.64 | 24.79 |
| | | s.b. | ---- | 0.00 | 5.46 | 5.46 |
| 9.03 | Motorcompressor, 15.0 m3/min capacity, 7.5 bar pressure | Op. | A | 0.20 | 40.08 | 40.28 |
| | | s.b. | ---- | 0.00 | 7.50 | 7.50 |
| 9.04 | Motorcompressor, 20.0 m3/min capacity, 7.5 bar pressure | Op. | A | 0.25 | 57.86 | 58.11 |
| | | s.b. | ---- | 0.00 | 9.26 | 9.26 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 9.05 | Motorcompressor, 25.0 m3/min capacity, 7.5 bar pressure | Op. | A | 0.29 | 77.99 | 78.28 |
| | | s.b. | ---- | 0.00 | 10.73 | 10.73 |
| 9.06 | Motorcompressor, 30.0 m3/min capacity, 7.5 bar pressure | Op. | A | 0.33 | 99.41 | 99.74 |
| | | s.b. | ---- | 0.00 | 11.98 | 11.98 |
| 10 | **Truck mixers and concrete tippers** | | | | | |
| 10.01 | Truckmixer (4WD-reversible steering ), 5.0 m3 nominal capacity | Op. | A | 0.28 | 25.38 | 25.66 |
| | | s.b. | ---- | | 10.68 | 10.68 |
| 10.02 | Truckmixer, 6.0 $m^3$ nominal capacity | Op. | A | 0.27 | 32.54 | 32.81 |
| | | s.b. | ---- | | 11.20 | 11.20 |
| 10.03 | Truckmixer, 8.0 $m^3$ nominal capacity | Op. | A | 0.33 | 41.72 | 42.05 |
| | | s.b. | ---- | | 13.62 | 13.62 |
| 10.04 | Truckmixer, 10.0 $m^3$ nominal capacity | Op. | A | 0.40 | 47.95 | 48.35 |
| | | s.b. | ---- | | 14.53 | 14.53 |
| 10.05 | Truckmixer, 12.0 $m^3$ nominal capacity | Op. | A | 0.46 | 52.69 | 53.15 |
| | | s.b. | ---- | | 16.74 | 16.74 |
| 10.06 | Truck with concrete body, 10.5 $m^3$ struck (8.70 m3 actual) | Op. | A | 0.38 | 39.07 | 39.45 |
| | | s.b. | ---- | 0.00 | 14.45 | 14.45 |
| 10.07 | Truck with c. body & agitator, 12 $m^3$ struck (9.00 m3 actual) | Op. | A | 0.45 | 52.53 | 52.98 |
| | | s.b. | ---- | 0.00 | 14.67 | 14.67 |
| **11** | **Towed concrete pumps** | | | | | |
| 11.01 | Diesel powered concrete pump w. pipes, 28 m3/h max cap. | Op. | A | 0.28 | 21.17 | 21.45 |
| | | s.b. | ---- | 0.00 | 11.10 | 11.10 |
| 11.02 | Diesel powered concrete pump w. pipes, 54 m3/h max cap. | Op. | A | 0.35 | 29.66 | 30.01 |
| | | s.b. | ---- | 0.00 | 13.76 | 13.76 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 11.03 | Diesel powered concrete pump w. pipes, 71 m3/h max cap. | Op. | A | 0.35 | 37.44 | 37.79 |
| | | s.b. | ---- | 0.00 | 14.10 | 14.10 |
| 11.04 | Electric powered concrete pump w. pipes, 47 m3/h max cap. | Op. | A | 0.45 | 30.85 | 31.30 |
| | | s.b. | ---- | 0.00 | 13.69 | 13.69 |
| 11.05 | Electric powered concrete pump w. pipes, 79 m3/h max cap. | Op. | A | 0.61 | 44.83 | 45.44 |
| | | s.b. | ---- | 0.00 | 13.85 | 13.85 |
| 11.06 | Truck mounted concrete pump, 21 m boom, 110 m3/h max c. | Op. | A | 0.82 | 53.49 | 54.31 |
| | | s.b. | ---- | 0.00 | 36.46 | 36.46 |
| 11.07 | Truck mounted concrete pump, 36 m boom, 140 m3/h max c. | Op. | A | 1.11 | 71.37 | 72.48 |
| | | s.b. | ---- | 0.00 | 49.06 | 49.06 |
| 11.08 | Folding pipe system for concrete pumps operating in tunnel | Op. | A | 0.06 | 3.54 | 3.60 |
| | | s.b. | ---- | 0.00 | 2.42 | 2.42 |
| **12** | **Shotcrete equipment** | | | | | |
| 12.01 | Truck mounted electric powered shotcrete robot with boom | Op. | A | 0.98 | 66.67 | 67.65 |
| | | s.b. | ---- | 0.00 | 30.85 | 30.85 |
| 12.02 | Diesel p. towed shotcrete pump, 25 m3/h m.c., hand h. nozzle | Op. | A | 0.34 | 26.09 | 26.43 |
| | | s.b. | ---- | 0.00 | 14.77 | 14.77 |
| 12.03 | Electric p. towed shotcrete pump, 22 m3/h m.c., hand nozzle | Op. | A | 0.33 | 26.52 | 26.85 |
| | | s.b. | ---- | 0.00 | 15.54 | 15.54 |
| **13** | **Concrete placer (Rotec System):** | | | | | |
| 13.01 | Concrete belt conveyor mounted on rought terrain crane | Op. | A | 2.48 | 224.77 | 227.25 |
| | | s.b. | ---- | 0.00 | 151.76 | 151.76 |
| 13.02 | Concrete "Auger Max" including feeding belt conveyor | Op. | A | 0.38 | 35.28 | 35.66 |
| | | s.b. | ---- | 0.00 | 27.28 | 27.28 |

| Item | Description | Op. & s.b. | Oper. condit. (A/S) | Hourly Cost L.C.P (US$ Eq.) | Hourly Cost F.C.P. (US$) | Aggregate Cost (US$) |
|---|---|---|---|---|---|---|
| **14** | **Immersion type concrete vibrators** | | | | | |
| 14.01 | Air powered hand-held concrete vibrator 77 mm diameter | Op. | A | 0.01 | 1.46 | 1.47 |
| | | s.b. | ---- | 0.00 | 0.42 | 0.42 |
| 14.02 | Air powered hand-held concrete vibrator 87 mm diameter | Op. | A | 0.02 | 1.63 | 1.65 |
| | | s.b. | ---- | 0.00 | 0.53 | 0.53 |
| 14.03 | Air powered hand-held concrete vibrator 157 mm diameter | Op. | A | 0.03 | 2.78 | 2.81 |
| | | s.b. | ---- | 0.00 | 0.16 | 0.16 |
| 14.04 | Electric powered concrete vibrator, 65 mm dia. | Op. | A | 0.01 | 1.69 | 1.70 |
| | | s.b. | ---- | 0.00 | 0.31 | 0.31 |
| 14.05 | Hydraulic powered concrete vibrators, n. 4x150 mm dia. | Op. | A | 0.45 | 36.19 | 36.64 |
| | including hydraulic equipment | s.b. | ---- | 0.00 | 20.39 | 20.39 |
| **15** | **Pneumatic external vibrators** | | | | | |
| 15.01 | Vibrator with mounting device and air distribution system, | Op. | A | 0.00 | 0.24 | 0.24 |
| | 11000 N centrifugal force | s.b. | ---- | 0.00 | 0.17 | 0.17 |
| 15.02 | Vibrator with mounting device and air distribution system, | Op. | A | 0.01 | 0.31 | 0.32 |
| | 14000 N centrifugal force | s.b. | ---- | 0.00 | 0.21 | 0.21 |
| | | | | | | |
| **16** | **Mobile cranes** | | | | | |
| 16.01 | Rought terrain crane, 10 t nominal capacity | Op. | A | 0.57 | 48.79 | 49.36 |
| | | s.b. | ---- | 0.00 | 33.42 | 33.42 |
| 16.02 | Rought terrain crane, 20 t nominal capacity | Op. | A | 0.62 | 53.36 | 53.98 |
| | | s.b. | ---- | 0.00 | 36.36 | 36.36 |
| 16.03 | Rought terrain crane, 35 t nominal capacity | Op. | A | 0.69 | 59.25 | 59.94 |
| | | s.b. | ---- | 0.00 | 40.11 | 40.11 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 16.04 | Rought terrain crane, 55 t nominal capacity | Op. | A | 0.89 | 76.62 | 77.51 |
| | | s.b. | ---- | 0.00 | 51.36 | 51.36 |
| 16.05 | Rought terrain crane, 80 t nominal capacity | Op. | A | 1.43 | 123.58 | 125.01 |
| | | s.b. | ---- | 0.00 | 84.20 | 84.20 |
| 16.06 | Track mounted crane, 100 t nominal capacity | Op. | A | ---- | ---- | ---- |
| | | s.b. | ---- | ---- | ---- | ---- |
| **17** | **Extendable lifters** | | | | | |
| 17.01 | Extendable lifter with 1,000 kg capacity platform, 12 m reach | Op. | A | 0.26 | 24.87 | 25.13 |
| | | s.b. | ---- | 0.00 | 15.28 | 15.28 |
| 17.02 | Extendable lifter with 1,000 kg capacity platform, 18 m reach | Op. | A | 0.33 | 30.84 | 31.17 |
| | | s.b. | ---- | 0.00 | 19.27 | 19.27 |
| 17.03 | Extendable lifter with 10,000 kg capacity platform | Op. | A | 0.64 | 65.27 | 65.91 |
| | | s.b. | ---- | 0.00 | 47.51 | 47.51 |
| 17.04 | Extendable lifter equipped with steel rib erector, 12 m reach | Op. | A | 0.32 | 37.39 | 37.71 |
| | | s.b. | ---- | 0.00 | 24.82 | 24.82 |
| **18** | **Electrical powered submersible water pumps** | | | | | |
| 18.01 | Submesible water pump, 10 kW | Op. | A | 0.05 | 4.17 | 4.22 |
| | | s.b. | ---- | 0.00 | 0.60 | 0.60 |
| 18.02 | Submesible water pump, 20 kW | Op. | A | 0.08 | 7.57 | 7.65 |
| | | s.b. | ---- | 0.00 | 0.69 | 0.69 |
| 18.03 | Submesible water pump, 37 kW | Op. | A | 0.15 | 13.26 | 13.41 |
| | | s.b. | ---- | 0.00 | 1.41 | 1.41 |
| 18.04 | Submesible water pump, 54 kW | Op. | A | 0.23 | 18.99 | 19.22 |
| | | s.b. | ---- | 0.00 | 2.09 | 2.09 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 18.05 | Submesible water pump, 90 kW | Op. | A | 0.39 | 31.87 | 32.26 |
| | | s.b. | ---- | 0.00 | 2.85 | 2.85 |
| **19** | **Electric powered centrifugal water pumps** | | | | | |
| 19.01 | Centrifugal multistage pump, 18.5 kW, 180 m max. head | Op. | A | 0.07 | 5.82 | 5.89 |
| | | s.b. | ---- | 0.00 | 0.31 | 0.31 |
| 19.02 | Centrifugal multistage pump, 30.0 kW, 175 m max. head | Op. | A | 0.11 | 9.23 | 9.34 |
| | | s.b. | ---- | 0.00 | 0.36 | 0.36 |
| 19.03 | Centrifugal multistage pump, 45.0 kW, 170 m max. head | Op. | A | 0.16 | 13.74 | 13.90 |
| | | s.b. | ---- | 0.00 | 0.47 | 0.47 |
| **20** | **Used trucks for tunnel formworks shifting** | | | | | |
| 20.01 | Truck with turret and hydraulic jaks, 10 t pay load | Op. | A | 0.09 | 7.91 | 8.00 |
| | | s.b. | ---- | 0.00 | 5.13 | 5.13 |
| 20.02 | Truck with turret and hydraulic jaks, 15 t pay load | Op. | A | 0.13 | 11.37 | 11.50 |
| | | s.b. | ---- | 0.00 | 7.32 | 7.32 |
| 20.03 | Truck with turret and hydraulic jaks, 20 t pay load | Op. | A | 0.15 | 13.48 | 13.63 |
| | | s.b. | ---- | 0.00 | 8.88 | 8.88 |
| 20.04 | Truck with turret and hydraulic jaks, 25 t pay load | Op. | A | 0.17 | 15.78 | 15.95 |
| | | s.b. | ---- | 0.00 | 10.59 | 10.59 |
| 20.05 | Truck with turret and hydraulic jaks, 30 t pay load | Op. | A | 0.20 | 18.17 | 18.37 |
| | | s.b. | ---- | 0.00 | 12.41 | 12.41 |
| **21** | **Mining trucks** | | | | | |
| 21.01 | Articulated tunnel (mine) dump truck, 20 t pay load | Op. | h | 0.63 | 62.22 | 62.85 |
| | | s.b. | h | 0.00 | 28.86 | 28.86 |
| 21.02 | Articulated tunnel (mine) dump truck, 25 t pay load | Op. | h | 0.73 | 75.31 | 76.04 |

| Item | Description | Op. & s.b. | Oper. condit. (A/S) | Hourly Cost L.C.P (US$ Eq.) | Hourly Cost F.C.P. (US$) | Aggregate Cost (US$) |
|---|---|---|---|---|---|---|
| | | s.b. | h | 0.00 | 33.01 | 33.01 |
| 21.03 | Articulated tunnel (mine) dump truck, 30 t pay load | Op. | h | 0.83 | 86.77 | 87.60 |
| | | s.b. | h | 0.00 | 37.32 | 37.32 |
| 21.04 | Articulated tunnel(mine) dump truck, 42 t pay load | Op. | h | 1.12 | 114.78 | 115.90 |
| | | s.b. | h | 0.00 | 50.07 | 50.07 |
| **22** | **Drilling and grouting machines** | | | | | |
| 22.01 | Electro-hydraulic rotary drill rig, 46-76 mm diameter holes | Op. | A | 0.36 | 31.03 | 31.39 |
| | | s.b. | ---- | 0.00 | 17.31 | 17.31 |
| 22.02 | Electro-hydraulic rotary drill rig, 46-131 mm diameter holes | Op. | A | 0.52 | 44.98 | 45.50 |
| | | s.b. | ---- | 0.00 | 26.76 | 26.76 |
| 22.03 | Water flush pump, 45 l/min., 50 bar max. pressure | Op. | A | 0.06 | 4.41 | 4.47 |
| | | s.b. | ---- | 0.00 | 2.53 | 2.53 |
| 22.04 | Water flush pump, 76 l/min., 50 bar max. pressure | Op. | A | 0.12 | 8.90 | 9.02 |
| | | s.b. | ---- | 0.00 | 5.21 | 5.21 |
| 22.05 | Colloidal cement grout mixer, 260 liters capacity | Op. | A | 0.04 | 3.29 | 3.33 |
| | | s.b. | ---- | 0.00 | 1.44 | 1.44 |
| 22.06 | Colloidal cement grout mixer, 500 liters capacity | Op. | A | 0.05 | 3.94 | 3.99 |
| | | s.b. | ---- | 0.00 | 1.55 | 1.55 |
| 22.07 | Cement grout agitator, 260 liters capacity | Op. | A | 0.02 | 1.25 | 1.27 |
| | | s.b. | ---- | 0.00 | 0.66 | 0.66 |
| 22.08 | Cement grout agitator, 500 liters capacity | Op. | A | 0.02 | 1.98 | 2.00 |
| | | s.b. | ---- | 0.00 | 1.00 | 1.00 |
| 22.09 | Cement grout pump, 34/40 l/min capacity, 30 bar max. pressure | Op. | A | 0.06 | 5.13 | 5.19 |
| | | s.b. | ---- | 0.00 | 2.62 | 2.62 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 22.10 | Cement grout pump, 100/140 l/min, 50 bar max. pressure | Op. | A | 0.11 | 9.64 | 9.75 |
| | | s.b. | ---- | 0.00 | 4.75 | 4.75 |
| 22.11 | Wheel-mounted compact type grout plant, 5.5 m3/h max. capacity | Op. | A | 0.22 | 25.58 | 25.80 |
| | (Atlas Craelius Unigrout 200-100 E 02) or HANY 650E | s.b. | ---- | 0.00 | 20.19 | 20.19 |
| 22.12 | Wheel mounted pump for rock bolt grouting | Op. | A | 0.05 | 5.27 | 5.32 |
| | | s.b. | ---- | 0.00 | 3.17 | 3.17 |
| **23** | **Miscellaneous** | | | | | 0.00 |
| 23.01 | Diesel powered rock bolting rig, 120 kW, 12.0 m reach | Op. | A | 1.55 | 103.96 | 105.51 |
| | | s.b. | ---- | 0.00 | 65.23 | 65.23 |
| 23.02 | Mechanized scaler with hammer, 120 kW, 10.0 m reach | Op. | A | 0.70 | 64.44 | 65.14 |
| | | s.b. | ---- | 0.00 | 40.23 | 40.23 |
| 23.03 | Explosive charging machine, 300 kg ANFO capacity | Op. | A | 0.59 | 40.16 | 40.75 |
| | | s.b. | ---- | 0.00 | 31.73 | 31.73 |
| 23.04 | Personnel transportation vehicle, 15+1 seats | Op. | A | 0.15 | 18.51 | 18.66 |
| | | s.b. | ---- | 0.00 | 7.46 | 7.46 |
| 23.05 | Scissors type elevator, capacity 450 kg, 11.70 max. height | Op. | A | 0.07 | 5.99 | 6.06 |
| | | s.b. | ---- | 0.00 | 4.40 | 4.40 |
| 23.06 | Portable diesel powered floodlight, 6000 W, heigth 9.0 m | Op. | A | 0.07 | 6.41 | 6.48 |
| | | s.b. | ---- | 0.00 | 3.46 | 3.46 |
| 23.07 | Halogen floodlight, 1000 W with support & connection cable | Op. | A | 0.01 | 0.75 | 0.76 |
| | | s.b. | ---- | 0.00 | 0.29 | 0.29 |
| 23.08 | Halogen floodlight, 2000 W with support & connection cable | Op. | A | 0.01 | 0.83 | 0.84 |
| | | s.b. | ---- | 0.00 | 0.33 | 0.33 |
| 23.09 | Hydraulic unit for tendon tensioning | Op. | A | 0.05 | 3.39 | 3.44 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| | | s.b. | ---- | 0.00 | 3.96 | 3.96 |
| 23.10 | Vibrating bar for slab finishing | Op. | A | 0.01 | 1.46 | 1.47 |
| | | s.b. | ---- | 0.00 | 0.42 | 0.42 |
| 23.11 | Soil stabilizer with 2400 mm wide rotor, 245 kW installed power | Op. | A | 0.75 | 80.64 | 81.39 |
| | | s.b. | ---- | 0.00 | 25.83 | 25.83 |
| 23.12 | Clay spreader 6100 mm wide, 82 kw installed power | Op. | A | 0.68 | 51.57 | 52.25 |
| | | s.b. | ---- | 0.00 | 27.79 | 27.79 |
| 23.13 | Dozer trap/belt loader with 48" x 45' conveyor with screen | Op. | A | 0.59 | 40.27 | 40.86 |
| | | s.b. | ---- | 0.00 | 8.19 | 8.19 |
| 23.14 | Rail mounted traveller for tunnel form shifting, 20 t pay load | Op. | h | 0.12 | 16.09 | 16.21 |
| 23.15 | Rail mounted traveller for tunnel form shifting, 25 t pay load | Op. | h | 0.15 | 20.91 | 21.06 |
| 23.16 | Hydraulic jaking system for arch form shifting | Op. | A | 0.33 | 37.39 | 37.72 |
| 23.17 | Bar bending and cutting machines | Op. | A | 0.05 | 3.57 | 3.62 |
| 23.18 | Grinding machine for button bits, 45 to 102 mm dia. | Op. | A | 0.04 | 5.32 | 5.36 |
| 23.19 | Grinding machine for integrals | Op. | A | 0.01 | 2.29 | 2.30 |
| 23.20 | Breaker tool resharpener | Op. | A | 0.01 | 1.57 | 1.58 |
| 23.21 | Concrete bucket, 1.50 m3 capacity | Op. | A | 0.02 | 1.55 | 1.57 |
| 23.22 | Concrete bucket, 2.00 m3 capacity | Op. | A | 0.03 | 2.35 | 2.38 |
| 23.23 | Concrete bucket, 2.50 m3 capacity | Op. | A | 0.03 | 3.05 | 3.08 |
| 23.24 | Concrete bucket, 3.00 m3 capacity | Op. | A | 0.04 | 3.52 | 3.56 |
| 23.25 | Elephant trunk, 200 mm dia., length 25 m | Op. | A | 0.01 | 0.98 | 0.99 |
| | | | | | | |
| **B** | **STATIONARY AND APPOINTED EQUIPMENT** | | | | | |
| | | | | | | |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| **1** | **Electric power station and distribution line** | | | | | |
| 1.01 | Diesel pow. motorgenerator, 1000 kVA with control board | Op&s.b. | m.th | 0.00 | 4,423.28 | 4,423.28 |
| | | ---- | h | 0.33 | 167.60 | 167.93 |
| 1.02 | Diesel pow. motorgenerator, 635 kVA with control board | Op&s.b. | m.th | 0.00 | 2,936.43 | 2,936.43 |
| | | ---- | h | 0.22 | 107.69 | 107.91 |
| 1.03 | Transformer cabin 0.40/24 kV - 7.27 MVA total power | ---- | m.th | 0.00 | 107.69 | 107.69 |
| 1.04 | Fuel tanks for motorgenerators, 150,000 liters capacity | ---- | m.th | 8.48 | 939.17 | 947.65 |
| 1.05 | On pole power distribution line, 24 KV (length 1 km) | ---- | m.th | 4.19 | 258.07 | 262.26 |
| 1.06 | Firefighting system for the power station | ---- | m.th | 65.34 | 4,057.87 | 4,123.21 |
| | | | | | | |
| **2** | **Aggregates, dam filters and concrete plants** | | | | | |
| 2.01 | Aggregate processing plant, 70 t/h capacity | O+s.b. | m.th | 0.00 | 9,346.86 | 9,346.86 |
| | | ---- | h | 1.93 | 85.09 | 87.02 |
| 2.02 | Aggregate processing plant, 190 t/h capacity | O+s.b. | m.th | 0.00 | 26,687.79 | 26,687.79 |
| | | ---- | h | 3.46 | 149.49 | 152.95 |
| 2.02 | Filter processing plant, 380 t/h capacity | O+s.b. | m.th | 0.00 | 21,165.99 | 21,165.99 |
| | | ---- | h | 7.17 | 250.66 | 257.83 |
| 2.03 | Radial staker for processed filters | O+s.b. | m.th | 0.00 | 3,143.25 | 3,143.25 |
| | | ---- | h | 0.74 | 17.57 | 18.31 |
| 2.04 | Concrete batch. & mixing plant, 4 aggregates, 55 m3/hr capacity | O+s.b. | m.th | 0.00 | 3,953.27 | 3,953.27 |
| | | ---- | h | 0.87 | 42.50 | 43.37 |
| 2.05 | Concrete batch. & mixing plant, 4 aggregates, 65 m3/hr capacity | O+s.b. | m.th | 0.00 | 8,280.96 | 8,280.96 |
| | | ---- | h | 1.03 | 50.67 | 51.70 |
| 2.06 | Cement silos, capacity 460 m3 with 2 cement feeders to mixer | O+s.b. | m.th | 0.00 | 1,374.59 | 1,374.59 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| | | ---- | h | 0.00 | 7.71 | 7.71 |
| 2.07 | Cement silos, capacity 1310 m3 with 4 cement feeders to mixer | O+s.b. | m.th | 0.00 | 7,214.38 | 7,214.38 |
| | | ---- | h | 0.47 | 15.75 | 16.22 |
| 2.08 | Aggregate reclaming system under aggregate stockpiles | O+s.b. | m.th | 0.00 | 1,291.52 | 1,291.52 |
| | | ---- | h | 0.16 | 6.75 | 6.91 |
| **3** | **Tunnelling jumbos, drillers and breakers** | | | | | |
| 3.01 | One boom tunnelling jumbo equipeed with 22 kW rock drill | O+s.b. | m.th | 0.00 | 12,651.92 | 12,651.92 |
| | | ---- | h | 1.95 | 50.77 | 52.72 |
| 3.02 | Two boom tunnelling jumbo equipeed with 22 kW rock drills | O+s.b. | m.th | 0.00 | 19,479.65 | 19,479.65 |
| | | ---- | h | 3.27 | 94.80 | 98.07 |
| 3.03 | Three boom tunnelling jumbo equipeed with 22 kW rock drills | O+s.b. | m.th | 0.00 | 21,868.22 | 21,868.22 |
| | | ---- | h | 3.71 | 122.14 | 125.85 |
| 3.04 | Hand held drill, medium weight type | O+s.b. | m.th | 0.00 | 130.63 | 130.63 |
| | | ---- | h | 0.04 | 2.03 | 2.07 |
| 3.05 | Hand held drill, heavy weight type | O+s.b. | m.th | 0.00 | 132.39 | 132.39 |
| | | ---- | h | 0.05 | 1.10 | 1.15 |
| 3.06 | Hand held feed pusher leg drill, heavy weigth type | O+s.b. | m.th | 0.00 | 187.16 | 187.16 |
| | | ---- | h | 0.07 | 1.53 | 1.60 |
| 3.07 | Hand held stoper drill, medium weight type | O+s.b. | m.th | 0.00 | 129.89 | 129.89 |
| | | ---- | h | 0.07 | 1.46 | 1.53 |
| 3.08 | Hand held paving breaker, medium weigth type | O+s.b. | m.th | 0.00 | 46.95 | 46.95 |
| | | ---- | h | 0.03 | 0.91 | 0.94 |
| 3.09 | Hand held paving breaker, heavy weigth type | O+s.b. | m.th | 0.00 | 62.21 | 62.21 |
| | | ---- | h | 0.04 | 1.20 | 1.24 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| **4** | **Tunnel loaders** | | | | | |
| 4.01 | Electro powered tunnel loader with steel belt, 55E+74D kW | O+s.b. | m.th | 0.00 | 8,943.66 | 8,943.66 |
| | | | | | | |
| 4.02 | Electro powered tunnel loader with steel belt, 110E+165D kW | O+s.b. | m.th | 0.00 | 12,874.72 | 12,874.72 |
| | | | | 1.95 | 55.22 | 57.17 |
| **5** | **Tunnel dumpers** | | | | | |
| 5.01 | Articulated tunnel (mine) dump truck, 20 t pay load | O+s.b. | m.th | 0.00 | 8310.47 | 8310.47 |
| | | ---- | h | 0.63 | 33.37 | 34.00 |
| 5.02 | Articulated tunnel (mine) dump truck, 25 t pay load | O+s.b. | m.th | 0.00 | 9508.27 | 9508.27 |
| | | ---- | h | 0.73 | 42.30 | 43.03 |
| 5.03 | Articulated tunnel (mine) dump truck, 30 t pay load | O+s.b. | m.th | 0.00 | 10747.12 | 10747.12 |
| | | ---- | h | 0.83 | 49.46 | 50.29 |
| 5.04 | Articulated tunnel (mine) dump truck, 42 t pay load | O+s.b. | m.th | 0.00 | 14420.38 | 14420.38 |
| | | ---- | h | 1.12 | 64.71 | 65.83 |
| **6** | **Electric powered air compressors** | | | | | |
| 6.01 | Electric powered air compressor, 5.0 m3min, 7.5 bar p. | O+s.b. | m.th | 0.00 | 365.28 | 365.28 |
| | | ---- | h | 0.14 | 8.73 | 8.87 |
| 6.02 | Electric powered air compressor, 10.0 m3min, 7.5 bar p. | O+s.b. | m.th | 0.00 | 697.26 | 697.26 |
| | | ---- | h | 0.22 | 19.73 | 19.95 |
| 6.03 | Electric powered air compressor, 15.0 m3min, 7.5 bar p. | O+s.b. | m.th | 0.00 | 1212.08 | 1212.08 |
| | | ---- | h | 0.34 | 33.30 | 33.64 |
| 6.04 | Electric powered air compressor, 20.0 m3min, 7.5 bar p. | O+s.b. | m.th | 0.00 | 1267.72 | 1267.72 |
| | | ---- | h | 0.43 | 48.61 | 49.04 |
| 6.05 | Electric powered air compressor, 25.0 m3min, 7.5 bar p. | O+s.b. | m.th | 0.00 | 1509.14 | 1509.14 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| | | ---- | h | 0.53 | 66.51 | 67.04 |
| 6.06 | Electric powered air compressor, 30.0 m3min, 7.5 bar p. | O+s.b. | m.th | 0.00 | 1723.27 | 1723.27 |
| | | ---- | h | 0.63 | 86.66 | 87.29 |
| **7** | **Tunnel fans** | | | | | |
| 7.01 | Sound-proof axial tunnel fan, 30 kW | O+s.b. | m.th | 0.00 | 440.40 | 440.40 |
| | | ---- | h | 0.12 | 9.00 | 9.12 |
| 7.02 | Sound-proof axial tunnel fan, 50 kW | O+s.b. | m.th | 0.00 | 636.14 | 636.14 |
| | | ---- | h | 0.20 | 14.93 | 15.13 |
| 7.03 | Sound-proof axial tunnel fan, 75 kW | O+s.b. | m.th | 0.00 | 747.05 | 747.05 |
| | | ---- | h | 0.29 | 22.25 | 22.54 |
| 7.04 | Sound-proof axial tunnel fan, 100 kW | O+s.b. | m.th | 0.00 | 856.34 | 856.34 |
| | | ---- | h | 0.38 | 29.58 | 29.96 |
| 7.05 | Sound-proof axial tunnel fan, 125 kW | O+s.b. | m.th | 0.00 | 918.32 | 918.32 |
| | | ---- | h | 0.46 | 36.86 | 37.32 |
| 7.06 | Sound-proof axial tunnel fan, 150 kW | O+s.b. | m.th | 0.00 | 978.67 | 978.67 |
| | | ---- | h | 0.55 | 44.15 | 44.70 |
| 7.07 | Sound-proof axial tunnel fan, 175 kW | O+s.b. | m.th | 0.00 | 1027.61 | 1027.61 |
| | | ---- | h | 0.64 | 51.43 | 52.07 |
| 7.08 | Sound-proof axial tunnel fan, 200 kW | O+s.b. | m.th | 0.00 | 1060.23 | 1060.23 |
| | | ---- | h | 0.73 | 58.70 | 59.43 |
| 7.09 | Sound-proof axial tunnel fan, 225 kW | O+s.b. | m.th | 0.00 | 1138.52 | 1138.52 |
| | | ---- | h | 0.81 | 66.00 | 66.81 |
| 7.10 | Sound-proof axial tunnel fan, 250 kW | O+s.b. | m.th | 0.00 | 1141.79 | 1141.79 |
| | | ---- | h | 0.90 | 73.25 | 74.15 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| **8** | **Stand-by motorgenerators** | | | | | |
| 8.01 | Diesel powered generator including control board, 25 kVA | O+s.b. | m.th | 0.00 | 82.94 | 82.94 |
| | | ---- | h | 0.01 | 4.39 | 4.40 |
| 8.02 | Diesel powered generator including control board, 50 kVA | O+s.b. | m.th | 0.00 | 128.05 | 128.05 |
| | | ---- | h | 0.03 | 8.70 | 8.73 |
| **9** | **Conveyor belt and loading station** | | | | | |
| 9.01 | Belt conveyor, fligth C, 2175 t/h capacity, length 3200 m | O+s.b. | m.th | 0.00 | 79,757.65 | 79,757.65 |
| | | ---- | h | 19.03 | 624.27 | 643.30 |
| 9.02 | Belt conveyor, fligth T1, 2175 t/h capacity, length 600 m | O+s.b. | m.th | 0.00 | 17,114.45 | 17,114.45 |
| | | ---- | h | 5.24 | 245.46 | 250.70 |
| 9.03 | Belt conveyor, fligth T2, 2175 t/h capacity, length 780 m | O+s.b. | m.th | 0.00 | 20,238.14 | 20,238.14 |
| | | ---- | h | 3.66 | 93.12 | 96.78 |
| 9.04 | Belt conveyor, fligth T3, 2175 t/h capacity, length 2500 m | O+s.b. | m.th | 0.00 | 50,103.96 | 50,103.96 |
| | | ---- | h | 10.68 | 369.78 | 380.46 |
| 9.05 | Loading station of belt conveyor, 2175 t/h capacity | O+s.b. | m.th | 0.00 | 6,690.27 | 6,690.27 |
| | | ---- | h | 1.97 | 59.90 | 61.87 |
| **10** | **Winches** | | | | | |
| 10.01 | Electric powered winch, 2 t rated load, 28 m/min wire speed | O+s.b. | m.th | 0.00 | 81.98 | 81.98 |
| | | ---- | h | 0.05 | 3.99 | 4.04 |
| 10.02 | Electric powered winch, 4 t rated load, 28 m/min wire speed | O+s.b. | m.th | 0.00 | 161.50 | 161.50 |
| | | ---- | h | 0.10 | 8.14 | 8.24 |
| 10.03 | Electric powered winch, 6 t rated load, 28 m/min wire speed | O+s.b. | m.th | 0.00 | 229.42 | 229.42 |
| | | ---- | h | 0.15 | 12.38 | 12.53 |
| **11** | **Tower cranes** | | | | | |

| Item | Description | Op. & s.b. | Oper. condit. (A/S) | Hourly Cost L.C.P (US$ Eq.) | Hourly Cost F.C.P. (US$) | Aggregate Cost (US$) |
|---|---|---|---|---|---|---|
| 11.01 | Tower crane, h=25 m, 160 t/m capacity (4 t x L40m) | O+s.b. | m.th | 0.00 | 5,559.90 | 5,559.90 |
| | | ---- | h | 0.66 | 19.52 | 20.18 |
| 11.02 | Tower crane, h=35 m, 240 t/m capacity (4 t x L60m) | O+s.b. | m.th | 0.00 | 9,840.90 | 9,840.90 |
| | | ---- | h | 0.99 | 29.29 | 30.28 |
| 11.03 | Tower crane, h=50 m, 534 t/m capacity (8.9 t x L60m) | O+s.b. | m.th | 0.00 | 28,521.28 | 28,521.28 |
| | | ---- | h | 2.75 | 75.41 | 78.16 |
| **12** | **Ligthing fixtures** | | | | | |
| 12.01 | Halogen floodlight, 1000 W with support & connection cable | O+s.b. | m.th | 0.00 | 79.92 | 79.92 |
| | | ---- | h | 0.01 | 0.43 | 0.44 |
| 12.02 | Halogen floodlight, 2000 W with support & connection cable | O+s.b. | m.th | 0.00 | 92.77 | 92.77 |
| | | ---- | h | 0.01 | 0.48 | 0.49 |
| 12.03 | Tunnel lighting line with waterproof lamp holders (L=100 m) | O+s.b. | m.th | 0.00 | 130.82 | 130.82 |
| | | ---- | h | 0.01 | 0.41 | 0.42 |
| **13** | **Steel pipelines with rapid type joints** | | | | | |
| 13.01 | Steel pipeline, 50 mm diameter (L=100 m) | O+s.b. | m.th | 0.14 | 13.13 | 13.27 |
| 13.02 | Steel pipeline, 75 mm diameter (L=100 m) | do | m.th | 0.20 | 18.98 | 19.18 |
| 13.03 | Steel pipeline, 100 mm diameter (L=100 m) | do | m.th | 0.24 | 22.33 | 22.57 |
| 13.04 | Steel pipeline, 125 mm diameter (L=100 m) | do | m.th | 0.37 | 34.41 | 34.78 |
| 13.05 | Steel pipeline, 150 mm diameter (L=100 m) | do | m.th | 0.44 | 41.32 | 41.76 |
| 13.06 | Steel pipeline, 200 mm diameter (L=100 m) | do | m.th | 0.74 | 69.67 | 70.41 |
| 13.07 | Steel pipeline, 250 mm diameter (L=100 m) | do | m.th | 1.40 | 139.97 | 141.37 |
| 13.08 | Steel pipeline, 300 mm diameter (L=100 m) | do | m.th | 1.79 | 167.99 | 169.78 |
| | | | | | | |
| **14** | **Compressed air tanks** | | | | | |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 14.01 | Air tank with water separator, 4 m3 capacity | O+s.b. | m.th | 1.07 | 105.20 | 106.27 |
| 14.02 | Air tank with water separator, 6 m3 capacity | do | m.th | 1.36 | 134.52 | 135.88 |
| 14.03 | Air tank with water separator, 8 m3 capacity | do | m.th | 2.01 | 198.33 | 200.34 |
| | | | | | | |
| **15** | **Bolted type steel water tanks** | | | | | |
| 15.01 | Steel water tank, 50 m3 capacity | O+s.b. | m.th | 2.37 | 278.28 | 280.65 |
| 15.02 | Steel water tank, 100 m3 capacity | do | m.th | 3.15 | 370.12 | 373.27 |
| 15.03 | Steel water tank, 200 m3 capacity | do | m.th | 4.35 | 511.31 | 515.66 |
| 15.04 | Steel water tank, 500 m3 capacity | do | m.th | 5.59 | 657.99 | 663.58 |
| | | | | | | |
| **16** | **Supporting steel structures for tunnel fans** | | | | | |
| 16.01 | Structure for 25-50 kW axial fans | O+s.b. | m.th | 0.14 | 33.45 | 33.59 |
| 16.02 | Structure for 50-75 kW axial fans | do | m.th | 0.31 | 73.58 | 73.89 |
| 16.03 | Structure for 75-100 kW axial fans | do | m.th | 0.42 | 100.34 | 100.76 |
| 16.04 | Structure for 100-150 kW axial fans | do | m.th | 0.57 | 133.79 | 134.36 |
| 16.05 | Structure for 150-250 kW axial fans | do | m.th | 0.71 | 167.24 | 167.95 |
| | | | | | | |
| **17** | **Ventilation flexible type pipes** | | | | | |
| 17.01 | Pipe 400 mm dia. (L=100 m) | O+s.b. | m.th | 0.63 | 42.42 | 43.05 |
| 17.02 | Pipe 600 mm dia. (L=100 m) | do | m.th | 0.87 | 58.95 | 59.82 |
| 17.03 | Pipe 800 mm dia. (L=100 m) | do | m.th | 1.07 | 72.47 | 73.54 |
| 17.04 | Pipe 1000 mm dia. (L=100 m) | do | m.th | 1.31 | 89.04 | 90.35 |
| 17.05 | Pipe 1200 mm dia. (L=100 m) | do | m.th | 1.51 | 102.31 | 103.82 |
| 17.06 | Pipe  1400 mm dia. (L=100 m) | do | m.th | 1.73 | 117.13 | 118.86 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 17.07 | Pipe 1600 mm dia. (L=100 m) | do | m.th | 1.93 | 130.66 | 132.59 |
| 17.08 | Pipe 1800 mm dia. (L=100 m) | do | m.th | 2.21 | 149.88 | 152.09 |
| 17.09 | Pipe 2000 mm dia. (L=100 m) | do | m.th | 2.35 | 159.52 | 161.87 |
| 17.10 | Pipe 2200 mm dia. (L=100 m) | do | m.th | 2.62 | 177.47 | 180.09 |
| | | | | | | |
| **18** | **Transformer cabins** | | | | | |
| 18.01 | Transformer cabin, 50 kVA | O+s.b. | m.th | 2.54 | 312.08 | 314.62 |
| 18.02 | Transformer cabin, 100 kVA | do | m.th | 4.61 | 566.03 | 570.64 |
| 18.03 | Transformer cabin, 150 kVA | do | m.th | 4.68 | 574.61 | 579.29 |
| 18.04 | Transformer cabin, 200 kVA | do | m.th | 4.98 | 611.06 | 616.04 |
| 18.05 | Transformer cabin, 250 kVA | do | m.th | 5.27 | 646.44 | 651.71 |
| 18.06 | Transformer cabin, 300 kVA | do | m.th | 5.68 | 696.82 | 702.50 |
| 18.07 | Transformer cabin, 350 kVA | do | m.th | 6.29 | 771.86 | 778.15 |
| 18.08 | Transformer cabin, 400 kVA | do | m.th | 6.80 | 833.80 | 840.60 |
| 18.09 | Transformer cabin, 450 kVA | do | m.th | 7.43 | 911.23 | 918.66 |
| 18.10 | Transformer cabin, 500 kVA | do | m.th | 7.96 | 976.74 | 984.70 |
| 18.11 | Transformer cabin, 600 kVA | do | m.th | 9.32 | 1,143.50 | 1,152.82 |
| | | | | | | |
| **19** | **Control boards** | | | | | |
| 19.01 | Control board, 10 kVA | O+s.b. | m.th | 0.24 | 27.23 | 27.47 |
| 19.02 | Control board, 50 kVA | do | m.th | 0.34 | 37.60 | 37.94 |
| 19.03 | Control board, 100 kVA | do | m.th | 0.53 | 58.60 | 59.13 |
| 19.04 | Control board, 150 kVA | do | m.th | 0.67 | 74.68 | 75.35 |
| 19.05 | Control board, 200 kVA | do | m.th | 0.79 | 88.17 | 88.96 |

| Item | Description | Op. & s.b. | Oper. condit. | Hourly Cost | | Aggregate Cost |
|---|---|---|---|---|---|---|
| | | | | L.C.P | F.C.P. | |
| | | | (A/S) | (US$ Eq.) | (US$) | (US$) |
| 19.06 | Control board, 250 kVA | do | m.th | 0.87 | 97.24 | 98.11 |
| 19.07 | Control board, 300 kVA | do | m.th | 0.95 | 105.80 | 106.75 |
| 19.08 | Control board, 350 kVA | do | m.th | 1.02 | 113.45 | 114.47 |
| 19.09 | Control board, 400 kVA | do | m.th | 1.17 | 129.66 | 130.83 |
| | | | | | | |
| **20** | **Medium voltage electric power cables** | | | | | |
| 20.01 | Flexible type cable, 10 mm2 section (L=100 m) | O+s.b. | m.th | 0.38 | 38.10 | 38.48 |
| 20.02 | Flexible type cable, 16 mm2 section (L=100 m) | do | m.th | 0.55 | 55.77 | 56.32 |
| 20.03 | Flexible type cable, 25 mm2 section (L=100 m) | do | m.th | 0.83 | 84.05 | 84.88 |
| | | | | | | |
| **21** | **Low voltage electric power cables** | | | | | |
| 21.01 | Flexible type cable, 6 mm2 section (L=100 m) | O+s.b. | m.th | 0.14 | 13.50 | 13.64 |
| 21.02 | Flexible type cable, 10 mm2 section (L=100 m) | do | m.th | 0.24 | 23.30 | 23.54 |
| 21.03 | Flexible type cable, 16 mm2 section (L=100 m) | do | m.th | 0.34 | 34.10 | 34.44 |
| 21.04 | Flexible type cable, 25 mm2 section (L=100 m) | do | m.th | 0.52 | 51.39 | 51.91 |
| | | | | | | |
| **22** | **Miscellaneous units** | | | | | |
| 22.01 | Mobile reinforcing steel carrier with extensible legs | O+s.b. | m.th | 0.86 | 213.60 | 214.46 |
| | | | | | | |
| (1) | *Op.=operating unit, s.b=stand-by unit, s.p.=spare parts available at Site store* | *(2)* | *Operating condition: A= Average, S= Severe* | | | |