Report and Proposal

FOR THE START-UP OF THE CHAMBAMONTERA MHPP

I.- BACKGROUND

This report will provide information on the implementation of some of the actions proposed in the report issued by ENISER in April 2010, describing the steps taken to solve the problem of the continuous power cuts in the electric system and, consequently, the safe energy level for this area.

The report is addressed to the Mathiessen Foundation in U.K., the main co-financer of the project.

Below is an account of the various actions carried out during the last two months, as well as a balance of completed tasks, so that we can later propose the final implementation alternative, once an external technical evaluation has taken place.

II.- CURRENT SITUATION

The Chambamontera MHPP and the El Eden settlement were inspected on the 5th of May, 2010. The visit was made by Mr. José Gaytán and Technician José Cieza, in the presence of the Town Mayor, José Quispe Pérez.

Below is a report on the inspection:

2.1.- General

a) The MHPS was not operational
b) There was no indication of the connection scheme for the generator windings in the MHPP.
c) There is no single line diagram of the internal connections for the Load Regulator, so that the voltage level for which it was manufactured could be defined.
d) The output channel of the Load Regulator supplies two areas. This 380V grid feeds two circuits:
    - The first is a single phase, 380V, double thread circuit leading to a 380-220V, 6kW single phase transformer, to feed the El Eden settlement.
    - The second is a single phase, double thread, 380V circuit leading to a 380/13,200V transformer to feed the Chambamontera Power Plant.
e) According to word of mouth, the circuit feeding the El Eden settlement is working normally. However, the Primary Line from the 0.38/13.2 kV transformer feeding the Chambamontera Power Plant has failed, as has the input transformer in the Power Plant.
f) The incompatibility between the power generator, the load regulator and the output transformer (earth return) in the Power Plant was observed.
g) It was impossible to switch on the machine, as the Load Regulator was not adequately fitted and there were no operators in the plant.

2.2.- Structures (Civil Works)

The majority of the civil works are operating, except the powerhouse, where the retaining wall located upstream is incomplete (only partly built). Also, the surrounding ditch to drain rain water needs to be rebuilt and connected to the discharge channel. Furthermore, the construction of a concrete base for the switchboard and regulator is essential, to ensure the stability of the equipment. Also, the electricity service needs to be restored, with the corresponding protection. At the present time there are loose cables on the walls, which could result in an accident caused by a short circuit.

2.3.- Electromechanical equipment

Turbine.- The Pelton turbine is 300 mm in diameter with 2 nozzle type injectors; the rotor is a single welded steel piece dynamically balanced. The turbine was working properly with no problems occurring since the tests began.

Power generator.- The power generator was initially three-phase with a star connection and 380/220V voltage, in neutral. During the initial tests the generator showed some vibration problems that were corrected by the manufacturer (Electromecánica Delta SRL). Subsequently, due to the problems that occurred in the electricity grids which caused the AVR failure, the manufacturer recommended that it should be converted to a single phase, 380V generator, so that there would be no load imbalance, since a single phase system was being transmitted to the Chambamontera town, where the elevation is a 380V single phase with 2 low voltage transmission lines, 13.2 kV medium voltage and an earth return line.

The three phase generator converted into a single phase was working properly, as proved by the permanent service provided to the El Eden settlement, where there is a single phase 380V input transformer fed by the generator and the 220 V output to El Eden with two lines. Problems always occurred when power was diverted to Chambamontera, as the transformers would burn out within two or three days. Claims were made to the manufacturer of the transformers, who always maintained that similar transformers were working properly in other areas.

Electronic Regulator.- It is a locally manufactured SISELCOM regulator with a 380V single phase system. In view of the problems with the electricity grid and the transformers, it failed on several occasions. However, the manufacturer visited the site and repaired it. We do not know if it is working now, in view of the latest events, therefore the manufacturer should be present when the plant is put into operation.

2.4.- Electricity grids

a) The switchboard in the input Sub-station of the Power Plant has two 15A thermo-magnetic switches for the distribution circuits and a public lighting control network. The holes for the cables in the base of the switchboard are exposed.
b) Secondary Grids are installed in the 440-220V system in Chambamontera and 220V in El Eden.

2.5.- Domestic electrical installations:

The domestic connections include a meter box and an electronic meter. The meter box contains a 10A thermo-magnetic switch. There are 20A thermo-magnetic switches in the homes.

According to the community, the electrical installations inside the homes are the responsibility of each owner. These installations were deficient due to the poor quality materials used and because the installations were done by people with a limited knowledge of electricity. ITDG has been providing technical guidance in this respect.

Households currently have twin cables calibre 2 x 16 AWG and lower calibre cables, the use of which is forbidden for domestic installations. In addition, their unions and insulation are faulty. The cables were mostly attached to the wall and to wood panels with bent nails.

The installations include thermo-magnetic switches of a poor quality. Similar switches installed in other areas fail to react to short circuits and are used only as section switches that will not react to any failure inside the homes. Nevertheless, as a result of the guidance provided by ITDG, some homes have installed good quality components.

2.3.- S*ocial organisation*

Household visits were made to beneficiaries of the micro power plant, which revealed that:

- The beneficiaries show no confidence in the situation being reverted, as various problems have occurred, many of them as a result of their lack of organisation and their debts.
- They admit that the community did not comply with the level of participation required by the project. They agreed to become involved in future activities, although obviously this change in attitude will take some time.
- The authorities are the main promoters of the project, although they do not have the backing of the majority of beneficiaries. Even though the authorities maintain that this apathy is a "characteristic" of the population, the active support of these stakeholders is essential to avoid any further deterioration of the project.
- A similar attitude was displayed by some community leaders, such as teachers and health staff.
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III.- Proposal for the start-up of the Chambamontera MHPP

3.1. Alternative solutions

After evaluating the problems that occurred in previous months and verifying the technical characteristics of the system, we believe that the best way to supply electricity for the Chambamontera Power Plant (presuming that things are working well in El Eden), is to install a primary line using an isolated system, i.e. with two threads which in turn provides two alternatives:

a) A 13.2 kV medium voltage grid using transformers and a 2 thread primary line; although this could be a security problem for the system operator, this situation could be reverted if the operator is submitted to thorough training and equipped with appropriate instruments and equipment, including a pole and 20 kV dielectric gloves, at the very least. This would cost about $13,300.00.

b) The second more economical alternative is to use a 380V primary grid with a self-supporting cable 2x50/35 mm2, using a transformer in the input sub-station in the Power Plant with a 380/440-220V, 20 kVA ratio, so as not to touch the secondary grid installations. Eventually, the transformer can be converted to 220V, so that both places can operate with 220V. This low voltage alternative is safer for the operator's operation and maintenance duties.

3.2.- Implementation Strategy

3.2.1.- For the electrical part

- Improve the arrangements to protect the sub-station in the Chambamontera Power Plant, to which end the 2x15A thermo-magnetic switches of the switchboard should be changed to 2x32A, 400v, 14 kA thermo-magnetic switches.

-The thermo-magnetic switches in the homes should be changed: the 20A switch should be relocated in the meter box and a 15 (16)A switch installed inside the homes as a main switch and the 10A for diverted circuits. This recommendation should also be implemented in the El Eden settlement.

- A control panel should also be installed in the load regulator output channel in the power house, so that each of the two circuits is adequately protected.

- Pending work must be completed, such as the channelling of all the cables inside the power house, setting the load regulator and putting up signs.

3.2.2.- For the mechanical part

Power generator

Obtain from the manufacturer the necessary information (manufacturing handbook) so that the installer and the operator can evaluate the working conditions and facilitate the corresponding operation and maintenance work.

Electronic Regulator

Evaluate the current performance, coordinating the manufacturer's participation in the implementation of the system as a whole. Information on the manufacturing scheme will also be requested, which will help the operator control the operation and performance of the equipment.

For the operation of both pieces of equipment, handbooks will be requested from the manufacturers to reinforce the training sessions for current or future operators on the respective operation and maintenance.

Lightning protection and renewed indoor reinstallations

There is no lightning protection system in the powerhouse, as it has not been the policy of ITDG to do so because accidents caused by electrical surges have never occurred there, but in power lines. Nevertheless, we consider it advisable to set up a lightning arrestor, due to the recent occurrence of electric surges during the rainy season. The following should be taken into consideration:

- The installation of a lightning arrestor to protect the electromechanical equipment from continuous power surges in the area.
- Renew the installations inside the homes, removing the twin cables and replacing them with an adequate solid cable to make the home safe.
- Change the thermo-magnetic switches for others of a better quality and with the necessary amperage to protect the home from a short circuit.
- Use plastic connectors to join the conductors.
- Use adequate clips to fix the conductors to the walls and wood panels.

3.2.3.- For the civil works

As regards the civil works, important activities need to be carried out, some of them complementary and others that remained pending:

- Complete the construction of the wing walls of the retaining wall above the powerhouse, whilst making arrangements with the owners of the land to carry out reforestation actions in both the higher and lower parts of the powerhouse.
- Restore the surrounding ditch that drains rain water, connecting it to the discharge cannel in order to prevent filtrations inside the powerhouse.
- Build a concrete base for the regulator and switchboard, in order to ensure their stability.

3.2.3 Social organisation

Organisation and management are fundamental for regaining the confidence of the population, leaders and authorities of the community, in order to involve them in the

process of re-establishing the project and finding the adequate mechanisms for the management of the service. The following actions are required:

- Regular meetings with users and authorities to encourage them to become involved in the re-establishment of the project and regain their confidence.
- Resume the implementation of the management model, with specific tasks such as the appointment of people responsible for the operation and maintenance of the system.
- Training events for the people selected to manage the service, preparing and distributing primers on the characteristics of the system and its operation and preventive maintenance.
- Workshops for users of the service, to discuss issues like security, the rational and efficient use of energy, the commitment to pay maintenance costs, among others. Primers on these subjects will be prepared and distributed
- Help teachers and authorities in the community to negotiate the implementation of a satellite system with the Central Government's Ministry of Transport and Communications, so as to gain access to internet and mobile telephone services (we are not involved in this line of work, but will help with the negotiations).

IV.- Budget

Two estimated budgets are proposed here. In Estimated Budget No. 1, the proposed technical changes are considered, based on the evaluation. All the components are included as part of the project and financial aid to cover all the costs has been estimated.

ESTIMATED BUDGET No1

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE $	PARTIAL $
	ELECTRICAL PART				
1	SELF SUPPORTING CABLE 2X50/35mm2, 1KV, CCAI NEUTRAL LINED	M	930,00	3,98	3.705,12
2	HOOK BOLT AºGº 16mm2ØX256mm, WITH SCREW, STOPPING NUT	UND	8,00	3,00	24,00
3	CURVED SQUARE WASHER FºGº 57X57X5mm	UND	16,00	0,30	4,80
4	SUSPENSION CLAMP	UND	6,00	4,00	24,00
5	CONICAL CABLE CLAMP 35mm2	UND	2,00	6,00	12,00
6	DISTRIBUTION TRANSFORMER 60HZ, 20KVA, 2000MSNM				
	340-360-380/460-230V, SINGLE PHASE, EXTERIOR MOUNTING	UND	1,00	1200,00	1.200,00
7	THERMO-MAGNETIC SWITCH 2X32 A, 14KA, 400V	UND	2,00	25,00	50,00
8	THERMO-MAGNETIC SWITCH 2X16A, 14KA, 400V	UND	45,00	8,00	360,00
9	CONTROL SWITCHBOARD IN THE POWER HOUSE,				
	COMPRISED OF:				
	*METAL CABINET TO ENCLOSE:				
	*01 THERMO-MAGNETIC 2X32A, 14KA, 400V				
	*01 THERMO-MAGNETIC 2X40A, 14KA, 400V	UND	1,00	150,00	150,00
	SUB TOTAL MATERIALS				**$5.529,92**
10	ELECTROMECHANICAL ASSEMBLY				
	06 WORKING DAYS, 01 OPERATOR AND 3 ASSISTANTS				
	OPERATOR	DIAS	6,00	18,00	108,00
	ASSISTANTS	DIAS	18,00	14,00	252,00
	PER DIEMS	DIAS	6,00	30,00	180,00
	SUB TOTAL ELECTROMECHANICAL ASSEMBLY				**$540,00**
11	FREIGHT: TRANSPORT OF MATERIALS LIMA-JAEN	ESTIMADO			$300,00
12	INSTALLATION TESTS AND SERVICE START-UP	ESTIMADO			$300,00
13	ADVISORY SERVICE	GLOBAL			$800,00
	TOTAL DIRECT COSTS				**$7.469,92**
	IGV (SALES TAX)				$1.419,28

	SUB-TOTAL				**$8.889,20**
	MECHANICAL PART				
14	EVALUATION OF REGULATOR	GBL	1,00	500,00	$500,00
15	TRAVEL AND PER DIEMS	GBL	1,00	200,00	$200,00
	SUB-TOTAL				**$700,00**
	PROTECTION SYSTEM AND DOMESTIC CONNECTIONS				
17	MATERIALS				
	Thermo-magnetic switch 10 Amp.	U	32,00	10,00	$320,00
	Thermo-magnetic switch 15 Amp.	U	3,00	10,00	$30,00
	Thermo-magnetic switch 20 Amp	U	4,00	10,00	$40,00
	Electricity conductors 14 AWG	Mts.	1240,00	0,35	$434,00
	Electricity conductors 12 AWG	U	300,00	0,40	$120,00
	Clips to attach cables	Caja	5,00	3,00	$15,00
	Plastic cables	U	38,00	2,00	$76,00
					$1.035,00
	SUB-TOTAL				**$1.035,00**
	LIGHTNING ARRESTORS				
18	Lightning suppressors for the machines	U	1,00	770,00	$770,00
19	30 m tower	U	1,00	770,00	$770,00
	SUB-TOTAL				**$1.540,00**
	ASSEMBLY AND INSTALLATION				
20	Assembly of lightning arrestors	GBL	1,00	250,00	$250,00
21	Installation of conductors	U	38,00	15,00	$570,00
	SUB-TOTAL				**$820,00**
	CIVIL WORKS				
22	CONSTRUCTION OF THE WING WALLS OF THE RETAINING WALL	GBL	1,00	250,00	$250,00
23	IMPROVEMENT OF RAIN WATER DIVERSION DITCHES	GBL	1,00	150,00	$150,00
24	CONSTRUCTION OF BASE FOR THE SWTCHBOARD - REGULATOR	GBL	1,00	100,00	$100,00
26	SUPERVISION TRIPS AND PER DIEMS	GBL	1,00	300,00	$300,00
	SUB-TOTAL				**$800,00**
	ORGANISATION				
27	TRAINING WORKSHOPS	GBL	1,00	200,00	$200,00
28	TRAINING MATERIALS	GBL	1,00	100,00	$100,00
29	TRIPS AND PER DIEMS	GBL	1,00	300,00	$300,00
					$600,00
	GENERAL TOTAL				**$14.384,20**

In Estimated Budget No. 2, some components are not considered as they are not necessarily essential for the proper operation of the power system according to ITDG's experience (lightning arrestors, for example).

ESTIMATED BUDGET No 2

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE $	PARTIAL $
	ELECTRICAL PART				
1	SELF SUPPORTING CABLE 2X50/35mm2, 1KV, CCAI NEUTRAL LINED	M	930,00	3,98	3.705,12
2	HOOK BOLT AºGº 16mm2ØX256mm, WITH SCREW, STOPPING NUT	UND	8,00	3,00	24,00
3	CURVED SQUARE WASHER FºGº 57X57X5mm	UND	16,00	0,30	4,80
4	SUSPENSION CLAMP	UND	6,00	4,00	24,00
5	CONICAL CABLE CLAMP 35mm2	UND	2,00	6,00	12,00
6	DISTRIBUTION TRANSFORMER 60HZ, 20KVA, 2000MSNM				
	340-360-380/460-230V, SINGLE PHASE, EXTERIOR MOUNTING	UND	1,00	1200,00	1.200,00

7	THERMO-MAGNETIC SWITCH 2X32 A, 14KA, 400V	UND	2,00	25,00	50,00
8	THERMO-MAGNETIC SWITCH 2X16A, 14KA, 400V	UND	45,00	8,00	360,00
9	CONTROL SWITCHBOARD IN THE POWER HOUSE,				
	COMPRISED OF:				
	*METAL CABINET TO ENCLOSE:				
	*01 THERMO-MAGNETIC 2X32A, 14KA, 400V				
	*01 THERMO-MAGNETIC 2X40A, 14KA, 400V	UND	1,00	150,00	150,00
	SUB TOTAL MATERIALS				**$5.529,92**
10	ELECTROMECHANICAL ASSEMBLY				
	6 WORKING DAYS, 0 OPERATOR AND 3 ASSISTANTS				
	OPERATOR	DIAS	6,00	18,00	108,00
	ASSISTANTS	DIAS	18,00	14,00	252,00
	PER DIEMS	DIAS	6,00	30,00	180,00
	SUB TOTAL ELECTROMECHANICAL EQUIPMENT				**$540,00**
11	FREIGHT: TRANSPORT OF MATERIALS LIMA-JAEN	ESTIMADO			$300,00
12	INSTALLATION TESTS AND SERVICE START-UP	ESTIMADO			$300,00
13	ELECTROMECHANICAL EXPERT	GLOBAL			$800,00
	TOTAL DIRECT COSTS				**$7.469,92**
	IGV (SALES TAX)				$1.419,28
	SUB-TOTAL				**$8.889,20**
	The technical part could be waived as long as the equipment is working properly (to be verified after the first tests)				
	PROTECTION SYSTEM AND DOMESTIC CONNECTIONS				
14	MATERIALS				
	Thermo-magnetic switch 10 Amp.	U	24,00	10,00	$240,00
	Thermo-magnetic switch 15 Amp.	U	3,00	10,00	$30,00
	Thermo-magnetic switch 20 Amp	U	4,00	10,00	$40,00
	Electricity conductors 14 AWG	Mts.	1000,00	0,35	$350,00
	Electricity conductors 12 AWG	U	300,00	0,40	$120,00
	Clips to attach cables	Caja	5,00	3,00	$15,00
	Plastic cables	U	38,00	2,00	$76,00
	SUB-TOTAL				**$871,00**
	LIGHTNING ARRESTORS				
	Lightning is not common in this area, occurring mainly in Andean Highland areas				
	Besides, the electricity grid already has lightning arrestors				
	CIVIL WORKS				
15	CONSTRUCTION OF THE WING WALLS OF THE RETAINING WALL	GBL	1,00	250,00	$250,00
16	IMPROVEMENT OF RAIN WATER DIVERSION DITCHES	GBL	1,00	150,00	$150,00
17	CONSTRUCTION OF BASE FOR THE SWTCHBOARD - REGULATOR	GBL	1,00	100,00	$100,00
18	SUPERVISION TRIPS AND PER DIEMS	GBL	1,00	300,00	$300,00
	SUB-TOTAL				**$800,00**
	ORGANISATION				
19	TRAINING WORKSHOPS	GBL	1,00	200,00	$200,00
20	TRAINING MATERIALS	GBL	1,00	100,00	$100,00
21	TRIPS AND PER DIEMS	GBL	1,00	300,00	$300,00
					$600,00
	GENERAL TOTAL				**$11.160,20**

Appendix 1

Technical Specifications of the materials that need to be changed.

Self-supporting cable:

The self-supporting cable for the low voltage primary grid will have the following characteristics:

Section	: 2x50/35mm2, neutral, lined
Type	: self-supporting
Material	: aluminium
Insulation	: Cross-linked polyethylene, black

Hardware:

Hot dip galvanized hardware will be used for the installation of the self-supporting cable. The following will be required:

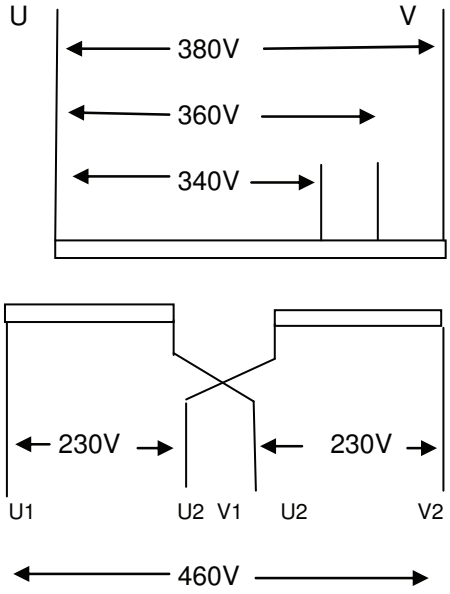
a) Hook bolts AºGº 16mm2 x 256mm, with screw and stopping nut
b) Flat square washer 57x57x5mm, middle hole 18mmØ
c) Suspension clamp
d) Conical anchor clamp

Distribution transformer:

The following are the characteristics of the distribution transformer:

-Nominal power	: 20kVA
-Frequency	: 60HZ
-Working altitude	: 2,000msnm
-Primary grid voltage	: 340-360-380V (single phase)
-Nominal secondary grid voltage	: 460-230V (in vacuum)
-No of coils in the primary grid	: 01
-No of insulators in the primary grid	: 02
-No of coils in the secondary grid	: 02
-No of insulators in the secondary grid	: 04
-Insulation level	: 3kV
-Assembly	: Outdoors, rainproof

-Connection scheme:



Thermo-magnetic switches

The thermo-magnetic switches will have the following characteristics:

* Working voltage : 400 (500) V
* Nominal working capacity:
  +In the switchboard : 2x32A
  +In households : 2x16 A
* Breaking capacity : 14kA
* Assembly : screwed onto a rail

Channelling

Heavy 2"Ø PVC pipes and 2"Ø curves will be used to protect indoor cabling in the powerhouse