Annex 1

Justification of additional output according to baseline study

1. Additional power installed in four units	22	MW
2. Operations time for a sufficient additional power flow	3,500	h/year
3. Maximum additional Power	77.000	MWh/year
4. Nongenerated thermal power due to additional production in CHE PF I on restriction 1	70.000	MWh/year
5. Increase of secondary control band from 21 to 29,5 MW/unit	34.00	MW
6. Utilization time, lower half-band additional	8,760	h/year
7. Hydropower additionally generated for secondary control	148,920	MWh/year
8. TOTAL ADDITIONAL HYDROPOWER	218.920	MWh/year
9. Energy generated in Romanian thermal units for achieving a 34 MW band with technical Pmin 65% of Pn		
- Pn = 34,72*100/35	97	MW
- Band	34	MW
- Pmin	63	MW
Least energy to be generated as thermo = Pmin tech.*Tu(6)	553,131	MWh/year
Remarks. To justify power amounts nongenerated in thermounits, the amount 553.131 GWh/year was not considered, only hydrogenation in addition respectively 218.920 GWh/year, with a risk factor Kr = 0,969 correction		
10. Energy equivalent = Kr*En hidro (8)	212.133	MWh/year

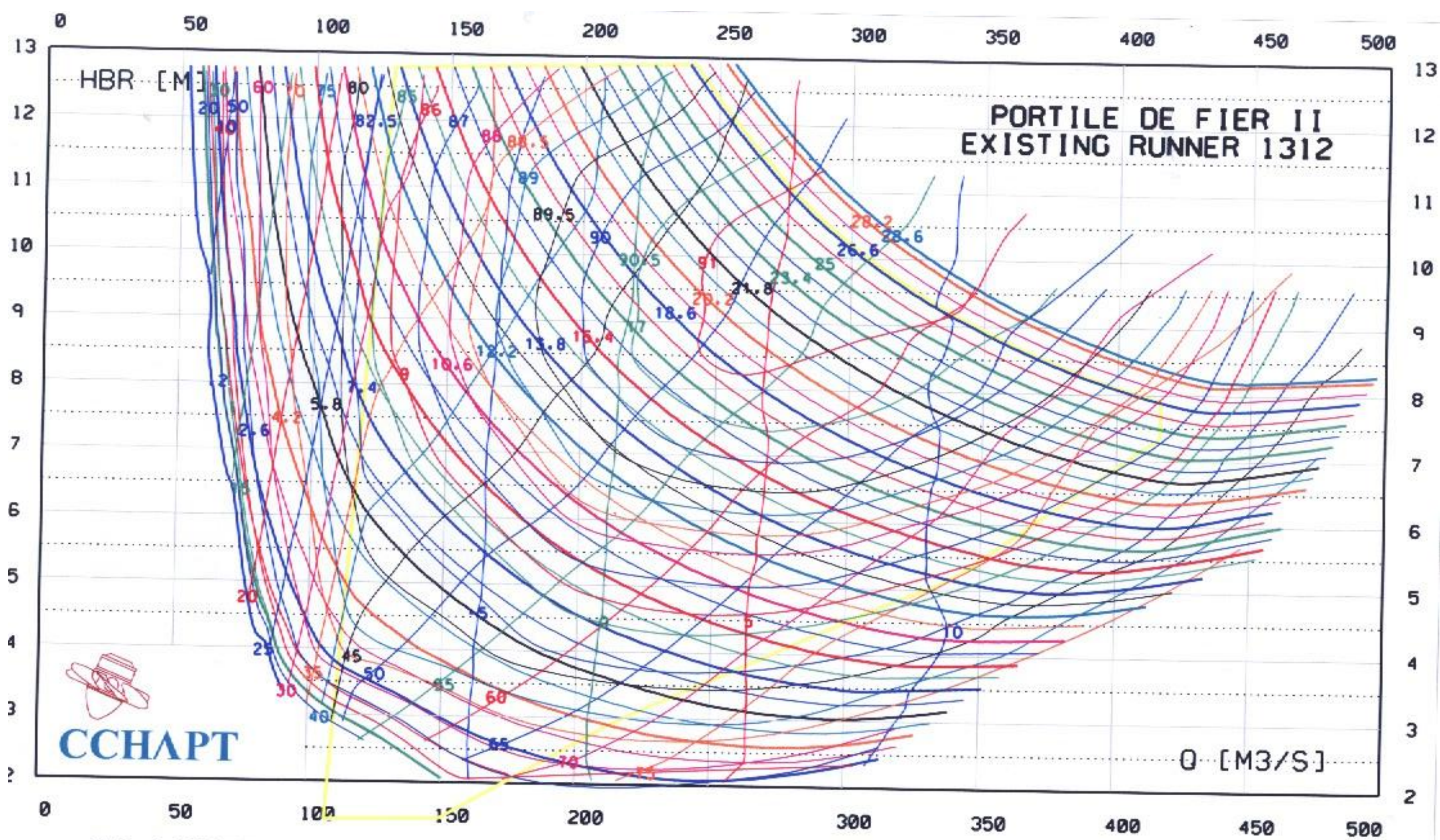

FIG. 2.3 DIAGRAMA DE EXPLOATARE HBR-F(Q) A HIDROAGREGATULUI EXISTENT DE LA CHE PORTILE DE FIER II

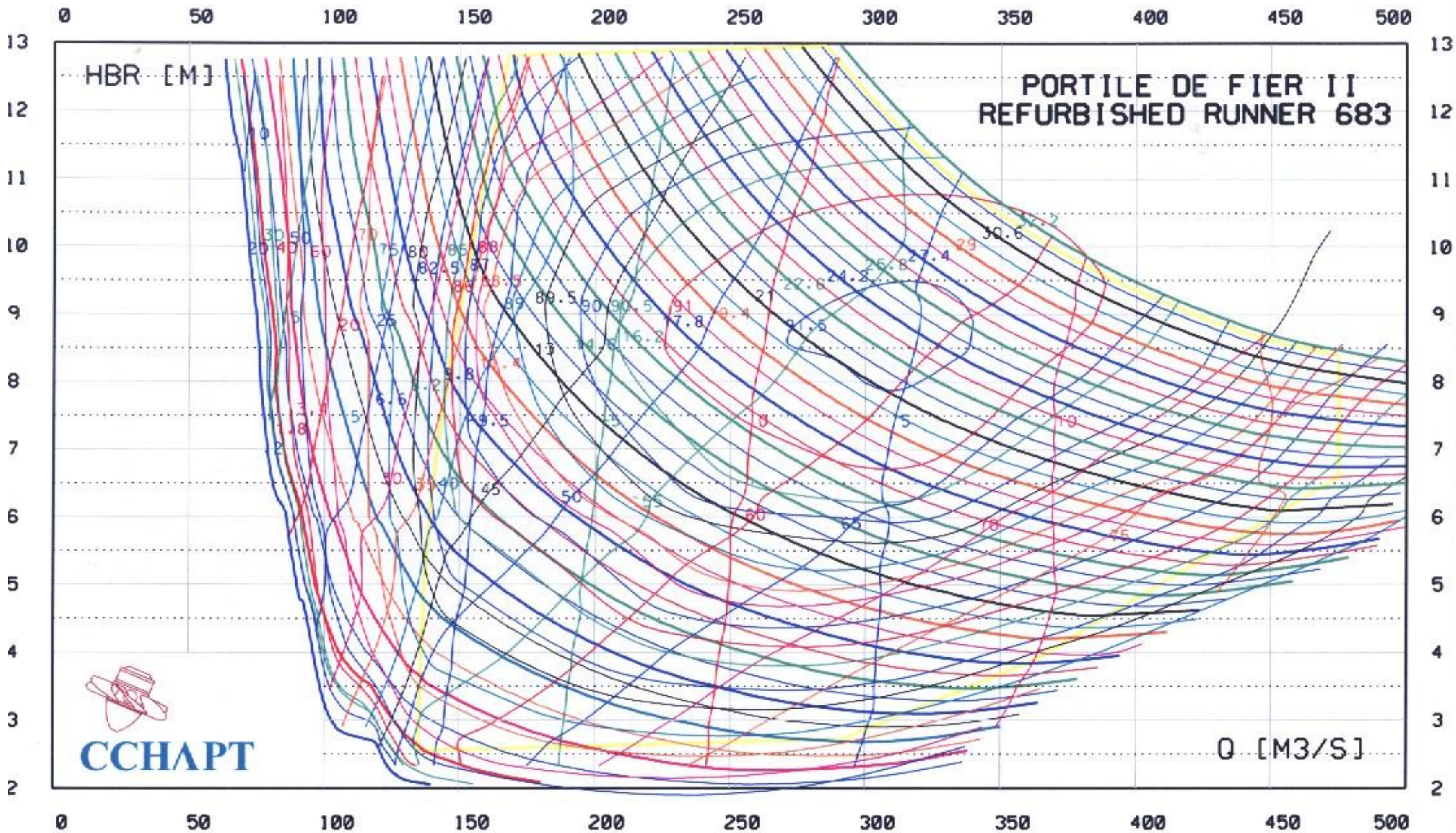

FIG. 2.4 DIAGRAMA DE EXPLOATARE HBR=F(Q) A HIDROAGREGATULUI RETEHNOLOGIZAT DE LA CHE PORTILE DE FIER II

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Quality Assurance and Quality Control Procedure for the process included in the Monitoring Plan

A. General

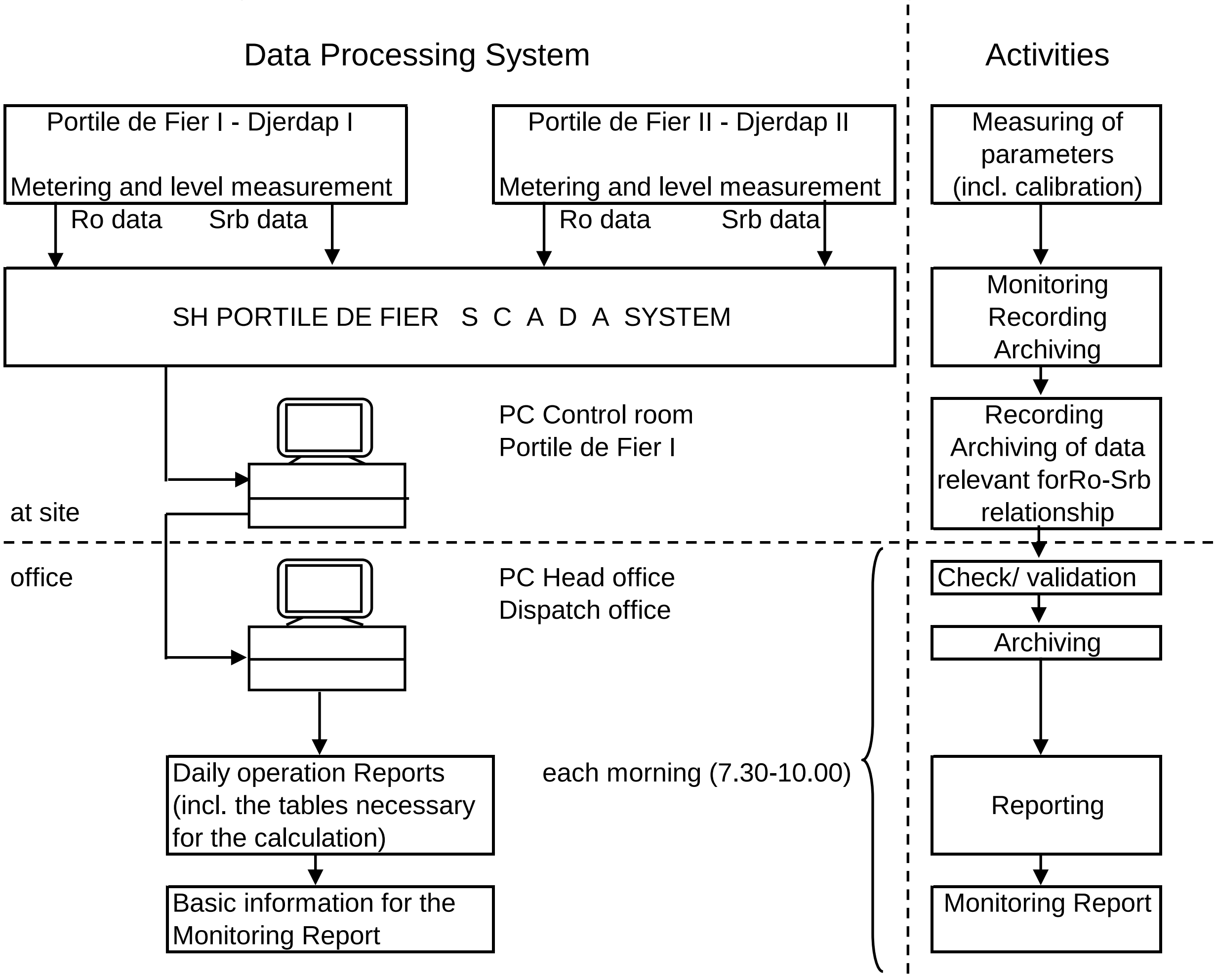
This procedure describes the process, activities and valid quality procedures implemented within SH Portile de Fier for the monitoring of the necessary parameters within the Monitoring Plan

The presented procedures are not created specifically for the JI Project for Portile de Fier I and Portile de Fier II being implemented since the beginning of the operation of both Portile de Fier I and Portile de Fier II Systems and is used for the split of the energy between the two parties.

The same data exchanged with the serbian side for the split of energy will be used as basic information for the Monitoring Report

B. Description

The following schema describes the data processing system and the step by step activities witnin the Monitoring Plan for both Portile de Fier I and Portile de Fier II JI Projects



C. Valid Quality Procedures and Regulations used in the process

The basic document used for the operation of both Portile de Fier I and Portile de Fier II in the relationship between romanian and serbian side is the "Regulation for the organization and operation of the common dispacht service for energetics of Portile de Fier and Djardap" appoved by the Common comitee for Portile de Fier which is in force at the level of the two governments.

On the basis of the provisions of this Regulation, Quality procedures and Working instructions were defined (see Attachment) and are used in the Process

Explanation of the factor that diminishes the maximum output of the non refurbished units due to real operation conditions

The additional energy generated by the refurbished units E_A is formed by:
- Ea = the difference between hourly generated power and the maximum power given by the original supplier at the head at which the refurbished unit operates during the respective time/hour;
- Eb = the difference between the efficiency of the refurbished unit and the old unit in the same conditions of head and power achieved at the respective hour.

For the calculation of the additional energy Ea, an achieved (real) value of the refurbished unit is compared to a maximum value given by the original supplier (P_{27}) which is a theoretical one from the operational hill-chart determined on the basis of model tests. For a clear understanding of the issue the site operational conditions of the units are slightly different to the conditions during the model tests. The model tests are done without to model the trash racks upstream the unit (at the unit intake). The net head and brutto head in the hill-charts are determined on the basis of the calculation of the head loss on **clean** trash racks. In the real operation the trash racks are slightly clogged (due to the materials and trashes that flows with the water) and this gives a small additional head loss on the trash racks that diminishes the output of the units. When the clogging gets to a certain values the unit is stopped and the trash racks are cleaned.

In order to compare values that reflects the reality in a more clear way, an analysis, made for the entire period before the refurbishment process started (respectively 1987-2004) the output value bandwith (dP) of the hourly energy of all units, in each day where the flow exceeded the capacity of the Units in operation (all Units were supposed to operate at maximum power given by the supplier), was carried out.

For all these days, for each hour (i), based on all 8 values the maximum power of the Romanian Units was established ($Pmax_i$), the minimum power ($Pmin_i$), as well as the difference between them dP respectively dP% in percentages

$dP_i = Pmax_i – Pmin_i$ where i is the hour and

$dP\%_i = dP_i*100/Pmax_i$

In the attached table one can find the annual average values dP and dP%, as well as the number of the analyzed hours during the respective year (N).

The average value of the entire analyzed period are for Portile de Fier II:

dP		dP%
2,332 Mw	respectively	12,96%

Due to the fact that the maximum power given by the original supplier is variable with the head it is not recommended the diminution with a fix value (dP) (expressed in Mw), but a percentage diminution. The most probably value is the half of the difference between the maximum and minimum values of the outputs recorded every hour during the overflow period between 1987 – 2004, this being: **6.48%**

Monitoring parameters

1. Head = difference between upstream water level and downstream water level (see ID 111.1)
This parameter is calculated parameters as the difference between 2 measured values (upstream and downstream levels)

Parameter	Measuring unit	Measuring device	Accuracy	Checking	Calibration	Spare
Upstream level	m	TLN	0,15%	Permanent checking with the Serbian value	Once per year by geodesic checking	Serbian device same accuracy
Downstream level	m	TLN	0,15%	Permanent checking with the Serbian value	Once per year by geodesic checking	Serbian device same accuracy

TLN = Telelimnimetru (device that measures the water level and transmit the value at distance)

2. Power = hourly measured power of each unit (the produced energy each hour) see ID 111.2
This parameter is a measured one

Parameter	Measuring unit	Measuring device	Accuracy	Checking	Calibration	Spare
Power (hourly produced energy)	Mwh	Energy counter	0,2%	Permanent checking with the OMEPA counters same accuracy	Every 5 years according metrological laws	OMEPA counters for delivered energy same accuracy

3. Increased efficiency = difference between the efficiency of the new and old turbine (see ID 111.4)

The other parameters like **Increased Power** (see ID 111.3) and **Increased Energy** (see ID 111.5) are derived from above mentioned item Power (see ID 111.2)
The determination of the **Additional electric energy for the entire PDF hydroelectric system E 2** (see ID111.6) is explained in detail in the Monitoring Plan

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"Modernization of 4 hydrounits of Portile de Fier II HPP"

Contract ERU 17/03

Monitoring Plan

rev 1, October 2007

Table of contents

I. Context

The project consists in the modernization of the first 4 hydrounits of the 8 existing hydrounits in the Portile de Fier II hydropower plant. The results of this modernization consist in the increase of the installed capacity with 4,4 MW/HU, the increase of the hydrounits' efficiency and in the prolongation of the hydrounits' life span with 30 years.

The modernization includes such main works as:

- turbine and associated installation;
- generators, auxiliary installations and excitation system;
- automation and electric protection system.

The amount of emission reduction units, contracted according to the ERU17/03 contract, was established based on the baseline study (Annex 1).

II. Justification of the proposed methodology

According to the baseline methodology developed for this project, the selection of the measurement plan is reliable enough. The measurement methodology takes into account all the relevant collected data in order to determine the emissions reduction resulted within the project, which can be confirmed. The hypothesis that defines the emission factor is described in the selected basis scenario and it is the same for the calculation of the emissions reduction units associated to the present project.

The main data categories are:

- Additional electric energy generated due to the refurbishment of the first 4 hydrounits through increasing the installed capacity with 17,6 MW
- Increasing of the efficiency of the hydrounits after the refurbishment

The monitoring methodology, described in the next chapter, accounts for all data relevant for determination of ERU achieved by the project, respectively the most conservative scenario.

All the collected and used data are verified and validated by neutral entities:

- The hourly energy values are measured by the counters installed at the terminals of each generator. The energy is also measured at the outgoings at the 110 kV network by OMEPA, a neutral entity abilitated for measuring and deduction of the electric energy between the producer and consumer. This system is considered the back-up system in case that one of the counters fails. At the same time we mention that the output split between Romania and Serbia-Montenegro (former Yugoslavia) is based on these values.

- The efficiency values for the old and the refurbished hydrounits were measured by a neutral laboratory EPFL - LMH from Lausanne, Switzerland and are used for the calculation of the additional output in the split between Romania and Serbia-Montenegro (annexes 2 and 4).

III. Calculation methodology for the additional generated energy

The supplimentary generated energy ΔE is calculated with the formula:

$$\Delta E = E_A + E_B \qquad [\text{Mwh}]$$

where:

1. E_A – *Additional electric energy generated due to the increase of the installed capacity and efficiency*

The calculation for the entire additional electric energy generated is done with the formula:

$$E_A = E_a + E_b = \sum_{1}^{8760} ((P - P_{27}) + \Delta\eta * P) \qquad [\text{Mwh}]$$

where:

P = hourly measured energy by the counters (hourly medium power) [Mw]
P_{27} = maximum power (depending on the head) of old hydrounits [Mw], where
head = difference between the upstream and downstream levels measured [m]
$\Delta\eta$ = increased efficiency represented by the difference between the efficiency of the refurbished hydrounits and the efficiency of the old hydrounits

a. Additional electric power generated due to the capacity increase (higher installed flow through the turbines)

The calculation of the additional generated electric energy is based on the difference between the hourly electric energy for each refurbished hydrounit and the electric energy that could have been generated by the old hydrounits in the same operational conditions (P_{27}).

I. The hourly electric energy generated by each hydrounit (P) is measured at the terminals of each unit with ABB meters, class 0,2%, which are installed both in the Romanian and Serbian power plants; based on these data, is done the split between the two parties.

II. P_{27} is determined from the power – head characteristic of the old hydrounits, it is given by the supplier and has 6 areas as follows:

i. for heads of 13 m – the power is 26,86 MW
ii. for heads of 7,95 m – the power is 26,70MW
iii. for heads of 7,35 m – the power is 24,46 MW
iv. for heads of 5,15 m – the power is 13,76 MW
v. for heads of 3,30 m – the power is 5,69 MW
vi. for heads of 2,1 m – the power is 1,78 MW

vii. for heads of 1,10 m – the power is 0,64 MW

between these head values, the power variation is linear.

Due to the fact that during the real operation the units don't achive the maximum output given by the original supplier, in the calculation this output must be diminished by a factor of 6.48% representing the most probably value being the half of the difference between the maximum and minimum values of the outputs recorded every hour during overflow period between 1987 – 2004 (for explanations see Annex 6).

The hourly values of the heads are measured in the process and represents also an element of the energy split process between de Romanian and Serbian parts.

b. Additional electric power generated due to the efficiency increase

The efficiency depends on power and head, parameters that were mentioned above. Due to the need to divide the Danube's potential when operating with hydrounits of different efficiencies, the two parties (Romanian and Serbian) addressed to an independent laboratory from Lausanne, Switzerland, in order to measure and validate the efficiency for each operated hydrounit. The validated values are confirmed by both parties and used in the calculation ($\Delta\eta$).

2. E_B - Additional electric energy for the entire Portile de Fier hydroelectric system

Due to the new operating rules, an additional generated electric power appears at Portile de Fier cascade.

The operation of the Portile de Fier I hydroelectric system with an output between 0 and maximum power (variation which has been requested by the two national electric systems) generates a variation of the turbines discharge, variation that has to be compensated by the Portile de Fier II hydro development. These rules were internationally established (Romania, Serbia and Bulgaria) and will be effective during the entire life span of the Portile de Fier hydro development. The increase of the installed capacity of Portile de Fier I system leads to an increase of the turbines discharge variation, which implies a change of the daily operation manner of the cascade. This change leads to a decrease of the head used for the operation of the hydrounits in Portile de Fier I system. The new hydrounits in Portile de Fier II system reach the optimum operational point at heads higher than the old hydrounits. Considering all the above and in order to achieve an additional quantity of energy on the cascade, the Romanian and the Serbian parties have agreed to a solution for operation with higher level in Portile de Fier II reservoir.

This additional energy results from the measurements performed by both parties and confirmed within the final deduction process, within the Joint Commission of Portile de Fier, commission that represents the Governments of the two countries.

This way, the head increase at Portile de Fier II (dh2) leads to a head decrease at Portile de Fier I (dh1). The dh2/dh1>1 ratio is proportional with the square of the inflow of Danube river. The result is an increase of the electric energy due to the increase of dh2 head, and the increase of turbine discharge. Likewise, the generation of electric energy at Portile de Fier I is diminished, but in a smaller proportion.

The difference between the increased generation at Portile de Fier II and the decreased generation at Portile de Fier I represents the electric energy gained in the entire hydroelectric system, which is equally divided between the Romanian and Serbian parties.

The heads at Portile de Fier I (h1), Portile de Fier II (h2) and Gogosu (hG) are daily measured. The increase of the heads dh2 and dhG and the decrease of head dh1 are defined through hydraulic calculation.

Because:
$E = \eta \times h \times Q \times t$ and $\eta = f(h)$ and $Q = f(h)$

The initial electric energy generation (if the heads h2 and hG would not be increased) for Portile de Fier II (respectively Gogosu) are daily calculated

$E2_{(h2-df2)} = \eta_{(h2-dh2)} \times (h2-dh2) \times Q_{(h2-dh2)}$ respectively

$EG_{(hG-dfG)} = \eta_{(hG-dhG)} \times (hG-dhG) \times Q_{(hG-dhG)}$

The gain from Portile de Fier II is:
$dE2 = E2+EG-E2_{(h-dh2)}-EG_{(h-dh2)}$ where

E2 and EG represent the daily electric energy generation.

The calculation for the initial electric energy generation (if h1 would not be decreased) is done in a similar way for Portile de Fier I

$E1_{(h1-df1)} = \eta_{(h1-dh1)} \times (h1-dh1) \times Q_{(h1-dh1)}$

The loss for Portile de Fier I is as follows:

$dE1 = E1-E1_{(h1+dh1)}$ where:

E1 represents the daily generation.

The gain for the entire system will be calculated as follows:

$E_B = (dE2+dE1)/2$ (dE1 has a negative value)
Due to the fact that the project is only for 4 units only half of the additional electric energy for the entire Portile de Fier hydroelectric system (dE2+dE1) is considered.

IV. Assessment of AAU's and ERU's

The quantity of ERUs results form the generation of an additional electric energy due to the refurbishment, starting from the assumption that this replaces the similar electric energy generated in the thermo power plants. The quantity of greenhouse gas that should have been generated in the thermal power plants (taking into account that in the next 30 years these will use natural gas supply) for the generation of a similar energy quantity will be considered as ERUs of this project.

therefore: $ERU = \Delta E * CEF$
where:

- CEF – CO_2 /carbon emission factor as it has been calculated in baseline study, scenario S6
- ΔE –electric energy additionally generated after the refurbishment

For each reporting year, the AAUs/ERUs will be calculated using the same tables as presented in baseline report.
The input data for this consist of ΔE, calculated as presented in chapter III of this measurement plan and CEF, as calculated according the selected baseline scenario.

The table bellow may be used:

Year	2005	2006	2007	2008	2009	2010	2011	2012
ΔE								
CEF (t CO_2/KWh)	894	875	856	838	819	800	781	763
CO_2 (tons)								

V. Data quality control and quality assurance

Hidroelectrica has implemented and certified an integrated management system according to the international standards:
ISO 9001:2000 for Quality Management System;
ISO 14001:2004 for Environmental Management System;
OHSAS 18001:2004 for Health and Occupational Safety Management System.

The management system provides for the control of the quality of the measurement and monitoring data. The certification of SC HIDROELECTRICA SA for the management system is proved by the certifications shown in the Annex 4.

The Quality Assurance and Quality Control Procedure for the process included in the Monitoring Plan is presented in Annex 5

VI. ANNEXES

1.Annex 1 - Justification of the additional output according to the baseline study
2.Running chart of the old hydro unit depending on the bruto head.
3.Running chart of the refurbished hydro unit depending on the bruto head.
4.IQNet certification for the managment system.
5.QA/QC procedures for the monitoring of the parameters included in the Monitoring plan
6. Explanation of the factor that diminishes the maximum output of the non refurbished units due to real operation conditions.
7. Monitoring parameters

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