# UP-DATE OF PLANE WATER GATES FROM HYDROPOWER STATIONS AND DAMS

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**Abstract:** This paper synthesizes the problems and solutions used in order to up-date the plane and "butterfly" gate installations from hydropower stations and dams, which belong to SC HIDROELECTRICA SA Tg-Jiu. Subsidiary. Moreover, will be analyzed the opportunity to realize the SCADA system with information about the plane gates, for processing of data in order to assure a central control of water flow from dam.

**Keywords:** water gate, hydraulically engine, dam, hydropower stations, Programmable Local Computer (PLC), incremental pulsgivare, transducer.

## 1. INTRODUCTION

The hydro-energetic system - Cerna-Motru-Tismana date since 1970. The system's project was a far-reaching project and implemented the concept of water successively machining, from Cerna through Hydro-Power Stations from Large-Valley, Motru and upstream and downstream Tismana-Station.

In the same time has begun to run CHE-Clocotis with adduction tunnel toward Tismana.

This is a hydrographical perimeter where SC IPA SA was involved and solved some problems of adduction, "butterfly" and dam's emptying gates from balance tower water.

Each plane and "butterfly" gate consists in two seriatim gates. The upstream gate is the security gate, closing just in case of revising or damages of working gate. The downstream gate is the working gate that controls the water flow into the tunnel.

Because the systems are old, the automation controlling and signaling are worn-out, have not a good running and especially are not safety in running.

The monitoring of the gates levels is made by a number of electromechanical limits. They are assembly on a cylinder with cams, activate by a steel wire with an extremity fixed on the gate and the other extremity fixed on the cylinder. The steel wire is keep stretched by a counterweight. In this condition is very difficult to put the electromechanical limits in the right positions and the limits must to be changed frequently because the humidity and corrosion. On the other hand, this system assures just a few points of monitoring: up, down, jump I, jump II. (The jump I and jump II points are under the up position near the open gate position and they are two check points

because the decrement of oil pressure into the hydraulically engine).

Because of these problems, we realized an automat system, using transducers of last generation from Telemecanique. We used intelligent proximity and incremental pulsgivare transducers. This kind of transducers are very resistant at humidity, offer a continuous measurement of the gate open level and their signals are analyzed by a PLC. The PLC command the gate and offer information: local on LCD, in control room of hydra-electric power station and to the general dispatch.
These informations are very important on little rivers but with high hydropower potential.

## 2. THE PORPOUSE

Is to control and supervision of the water accumulations in hydropower fitting out, management from distance of the hydropower stations, optimal control of a large area with successive water accumulations.

- The increase of energetic capacities using optimal the water accumulations in a successive line of micro hydro-power stations;
- Permanent and continues report to the decision persons about the situation of water flow in hydro-powers area;
- The establishment of an optimal working regime for a micro hydro-power station during an entire year (four seasons with different rain conditions);
- The eliminate of inundation risk in spring or in autumn because the increase of safety of working system and anticipate and supervision management;
- The increase of efficiency in whole line of micro hydro-power stations and integration of energetic field in UE standards;
- Complex automation for management from distance of the micro hydro-power stations in an entire hydro energetic area;
- The increase of the technological performance (continues risk supervising means technological concordant supervising);

Based on the technological process of the hydropower fitting out and operative managing of the hydropower stations, we propose a solution suitable to integrate in informatics system. The type of informatics system is SCADA, Decision Support System / Management Support System, witch according with the mathematical model and action strategy must conduct to more safety in running, optimum usage of water and energy resources and decrease of inundations risks.

In our country such in all world, is very important to have an increase attention to prevent the risk situations because the inundations. In hydropower fitting out, the long term plans to prevent the inundation situations are correlated with the water flow monitored at gates, hindrances and flaps on each dam of water reservoir.

The new global concept from The European Community about the security of rivers for prevent the inundations risks situations, will be obligatory for Romania in the context of our integration in European Union. This concept supposes the regulation of watercourses to prevent the inundations.

Although a lot of rivers from our country have dams and water accumulation lakes, the risks for inundations are very high, because there are no systems to allow an optimum control for automat opening of water gates, hindrances and flaps of the dams from a general dispatch. Such automat opening system, allow to increase or decrease the water flow according with the real situation and allow the correlation between all hydro-power stations situated on entire area of a hydropower fitting out.

This system is put into service in a few points and allow: a real time analyze of the measured parameters, remote control of the water flow in a micro hydro-power station, automat manipulate of the gates, finding of deficiencies, optimum managing of the energetic system and report in real time for decision factors.

## 3. ADVANTAGES

The system allows: an efficient administration of the hydro energetic resources, decrease of the price of electric energy, increase of safety in service and efficiently managing of hydropower stations and hydropower fitting out. These systems are very important on little rivers but with high hydropower potential.

## 4. DIVISIONS INVOLVED IN PROJECT

- Producing division;
- Mechanical and energetically division;
- Designing division;
- Planning division;
- Informational division;

## 5. THE DESCRIPTION OF TECHNICAL SOLUTION

The purpose is to put into service a complex system of automation for managing the hydropower stations from distance and correlations between hydropower fitting out and the water flow used for producing electrical energy.

### *5.1. From scientific point of view*

It will be study the following problems:

- The conception of an automatic system for monitoring and operate of the water gates from distance;
- The elaboration of a mathematical method for modeling, used in optimum managing of hydropower fitting out;
- The elaboration of the mathematical algorithms for optimum managing in medium and long time of all hydropower stations existing on a river. The algorithms are based on forecast, assure the maximum of electrical energy produced by each hydropower station and avoid the inundations;
- The determination of a mathematic model for technological equipment and hydropower fitting out;
- Study and simulation of freshet propagation in case of forced sloping; functions of estimations of freshet propagation, elaboration of estimations programme;
- It will be calculate the water flow toward the storage basins, basing on information provided by the transducers set from storage basins;
- It will be calculate the period of time in which the upstream water flow arrives in downstream storage basin;
- It will be calculate the flow out from the storage basin, function of the opening and geometry of the water gates;
- It will be calculate the necessary opening of the water gates;
- It will be calculate the control rules for the system;

For realize, implement and test the system take into account the Hidroelectrica's Standards- PE503/1987 and the Metrology's Law No. 11/1997.

*5.2. The monitoring equipment's functions:*

- Acquisition, real time processing of the input signals, processing of the information;
- Automatic control to water gate equipment;
- Optic signalization of the equipment state;
- Local displaying and configuration, RS232 output to programmer equipment;
- RS 485 output connecting with the network of hydropower stations and dispatch, for supervising of the parameters from distance;
- Data saving on the equipment's Hdd;
- Possibility to access the real time data; off-line data analyze using data bases for a normal running or damage; elaborate the graphic and numeric reports-local or remote;
- Connecting with SCADA equipment for remote monitoring;

*5.3. The operate equipment's functions:*

- Checking operate conditions (oil level, oil pressure in cylinders, water gates position);
- Start water gate installations, local/ remote;
- Checking open/close level for water gates;
- Setting the new position for work water gate, in case of operate;
- Keeping the position of work water gates, till to next operate;
- Keeping open position for safety water gate in case of jump I or jump II;
- Stopping open/close operate in any position of the water gates in case of damage or inspection and recondition and keeping the position till to next operate;
- Local displaying the position of the water gates on LCD and LED barograph;
- Automat stopping in case of damage, or normal local or remote from operate personnel;

*5.4. The protections equipment's functions:*

- Protection to oppression in guide systems;
- Protection to over level of hydraulic oil's pressure in the cylinders;
- Protection to start the operate when the level of oil is under minimum;
- Protection to work with loss of oil when the oil pressure is too low;
- Protection in case of clogging for standing thresholds in tunnels (the water gates can not be put in close position and PLC order general stop);

*5.5. Description of the solution*

The PLC receive the data from system, display and transmit the parameters and wait for commands to operate the water gates.

For commands is enough to set on LCD the new position of the water gate. Setting operation use only four switches from frontal panel of PLC, near the LCD.

During the operate time, the equipment supervise the work parameters of the installation and the prescribed levels to open or close for each water gate. When the water gate is on the prescribed level, PLC command stop and keep it in position till another operate.

It is necessary to realize the keeping of the water gate in the prescribed position, because on a long period of time, loss of oil pressure allow the water gate to go down under the influence of its own weight. To keep the water gate in the same position, the equipment allows 3cm to5cm range of hysteresis.

The exactly position of the work water gate is detected by an incremental pulsgivare transducer mounted in the old system on the axle of the cylinder with cams. So, after an initial sizing of whole range of water gate, any time is possible to know the momentary position

of the water gate 1-3 mm precision. The PLC will process the signals from the incremental pulsgivare transducer and convert its in length. In this way it is possible to have a continues monitoring on the opening of water gate. The old system allowed just four points for water gate position: open, close, jump I and jump II in a range between 0m and 2.5m.

The new measure system allow opening and keeping of the work water gate position in any point between open and close points and can control the water flow on bringing tunnels or evacuation gates from dams. We kept the old command system with four measure points, just for safety water gates. The normal positions for safety water gates are total open or close. Keeping of the open safety water gate position is realized by jump I and jump II transducers. The PLC receive signals from them, process the information and command start for hydraulically engine. The engine will stop when the safety water gate arrive in open position.

Because for safety water gates is enough just four points for operate, we changed the electromechanically limits with proximity transducers. The electromechanically limits, always create electrical problems because the corrosion of electrical contacts. The new transducers are compatibly with PLC, are very resistant at humidity and corrosion and don't have any mechanic contact with the system. So we solved the great problems generated by high humidity from tunnels.

*5.6. Buttons and command keys on the frontal panel of PLC and electrical control panel:*

- The select key for equipment running with 3 position „Manual / Revision / Automat";
- The select key for commands type with 2 positions "local control/remote control";
- The select key for group type with 2 positions "base group/reserve group";
- Four switches for local programming of PLC and adjust the level for next operate;

*5.7. Light signals on PLC control panel:*

- LED signal for electrical power line/UPS;
- 4 points LED signals for position of safety water gate: open, close, jump I and jump II;
- 11 points LED signals for work water gate positions, with 10% rate in entire range, use for distance appreciation of opening;
- Accurate displaying of the work water gate position on local LCD in front panel of PLC, in length units (mm or cm);
- LED signal for oppression of the water gate in guide systems, during operate;
- LED signal for loss of oil when the;
- LED signal for low level of oil pressure in the hydraulic system;
- LED signal when the water gates can not be put in close position because clogging of standing thresholds in tunnel;

*5.8. The formulas for calculation the water volume in the storage basins take into account the following:*

- Models for the reconstituted flows;
- Affluent flows;
- The diagram of the lakes water capacity;
- The mathematic models for the statistic calculation and analyze;
- The models for the flows and level prognosis;

## 6. THE ADVANTAGES OF THE WATER GATES AUTOMAT SYSTEMS FOR HYDROPOWER STATIONS, DAMS AND HYDROPOWER FITTING OUT

From technical and economical point of view, using the systems with PLC in hydropower stations, dams and accumulation lakes, is connected with optimum managing of energetically resources, prevention of inundations and start working with PC in the managing process.

Some advantages of working with modern equipments in hydropower fitting out are:

- The supervising equipments ease the user's activity, by a fast monitoring of the events;
- Allow an analyze for each equipment and installation;.
- The after damage analyze is made efficiently and rapidly;
- The maintenance of the whole installation is made easier and low costs;
- The equipment allows a real time monitoring and remote control for water gates;
- Increasing the availability of the hydropower stations, due to the rapidity with which an event is detected;
- Increasing the produced energy due to a high efficiency by using optimum the water volumes from storage lakes;
- The data can be transmitted by Intranet;
- Decreasing the maintenance costs due to the automatic control equipments;
- Is an open system allowing the subsequent development and the other systems interfacing;

The system aims the following effects: economic efficiency, good management, an optimal using of the resources, plants organizing, human problems, the failure impact to realize the system.

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