# THE VOLUME OF INFORMATION, AT DHA LEVEL, NECESSARY FOR OPERATIVE CONTROL OF HYDROPOWER PLANTS AS PART OF A COMPLEX HYDROPOWER ESTABLISHMENT

F. VATRĂ, Institute for Studies and Power Engineering, Blvd Lacul Tei no.1, Bucharest, fanica.vatra@ispe.ro
A. POIDA, Institute for Studies and Power Engineering, Blvd Lacul Tei no.1, Bucharest, ana.poida@ispe.ro

**Abstract. This paper wants to present some aspects regarding to the volume of information from the point of view of the needs for the operative control of hydropower plants as part of a complex hydropower establishment. These aspects are part of the contribution of ISPE at the MAREA research project, developed under CNMP management.**

**Key words: information, operative control, hydropower plants**

## 1. INTRODUCTION

The main objective of the research project "Distributed Intelligent System for technological resources management of a hydropower establishment - MAREA, a project, which belongs to the thematic area S / T according to Schedule / Program 4 -"Partnerships in priority areas", is to increase operational efficiency in exploiting resources and equipment of hydropower cascade establishment through the development of applications applicable to distributed systems and their implementation in a computer system with distributed intelligence to support managerial decision.

One of the crucial elements in achieving this objective is to determine the amount and types of information necessary for a Hydro Power Dispatchers/Dispatching System for operational/ operative control of the hydropower plants/ facilities within a complex hydropower cascade establishment.

## 2. THE STRUCTURE AND ORGANIZATION OF OPERATIONAL/OPERATIVE CONTROL - FACTORS THAT GENERATE / IMPOSE THE VOLUME AND TYPES OF INFORMATION REQUIRED AT DHA

The Operational/Operative Control of SEN is performed/achieved unitary and hierarchical organized, by the central, territorial, regional and local levels. The Operational/Operative Control Levels are:

1st Level - The Central Power Dispatcher (DEC);
2nd Level - The Territorial Power Dispatchers (DET);
3rd Level - The Regional Power Dispatchers that can be:

- Distribution Power Dispatchers (DED) - organized as part of the Distribution Power Operator for the Operational/Operative Control of 110 kV electricity networks;
- Hydro Power Dispatchers/Dispatching System (DHA);

4th Level - The Local Power Dispatchers that can be:

- Power Dispatchers of/for electrical distribution networks (DEDL);
- Power Dispatchers of Electrical Power Plants: CTE, CET, CHE, CNE, CEE (DLC);
- Power Consumers Dispatchers (DELC).
- District Heating Dispatchers (DT).

Is shown in Figure 1 the Structure and Organization of Operational/Operative Control of SEN installations and operational subordination of various dispatching centers and energetics objectives in terms of control by the dispatcher, according to the importance of each objective in SEN.

Organized under the management of hydro units, the DHE centers provide the dispatching control of hydropower plants installations in respective area, in compliance with the investiture order [1,2,3,4,5,6,7,8,9].

In the case of small hydropower plants, located in the same geographical area can be arranged Hydroelectric Control Centers (CHC).

Organized under the operational management of power plants, the DLC centers provide the dispatching control of hydropower plants equipment/ installations in respective area, both in compliance with the investiture order issued by the dispatching centers and with the internal investiture order issued by the management of units concerned.

Organized under the administrative units which administrate the respective hydropower establishments, the Hydro Power Dispatchers of Hydropower establishments (DHA) provide the dispatching control of power installations in respective area and some electrical equipment which connect these installations with SEN, in accordance with dispatching control authority, assigned by order of investiture.

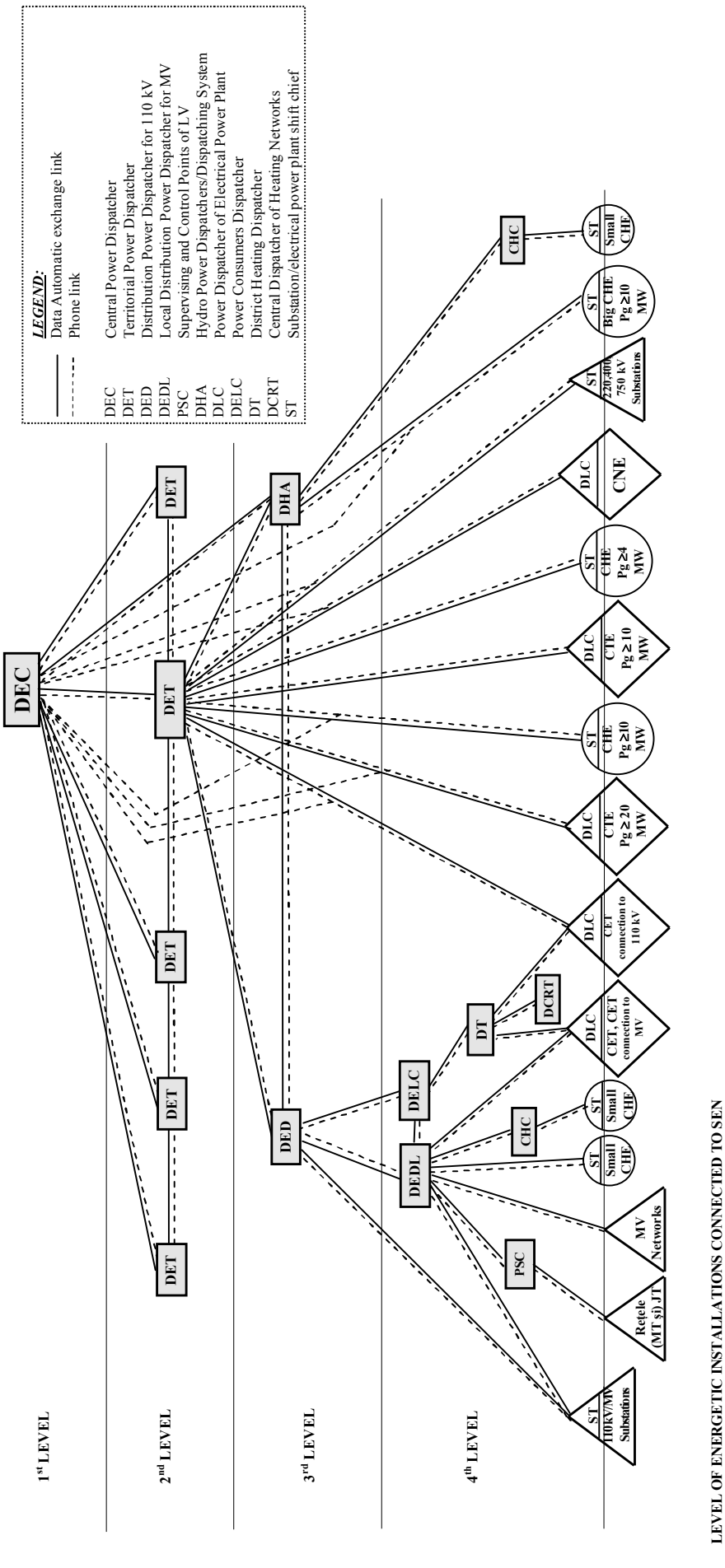


**Fig. 1.- The Dispatching Control Structure of the SEN installations. Hierarchical subordination.**


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Also correlated with the operating programs and orders of dispatching higher level, DHA assures the coordination of electricity production of and the various water needs of respective complex/establishment.

## 3. TYPES OF INFORMATION AT DHA LEVEL, NECESSARY FOR DISPATCHING CONTROL OF HYDROPOWER PLANTS AS PART OF A COMPLEX HYDROPOWER ESTABLISHMENT

In accordance with the analysis carried out under the MAREA project and considering the normative documents, the main information necessary at DHA level for operative control of hydropower plants as part of a complex hydropower establishment are:

### 3.1. Values

***3.1.1. Main Values***, determining the knowledge of installations general state (the maximum period for renewal is up to 3-5 s), such as:

a) From hydropower plants:

- The produced and delivered active and reactive powers, on each hydro generator;
- The produced and delivered active and reactive powers, on power plants or groups of power plants;
- The produced and delivered active and reactive powers, on connection lines with SEN;
- The voltages at the terminals of hydro generators and the voltages at hydropower plant bus-bars;
- The voltages at the substation bus-bars associated to the respective hydropower plant;
- Stator and rotor currents in the hydro generators;
- Power factor (cos φ);
- The frequency on the power plant bus-bars;
- The frequency on the substation bus-bars associated to the respective hydropower plant;
- The speed of hydro generators;
- Instantaneous water flow machined on hydro units, respectively on hydropower plant.

b) From electrical substations:

- Active and reactive power on the 110 kV (220 kV) transformers block generators, transformers (autotransformers)
- The active and reactive power on 110 kV (220 kV) and MV connection power lines with SEN;
- The active and reactive on power outgoing lines that feed the captive customers;
- The active and reactive powers supplied by power plants to SEN;
- The voltages on the 110 kV (220 kV) and MV substations bus-bars;
- The frequency in several network nodes.

All these values will be automatically printed at fixed characteristic times/hours by the analysis of system characteristics and at the operator's demand.

***3.1.2. Secondary Values***, characterizing the state of some installations elements of locally importance and information of lower updating (30 s is maximum time period for renewal), for example:

a) From hydropower plants

- Upstream water level;
- Downstream water level;
- Hydraulic fall (m) on hydro units, respectively on hydropower plant;
- Influent flow and effluent flows;
- Turbined flows and volumes;
- Flows discharged;
- Non-energy flows prevailed;
- Pressure drop on the lattice;
- Pressure in pressure pipe-line, pressure at/in oil pressure systems and pressure at/in the air compressors;
- Active and reactive energy produced on hydro units, respectively on hydropower plants (hourly, variable interval, cumulative from the beginning of the day, 24 hours and monthly);
- Active and reactive energy on transformers and power lines;
- Energy consumed by auxiliaries;
- Hydrological and meteorological data.

b) From electrical power substations:

- Voltages on 110 kV (220 kV) and MT power lines;
- Active and reactive powers on 110 kV (220 kV) / MT transformers;
- Active and reactive powers on of 110 kV (220 kV) power lines and radial MV power lines to consumers;

- Active and reactive powers on the 110 kV (220 kV) and MV couples;
- Voltages and electrical currents of the compensation coils;
- Reactive power of the compensation installations;
- Voltage on DC and 230 V AC bus bars sections;
- Active and reactive energy supplied / received by CHE into the settlement points:
- Active and reactive energy supplied / received on:
  - Connection lines with SEN;
  - Outgoing lines that feed the captive customers.

## 3.2. Signallings

***3.2.1. State Signallings****, necessary to establish the operating network diagram configuration* in 30 seconds, at most, since the equipment position modification, following the operator's desired actions:

a) From hydropower plants:

- Opening of gates, valves, valves for bottom dams drain/emptying;
- Opening valves on the main circuit of water feed pipe to the turbine;
- AD opening;
- Switching equipment position (disconnectors, breakers);
- Automation and process installations (start, operating connected to SEN, stop);
- Transformers with tapping switch control;
- Power units' status: off / idle (without load) / sync / connect to the network;
- Hydro units operating regime: manual / group / primary adjustment (control) / secondary adjustment (control);
- Power units/groups control regime/system: local / dispatcher / central / remote.

b) From electrical substations

- Disconnectors and breakers positions on transformers, lines, couples and connections to the earth of neutrals;
- Positions and automation actions (AAR, RAR, DRRI, DAS, equipment/ installations automation, etc.)
- Transformers tapping switch positions;
- Protection actions;
- Damage to the electrical substation.

***3.2.2. Alarm Signallings*** *(preventing),* necessary to take some preventing measures regarding the operating conditions of the operationally controlled network, letting the operator know this within 5 s max., such as limits overtaking:

- Exhaustion of the adjustment/control band for system services;
- Temperatures of bearings, generator windings and iron;
- Hot and cold air temperatures at generators;
- The currents asymmetry in generators, transformers and power lines.
- Minimum and maximum permitted levels of voltage on generator units and electric substations bus bars;
- Operating / signallings of/from electrical and technological protections of equipment (generators, transformers and power lines etc.).
- Gates soil compression, valves for bottom dams drain/emptying and valves on the main circuit of water feed pipe to the turbine;
- CHE upstream and downstream levels: maximum, minimum.

***3.2.3. Event****,* necessary to take some quick remedies letting the operator know in 5 s. These signallings correspond to protections and automatics installations (RAR, AAR, DAS, DRRI) actions and exchanges of configuration of the operationally controlled network resulting in these actions as well as signallings of the type: the general fuse burning on the battery, rectifiers failure, D.C. earthing, "fire in the substation" signal (for power substations without shift personnel), failure in power plant, failure in hydro facilities, failure to valves, maximum / minimum lake level etc.

***3.2.4. Flood regime****.* - Flood regimes can be supervised / monitored by timely submission of the precipitation and accumulation levels

***3.2.5. Status of HPMS / SCADA System****,* including information on equipment for collecting and transmitting data.

**3.3. Telecommands /telecontrols for:**

a) Hydropower plants

- Start - stop hydro groups;
- Breakers connecting - disconnecting;
- Disconnectors closing - opening;
- Instruction for active power loading - unloading;
- Instruction for reactive power loading - unloading;
- Instruction for turbined / discharged flow or dam upstream / downstream level;


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- Instruction for opening - closing valves, gates, valves associated with the dam.

b) Electrical power substations

- Switching devices (breakers of 220 kV and 110 kV and MV, 220 kV and 110 kV disconnectors);
- 110 kV/MV transformers tapping switch positions;
- Automation (AAR RAR DAS, DDRI, etc.).

The maximum duration of transmission (from its initiation - at the central point - up to receiving it by the remote addressee equipment/installation):

- 1 s for remote control;
- 5 s for telecontrol.

### 3.4. From DEC and DET

- Loading / unloading instructions for hydropower units / plant;
- Starts / stops commands for hydropower units.

## 4. CONCLUSIONS

The determination of the amount and types of information necessary for DHA level for operative control of hydropower plants as part of a complex hydropower establishment were key / critical and defining the way in which software packages will be developed in MAREA research project.

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