**Georgian Industrial Group**

**Building SCADA Systems**

**Technical Task**

(pre-design stage)

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Introducion

This technical task is intended for the creation of SCADA systems at GIG-s power plants. Software complexes of this class are used as an element of automation systems for industrial processes. This moment we are talking about the production of electric energy at the GIG hydro power plants.

To create SCADA systems at hydro power plants, a digital control system must have Industrial control system. Which consists of:

- measuring sensors;

- executive mechanisms;

- controllers for collecting data from sensors, their processing and issuing control actions;

- SCADA systems.

In some cases, SCADA systems can be used at the controller level, while performing the functions of the controller, as well as the functions of the SCADA system.

Currently, there are a fairly large number of SCADA systems. The vast majority of them work under Windows OS of the NT family (iFIX from Intellution (USA), Genesis software package (USA), InTouch of WonderWare corporation (USA, “pioneer” in the field of “SCADA under Windows”), WinCC from Siemens (Germany), Trace Mode from Adastra (Russia)). At the same time, the SCADA market for Unix-like OSs (in particular, Linux) is presented much more modestly: ScadaBase from MODCOMP, Linux PRISM SCADA from Advanced Control Systems, AccessPoint from Accessware, etc. It is desirable to use one of them to create SCADA systems, higher specified software.

1. Development basis

Decree No. 10; April 17, 2014, by the Georgian National Commission of Energy and Water. On the approval of the "Network Rules". From this decree, companies engaged in the production of electric power should install SCADA systems at hydroelectric power stations.

From the rules of networks, it should be noted that GIG companies must install SCADA systems at hydro power plants. This moment in the orders of GIG there are 8 hydro power plants. This year it is planned to install SCADA systems at 3 hydro power plants. For the installation of SCADA systems, particular attention should be paid to the following points. №45 on the installation of SCADA systems, № 45.4 On communication networks to ensure the uninterrupted operation of SCADA systems. Compatibility of the SCADA systems of companies, to the SCADA systems used by the central control room. № 45.6 rules and purpose of operation of SCADA systems.

1. Aim and purposes of SCADA systems

The SCADA system is designed to monitor production processes in hydro power plants, in real time. For SCADA systems, it must have a program of visualizations on the monitor of the operator's computer and the service manager, and the management of energy networks. And SCADA visualization subsystems should be as follows:

* visualizations:

• operational information: values of the parameters of the production process, violations of the parameters of regulatory boundaries (alarms);

• archived data: parameter values; text messages about violations of production processes, user actions to manage processes, as well as system messages from all ICS and SCADA subsystems;

* management of technical equipment and process parameters that took place at hydroelectric power stations: changes in settings and operating modes of control loops, changes in system settings, input of numerical data.

Система должна работать в двух режимах – разработки (Development) и исполнения (Runtime).

Application of SCADA systems together with the visualization subsystem and ICS systems should provide:

• improving the quality of electric energy due to:

• prompt submission of information to the maintenance staff about the condition of the equipment and the processes taking place in the hydroelectric station in real time;

• automated start and stop of technical equipment;

• monitoring the actions of operators managing technical equipment;

• archiving parameters of technical and technological processes during the generation of electric energy;

Improving the safety of production processes by ensuring the operation of technological equipment without a permanent presence in the area of its deployment of operational personnel.

1. The basic structure of SCADA systems in GIG

According to the requirements of the “network rules”, hydropower plants subordinate to the Hydroenergo department of companies, for the installation of SCADA systems, for technical re-equipment of some systems is needed. According to the requirements of the “network rules”, hydropower plants subordinate to the Hydroenergo department of companies, for the installation of SCADA systems, the need for technical re-equipment of some systems. There is also a need to install new ICS systems. The following devices and equipment should be installed at hydroelectric power plants of subordinates of the Hydroenergo Department for technical re-equipment: digital thyristor excitation systems on 4 units, hydraulic unit speed controller with digital control and monitoring systems on 12 units, digital relay protection systems on 12 units and distribution networks at 5 hydroelectric power stations, digital technological protections at 12 units, digital thermal monitoring systems at 12 units, digital monitoring and control systems at 18 units at 5 Hydroelectric power station. System of Supervisory Control and Data Acquisition (SCADA) in 5 hydroelectric power stations.

The structure and architectures of SCADA are shown in Fig. 1. Data is collected at each hydroelectric station on the basis of an existing server in digital monitoring and control systems. Data is transmitted using 3G or 4G Internet networks.



fig. 1. The basic structure of SCADA.

From the servers of individual hydroelectric stations, the data will be transferred to the central server of the companies, which will be located in the dispatch of companies. On this server, the company’s dispatcher and central dispatching office will have full access. As for the access level of the central control room, it will be subject to the “network rules” and the central control room agreement.

At the moment, and within the framework of this technical task, we plan to equip SCADA systems with only three hydroelectric power stations: Alazani 1, Alazani 2, and Racha HPPs. On These Scales We have some modern digital devices that will be used to build SCADA systems at these HPPs.

1. Requirement for the program and technical means
	1. Functional characteristics requirement

SCADA and visualization functions should include:

• display of operational and current production process information in numerical, graphical froms (in the form of a mimic diagram of the electrical, mechanical and hydraulic parts, real time schedules);

• alarm about violations of production processes by color, flashing background, lines, text, a list of violations in a tabular form; display specific graffiti produced by digital devices for protection and control.

• providing archived messages about violations of the production process, actions of the hydroelectric station operator and system ones. Messages should be displayed using various filters: by category, time / date.

The management functions of technical and technological equipment and the parameters of the production process should provide:

• remote and local control of discrete actuators, operating modes;

• operator input of analog and digital values;

• there should be a mechanism for confirming the execution of an operator’s command, fixing the operator’s actions in the message subsystem, as well as delimiting the rights of operators and dispatchers to execute commands.

Operator control commands, production processes, single-line circuits, regulators, excitation and navigation systems within the subsystem must be made using the keyboard and mouse.

The SCADA visualization subsystem in the process of its functioning as input must use the data of the following SCADA subsystems located on sections of the entire system:

• subsystem of current parameter values - to obtain a list of production process parameters and their attributes, parameter values, control of generators and networks;

• subsystems of archives - to display archived values of the parameters of the production process, the entire system and display messages about the arrival of various kinds of events;

• security subsystems - to get a list of registered users.

The output information of the visualization subsystem is:

• image on the display;

• the operator’s current values of the parameters of the production process (for example, the controller’s operating mode, the controller’s task, the controller’s output, controller’s settings, remote excitation control, remote control of switching equipment, etc.) that enter the parameter subsystem.

The configuration of the visualization subsystem must be saved in xml files.

The update cycle of operational information on the screen should not exceed 1 second.

* 1. Reliability requirement
* Ensuring reliable operation and protection against unauthorized access of the system is implemented at several levels:

• at the level of SCADA as a whole;

• at the level of a separate SCADA subsystem:

• for each display element, the delimitation of editing rights (Development mode), dynamization (Runtime mode) and reaction to events (Runtime mode) by changing the owner (using the security subsystem functions) and rights to change, read and execute, respectively;

• detection of errors (absence of a frame file, exceptional situations) and the issuance of relevant messages;

The visualization subsystem must satisfy the following reliability requirements:

• continuous operation 24 hours a day and 360 days a year;

• number of errors - no more than 1 per 1000 operators;

• mean time between failures - 1500 hours; maximum recovery time - not more than 1 h

* 1. Terms of Use

To ensure the reliable functioning of SCADA systems at the operator’s hydroelectric station and at the control room, it is necessary to ensure the following conditions:

• temperature: 20-25 ° C;

• humidity: 40-60%

The qualifications of the personnel servicing the software and hardware of ICS and SCADA should ensure the effective functioning of the system in all specified modes and meet the requirements for the corresponding categories of workers adopted at hydroelectric stations.

The ICS for the production of electric energy should be serviced by personnel who have undergone training and knowledge testing according to the rules for safe work with the software and hardware of the system in the manner adopted by the enterprise, and taking into account the requirements of organizational support instructions.

Specialists serving the software and hardware of the ACS for the production of electricity should have:

• sufficient knowledge to:

• performe operations to implement the corresponding automated and interconnected non-automated functions of ACS, the production of electric power and the operation of hydrogenerators;

• making the right decisions in emergency situations or other violations of normal operation;

Skills that allow you to perform all maintenance, installation and commissioning operations with a given error-freeness and speed.

Operational and technical personnel must undergo training in the operation of the operator’s hydroelectric power stations, followed by knowledge testing in the manner adopted by the enterprise.

The number and mode of operation of operators, personnel servicing the hardware and software of the automated control system for the production of electric energy is determined by the approved staffing table.

* 1. The requirement for the composition and parameters of technical means

 For the functioning of the SCADA system, the computer hardware must meet the following minimum requirements:

• x64 computing system: AMD-Intel, Intel-P5, AMD64 with a processor frequency of about 2.7 GHz;

• RAM 4000 MB;

• 500 GB HDD;

• monitor;

• keyboard;

• “mouse” manipulator.

As for the ICS tools and servers, they must satisfy the technical requirements by entering the output and storage of information for the management and control of hydroelectric power stations. These devices must be located in a separate electrical cabinet in a cabinet with ventilation and heating. To create a condition of exploitation of electronic devices at all stages of its operation.

* 1. Information and Software Compatibility Requirement

The SCADA system in the process of its functioning as input uses data from other SCADA subsystems:

• subsystems of parameters - to obtain a list of parameters for the production of electric energy and their attributes, parameter values, process control.

• archive subsystems - for displaying archived values ​​of process parameters and displaying messages about the arrival of various kinds of events.

• Subsystems of digital relays about alarm messages during the production process.

• security subsystems - to obtain a list of registered users during installation and verification of access rights.

The visualization subsystem of an open SCADA system must be developed in C ++, compiled using the GCC compiler. QT3 should be used as a graphics library. Such requirements are due to the general idea of cross-platform SCADA system, and the compatibility of the SCADA central control system.

It is recommended that you store the configured frames in the production process in xml files, since this format is convenient for storing data about objects in text form.

* 1. Marking and Packing Requirement

To uniquely identify the visualization subsystem in the SCADA system, you must use the version number. The version is presented in the form of three digits separated by a dot, for example, like this: 1.2.3.

The last figure determines the level of stabilization of the system within the framework of the main version. The other two digits form the main version number. If the first digit has 0, then the system is still being developed, i.e. not all designed features of the system are implemented.

For example, the number 0.3.4, says that the system is being developed and has version 0.3. Furthermore, stabilization level is 4.

The visualization subsystem is distributed both in conjunction with the SCADA system, and separately. In any case, for convenient distribution, the visualization subsystem should be packaged in a distribution kit. The name of the distribution should include the name of the subsystem and its version.

To prevent unreasonable claims, in case of damage to the distribution package, the method of packaging in the distribution package should include checking the integrity of the distribution package.

Distributions can be recorded on any medium or placed on the Internet.

* 1. Requirement for transportation and storage

Distributions can be stored both on physical carrier and on information resources on the Internet.

In the case of storage of the distribution kit on physical carrier, the following requirements are established for the storage location: it must be dry, exclude direct sunlight and direct exposure to electromagnetic fields. Shelf life is determined by the type of carrier.

Physical carrier can be transported in any way excluding mechanical, thermal and electromagnetic effects.

Distributions posted on Internet information resources can be copied in any way, possibly with subsequent recording to physical carrier.

1. Requirements for software and engineering documentation

The documentation for SCADA systems and technical equipment should include:

1) terms of reference;

2) technical descriptions of systems (passports).

3) Technical documentation of wiring diagrams.

4) Technical documentation of electromechanical construction drawings and installation documentation.

5) Factory and installation equipment warranties.

6) Product specifications and overall devices.

7) a working draft, consisting of:

• specification;

• program description;

• program text;

• programmer's manual;

• management of an ICS and SCADA engineer.

• Backup software for all levels of an ICS systems and SCADA systems. (installation copies or finished media with working programs.)