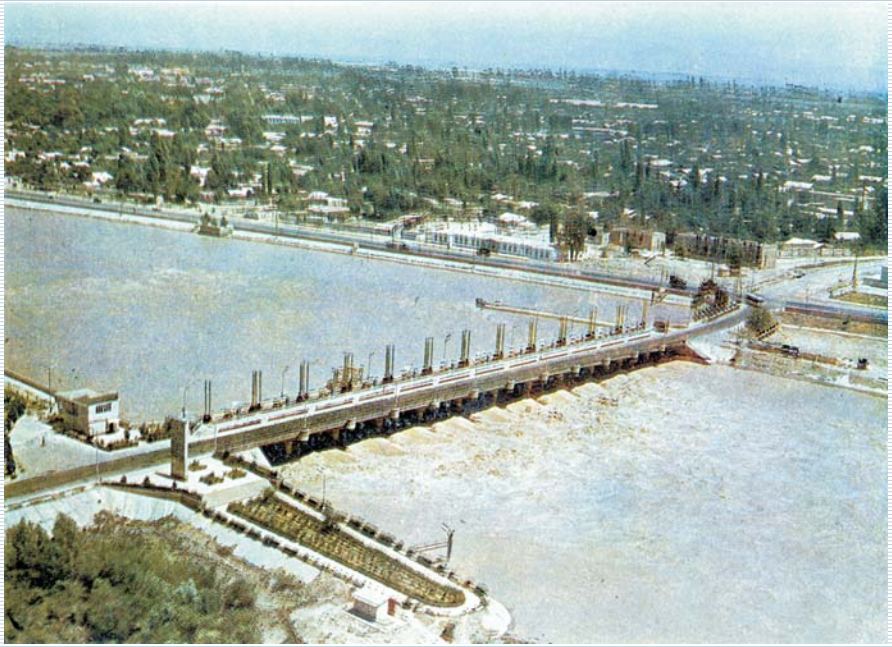
DEZA DIRECTION FÜR ENTWICKLUNG UND ZUSAMMENARBEIT
DDC DIRECTION DU DÉVELOPMENT ET DE LA COOPÉRATION
DSC DIREZIONE DELLO SVILUPPO E DELLA COOPERAZIONE
SDC SWISS AGENCY FOR DEVELOPMENT AND COOPERATION
COSUDE AGENCIA SUIZA PARA EL DESARROLLO Y LA COOPERACIÓN

BVO "SYRDARYA"

SIC ICWC



AUTOMATION AND DISPATCH SYSTEM OF UCHKURGAN WATER WORK ON NARYN RIVER

To provide with water countries of the Central-Asian region taking into account their socio-economic development and environment protection, set of programs has been developed.

Program "Water resources management and control in Amudarya and Syrdarya basin " is devoted to water conservation and rational use. This program is developed by ICWC (SIC ICWC, BWO "Syrdarya") together with Canadian UMA Engineering Ltd. It will help to basin organizations:

- Provide with water states of the region according to limits established by ICWC;
- Prepare operative plans of reservoirs and intakes functioning, develop system of management, information and communications.

For this BWO should be equipped by modern technical means for hydraulic structures management and control as well as by communication and data transfer devices.

Presently, under international sponsorship modern automation systems are being introduced in practice.

Goal of the project completed under Swiss Cooperation Agency (SDC) support is system of automatic management and control on Uchkurgan water work as a typical object of automation and dispatching water allocation within Syrdarya basin using advanced information and program technologies on base of radio-telemetric systems.

Object brief characteristic

Uchkurgan water work is included in Naryn-Karadarya subdivision of BWO "Syrdarya". It consists of the dam on Naryn river, head work of recharge canal (RC) and head work of North Ferghana canal (NFC).

Barrage dam (fig.1) creates back water to provide necessary discharge to canals: right NFC and left RC. Dam has 12 flat two-tier gates with size 10x2.5 m. Dam capacity is 2490 m^3/s. RC head work has 8 gates in lower tier and 4 gates in upper tier of 2.5 m width. Total capacity is 330 m^3/s. NFC head work has 6 flat gates with size 4x2.3 m. Its capacity is 110 m^3/s.

Water flow downstream Uchkurgan power plant is uneven and depends on plant operation mode. Water discharge and level fluctuations in tail water are as follows: 110-190 m^3/s and 55-115 cm within 6-8 hours. Big water discharge fluctuation during short period of timemake it difficult water distribution management between NFC and RC.

Uchkurgan water work in 1978-1980 was equipped by telemechanic system T-132 controlled by control pint КП-130. Operators could:

- remote and local control of water level in canals' head water and tail water;
- remote and local management of dam and canals' gates.

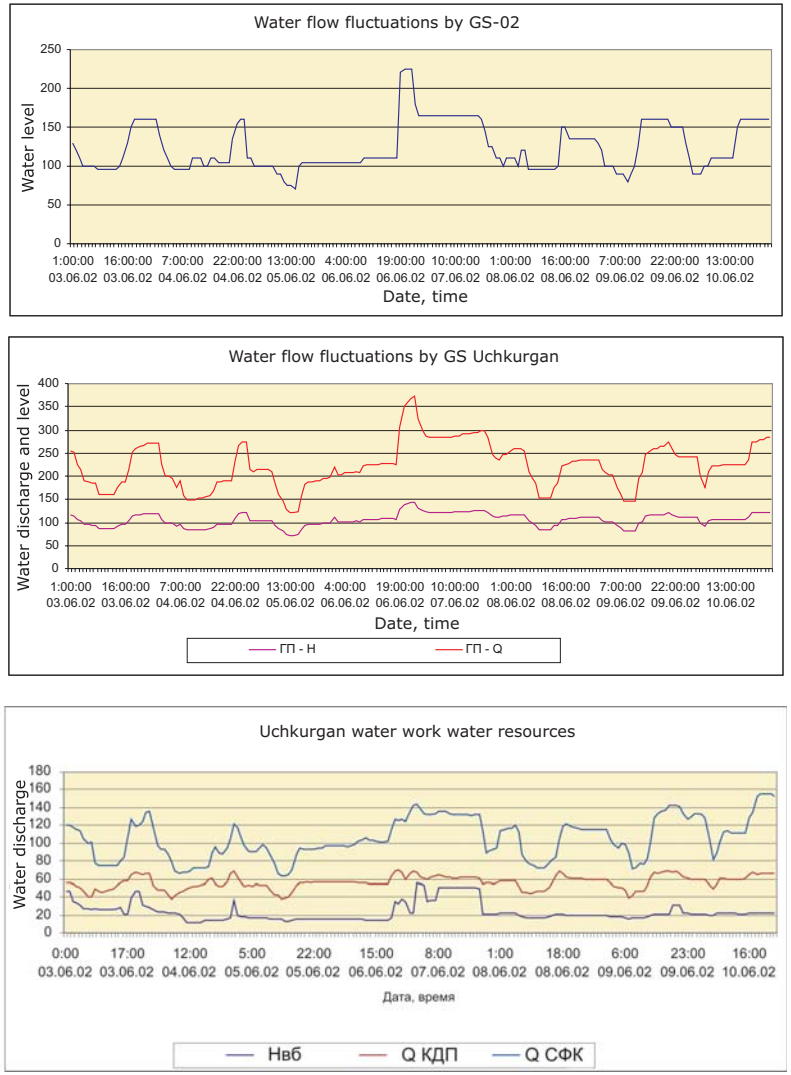


Fig. 13. Comparative water level and discharge changes (example)

Automatic regulation, data collection, storage and processing in this system was not implemented. Data was registered in special journal each hour. Then it was transferred by phone for further processing.

By 2002 due to moral and physical weariness system T-132 worked unstably and unreliably. Because of that mistakes and deviation from limits.

This project was proposed to stabilize water supply to canals.

Goal of the project is system of automatic management and control on Uchkurgan water work as using advanced information and program technologies. Project was developed by SIGMA enterprise (Kyrgyzstan).

a) b)

Fig. 1. Uchkurgan dam:
a - head water;
b - side sight

Tasks of automation and dispatching

Main task of automation stabilization of established water discharge to NFC and RC by head work gates regulation. Maximum regulating capacity (120-150 th.m^3) smoothes fluctuations in head water at expense of water accumulation and release.

Main functions of automation system are as follows:

- Remote measurement of water level, discharge and salinity and hydraulic structures' gates regulation;
- Automatic regulation of water level and discharge;
- Remote revealing and eliminating equipment failures.

Main task of dispatching is automatic information collection, processing and presentation about system technological parameters and ensuring conditions for automatic water distribution.

Main functions of dispatch system:

- Continuous collection, storage and processing measured data in head work computer;
- Remote and local management of separate gates and group of gates on head work from dispatch point;
- Continuous link between head work and dispatch point and BWO "Syrdarya".

Improvement of water account accuracy and water consumers trust to water management.

Project implementation

Following works were included in the project:

- preparatory construction works;
- work project preparation;
- mounting and setting of technical means (gates position, level and salinity sensors; transformers, controllers, input and output modules, computers, radio stations, etc.);
- program complex development and setting;
- project implementation monitoring and experimental operation.

Construction work with cost about 40 th.$US were performed by BWO "Syrdarya". Work project, complexion, mounting and setting were performed by SIGMA. Methodological guiding, expertise and monitoring were performed by SIC ICWC and BWO "Syrdarya" specialists. Naryn-Karadarya subdivision specialists also actively participated in all activities.

Principle of work

Analogue signals about water level in Naryn river, NFC and RC come from 4 gauging stations equipped by floating level sensors, measuring sticks and information transfer devices: one in head water, second in tail water, third on RC and fifth on NFC.

Flat gates drivers are equipped by mechanical sensors with remote transfer devices.

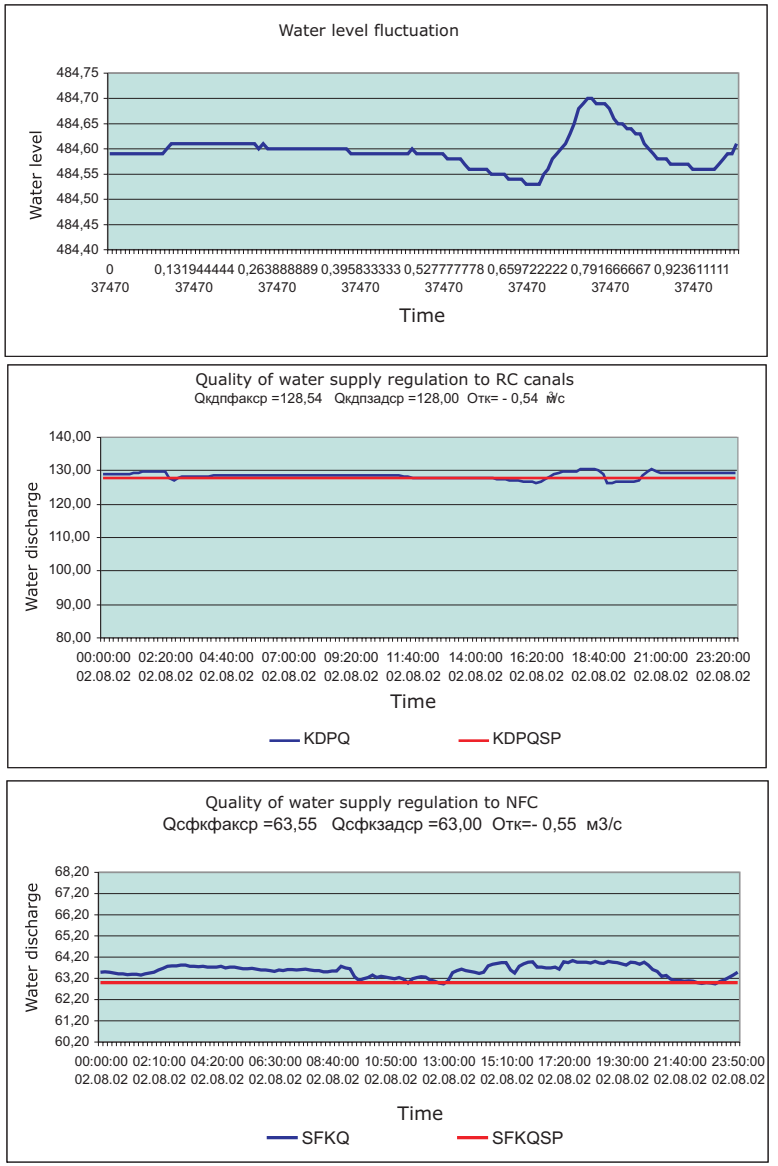


Fig. 12. Results of discharges in NFC and RC stabilizing by August 2, 2002 (example)

- Information provision improvement due to continuous data collection, storage and processing;
- Increasing efficiency and accuracy in water management at expense of information quicker receiving and processing;
- Increasing efficiency of failures revealing and eliminating.

Cost of development

Cost of automation and dispatching system development and introduction is 186 th. USD.

Uchkurgan water work automation and dispatching improving water management provide only partial management of water resources within the Syrdarya river basin.

Uchkurgan water work automation and dispatching improves management quality and allows only partial water resources management in Syrdarya basin.

Further development of automation and dispatch system foresees inclusion into the system other structures within Syrdarya basin that will allow fully automatize water supply management to all consumers.

SDC, BWO "Syrdarya", SIC ICWC, SANIIRI performed preliminary assessment of cost for BWO "Syrdarya" main structures equipment by SCADA system.

Approximate cost in price of 2000 amounts for 2.2 mln. USD. Total expenses for technical perfection of water management including hydraulic structures rehabilitation, communication system installation, information system modernization, metrological center equipment, water quality management, etc. amounts for 7.5 mln. USD.

State of functioning mechanisms is controlled by following discrete signals: power availability, remote/local working mode, protection from driver overloading (fig.2).

All analogue and discrete signals from transformers and governing stations are transferred on special cables to input modules DIN and AIN which are commutated by intellectual controller (fig.3). All modules of signal input and output are located in three cupboards positioned in water work's dispatch point (fig.4).

Operator controls head work functioning on twenty four-hours basis. He sets up established operation regime, registers current state and communicates with dispatchers of Naryn-SyrDarya subdivision in Uchkurgan, Naryn-Karadarya department in Kuiganyar and BWO "Syrdarya" in Tashkent. Communication is executed by radio and telephone.

Intellectual controller is connected with dispatcher's personal computer located in water work dispatch point, which is main link of dispatch system calculating current water discharge and automatic gate management.

Functional scheme of Uchkurgan dam automation is shown on fig. 5; communication scheme on fig.6.

Intellectual controller by cable lines or by radio transfers information to network of dispatch PC located in dispatch point.

PC reflect received information, process it and form structure's working mode. Managing signals from PC come to intellectual controller through output modules "ДОИТ" and back to station of gate management.

Fig. 2. Cupboard for gates local control

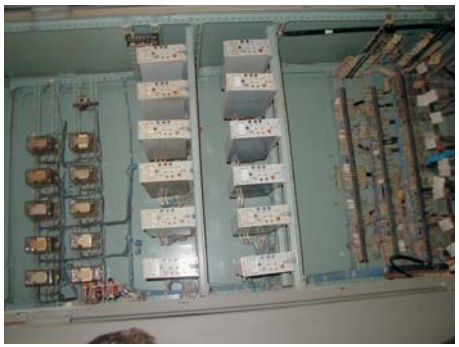


Fig. 3. Cupboard with transformers

Fig. 4. Cupboard for controllers and input and output modules

From computer keyboard it is possible to manage gates keeping all dispatch functions.

Dispatch point in water work through controller's radio-modem Z-MR and VHF transmitter is connected with controllers and computers positioned in dispatch points in Uchkurgan and Kuiganyar.

Dispatch system works on twenty four-hours basis. It is equipped by continuous power source ensuring its functioning during one hour.

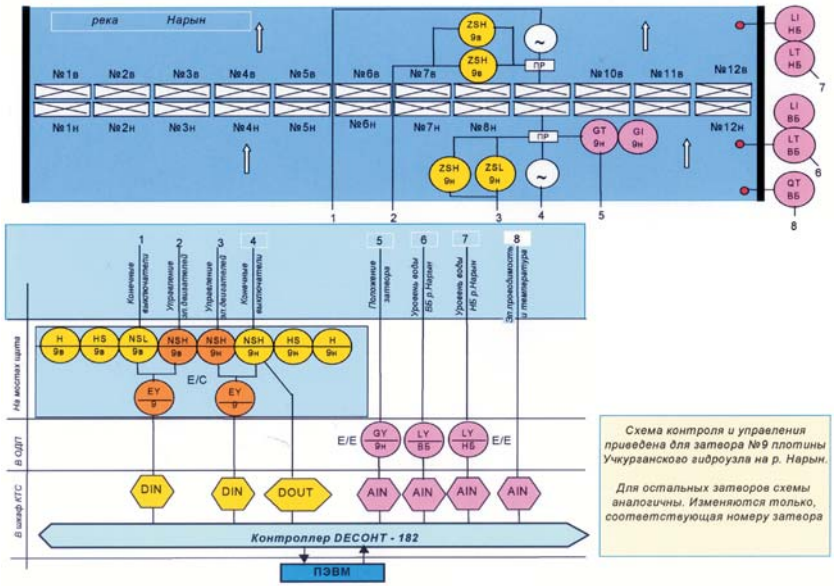


Fig. 5. Functional scheme of Uchkurgan dam automation

Accuracy of water level control and gates position is ±1cm. Regulation quality is defined by discharge depending on water level. Gates' electric drivers management is performed without re-regulation through change of all gates position simultaneously or position of two-three gates.

In result of automation and dispatching system introduction water supply to NFC was stabilized and supply fluctuation to RC was reduced. System works uninterruptedly.

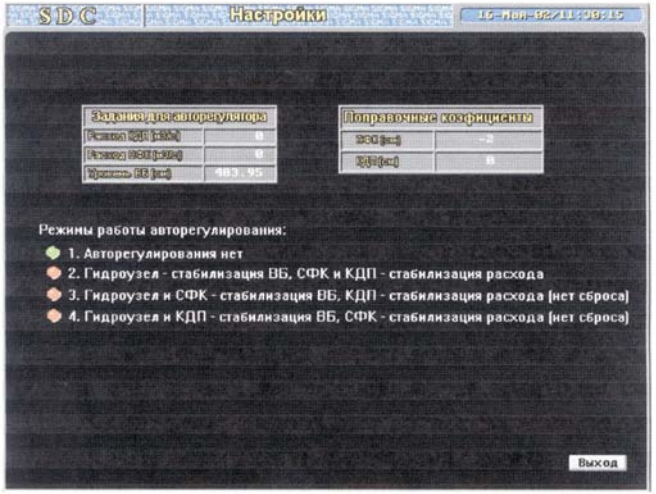


Fig. 11. System settings display

On fig.12 examples of water discharge stabilization on NFC and RC canals by August 2, 2002 are shown. From this figure is evident that though water level fluctuation in head water is within 484.0-484.8m, canals' discharge is more stable because system uses head water capacity. Discrepancy between set and actual mode does not exceed 1-2%. Early this deviation was 7-10% from set values.

On fig. 13 comparative water level and discharge changes by ГП2 and ГП-Uchkurgan as well; as discharges over Uchkurgan water work's objects for the first decade of June are shown. Stability of water supply to NFC is evident.

Main advantages of automatic control system are as follows:
- Increasing water level discharge and salinity measurement and gate position accuracy; discharge measurement discrepancy: from 5 to 2-3%.

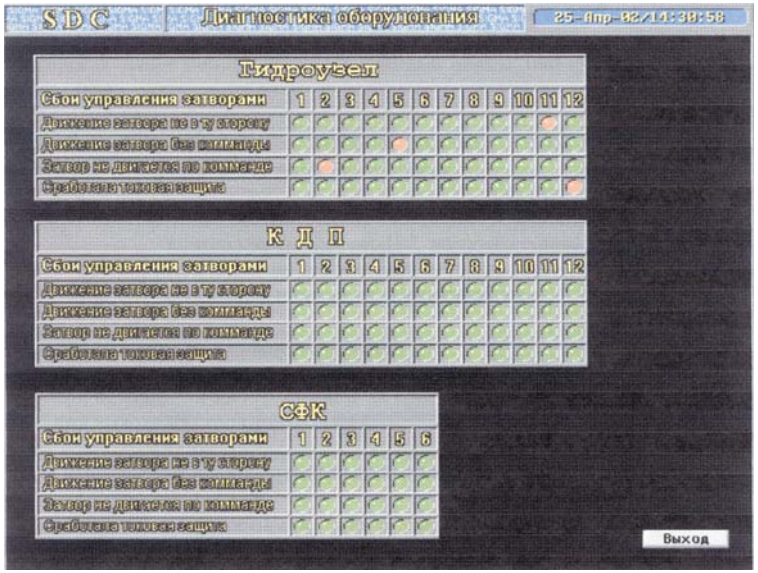


Fig. 10. Diagnostic display

Database allows:
- system operation information import into MS Access database for storage and processing;
- calculation and storage of average daily, weekly and monthly measured data;
- input data of hourly and daily visual observation (ordinary method), calculation and storage of average daily, weekly and monthly measured data;
- definition of deviation (error) hourly and daily observations compared with information from SCADA system;
- preparation of reports on system (SCADA prototype) functioning and data processing.

Results of experimental operation

One of the main tasks is water supply to NFC and RC canals water supply stability and water account accuracy increase under water level fluctuation in water work's head water. Uchkurgan water work's dispatcher, depending on coming water discharge and limits established for NFC and RC, set discharge for these canals' regulator. Water supply stability is provided by system of automatic regulation at expense of head water capacity and excessive water release to dam's tail water.

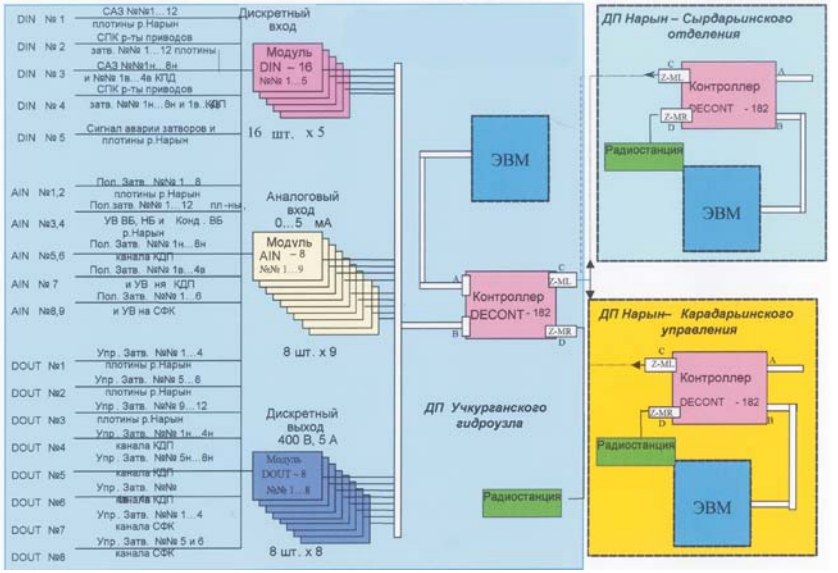


Fig. 6. Uchkurgan water work communication scheme

Specific features of software

While dispatch point's computer loading (fig. 7) reflecting and managing program is put into running automatically; then Uchkurgan water work scheme appears on display (fig. 8).

This scheme includes:
- readings from sensors in head water, NFC and RC above sea level;
- designed discharge (m^3/s);
- schematic image of each gate with its state reflection;
- two graphs illustrating level changes for last 2.5 hours in tail water of NFC and RC as well as level changes in head water and discharge through the dam (third graph).

Near each regulator there is button "management" (fig. 9).

Fig. 7. Dispatcher-operator's working place

On this display, which is the same for each regulator (NFC, RC and water work), scheme of all gates is reflected and information about gate state and management regime is given.

Displays "Diagnostic" and "Setting" are also available (fig. 10, 11).

All failures are reflected on display for each gate. Gate number is positioned horizontally, all failures vertically. Green indicator shows normal work, red one failure.

On display "Setting" task is assigned for program-auto-regulator and corrections for water discharge calculation and auto-regulation regime.

Special "Guidebook" for operator helps to manage system as a whole.

System of technological and operational information archiving automatically retains main technological indicators each 10 minutes as separate files, which analysis allows assess system operation.

Database is devoted to import, storage, processing and submitting information about system functioning.

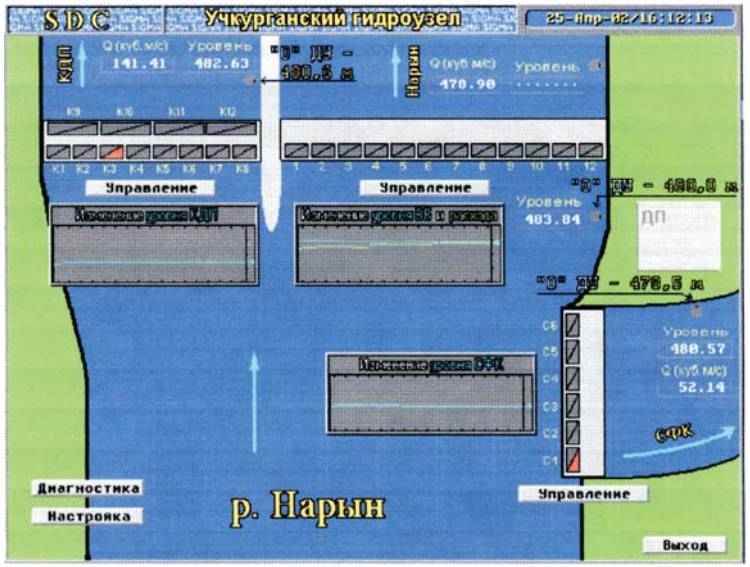


Fig. 8. Main working display for operator's work

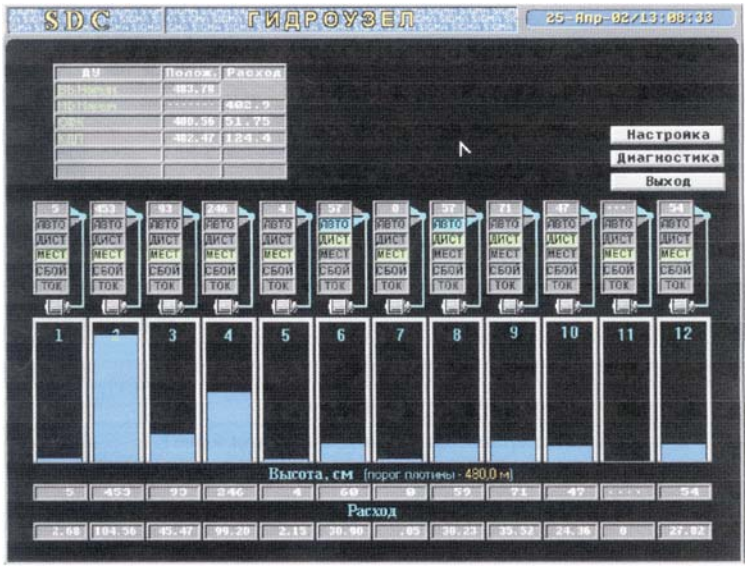


Fig. 9. Display for hydraulic structure management