

Automatic process control system of flood protective shelter complex in Saint Petersburg

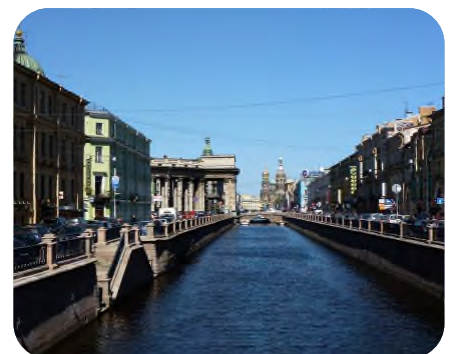
Information about the object: 'BPA' LLC took part in a large-scale project which was carried out together with the I&S department of 'Siemens' LLC, Moscow. The full name of the project is “Automatic process control system of flood protective shelter complex in Saint Petersburg”. The purpose of the first stage of the project was automatization of culverts. It is worth to mention that the object of automatization is a rather large complex of hydro-technical utilities and construction facilities around Saint Petersburg. Flood protective shelter complex includes culverts, navigation channels and protective dams. In total on the border of the Gulf of Finland and Neva Bay there are 6 culverts (B1...B6) and 2 navigation cannels C1 and C2. 'Siemens' LLC, the customer of BPA LLC, was responsible for engineering and supply of technical equipment. 'BPA' LLC carried out the full complex of engineering works, such as:

1. Inspection of objects of automatization
2. Working out the part of “Mathematical support”
3. Working out the automatic process of control system software
4. Start-up and adjustment works at the building yard and system start up.

Description of the object:

Flood protective shelter complex in Saint Petersburg, the dam is the complex of dams and neighboring hydro technical constructions (culverts, navigation chennels) located across the top of the Gulf of Finland starting from Bronka till Sestroretsk (Gorskaya town), then across Kotlin Island where the city of Kronshtadt situated (which is a part of St. Petersburg).The Complex was frozen when it was 60% completed. The construction was gone on in 2001. From the 2007 till the 2012 the total amount of investments was about 55 billion of rubles. Federal Treasury Enterprise “North-West business unit of the Russian Federal Agency for Construction, Housing

Maintenance and Utilities – business unit of Flood protective shelter complex of Saint Petersburg” is responsible for the construction. The full extension of flood protection constructions is 25.4 km. During the biggest flood in the history of St. Petersburg the rise of water was 4.2 m above the zero level. Flood protective shelter complex is able to stand the maximum rise of the water level of not more than 4.5 m. Within 3 hours after the alarm system is activated the water gates of the flood protection constructions are completely closed. So the waterfront of the city is 100% protected from flood.



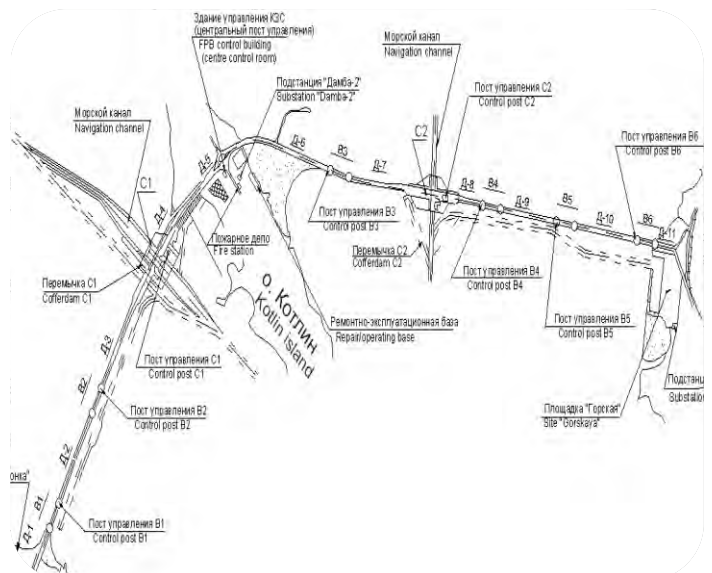
Project description:



'BPA' LLC, together with 'Siemens' LLC, have completed start-up and adjustment works of the culverts. All culverts consist of several separate parts with the length of 26-27.2 m. Each part has length of 24m. The culverts are situated on the part of the Gulf of Finland. On the part of the Neva Bay the culverts are connected with the cut bay. There is a highway above the bridge which cut bays are connected to the culverts. The length of each cut bay is the same as the length of the part of culvert. The quantity of the cut bays and the parts of the culvert is also the same. In case of the flood the apertures of the parts of the culverts are shut by the deep gates made of metal. All culverts: B1, B2, B3, B4, B5 and B6 are more or less the same in construction. The only difference is the quantity of the apertures of the parts of the culverts and their depth. The aperture of each part is restricted by the bottom, the pier, the bottom of the boom and it is shut by the deep gate. Each aperture has 10 or 12 holes with the width of 24m and 5m or 2.5 m depth. In case of flood it is shut by the deep metal gates with the width of 24m and height 4.5m. B1 and B6 culverts have 12 deep gates with the height of 4.5m. B3 culvert has 10 deep gates with the height 4.5m. B2, B4 and B5 culverts have 10 deep gates with the height 7.2m. All the deep gates are of radial-type. Each deep gate is raised with the help of 2 hydraulic cylinders placed on both sides of the gate. The gate is rather heavy so it shuts under its own weight. The weight of the gate can break 0.6m width ice. In order to unify the engineering solution the gates are operated with the help of the same electro mechanical systems that are used to operate the culverts.

This system involves: hydraulic equipment, mechanic equipment (bars, contact sensors and so on). Moreover, in the culverts' rooms there are heating and ventilation extensive systems, fire alarm and fire suppression system.

Each culvert has the under ramp room. The control post is situated in the room. In another room there is a software and hardware complex of automated control system. In order to shut the deep gates, hydraulic equipment made by 'Inzenjering' PPT, Beograd, Serbia is used. Each deep gate is equipped with: Two main hydraulic cylinders to shut and to open the gates; Two hydraulic cylinders to fix the gates; A set of electro- hydraulic distributors; A set of movement and blocking control sensors.



Moreover, there is the common pressure and drain line which is used for all twelve deep gates. For maintenance of the pressure line oil pressure installation is used. It is equipped by two axial-plunger pumps. Therefore, the system allows to rise and to fix the deep gates by turns, using the common pressure line. The gates can be shut as individually as all together.

Problem solving: The structure of the system and description of complex of engineering works Complex of engineering works of the system is based on the equipment made by 'Siemens' Company. Sensors and power hydraulic equipment is produced by 'Inzenjering' PPT, Beograd, Serbia. The complex of engineering works was constructed with PCS7 software and hardware complex made by 'Siemens' Company.



Programmed logic controllers S7-414 were used as the main central processing unit. Bus terminals are connected with the help of ProfiBus DP. Controllers, bus terminals and other equipment are based in standart control cabinets TS8 in the control room. On the door of the cabinet there is a control board where the object status can be observed. All the deep gates cycles can be opearted with the help of the control board. The distinctive feature of the complex of engineering works is its whole-system redundancy. The redundant units are mentioned below: logic controllers management modules; network segments ProfiBus DP; Bus terminals; Power systems. The sets of bus terminals are grouped in cabinets. Working and backup sets of modules are in different cabinets. So it can be said that the redundancy of the bus terminals is made on the level of the cabinets only. Input and output of the working and backup cabinets are connected in cross cabinets made by Siemens' Company. The powerful diagnostic system is located in a separate cabinet above the backup cabinet. The power system is also based in a separate cabinet.

The peculiarities of implementation of software. Using PCS7 hardware complex made by 'Siemens' Company at the time of the project developing allowed to make the process of developing fully automatized. Standard options of PCS7 used during developing are mentioned below: hierarchy of the installation concept; Library functional cases; Standard driver blocks; IEA for automatic generation of tag bases and program codes by a pattern. So the program code developed for one gate was later used to create the codes of the other twelve gates. One of the problems which occurred during the adjustment works at the object was the high noiseness of the cable lines. The reason was too long distance between the sensors and the analog input modules. To filter the changing data of gates movement BPA specialists implemented median filter algorithm. Using this filter together with the normal first-order filter showed good results. Good filtration helped to avoid the channel interference and to keep good pattern of synchronization of gates movement. As the options to the standard blocks the library functional blocks were developed. There were a lot of other algorithms of separate functional blocks connection in order to implement the logical operating of the whole flood protective shelter complex.



Terms of project execution:

The terms were short and only with the help of good teamwork of "BPA" Company and 'Siemens' Company all the works were performed in time.

All the works with six culverts B1.... B6 were completed. In 2010 start-up works of two navigation channels: C1 and C2 were restarted. Related projects: wind-driven electric power station was installed at the dam. It includes about 30 turbine towers in order to achieve the total capacity of 100 megawatt in 2014.

Additional information can be received at the below mentioned links

<http://www.bpa.ru/>

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Bureau of Industrial Automation LLC
115280, Russia, Moscow, 19 Leninskaya Sloboda Str.,
«Omega Plaza» office center
phone: +7(495) 645-79-99,
fax: +7(495) 645-79-99
info@bpa.ru | www.bpa.ru