Success stories R4 Leningrad

R1.04/92A-94A "LENINGRAD NUCLEAR POWER PLANT ALL STATION COMPUTER NETWORK"

Nuclear power plant	**Leningrad NPP, Russian Federation**
Project reference	R1.04/92A
Project name	**All-Station Computer Network**
IAEA safety issue	I&C 1 I&C Reliability
Safety rank	II
Budget year	1992-1994
Contract amount, Euro	**3,105,611**
Contract status	Completed
EC endorsement of the contract	1996
Supplier	**Marex Technology**
Current status of the project	Completed
Provisional acceptance certificate	1997
Final acceptance certificate	signed 23.10.2002

1. Project impact on safety

Instrumentation and control equipment of reactors built in former USSR was known to be based on technology of low reliability. Operational experience showed that the failure rate of the plant I&C systems was high. Moreover, in a plant like RBMK which covers a significant ground area and includes many separate locations the effective information transfer should be provided by a computer network.

Leningrad NPP proposed to upgrade its computer network to provide an "All Station Computer Network" which would significantly enhance NPP safety and reliability. A study has identified those functions and separate locations which required access to the system.

The proposed computer network incorporated an information retrieval system and associated databases, analysis and expert systems for monitoring plant reliability.

The system had three main functions :

- process monitoring and control;
- on-line supervision;
- organisational and management related tasks.

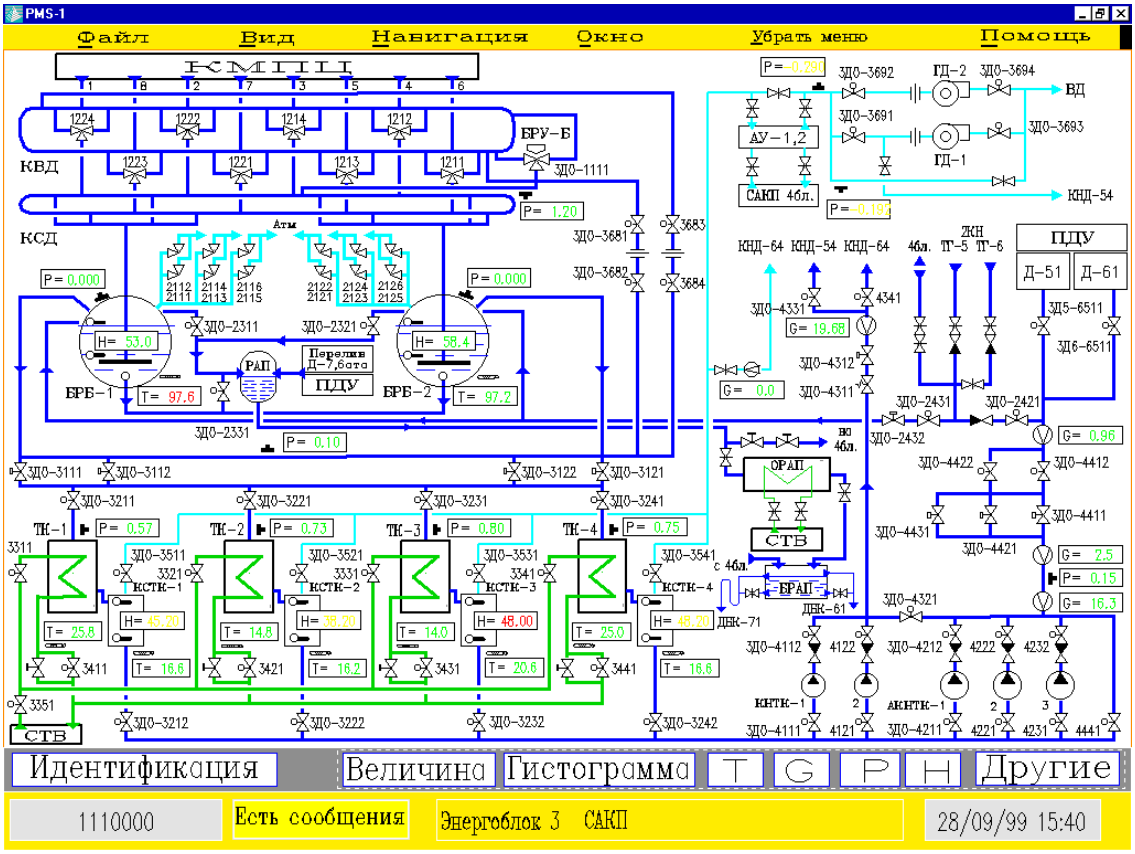
In addition to on-site use to enhance safety, the network was to be a link with the Technical Support Centre realized under another Tacis project, namely Project R1.04/92 B, and provide high quality plant data more effectively than was achievable by alternative means.

Support for the All Station Computer Network was given by the REA Consortium report in section concerning RBMK reactors; Recommendation 2R15-8 stated:

"The use of a distributed network should be considered for data collection and processing. The nature of the RBMK reactor results in a lot of plant data. The complex nature of the plant and the resulting complex nature of model calculations suggests a distributed system with one or two technical work stations and a larger number of graphic display systems may be the appropriate way forward."

Further support could be found in Recommendation 7R 3.3.1 which was phrased in similar terms.

2. History of the project.



Flow sheet diagram for LNPP

Objectives and budget

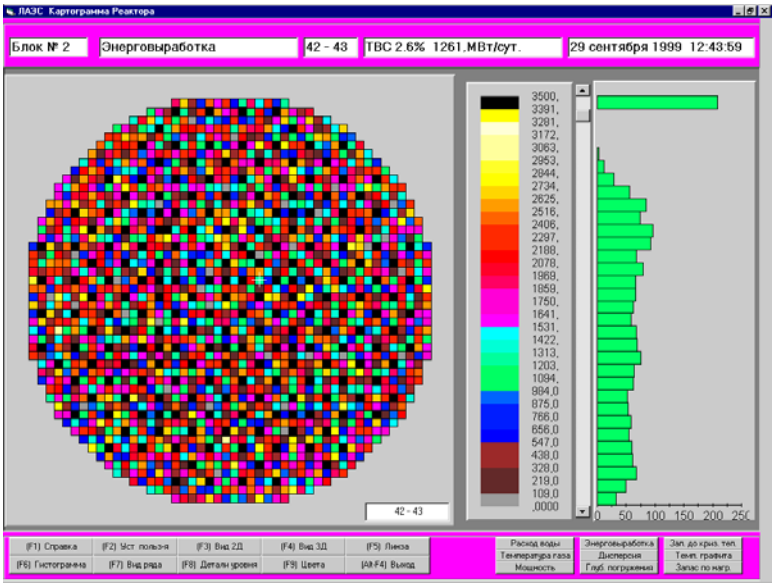
The budget was initially planned to be 0.75 MECU. Eventually with phase 2 described as R1.04/94A the budget was increased to 3.1 M€. The contractor was Marex Technology.

Time schedule of the project was tight, equal 12 months. The contract was signed in 1996 and the final acceptance was given in 1997. Thus the project has been successfully completed.

A significant effort was deployed on software and the computer architecture development

The project was aimed to reach several objectives important to safety:

- Improve information transferred to the engineer staff of the NPP on the status of operating units and thus upgrade safety of their operation
- Provide an "open ended " system, allowing for future modifications and development
- Give computer experts the possibility to learn to work with the system (service, operation, modifications and programme development)



Map of fuel burnup in LNPP

The project assumed development and implementation of a computer network covering the main operational parts of the NPP with distributed intelligence system consisting of a number of servers computer communication lines, network equipment and personal computers. This equipment would perform priority task of process monitoring with all technological parameters including database for the technological processes. The same network would be used for information processing for fuel elements. In other words, the system should serve as the engineering support of the operational staff.

From the very beginning the project was NOT designed as a turn key contract. LNPP was to receive apparatus and programs for the system, and the personnel should be trained to be able to serve and develop the system. There were a minimum number of on-line documents (7) and reports (3) and the whole remaining work was to be done by LNPP, using the training and equipment provided within the project.

Short chronology of the project:

1993-1994 – preparation of invitation to tender for system delivery.

1995 – tender, in which French, German and UK companies participated. The winner was Marex company from the UK.

The second half of 1995 till July 1997 was used for development of project documentation, training of LNPP specialists, joint work on implementation of the main programme modules and factory tests of equipment.

August 1997 – delivery to the LNPP of the whole computer network made according to the project

October 1997 till April 1998 – start-up and tests of the system in LNPP

May 1998 - acceptance of the project at LNPP

Till November 1999- support of the system by the producer (Yokogava Marex) continued for 2 years after delivery of equipment in stage 2A of the project.

After that, till nowadays, the operation and development of the system has been continued by the NPP personnel. Presently the system is in operation and being developed.

3. Project effects

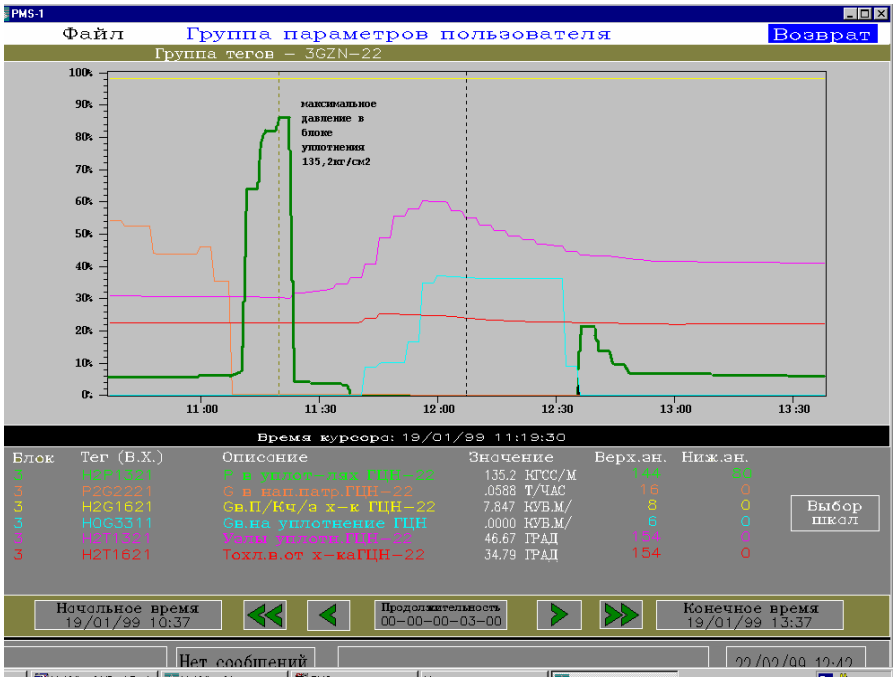
In the result of this project LNPP has a network of engineering support for operational personnel. This means:

1. Computer network, including 15 specialized servers of Hewlett-Packard (D260/2 and 210) and mounted expressly for this project, covers four buildings 601,401, 602, 445. The network was designed by IBM and installed by "Kvarc" company. The connection network of the system is made of fiber optic cable.
2. Personal computers of HP are connected to the system in 90 working stations. The PMS users include heads of NPP shifts and their deputies, heads of departments in all shifts, deputy heads of some departments dealing with maintenance and repair, engineers of safety department, chemistry dept, all group leaders, director, chief engineer and his deputies.
3. A licensed programming has been obtained for all elements of the system. In particular there is ORACLE programme and the equipment needed for its full application.

The data for the system are provided from SKALA sensors to the servers, which process and store this information. Owing to that the system fulfils the important task of archiving all data and storing them for several months, after which the data are compressed and recorded on magnetic tapes. They are available from the system administrator on demand of the system users.

The servers provide to the user the information according to the users demand, prepared in graphical form requested by the user. Each server of graphical data preparation serves 8 clients, sending requests for data to SKALA equipment in accordance with the demand of the users.

The parameters include water flows, temperatures, reactor channel power and energy balance, graphite temperatures, reactor core loads, Departure from Nucleate Boiling Ratio, neutron flux, control rod positions, currents from radial and axial sensors of power generation distribution , calculated parameters and signals of threshold crossing for water follow and gas temperatures.



Study of the failure of the flange in sealing water system of the main circulating water pump which h occurred on 19.01.1999. (Max pressure in sealing system reached 135 bar.)

The system works continuously full time, with information collected periodically once in every 1-2 minutes. Overall quantity of signals is about 30 000 for each unit. The main forms of information presentation are

- "Living" symbolic circuits,
- Graphs of changes of parameter values versus time with the possibility to choose the interval of registration and the set of parameters,
- Alpha-numerical panel presenting current values of parameters in tabular form.
- Screen maps of the reactor core with some additional possibilities
- And reports of various kinds.

4. Sustainability of the project, its development and implementation in LNPP

Since the delivery of the first system to LNPP the LNPP staff has performed the following tasks:

- Development of drivers for data collection SKAL-M and SKALA-MICRO. Within the contract the company MAREX developed such a driver only for SCK Skala.
- The number of symbolic circuits was increased 30 times and presently there are about 240 new "living" symbolic circuits with corresponding alpha-numerical and trend panels, which fully represent all systems of all units. All symbolic circuits have been successfully tested by the NPP staff.
- The system has been enriched by 20 new types of reports,
- System users have been trained in its utilization
- Measured information recorded by then system is used to investigate failures of equipment and provides important source of data for plant simulators. It can be also used to study events which have not led to accidents nor to incidents,

but can be used as precursors for trend detection. Two pictures below show an example of visualization of the problems with flowmeters in the NPP.

Information about the project was transferred to REA and NIKIET, which obtained all details and full documentation. In 2002 during a meeting in Balakovo with all NPPs the LNPP made a presentation and also published it in a REA journal. Kalinin NPP was doing a similar job in parallel and could use the information in full extent.

Presently the chief engineer uses the information from the system very often, every day. The system is needed and kept open ended to provide for further improvement of information collection and processing concerning technological system control. It is planned to be further modernized and the plant expects to get TACIS assistance in this very important task.

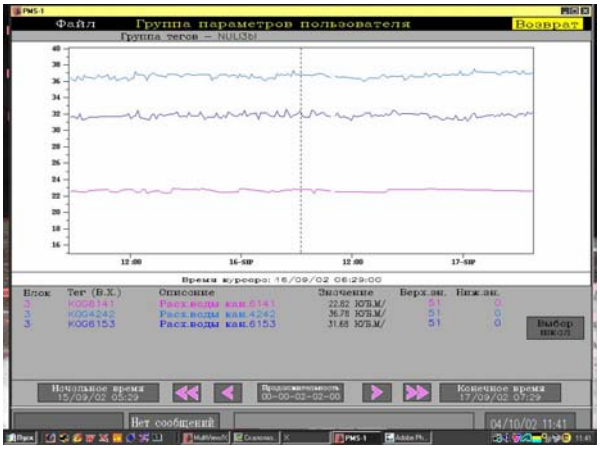


Fig. A – Monitoring of defective flowmeters before Unit 3 shutdown on 16.09.02, The lines show instabilities in the operation of the flowmeters.

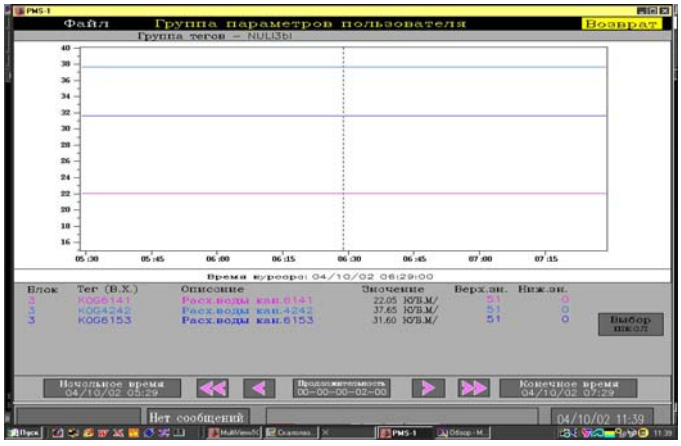


Fig. B. The flow meters have been replaced during maintenance period. The readings are steady now.

5. Factors which contributed to the success of the project:

- Clear division of responsibilities of all players participating in the project
- Good choice of reliable supplier of the components of the system (HP, IBM. ORACLE) which simplified solution of many questions during the implementation of the project
- Good training of LNPP engineers in all programming tools needed for the development of the system
- Direct cooperation of LNPP engineers with the supplier in the process of design and production of the system in close contact with the designers and developers of the supplier.
- Strong support of OSA Consultant, who organized trips to similar installation before the contract and cooperated with the plant during the contract implementation.
- Clarification of all issues during contract finalization and inclusion of agreed items in the contract.