REGIONAL ENVIRONMENTAL MONITORING SYSTEM "CLEAN IZHORA"
Ecological proving ground

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Environmental situation in St.Petersburg and the closest surrounding is very tense now. That is why a group of specialists gathered on a voluntary base works for several years at a project named "Clean Izhora" with the main aim to control improvement of the situation.

The Izhora river is a part of water system of Ladoga-Finnish Bay. Its Basin is placed to south from St.Petersburg at a distance of 20–50 km from it and covers about 1000 square km. About 500,000 persons populate this area, including such towns as Gatchina, Pavlovsk, Pushkin and Kolpino. These towns are known world-wide by their palace-park ensembles visited by the large number of tourists and guests.

Meanwhile the basin of the Izhora river is one of the most ecologically tense areas of the Leningrad region. The main pollution sources of natural environment of the Izhora basin are industrial and agricultural enterprises. Among them one should mention the Izhorskiy plant (Kolpino), pork productive complex "Noviy Svet" (Gatchina), polygon "Krasniy Bor" for burial of industrial wastes. Near the bank of the river the site of the Petersburg Nuclear Physics Institute is placed with 30-years old research reactor WWR-M, 1 GeV proton synchrocyclotron, radiochemical laboratories etc. Very close to this place the Leningrad Nuclear Power Station is situated. Altogether up to 200 enterprises are located in and near the Izhora basin.

For a long-period of time large volumes of polluting and harmful substances are being dumped by these enterprises into the air and into the water system of Izhora. For example only enterprises of Gatchina throw out about 20,000 tons of contaminants into the air with some tens of tons of heavy metals being dumped directly into the Izhora river.

The following reasons underlie such a situation:

- imperfect technology that results in producion large volumes of production wastes;
- low efficiency of cleaning equipment at the enterprises;
- bad control system for checking pollution amount and abundance;
- imperfect relations of municipal authorities and state supervisory organizations with the enterprises in the field of using natural resources and guarding the nature.

At present the ecological situation in Izhora basin is such that degradation of environment and ecosystems is becoming a reality. So the aim of controlling and improving ecological situation in the basin of Izhora arises as one of the immediate tasks.

At the same time in the area under consideration there is a number of enterprises and

organizations that have vast scientific potential and large experience in the field of investigation of matter composition and radioactivity. Here one should mention Petersburg Nuclear Physics Institute and Radiochemistry Laboratory of Radium Institute in Gatchina and Efremov Physical and Electric Equipment Institute and Izhora plant in Kolpino. Specialists of PNPI, Izhora plant and Efremov Institute are pioneers of the work on creation of the system of radiation and chemical pollutant monitoring.

When constructing the system the experience was used accumulated in these organizations on development of operating automated storage systems and processing experimental information with the use of the local measuring and computation networks. There is also an experience of analytical performance using nuclear and chemical methods of investigation. Enthusiasts from the above mentioned organizations carry out a detailed development of the system described modeling its selected elements and creating a special computer programming and communication means. The system modeling fulfilled by specialists of the above mentioned organizations showed the necessity of:

- production of home made automated units for chemical and radiation control or use of the equipment from abroad;
- production of digital connection channels on the basis of existing telephone lines using imported modems with errorproof equipment and digital connection channels on the basis of VHF transmitters;
- production of basic stationary laboratories;
- production of information and analytical center.

As a result of this work a model of the environmental monitoring system named "Clean Izhora" was designed and now is in operation. The heart of the system is the HARMON γ-radiation monitoring system.

The HARMON system produced by the Instrumentation Division of Harwell Laboratory, UK was supplied and installed here by the Delta Medical Scientific Instruments BV, the Netherlands for Public organization named Ecological Movement.

The system is in operation since March 1991 measuring each hour gamma dose rate in several points around St.Petersburg. The points are:

- Gatchina, PNPI (research reactor. proton synchrocyclotron);
- Gatchina town;
- Pushkin town;
- Sosnovy Bor, town (near nuclear power plant);
- Metallostroi (production of particle accelerators);
- Izhorski Zavod (atomic industry);
- St.Petersburg.

In Gatchina there is also a meteostation that measures temperature, air pressure, wind speed and direction.

The HARMON is one the subsystems. One more subsystem, OPSIS, to measure concentration of gases was integrated to the system temporarily for several months. As one of subsystems a prototype of the interface unit with gamma-radiations probes is working now in one of Gatchina schools.

All the tasks of the Project are:

- to design communication interface with world wide computer network;
- to design a new interface unit capable to integrate into the system any type of probes;
- to develop new types of radiation detectors.

Interface Unit SMU-03

A signalling and measuring unit (SMU-03) is a basic measuring instrument of the regional automated system of ecological safety. Together with suitable detectors the instrument allows to control various parameters of environment both as a part of a system and in off-Line mode.

SMU-03 may be applied in ecology, meteorology, nuclear power, engineering industry, medicine, food industry and so on.

Basic Technical and Service Potential of SMU-03

SMU-03 is designed to work with a wide set of various detectors having impulse, frequency or analog output signal, which are intended for a control over such parameters as temperature, pressure, moisture content, chemical and radioactive contamination, etc.

Intelligence of SMU-03 permits to reprogram main parameters of the instrument both with the help of its own keyboard and from the central computer. The memory capacity is chosen reckoning of the instrument operation in off-line mode for several days.

Telephone set or radio channel may serve as a physical medium to connect SMU-03 to the central computer. The instrument has a standard serial port to be connected to communication lines.

SMU-03 realizes a group detector servicing, maximum number of detectors being 8. Information is shown on a liquid-crystal in a digital, word or graphic form. It is possible to connect floppy magnetic dick drive.

SMU-03 provides for light and audible signalling in the case when a measured value exceeds warning and emergency thresholds. As this takes place, allowance is made for automatic compensation (subtraction) of the background.

SMU-03 has a clock for result referencing to astronomical time.

The instrument is fed both from alternating current network (50 or 400 Hz) and from self-contained sources (12 or 24 V accumulators). Temporary storage of SMU-03 has a buffer power source providing a mean to save accumulated information in the case of self-contained source failure.

Analogs, Prototypes and Characteristic Features of SMU-03

Possibilities of the most part of known analogous instruments are limited by their technical and operating characteristics. These instruments fail to vary flexibly an algorithm of work, they are intended, as a rule, for a control over only one parameter and mostly have no connection with a computer.

It was a signalling and measuring unit SMU-02, previously developed in PNPI RAS which served as a prototype for SMU-03. SMU-02 has been designed for a system of radiation monitoring for the reactor PIK and is widely used in St.Petersburg and Leningrad district in places of traffic radiation control, sea ports, railway stations, food depots etc. for a prompt control of radioactive contamination offer the break-down at the Chernobylskaya Atomic Power Station. At present SMU-03 is in use at ecological testing ground "Clean Izhora".

Data obtained when using the instruments SMU-02 as well as requirements of ecological, sanitation and radiological services formed a basis for SMU-03 design.

Besides being an aggregate of wide technical and service potential, SMU-03 is characterized by the principle of processing and representation of measured information which enables

to obtain high measurement accuracy with possibility for detectors to observe the measuring process being preserved.

Design

The instrument SMU-03 is designed in three variants:

- stationary (for usage in stationary automated control system);
- transportable (for mounting on vehicles);
- portable (for prompt usage by an operator).

The instrument is being developed with the use of method of surface component mounting on a basis of microprocessor technique.

Conclusion

Usage of the instrument being developed in the aggregate with detecting devices, having been developed or being in the process of development (e.g. a detector described further on) provides a possibility to create a system based on the single instrument and to obtain complex information about state of environment with high accuracy and promptitude.

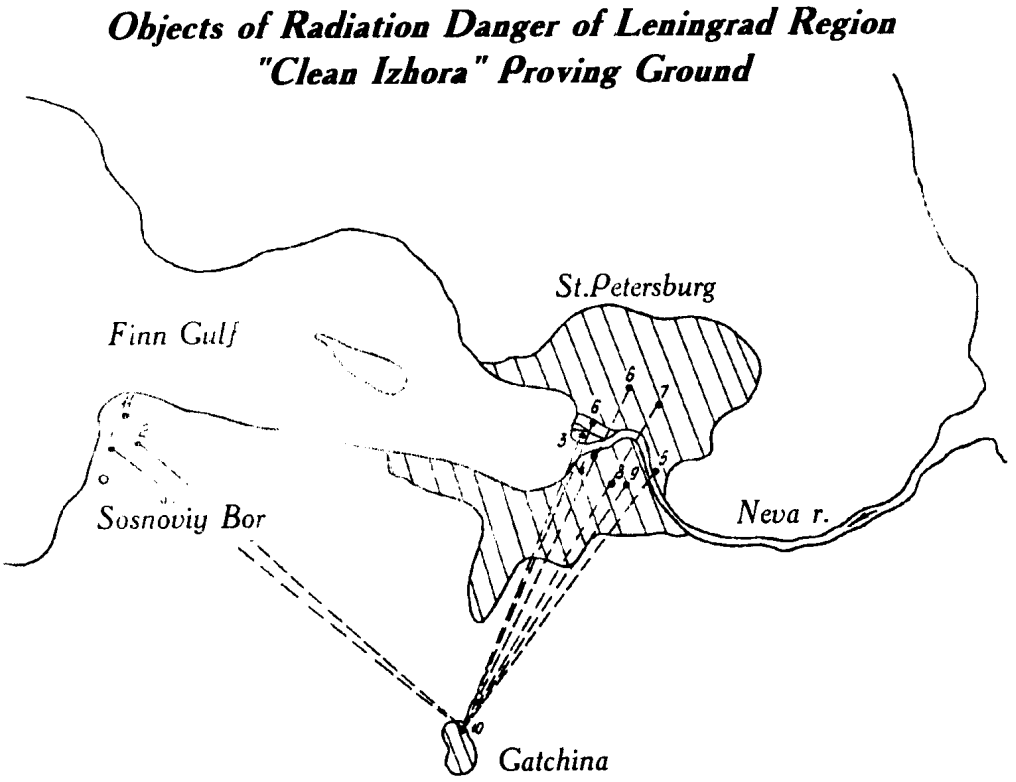

Fig. 1 – LAPS, (reactor RBMK), Sosnoviy Bor town; 2 – "Lenspetskombinat" Plant (radioactive waste storage, Sosnoviy Bor); 3 – Concern "Admiraltejskiy Verf" (ships with nuclear power sources); 4 – concern "Baltijskiy Zavod" (ships with nuclear power sources); 5 – Krilov Research Institute (research reactor) St.Petersburg; 6 – Radieviy Institute (radioactive sources production, St.Petersburg, Gatchina); 7 – Concern "Nedpolymer" (powerfull gamma-setup, 1.10^6 Ku) St.Petersburg; 8 – Concern "Postest" (radioactive sources production) St.Petersburg; 9 – Technological Institute (radioactive sources production) St.Petersburg; 10 – PNPI (research reactor), Gatchina; 11 – Research Institute NITI (research reactor), Sosnoviy Bor

Development of New Types of Charged Particle Detectors for Use in Environmental Monitoring

We suppose to apply the Si detectors with ultra thin windows for detecting of α- and β-particles, ultraviolet and x-ray radiation. These detectors work at room temperature and can be used as a sensitive elements in mentioned above SMU-03 system for radiation monitoring of the proving ground, meteorology, atomic energy and so on.

Usually these types of the detectors are produced by traditionally surface-barrier technique. Made in such a way they have a set of defects connected with absence of long time stable characteristics, insufficiently low level of the leakage current and the high cost due to gold rectified contact using. Besides, the shortcoming of surface-barrier technology is impossibility of serial detector production.

To remove these shortcoming it is necessary to make a design of construction and technological regimes allowing to obtain the detectors with the better characteristics.

In literature there are the data about a production of testing detector samples in Germany with the entrance window thickness of 1000 A using ion-implantation [1].

We suppose to perform designing and production of Si detectors with ultrathin windows (300-500 A) using recent achievements of semiconductor planar technology. The detectors will be made of the high purity floated zone silicon with resistivity varying from 1000 to 5000 Ohm·cm. To achieve the most universal application these detectors must have a big sensitive area (up to 25 cm^2), low level of leakage current ($\sim$1 nA/cm^2), the full depletion along the detector thickness (300–500 μ), the applied reverse voltage of about 100 V and long time stable characteristics. The possibility of serial detector production is planned.

Our work will have the following directions:

- selection of high-purity Si materials without structure defects and low contamination of residual impurities;
- the technological design and optimization of technological cycles to produce the detectors with characteristics mentioned above;
- the detector production;
- the detector testing including measurement of electric and spectrometric characteristics;
- the detector application to the SMU-03 system.

This proposal is based on the results that have been obtained in Petersburg Nuclear Physics Institute (PNPI) concerning the design of silicon planar technology. We have the 6 years experience and the modern experimental and technological base.

The design and production of Si detectors are supposed to be done in PNPI with assistance of Physical and Technical Institute and "Electron" Research Institute in St.Petersburg.

Detectors for Radiation Monitoring of Environment at High Level of Radiation

It is proposed to develop and make detectors capable to work and to perform environment monitoring at high level of radiation, that is at force major situations on nuclear objects (atomic power stations, nuclear testing grounds, radiation sources and so on) or in the places with high radiation contamination.

In order to realize this purpose, it is planned to use new, materials which will enable to detect high energy charged particles and gamma rays with high efficiency, high energy resolution, super high response speed and high durability in radiation fields. Besides, it is

supposed to use the latest achievements in creation of super fast electronic systems of data read-out from such detectors.

The traditionally used detectors made on the basis of such materials as NaJ, CsJ and so on can not be used at radiation levels of more than 0.02 Rad/s and at integral dozes of several tens of kRad. Application of new materials, such as BaF_2, CeF_3, $PbWO_4$, GSO, $YAlO_3$ and so on, will give possibility for detectors to work at dozes up to 2 Rad/s and at integral dozes up to several MRads.

Till 1992 Russia was a leader in such crystals investigation which have been carried out during 8 years. Now investigations in this direction are being actively performed in China, Switzerland and America. Large experience in creation of detectors in PNPI, high technology level of obtaining crystal materials reached in VNIISIMS (Alexandrov, near Moscow) and developments of nanoseconds electronics in PNPI allow to achieve success in realization of the program discussed above.

All works on development and production of this type of detector are planned to be performed in PNPI in collaboration with VNIISIMS (Alexandrov, Russia).

REFERENCES

1. *Maisch T. et al.* Ion Implanted Si p–n Function Detectors With Ultrathin Window. Nucl.Instr. and Meth., 1990. V.A288.