IBRAE RAS TECHNICAL CRISIS CENTRE

Data analysis for over 60 years of development of nuclear power shows high level of its safety.

Health effects of exposure for the population and staff are negligible comparing to other factors of other health adverse effects in nuclear power industry and ignorable comparing to other industries.

Additional exposure dose rates due to nuclear power industry operations are also insignificant comparing to natural exposure rates of the population, even allowing for the Chernobyl NPP accident. At the same time, radiation accidents in the past caused inadequate reaction of the population, first of all, due to exaggeration of nuclear risks by all social groups.

On the other hand, radiation accidents are quite rare, so local authorities often do not pay enough attention to the problem of nuclear safety and are not ready to respond properly to such accidents.

The result of inadequate overreaction of the population is overestimation of social, economic and psychological impact of accidents, while direct radiation risks are small. The well-known example of this is the Chernobyl NPP accident. Therefore, it is very important to establish effective emergency response system to radiation accidents. The main task of state, operational and local emergency response and monitoring systems is rapid and adequate estimation of nuclear environment and radiological impact.

The present booklet describes activities and certain results of IBRAE RAS research in this sphere.

L. A. Bolshov
Directore of IBRAE RAS,
RAS corresponding member

GENERAL INFORMATION ON THE CENTRE

IBRAE RAS TCC SOFTWARE AND HARDWARE SYSTEM

TRAINING, EXERCISES

RADIATION MONITORING SYSTEMS

PUBLIC SITE

INTERNATIONAL CO-OPERATION

Availability of emergency response system to mitigation of radiological accidents of any kind and impact reduction is one of the main elements of nuclear power industry safety system. High technologies of nuclear power industry require specific organising of emergency response system. First of all, it requires modern system of scientific and technical support of solving technical and scientific problems of emergency response. Therefore, scientific and technical support of environmental assessment, impact forecast and making decisions on the required measures is one of the main elements of emergency response system.

Technical Crisis Centre of IBRAE RAS is one of such centres in the system of RSChS (Unified State Service for Preventing and Elimination of Emergency Situations).

The system of technical and scientific support of emergency operation management is developed to solve the above-mentioned problems. Special crisis and technical support centres operate within the system, providing recommendations for organizing and execution of emergency preventing activities. IBRAE RAS technical crisis centre is one of such centres. Rapid providing of recommendations on protective activities preventing excessive exposure of the population according to international standards is the first priority at the initial stage of an accident.

The task of preventing and minimization of social and economic losses should be supplemented by the task of providing radiation protection at intermediary and long-term stages of the accident.

R. V. Arutyunyan
First Deputy Director of IBRAE RAS,
Head of IBRAE RAS TCC

Deputy Director
of IBRAE RAS
I. I. Linge

Scientific research and engineering results of IBRAE RAS on wide range of topics in nuclear and radiation safety are the scientific and technical basis for solving problems the TCC meets:

- Developing and practical application of system codes for modelling of emergency situations at nuclear power plants and transport NPE.
- Developing and justification of complex system of computer codes modelling of distribution of exposure in environment and through foodchains (air, water, ground), model-based risk analysis and practical application of models at engaged structures.
- System analysis of radiation terrorism hazards and providing first priority measures for preventing such hazards and minimization of losses.
- Developing of object local radiation monitoring and emergency response systems and assistance in developing of such system for particular organisations.
- Developing of full-scale scenarios and simulation computer modelling systems for simulation of emergency situation for training purposes and staff exercises.

TCC experts are highly qualified specialists in nuclear radiation safety and protection, having practical experience in rectification of the consequences of the accident at the Chernobyl nuclear power plant, which is one of the main elements of efficiency of TCC. IBRAE RAS participates in international cooperation in research on all above-mentioned problems.

GENERAL INFORMATION

R. V. Arutyunyan, I. I. Linge
Heads of IBRAE RAS TCC

I. A. Osipyantz
IBRAE RAS TCC Director

V. F. Evseev
Head of administrative-and-technical group

O. A. Pavlovsky
Head of expert group

V. P. Kiselev
Head of research and information group

K. V. Ogar
Head of software and hardware group

V. N. Lazarev
Head of technical group

IBRAE RAS technical crisis centre (TCC) is the structure performing practical application of IBRAE RAS research results in nuclear, radiation and environmental safety for providing scientific and technical support of radiation accidents emergency response system.

IBRAE RAS TCC was founded in 1996 for providing scientific and technical support of estimation of impact of the accident at the Chernobyl nuclear power plant on the population and environment. TCC started operating as the centre of technical support of the Crisis Centre (CC) of «Rosenergoatom» concern. Since 1998 TCC provides scientific and technical support to the duty shift of Emergencies Ministry of the Russian Federation. The works on scientific and technical support for Department of nuclear and radiation safety and Situation Crisis Centre of (SCC) of Minatom started in 1999. In recent years IBRAE RAS performs works on improvement of local radiation monitoring and emergency response systems in the regions of the Russian Federation. Scientific and technical support of local authorities is one of the key elements of local radiation accidents emergency response systems. Since 2005 TCC operates as the monitor and forecast centre of Moscow Civil Defence Department and provides support for Murmansk region crisis centre since 2007.

White papers on nuclear energy uses and emergency situations, state standards and rules, including Regulation on procedure of announcement of emergency situation, rapid providing information and organising emergency support for nuclear power plants in case of radiation hazard, agreements and routine of cooperation regulate TCC activity. TCC creates and develops separate trends of scientific and technical support for Rosatom enterprises within the programs of scientific research and execution of international projects.

TCC RESPONSIBILITIES

The main responsibility of IBRAE RAS TCC is estimation of impact and providing recommendations on protection of the population and the environment in case of accidents at nuclear power sites. TCC experts are on duty 24 hours a day including weekends.

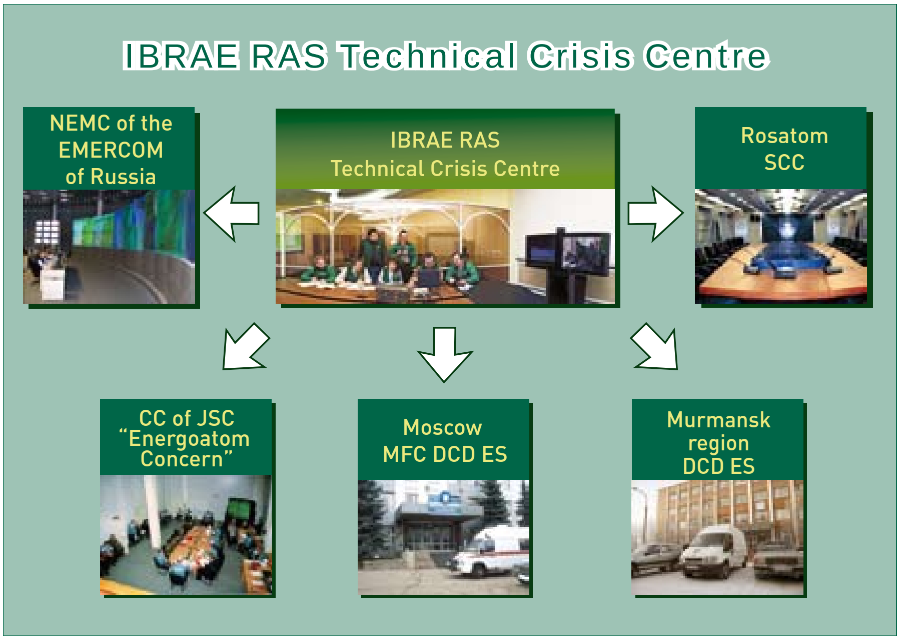
The basis of making decisions on protection of the staff, population and the environment in case of radiation accidents:

- identification of radiation situation, estimation and forecast of development of the accident, environmental pollution and impact on the staff and the population;
- planning and estimation of efficiency of protective activities and optimization for particular radiological, social and economic conditions;
- application of modern technologies and equipment to provide effective cooperation of emergency response participants.

In case of radiation accident threat TCC provides:

- estimation and forecast of the main parameters of the exposure source beyond the industrial site;
- forecast of environmental pollution on the basis of radiation monitoring data;
- estimation and forecast of the population exposure rates;
- providing recommendations on protection of the population and the environment;
- estimation of efficiency of protective activities and optimization for particular radiological, social and economic conditions.

I. A. Osipyantz TCC Director



TCC MAIN RESPONSIBILITIES ARE:

- participation in emergency response;
- participation in emergency-response exercises and trainings;
- development of scientific, methodological, and informational support to emergency response systems;
- development of software and hardware systems.

TCC STRUCTURE

TCC staffs 37 employees, 24 of then form the expert group (EG). Forteen staff members are engaged with 24-hour duties. Four TCC staff members are members of Group for providing assistance to nuclear power stations (ANPS). Thirteen specialists of administrative and technical groups (ATG) support TCC activity.

ATG, Information and Analysis group (IAG), Software Group (SG), and TG operate permanently providing organizational, information, analytical, and technical support of TCC activity. EG operates during trainings and exercises or in emergency situations.

V. P. Kiselev, Head of the Research and information group

O. A. Pavlovsky, Head of the Expert group

TCC ORGANIZATIONAL STRUCTURE:

- TCC top management
- expert group (EG)
- administrative-and-technical group (ATG)
- information and analysis group (IAG)
- software group (SG)
- technical group (TG)

TCC IAG RESPONSIBILITIES ARE:

- routine maintenance of TCC software;
- modernisation of methodological, information-analytical, and software support systems, maintenance of TCC software and hardware;
- information and analytical support of TCC EG during exercises and in emergency situations;
- preparation of information and analytic materials.

TCC EG ACTIVITIES ARE:

- analysis and improvement of exposure source characteristics;
- analysis and improvement of environmental contamination rates and exposure rates of the population;
- analysis of radiation situation and providing recommendations on protection of the population and other activities aimed at minimization of the accident impact;
- cooperation with the experts of crisis centres and technical support centres of other organisations;
- participation in preparing information materials and recommendations for the population in the accident area.

ATG RESPONSIBILITIES ARE:

- coordination of all kinds of TCC activities;
- organizational support of TCC activities, both in routine mode and in emergency situation;
- preparation of alarming and rally plans for TCC staff;
- providing orders on rally of complete TCC staff (on the order of TCC head or IBRAE RAS managerial body) according to operating mode, alarming and rally plan; engaging of predetermined additional staff and resources from IBRAE RAS reserve;
- communication with other organisations participating in emergency response activities;
- participation in preparing materials on the main TCC activities;
- preparation of data for the engaged organisations and authorities;
- prospective planning of activities on protection of the population and the area in emergency situations;
- improvement of process of making decisions on protection of the population and the area in emergency situations;
- development and improvement of IBRAE RAS TCC technical systems and facilities.

SG RESPONSIBILITIES ARE:

- implementation, support and development of high-tech software, information systems, communication and data exchanging systems;
- maintenance and development of TCC server and communication systems.

TG RESPONSIBILITIES ARE:

- maintenance of TCC equipment;
- development and improvement of TCC technical facilities;
- technical support of exercises and in emergency situations.

K. V. Ogar, Head of SG

V. F. Evseev Head of ATG

Discussion between TCC experts: A. V. Shikin, S. N. Krasnoperov, and R. I. Bakin

OPERATING MODES

IBRAE RAS TCC can work in three different modes according to the situation:

Routine mode

Advanced mode («emergency preparedness»)

Emergency mode («emergency situation»).

TCC night shift from 31.1 2.1999 to 01.01.2000

IBRAE RAS TCC works 24 hours a day, seven days a week.

Routine mode: TCC staff work following their daily routine (except the duty shift).

Working in routine mode, the members of TCC EG shall be within the reach of TCC staff alert plan and participate in:

- methodological and scientific support of research and design works on problems of emergency response, nuclear and radiation safety, including development of radiation accident scenarios and emergency response exercises;
- development of TCC software and hardware;
- teaching and training of specialists in protection of the population and the area in case of radiation accidents;
- preparation of information and analytic materials.

Advanced mode: IBRAE RAS TCC should organize staff rally, check software (SG) and communication systems. If the situation at the site grows emergency before TCC deployment, TCC should perform the above-mentioned activities in emergency mode. After putting the resources into alert, TCC staff should start providing scientific and technical support according to received requests and initiatory information.

In advanced mode TCC EG staff should:

- arrive at IBRAE RAS within one hour at working hours and 1.5 hour at free time;
- prepare requests on required information on the situation at the site;
- provide draft recommendations on activities aimed to improve parameters of probable source;
- provide draft forecast of radiation situation taking into account the worst way of emergency situation development;
- provide preliminary recommendations on protection of the population.

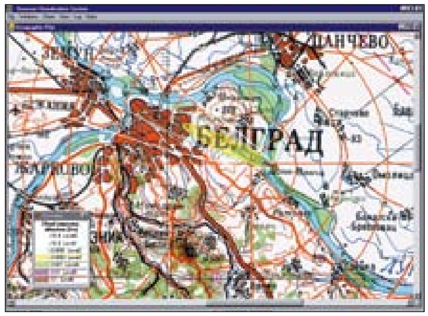
Emergency mode: IBRAE RAS TCC provides scientific and technical support according to operational objectives.

In emergency mode TCC EG staff should:

- arrive at IBRAE RAS within 1 hour at working hours and 1.5 hour at free time, if IBRAE RAS does not operate in advanced mode;
- participate in estimation and forecasting of the main source parameters (dynamic parameters, nuclide and physico-chemical composition etc.), preparation of preliminary forecast of environmental contamination and its correction on the basis of improved source parameters, monitoring, and other relevant data;
- provide unbiased estimation of the accident scale, radioactive environmental contamination, and expected population exposure rates;
- provide recommendations on protection of the environment and the population;
- analyse adequacy of the normative intervention levels and optimize them for the particular radiation situation;
- perform other works on the order of the head of IBRAE RAS TCC.

LEGAL FRAMEWORK

- IBRAE RAS administrative order dated December 16, 1996 on establishment of technical support centre for support of Rosenergoatom Concern Crisis centre.
- Procedure of declaring the emergency situation, data transfer, and organising emergency assistance to nuclear power stations in radiation hazardous situations (NP-005-98), endorsed by the decree of Rosatomnadzor of the Russian Federation dated January 5, 1998, No 1, and amendment 1, endorsed by the decree of Rosatomnadzor of the Russian Federation dated August 30, 2002, No 8.
- «Standards of alarm and operation in emergency situations of «Rosenergoatom» concern. IBRAE RAS Technical Support Centre. General provisions.» endorsed by the Head of the Crisis centre of «Rosenergoatom» concern on August 18, 1999.
- IBRAE RAS administrative order No 3 «On providing IBRAE RAS TSC operation in routine mode and appointment of representatives of the institute to ANPS group» dated January 14, 2003.
- «Staff instruction for duty shift of IBRAE RAS TSC», endorsed by the Deputy Director of IBRAE RAS January 21, 2003.
- «Agreement between EMERCOM of Russia and IBRAE RAS about cooperation on prevention and elimination of emergency situations of nuclear nature and response to threat and actions of radiation terrorism for 2004-2008» No 16 dated July 12, 2004.
- «Agreement between EMERCOM of Russia and IBRAE RAS about cooperation on prevention and elimination of emergency situations of nuclear nature, elimination of the consequences of the accident at the Chernobyl NPP, activity of «Mayak» enterprise, and nuclear tests at Semipalatinsk proving ground, and response to threats and actions of radiation terrorism for 2009-2015»
- Procedure of cooperation of IBRAE RAS Technical Crisis Centre, Moscow Head Department of EMERCOM of Russia, and Moscow Civil Defence Department dated April 28, 2005



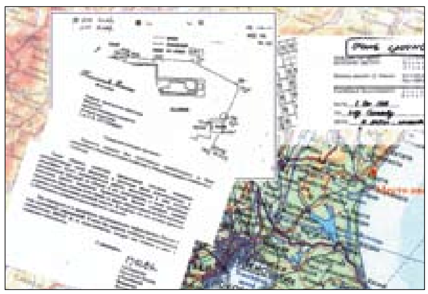
Analysis of potential radiation impact of bombing at Balkan Peninsula and bordering countries (24.02.1999)

EXPERT EXPERIENCE

TCC experts are leading specialists in nuclear physics, reactor physics, nuclear safety and protection and radioecology. There are 11 PhDs and 6 ScDs among them.

Many of our experts participated personally in eliminatyion of the consequences of a number of radiation accidents and in estimation of impact of the accidents for the staff, population and the environment.

- Estimation of impact of accidents in South Ural (1949-1951, 1957).
- Elimination of the consequences of the accident at the Chernobyl NPP (1986).
- Estimation of impact of accidents at SChC (1993) and in Chazhma Bay (1985).
- Participation in nuclear tests at Semipalatinsk and Novaya Zemlya proving grounds and peaceful nuclear explosions.



IBRAE RAS performed analysis of potential impact and countermeasures to the accident at nuclear fuel plant in Tokaimura, Japan on request of the Embassy of Japan in Moscow and Minatom SCC (30.09.1999)

GENERAL INFORMATION ON THE CENTRE

IBRAE RAS TCC SOFTWARE AND HARDWARE SYSTEM

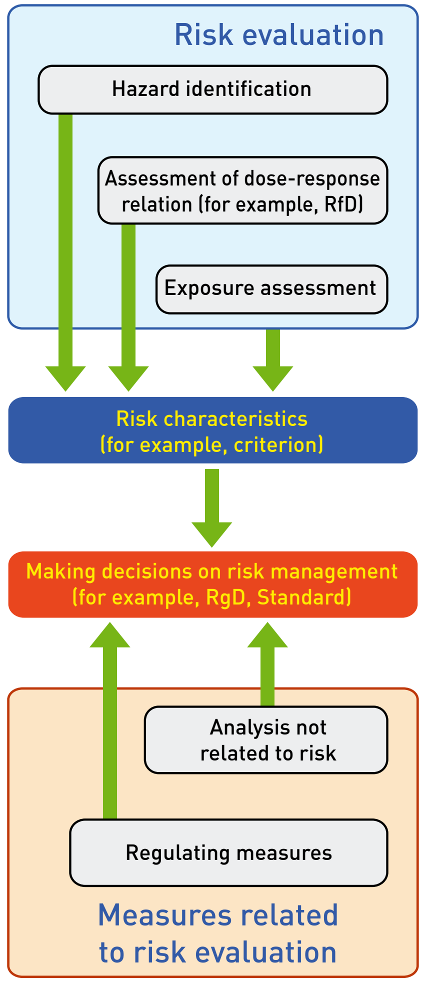
RADIATION MONITORING SYSTEMS

MODEL BANK

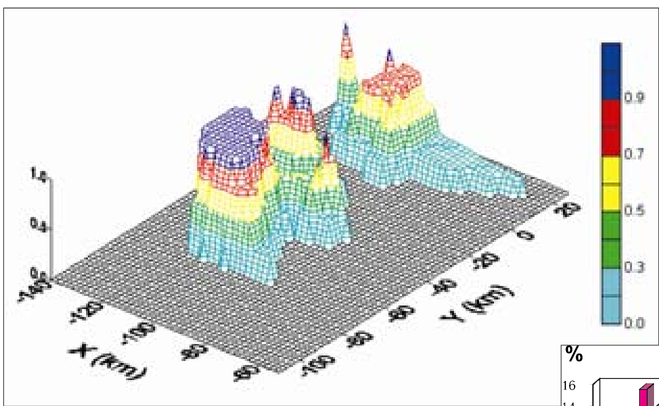
Creation and development of expert systems on decision making support and scientific and technical support of measures on protection of the population and the area in case of radiation accidents is one of high-priority activities of IBRAE RAS TCC.

For twenty years of IBRAE existence, we created the bank of algorithms and code packages, including those for exposure rates computation, estimation of relative and absolute radiation risk, and transition and migration of nuclides. Well-known and original technologies support the developed tools. Created and permanently updated bank of digital maps provides creating maps and matching attributive data. We created the unique geoinformation RVS system for the areas of enhanced radiation risk, containing data on over 1000 settlements of Russia, on the basis of developed tools and IBRAE general database on impact of the accident at the Chernobyl NPP.

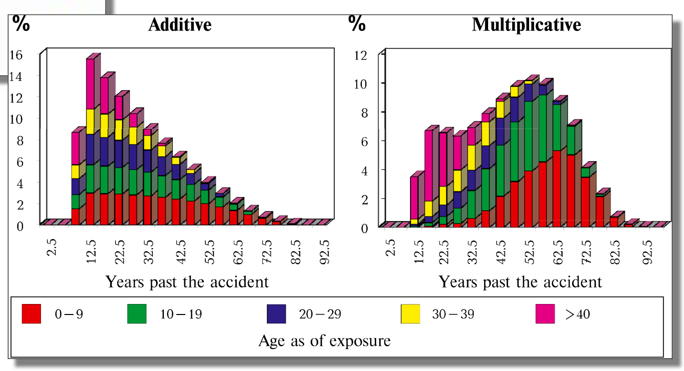
We created and applied a number of integrated computer systems for analysis of various impacts of radiation accidents. We were the first to use modern geostatistics and fractal theory standards and models for analysis and modelling of Chernobyl fallout. We also created internationally recognized new method of analysis and processing of geographically dispersed data on environment, based on artificial neural networks and genetic algorithms.



Conceptual estimate of risk related to impact of hazardous chemical substances in the code package WinArm



Probabilistic estimate of ^{137}Cs contamination level to exceed 20 Ci/km^2 (Bryansk region)



Models to estimate radiation-induced carcinogenic risk

Model/code	Model/code
DIANA Calculation of the effective equivalent human dose and equivalent doses for individual organs foe external outdoors exposure allowing for the natural radiation background.	**FOOD-CHAIN** Dynamical models of the radionuclide migration along the nutrition chains. Prediction of contamination of the agriculture production.
HEAVYGAS Lagrange stochastic model for scattering of gazes with density different fron the air density.	**GEOSTAT** Geostatistical analysis of monitoring data.
POLE (Field) Calculation of fields and rates of external exposure from sources of various geometry	**INTER** Model for the calculation of the external exposure doses of the contaminated pool through the water nutrition chains.
ACD Specialized information and modelling system that enables modelling and analyzing the consequences of the radioactive releases in the atmosphere from the radiation hazardous objects; map the data of the radiation monitoring; predict the scale of contamination by aggressive toxic substances during chemical accidents; create topical maps to support decision making in the emergency situations.	**MicroShield (MS5.EXE)** The code package for calculation of protection and estimation of gamma-exposure rates includes options of analysis of shielding and containers of various configuration, estimation of exposure rates of the staff and doses in materials, choice of protective measures for maintenance, estimation of source power based on field measurement, minimization of the staff exposure.
BASIN Model to estimate the radionuclide concentration in water and bottom sediments of the contaminated pool.	**RISK-2** Forecast of the distant carcinogenic risk of exposure.
NEPTUNE Model for forecast of radiation situation in case of spillage of nuclear substances to the surface of oceans and seas and for estimation of nuclide concentration in case of contamination dispersion in sea water.	**RVS** GIS on radiation and hygienic situation in Chernobyl area (10,000 settlements). Geoinformation system for visualisation of ARMS data and information support of estimation of radia-toin accident consequences.
CASSANDRA Code package (modelling and information system) for modelling of migration of nuclides in aquatic systems and estimation of exposure rates of the population from water consumption.	**RADOFOR** Calculation of radiation monitoring parameters of human external exposure by photon irradiation from flat mono-directed and point emitters of various kinds and arbitrary shape.
CHEM-RISK Estimation of chemical risk.	**REVERS** Reconstruction of the release parameters from the actual measurement data.
3D DYNAMIC MODEL of air transport of contaminants in urban environment.	**PARIS** Simulation of the radiation situation for the radiation accidents allowing for the countermeasures.
NOSTRADAMUS Regional model of atmospheric transport, forecast of radiation situation, exposure rates, countermeasures.	**ENVELOP** Simulation of radiation monitoring data.
EXPLOSION Model for the dynamics of the contaminant cloud appeared in result of the energy release.	**PIONEER** Training system of simulation of radiation monitoring data created and developed on the basis of ENVELOP system.
FIRE Model of the stationary convection above the heat source.	**TRACE** Local model of the atmosphere transport, prediction of the radiation situation, exposures doses, monitoring data.
METAN (Methyl hydride) Model for estimation of source of admixture on basis air concentration of admixture at different locations.	**SOCRAT** Code package for analysis of severe accidents at NPP.
MELCOR-VVER Code package for analysis of severe accidents at NPP.	

CODE PACKAGES FOR ANALYSIS OF NPP SAFETY

Development and implementation of code packages for analysis of NPP safety is one of the top priorities of IBRAE activity. Working on the problem for over ten years, we formulated the development methodology for such tools. First of all, it involves physically grounded models based on equations of mathematical physics and modern information on processes and phenomena. We estimate quality of codes through verification against experimental data on particular phenomena. Integral experiments enabling verification of integral codes are of particular concern. At the same time, we assess the existing database on various phenomena, which enables better clarification of the experiment goals. IBRAE RAS participates in projects peformed both in Russia and abroad.

MELCOR CODE PACKAGE

Integral computer code MELCOR enables research of all stages of severe accidents at water-water reactors of PWR and BWR types and estimation of fission product release outside fuel claddings. Sandia National Laboratories (SNL) created the code in the 80s on the order of US NRC. In the 90s, IBRAE RAS and SNL upgraded certain models and modules of the MELCOR code on the order of US NRC. In 2001, NRC approved and supported modernization of the MELCOR code proposed by IBRAE RAS. The work scope of the project assumed full revision of the code architecture and internal data format based on the modern programming technology and new standard of APL, FORTRAN-95. As a reesult, MELCOR 2.0. code version was developed. The next step in improving the MELCOR code was creation of graphical user interface (MELCOR GUI) for operating in Windows environment. MELCOR GUI features the following advantages:

1. Enables interactive data input and/or data copying, data input check by choosing options or graphical visualisation of the input (Fig. 1).
2. Supporetd by user manual and on-line help system, thus making work easier (Fig. 2)
3. Interactive post-processing enables watching changes of required parameters in process of calculation (Fig. 3).

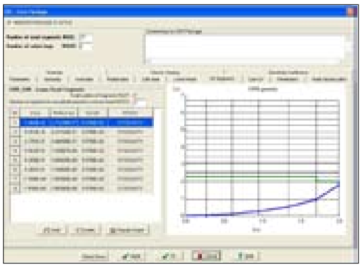


Fig. 1 Input window of the COR code

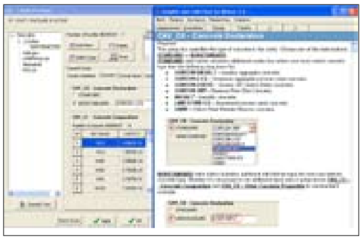


Fig. 2. Input window of the CAV code and help system

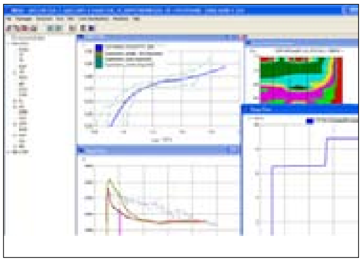


Fig. 3. Calculation process check, comparing to experimental data

SOCRAT CODE PACKAGE

V. F. Strizhov Department Head

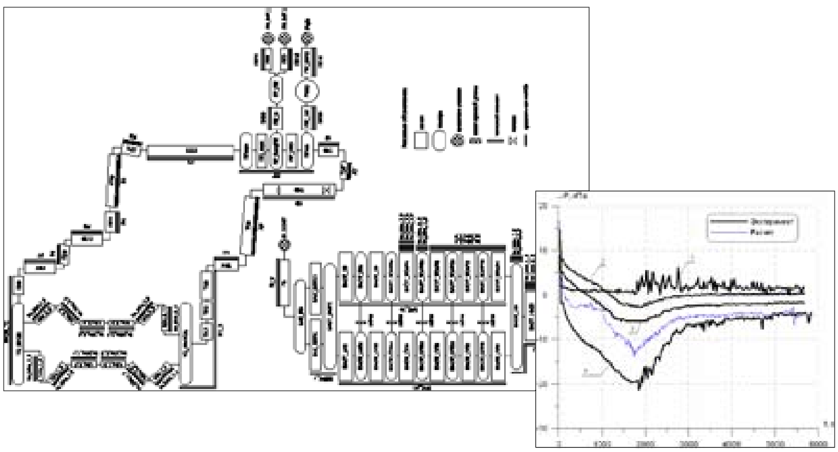
IBRAE RAS together with VNIIEF, RSC «Kurchatov Institute», SPb AEP and AEP developed advanced code package SOCRAT for analysis of accident dynamics at NPPs with VVER reactors. The code package features upgraded estimation capabilities; it combines advantages of systematic approach to the analysis of nuclear power facilities and modern achievements in modelling of individual processes and elements. SOCRAT code package enables system modelling of physical processes from the initial event to the melt release outside the reactor vessel with due regard to design features of VVER.

THE MAIN TASKS TO BE SOLVED BY THE SOCRAT CODE PACKAGE ARE:

- realistic estimation of hydrogen and steam sources for providing fire and explosion safety of the containment;
- realistic estimation of the reactor state, analysis of reactor response to possible measures of emergency control;
- realistic estimation of mass and energy of the melt released from the reactor vessel in case of destruction of its bottom;
- realistic estimation of the release of fission products outside the protective barriers and to the environment.

Example of verification of SOCRAT code:

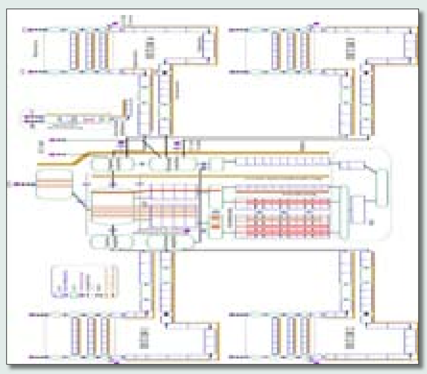
computation model and the results of modelling of experiment at thermohydraulic unit of RHRS SG for justification of passive safety systems of new VVER design.



We verified SOCRAT code quality against numerous experimental data. The figure shows the results of modelling of passive protective systems of NPP with VVER

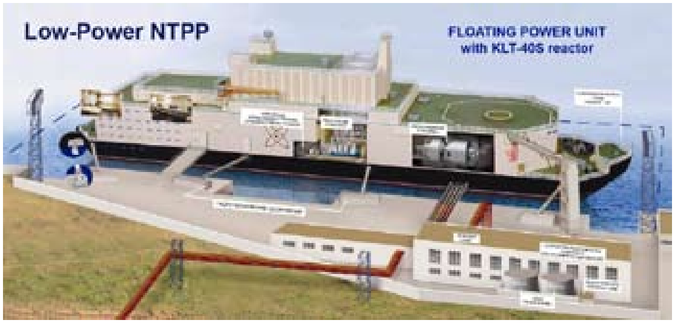
Application field of SOCRAT code includes operating reactors and projects:

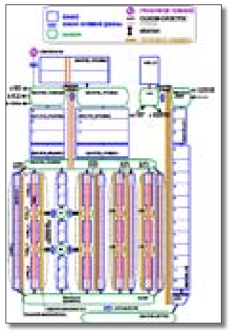
Balakovo, Kola NPP, Novovoronezhskaya, Yuzhno-Ukrainskaya NPP, NPP in China, India, and Bulgaria, new projects at Novovoronezhskaya and Leningradskaya NPP-2.



Typical VVER circuit

The Institute in co-operation with OKBM upgraded the SOCRAT code to allow for specific features of low-power reactor facilities thus enabling modelization of hypothetic severe accidents at low-power reactors. In result, the safety of the NPP with KLT-40S reactors was significantly enhanced.





KLT-40s: general view and nodalisation of the reactor vessel

A. V. Kiselev, Head of development of SOCRAT system

CONT CODE PACKAGE

IBRAE developed methods, mathematical models and software modules for analysis of deflected mode (DM) of NPP containment under the impact of the operational and emergency loads.

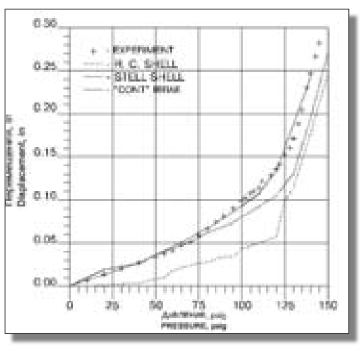
We certified CONT software system for computational modelling of DM of NPP containments under static operational and emergency loads. The code is based on the finite-element method. To upgrade computing algorithm and enable its use for handling the DM of the complicated-shape constructions, we supplemented the customary finite-element method with the superelement algorithm, enabling step-by-step calculation of the construction DM allowing for repeatability of geometry of individual elements.

CONT was user to calculation and justify safety of real containments at Kalininskaya, Rostovskaya, and Novovoronezhkaya NPPs, and certain containment models constructed in the USA.

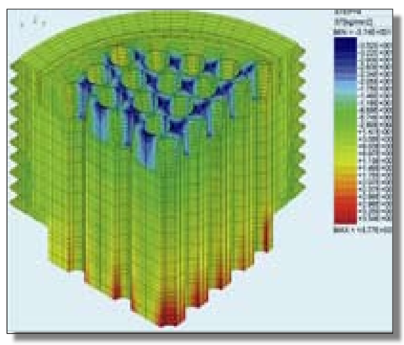
CONT code justification for containment models scaled 1/6 Sandia and 1/4 Sandia

Specific features of modelling: allowing for reinforcement ropes in the form of thin sheets; calculation with account for concrete crusting

Model of pre-stressed ferroconcrete containment scaled 1/4 Sandia



Modelling of reinforcement in the form of thin sheets enables calculations allowing for crusting with sufficient accuracy



Distribution of the ring tension in anchor pad under the rope strain N=1 000 t.

COMPUTER SYSTEMS FOR MODELLING NUCLIDE SCATTERING IN THE ATMOSPHERE

V. N. Semenov, O. S. Sorokovnikova, V. V. Belikov, developers of NOSTRADAMUS system

Figs. 1, 2 show landscape impact on characteristics of radiation trace. Fig. 3 shows modelling of the Chernobyl fallout.

NOSTRADAMUS system is designed for rapid forecast of radiation situation in case of emergency release from radiation hazardous sites of nuclear industry. NOSTRADAMUS system is verified and has certificate of the Federal Inspectorate for Nuclear and Radiation Safety (GAN), registration number of program tool (PT) at COEE of RSC KI 491 dated 14.03.2003; registration number of PT certificate 158 dated 28.03.2003.

Lagrange trajectory model of atmospheric transport underpinning the NOSTRADAMUS system takes into account:

- real 3D heterogeneity and instability of the source and wind field within the atmospheric boundary layer;
- particle distribution of aerosol;
- impact of local precipitation;
- landscape impact on scattering process.

Fig. 1

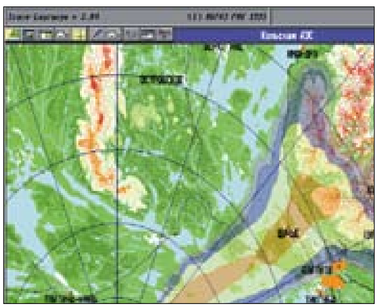


Fig. 2

The code is modified for estimation of radiation situation around radiation hazardous sites not only in emergency situations, but also for regular release in routine operating mode.

Fig. 4 shows calculation of average monthly concentration of 54Mn nuclide (Ci/m^3) around Smolensk NPP in February, 1997.

The advantage of the system is that it can use forecasts prepared by the Hydrometeoroligical Centre as input data.

The development of the NOSTRADAMUS system matches the mainstream of new generation of the complex calculation methods for atmospheric transport of aerosol and gas admixtures. It uses the state-of-the-art options of receiving detailed meteorological data with high spatial resolution. Regional forecasts have resolution of 1-10 km and recently they become a part of normal practice (Russian Hydrometeoroligical Centre provides its forecasts at the grid of 1.25x1.25 degrees, which is about 100x100 km).

Murmansk Department for Meteorology and Environmental Monitoring is testing such complex system, combining high resolution meteorological forecast and the model of the atmospheric transport.

Fig. 5 shows the calculation results of radiation situation obtained with the NOSTRADAMUS system.

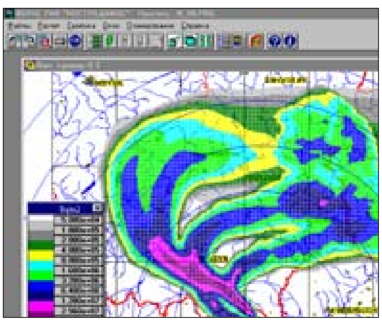


Fig. 3

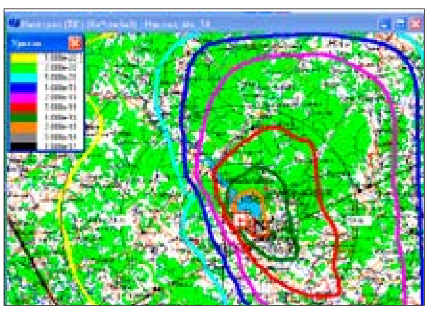
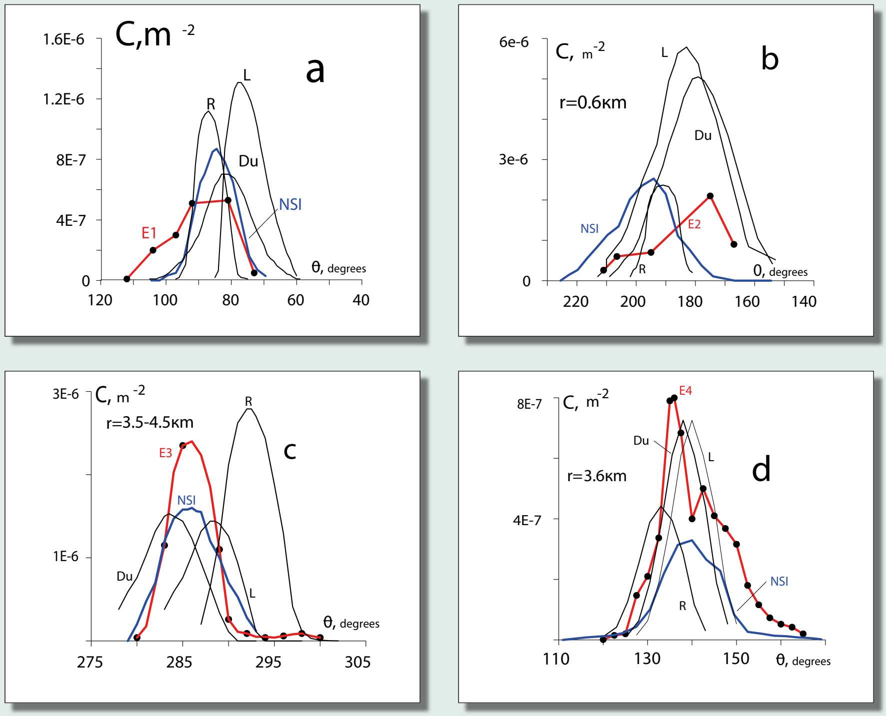


Fig. 4

Fig. 5

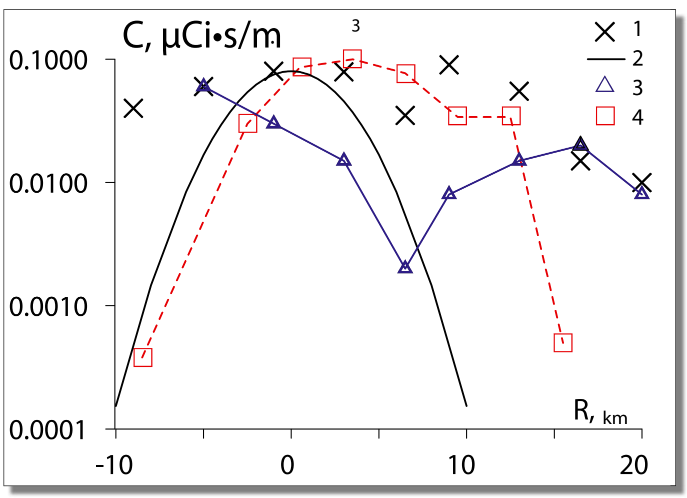
NOSTRADAMUS system is verified against experimental data (about 1,000 measurements data).

Comparison of the NOSTRADAMUS calculation results to the calculation results of with the use of other models and experimental data



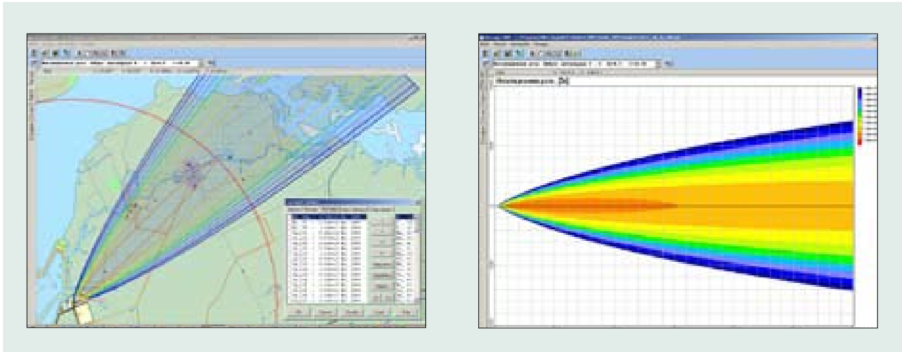
Integral ground concentration of admixture: E1, E2, E3, E4 — experimental data; NSI — IBRAE RAS model; R — Gauss puff-model (Denmark); L — Lagrange model (IABG); Du — Euler model (Germany)

Discussion on NOSTRADAMUS system



Comparison of the NOSTRADAMUS calculation results to the Livermore calculation results and experimental data by INEL (Idaho National Engineering Laboratory). Integral ground concentration of admixture 131I within 60 km area: 1 — experimental data; 2 — Gauss model (Livermore); 3 — ADPIC model (Livermore); 4 — IBRAE RAS model

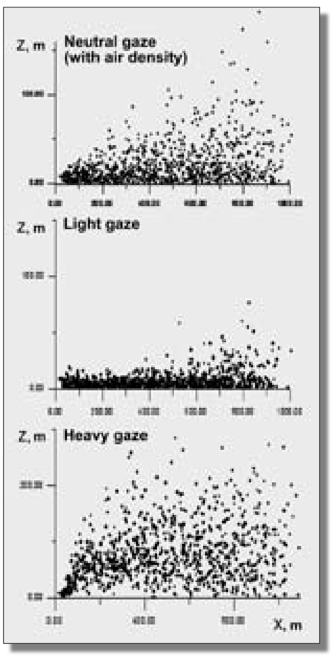
TRACE SYSTEM. Fast integral computer code, based on Gauss model of atmospheric transport, is the basis of the system. The program predicts value of contamination density (total and for individual isotopes) of the ground surface, effective equivalent exposure rates for the whole body and individual organs (thyroid gland, gonads, lungs, red marrow etc.) in digital, table, and mapped forms for various age groups as functions of time.



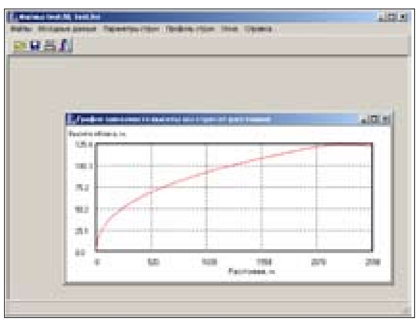
Modelling of radiation situation using the TRACE system

HEAVYGAS is the Lagrange stochastic model of gas scattering for the gas density different from the air density.

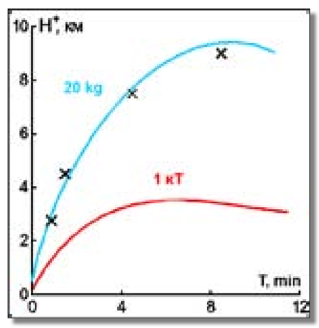
FIRE program estimates parameters of convection above the thermal source, developed in practical application to jets of light gases, including methane. It is the basis of new METAN program, designed for the inverse problem of estimation of the admixture sourse density on the basis of admixture concentration in the air in different locations. The program estimates amount of the natural gas release at gas-industry sites using methane concentration in air measured by the aircraft technique.



Side view of the jet with the flow velocity 3 m/s propagating along the wind direction (5 m/s). The figure clearly demonstrates the difference in scattering of the jets of light, heavy, and neutral gaze. The floatage effects strongly affects the vertical size of the jet, and, therefore, the surface concentration of a contaminant

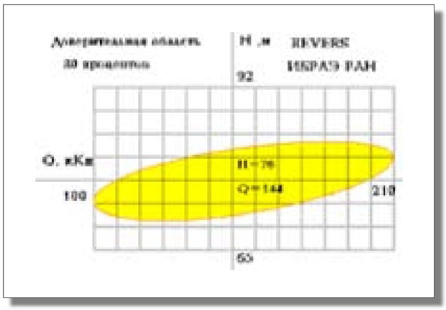


METAN program. Predicted trajectory of light gas (methane) jet

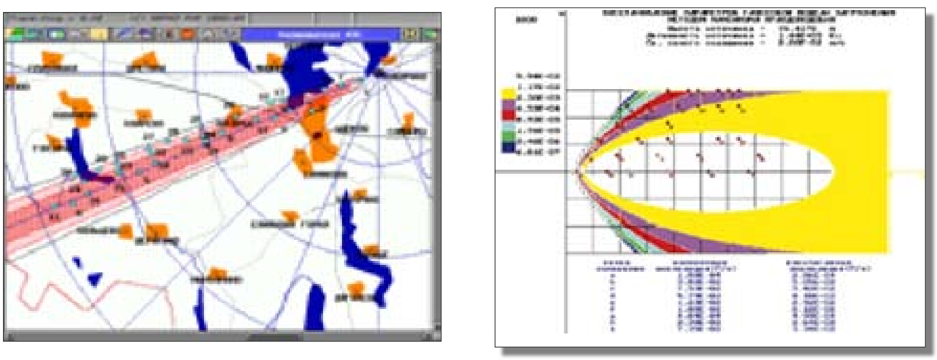


Comparison of the cloud parameters in the explosion cases calculated by the code «EXPLOSION» with the experimental data. Dynamics of the cloud motion in result of an explosion. Nuclear explosion (from 1 to 20 kt). Dynamics of the upper edge of the cloud

REVERS is a fast computer code to reconstruct the release source parameters (total activity, isotope composition, effective ascent height) and sedimentation constants from the data of the actual measurements of the dose power and/or radioactive contamination density. The confidence intervals for the reconstructed values are calculated through statistical analysis. The developed methodology enables calculating of the average values and confidence intervals for the integral activity of the radioactive release, ascent height of radioactive materials, and sedimentation velocity of particles released to the atmosphere on the basis of the measured surface activity field. The method assumes that the stationary surface activity field is created by instant pointlike source with known nuclide composition and field fluctuations in the measurement points are statistically independent and follow the lognormal distribution. We obtained analytic estimations for the dependence of the accuracy of the determined source integral characteristicse on relative fluctuations of the surface activity. The model was verified against the data on radiation accident in South Ural.

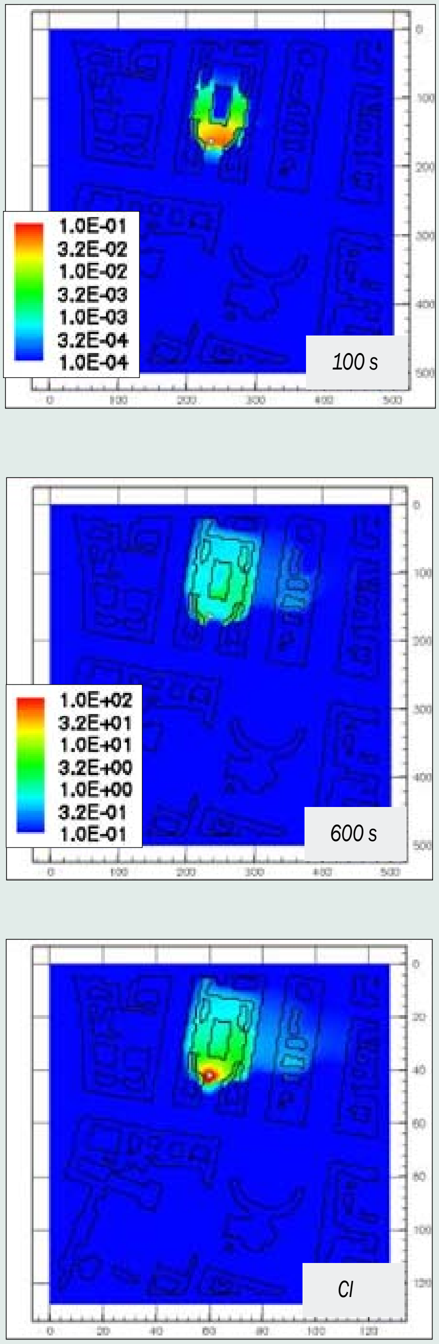


Reconstruction of the source parameters. Command and headquarter exercise of the EMERCOM of Russia, November 22–24, 1994



Map of measurement points used for the source reconstruction.

MODELLING OF ADMIXTURE SCATTERING IN URBAN ENVIRONMENT



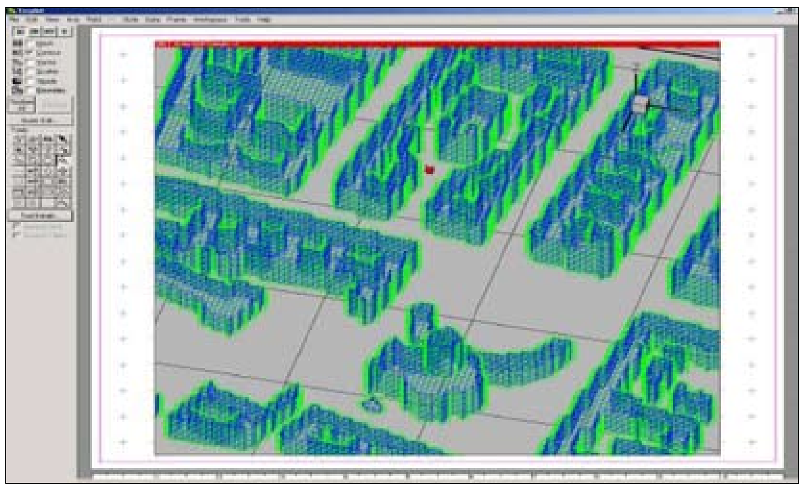
Example of 3D calculation of admixture scattering in urban environment. Contaminant concentration at a height of 20 m for various time passed after release and concentration integral (CI) value

IBRAE RAS calculations of modelling the admixture scattering based on the experimental data.

Owing to radiation terrorism threat, modelling of the radioactive admixture scattering in urban and industrial environment is an acute problem.

Modelling of admixture scattering in urban environment is a difficult problem owing to inhomogenity of wind field and characteristics of turbulence. Numerous models proved practical efficience and based on the observation data on admixture scattering above various virtually uniform surfaces are inapplicable for the urban environment.

The main basis of modelling of admixture scattering in the urban environment is 3D modelling of hydrothermodynamic flows above complicated underlying surface. Such models contain lot of parameters requiring correct determination. In the world practice, the only estimation criteria for the capability of the developed models is its validation against experimental data. Experimental data, obtained in real megalopolis environment, obviously would be the most valuable data for validation of admixture scattering models in question.

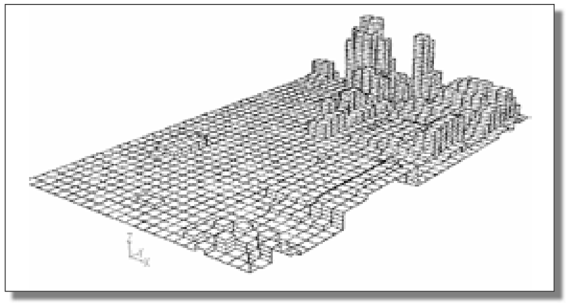


Numerical model of an urban quarter. The asterisk shows the place of contaminant (gas) injecting

In view of radiation terrorism threat related to nuclide dispersion in megalopolis, the USA performed three large-scale experiments in megalopolises. Major American research laboratories and universities performed the experiments supported by state:

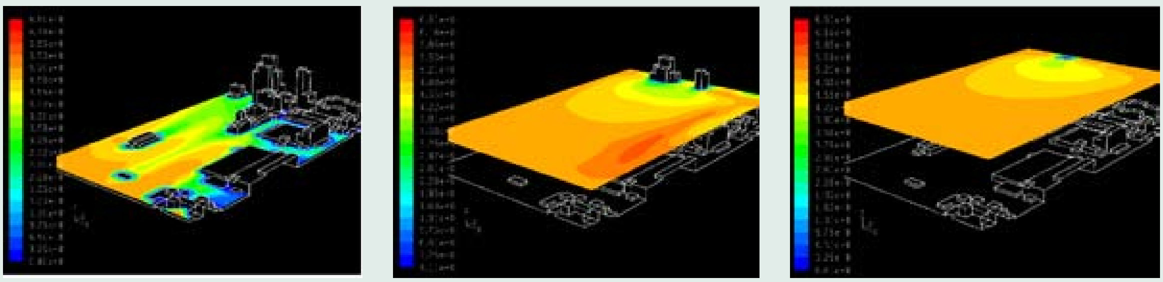
- URBAN 2000 field study (Salt Lake City);
- Joint URBAN 2003 (Oklahoma City. http://www.ral.ucar.edu/projects/ju2003/index.htmL);
- Urban Dispersion Program (New York) 2005.

They performed URBAN 2000 experiment in complicated landscape, though meteorological situation was rather simple. The URBAN 2003 experiment in Oklahoma was better equipped by measurement facilities and was performed under complicated meteorological conditions.



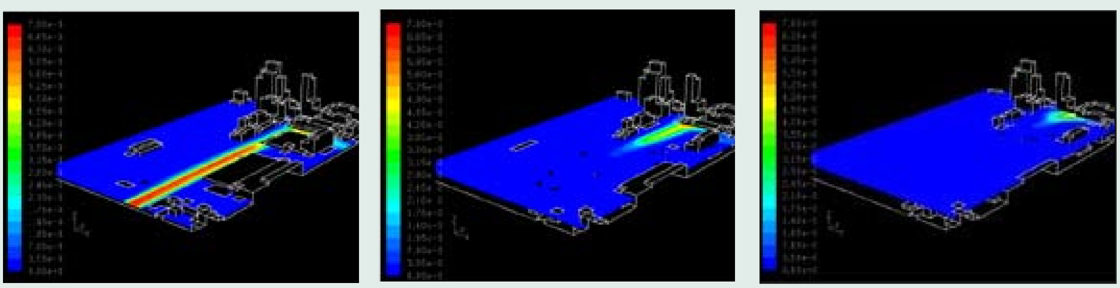
American model of a part of Oklahoma City

Example of calculations of wind field modelling performed by IBRAE RAS for Joint URBAN 2003 experiment:



Distribution of the wind velocity module at the heights 10, 70, and 120 m

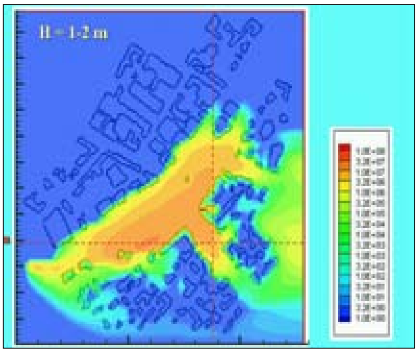
Example of calculations of admixture scattering from the local source performed by IBRAE RAS for Joint URBAN 2003 experiment



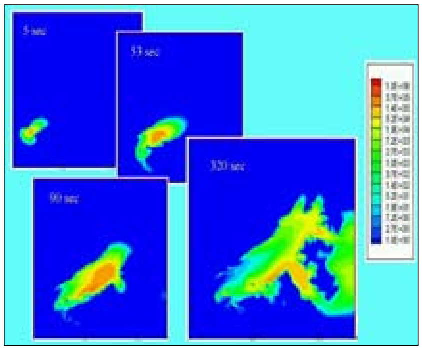
Dispersion of admixture from local source at the heights 10, 20, and 30 m

3D DYNAMIC MODEL of atmospheric transport of contaminating admixture in urban environment.

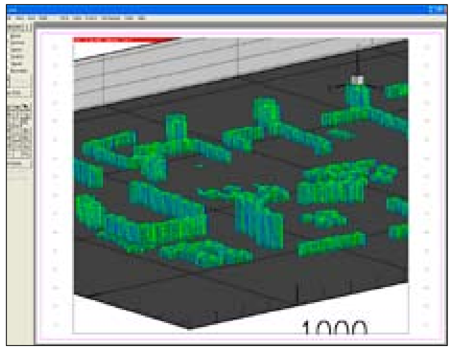
Calculations demonstrate the feasibility of creating computer codes for early identification of critical areas of a particular city and evaluation of potential scale of radiation impact scale at the stage of planning activities on elimination of possible accident consequences. Such codes are also capable to provide scientific and technical support for making decisions on the population protection.



Integral of Am-124 concentration in the air in case of explosion of explosive device with a radiation source inside it for certain urban environment, arb. unit.



Dynamics of Am-124 concentration in the air in case of explosion of explosive device with a radiation source inside it for certain urban environment, arb. units.



3D visualization of group of buildings in TecPlot code packag

RADIATION TERRORISM: REGULATION OF RADIATION RISKS AND PUBLIC VULNERABILITY. RESPONSE FEATURES

Currently, the problems of terrorism and particularly, the problem of radiation terrorism (RT) attracts the attention all over the world. Non-proliferation regime, systems of special registration and control over radioactive materials create the situation in which using radioactive materials (RM) contained in ionizing radiation sources (IRS) for terrorist purposes grows more probable. Recently, the problems of «dirty bombs» or «radiation dispersion devices» attract the enhanced attention of the specialists, public and mass-media. The amount of active materials in such devices can reach fractions of gramme and conversion of an ordinary explosive device into dirty bomb does not require complicated technical solutions.

The major factors, which determine the level of potential hazard of RM using for terrorist purposes, are wide use of IRS in various spheres (industry, agriculture, medicine, indepentent power sources) and lack of proper solutions of the problem of registration, control and preventing unauthorized use of IRS.

System analysis of threat of RT and related potential impact shows that execution of scenarios causing significant harm to the health of great number of people is hardly possible.

Nevertheless, we have to stand against such threats. Therefore, the measures preventing the very option of organizing RT actions are the key part of social security systems. A number of international programmes under the IAEA supervision with participation of Russia and the USA include a number of such measures.

Execution of scenarios with dispersing of small amount of nuclides in megalopolises and at public infrastructure sites (airports, railway stations, underground etc.). Despite insignificant radiation impact, such actions may cause great social and economic damage. Efficiency of response system, including regulatory norms, enabling minimization of social and economic damages, affects its scale much stronger than characteristics of radiation situation.

Social impact of regulatory norms toughening

Among other factors increasing social and economic damage in result of RT actions, inadequacy of public response and low eficiency of regulatory norms on radiation safety require special attention from the viewpoint of preventing unreasonable level of losses.

Inadequate world-wide public reaction to actual impact of radiation accidents and, therefore, impact of potential RT actions has psychological and historical ground (tragic consequences of atomic bombing in Hiroshima and Nagasaki, nuclear arms race, accident at Chernobyl NPP).

Adequacy of public reaction and level of social and economic damage depend directly on limits of additional human-caused exposure rates established by regulatory norms and different intervention levels, permittable contamination level for the environment, food etc.

Upon Chernobyl accident, Russia and some other countries implemented laws establishing unreasonably strict norms of radiation safety. For example, Russian «Chernobyl law» includes regions with 1 Ci/km^2 contamination level into the category of affected areas. Later, the limit of additional exposure dose at the rate of 1 m^{Sv}/year as the level of safe inhabitance was established. Upon SKhC accident in 1993, large-scaled intervention measures were implemeted (children evacuation, delivery of clean food, decontamination of the area), while expected exposure rates of the population were about 1 m^{Sv}/year. So, activities on the population protection were implemented in the situation where the expected exposure dose was about 10% of the natural exposure dose for the population of Altay, Finland, or Sweden.

Owing to unreasonably strict radiation safety norms, even insignificant excess of the exposure rate over the permitted level, which is obviously harmless and quite acceptable for the population of the most European countries, cause enhanced public concern in Russia. Existing Russian legislation also contributes to inadequate attitude to radiation risks. It guarantees the population of the «Chernobyl area» compensations of the health loss, though the additional exposure dose is certainly below the natural exposure dose.

Toughening of regulatory norms reduced threshold of «radiation hazard» virtually to zero level. Violation of these norms in case of releases with insignificant radiation impact resulted and will result to public overestimation of radiation risks with respective negative social and economic consequences. People rely both on public mentality stereotypes and formulations of actual legislation and regulatory norms. As a result, exceeding of exposure rates is considered as «abnormal and dangerous» living conditions, causing threat to life and health, and cannot change the point of view.

Safety criteria and estimation of damage

The existing super-strict regulatory norms, which are not based on actual effects of small exposure doses on human health makes the community vulnerable to RT threat. Owing to public overreaction to the problem of radiation and obvious reaction of mass-media, any accident with radioactivity release, especially in densely populated area with high economic potential fraught with severe social and economic damage.

Let us show the results of our calculations for the case of intentional or unintended distribution of RM in megalopolis. Fig. 1 shows the square of affected areas against different norms of intervention levels. Unfortunately, it is easy to predict how the situation will look for the public and decisions-making persons in case of such accident. Taking the strictest protective measures will be unavoidable, which will lead to severe effects on everyday life, disorganization of social and economic sphere, while radiation risks are practically negligible.

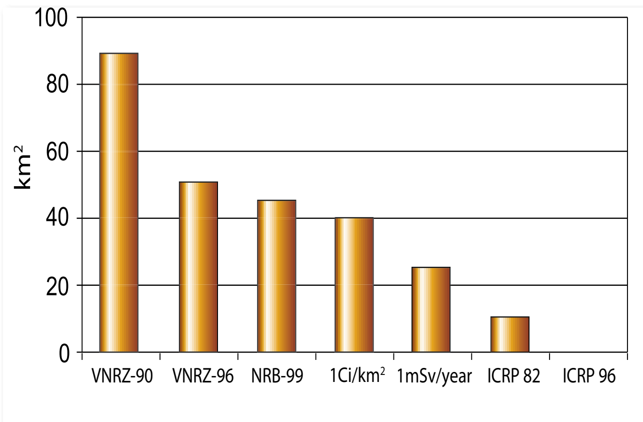


Fig. 1. Intervention levels

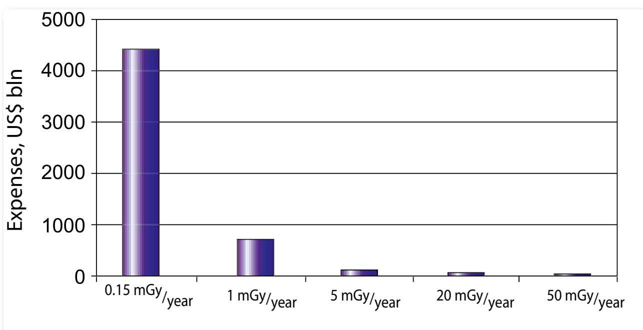


Fig 2. Exposure criteria of remediation

Specialist of the Pacific Northwest National Laboratory presented the similar estimation of RT action in New York. Their work shows direct correlation of the amount of economic damage and application of different remediation criteria (Fig. 2).

There will be few victims of such RT, but expenses for remediation and restoration of buildings will be significant (up to 50% of annual GDP of the USA), especially in case of application of the most conservative standard of remediation of contaminated area (to the residual rate of 0.15 mGy/year).

Upgrade of regulatory standards

Therefore, well-directed efforts on informing of public on radiation risk and upgrade of regulatory standards of radiation safety is an effective preventing measure of enhancing radiation safety threshold in case of radiation accidents, including RT actions. In addition, it does not assume significant expenses .

Unfortunately, we have to say that the existing regulatory standards do not enable and support adequate reaction to radiation risks and public stability in case of radiation accidents (Table 1). ICRP issued its new recommendations in 2007, so in 2010 IAEA will implement new standards, and Russia started development of new radiation safety norms, sanitary regulations and making amendments to other regulations. Our knowledge and experience allow us to claim that with positive changes in international recommendations, it is quite possible to implement radiation safety regulations enabling effective health protection, minimization of social and economic losses, damages and risks in case of radiation emergencies.

We must establish more determined exposure rates justifying intervention during the first year after the accident and later. It is also important to develop the system of derived intervention levels, consistent and fit to exposure rates and preventing unreasonable toughening of norms. Due to contradictions in the existing intervention levels, they became an independent instrument, which may cause direct social, economic and psychological damage, without any positive effect and even harmful for human health.

In our opinion, new international recommendations enable developing of new, significantly upgraded national regulatory standards of response to radiation accidents and RT actions on the basis of large-scale practical experience of research into radiation safety.

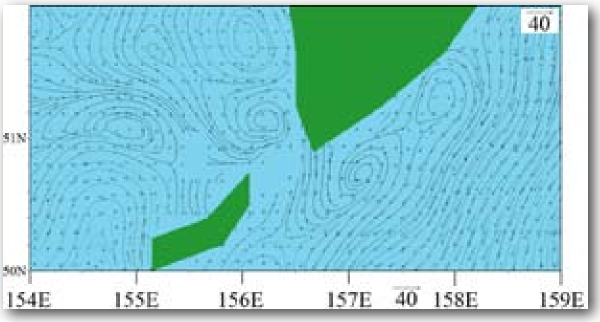
Provides socially acceptable of radiation safety for the population and personnel under standard conditions.	Yes
Provides acceptable health protection in case of radiation accidents and radiation terrorism actions.	Yes
Prevents unreasonable expenses under routine operation mode	No
Creates basis for effective response system and prevents unreasonable social and economic damage in case of radiation accidents and RT actions.	No
Enables adequate reaction to radiation risks and decreases public vulnerability in case of radiation accidents and RT actions.	No

Table 1

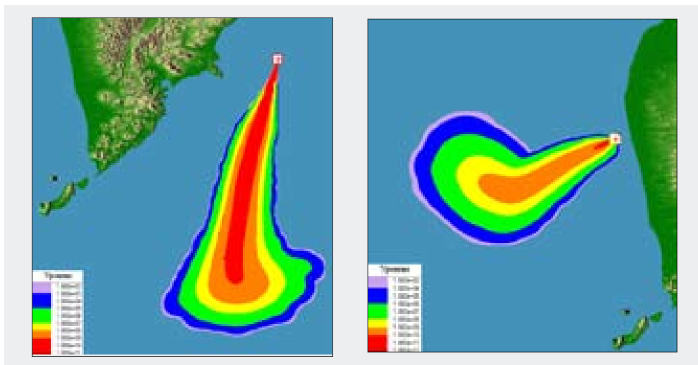
COMPUTER SYSTEMS FOR MODELLING OF NUCLIDE MIGRATION IN AQUATIC SYSTEMS

NEPTUNE MODEL

Analysis of nuclear and radiation hazardous sites of location and decommissioning of nuclear submarines requires programme tools for forecasting of radiation situation in case of spillage of RM on the surface of seas and oceans. IBRAE RAS develops the instrument for estimation of contamination concentration in case of scattering of RM in sea water. NEPTUNE considers specific features of admixture dispersion of in sea water and mobility of sea streams. We work in co-operation with the leading specialists of P.P. Shirshov Institute of Oceanology and Institute of Numerical Mathematics (RAS) with support of Russian Foundation for Basic Research.

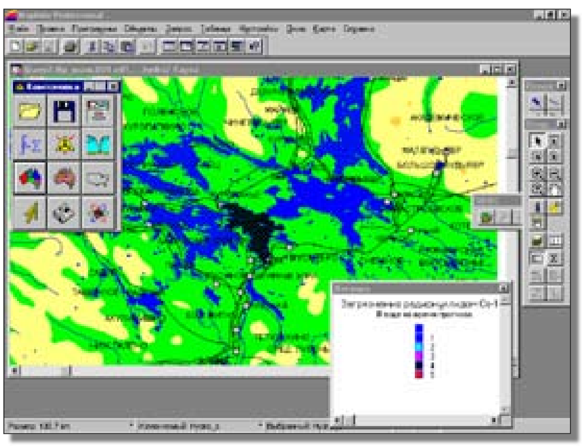


Typical map of streams in Kamchatka region in June



Time integral of Cs-137 and Sr-90 concentration in the upper mixing layer 117 days upon severe hypothetic accident during RW shipping

«CASSANDRA» PROGRAMME SYSTEM



Calculation of exposure doses. The map presents the calculation results

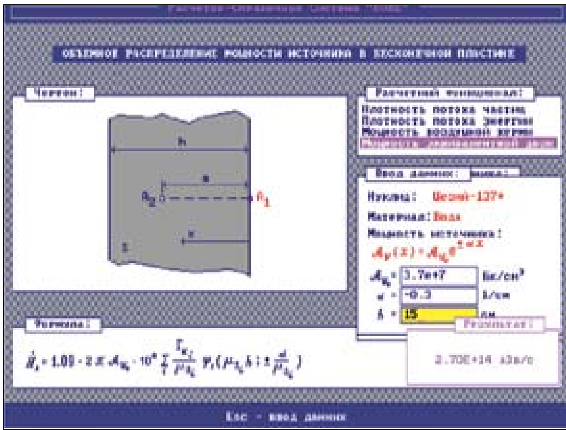
«Cassandra» system models migration of nuclides in aquatic systems and estimates exposure doses of the population owing to water consumption. The programme was used in numerous exercises.

«Cassandra» was successfully validated by comparing the results of modelling to experimental data on contamination of the Techa and Plava rivers, cooling pool of Chernobyl NPP and a number of other aquatic systems contaminated in reslut to the Chernobyl accident.

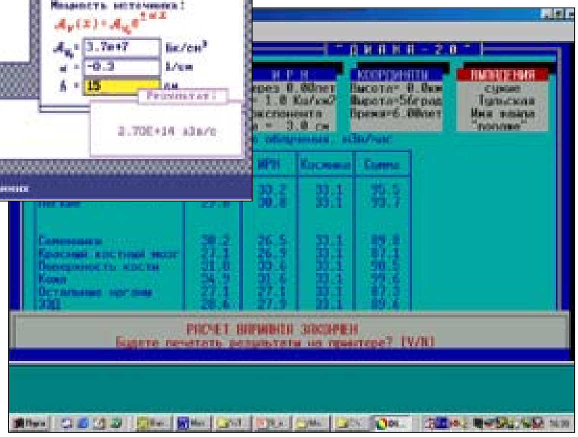
COMPUTER SYSTEMS FOR ESTIMATION OF EXTERNAL AND INTERNAL EXPOSURE DOSES

DIANA and POLE models

were developed and used for estimation of Chernobyl accident consequences. The systems estimate functionals of ionizing radiation fields for sources of various shapes, various conditions and exposure paths.



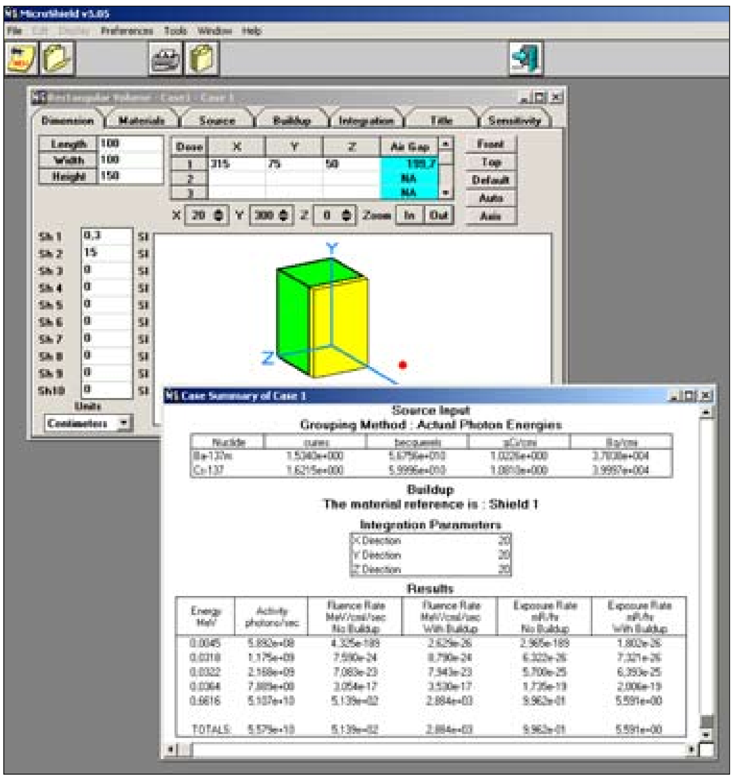
POLE model — calculation of fields and external exposure rates for sources of various shapes



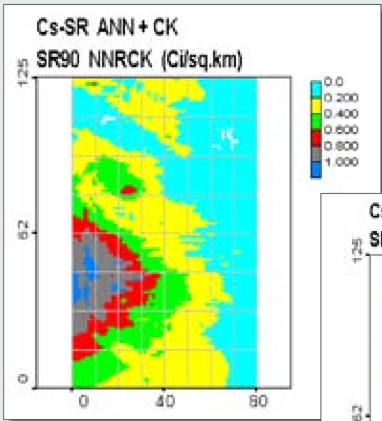
DIANA model – calculation of effective equivalent exposure dose for a human and equivalent exposure doses for individual body parts of in case of external outdoors exposure and with regard to natural background radiation

MICROSHIELD PROGRAMME

Calculates shielding and estimates gamma-exposure doses. It includes options to analyse shielding and containers of various configuration, estimation of exposure doses for the staff and materials, choice of protective measures for mainten-ance, estimation of the source power based on field measurement, minimization of exposure of the personnel.

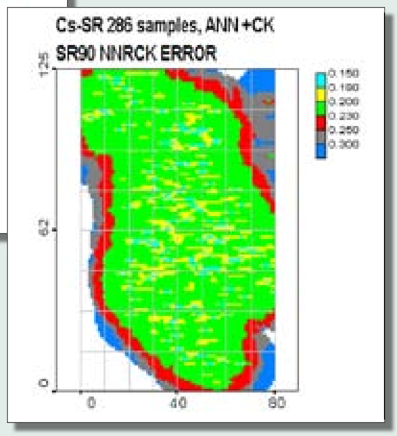


ARTIFICIAL BRAIN METHODS FOR DATA ANALYSIS



Estimation by neural network and geostatistics methods

Creating map of precipitation after Chernobyl accident

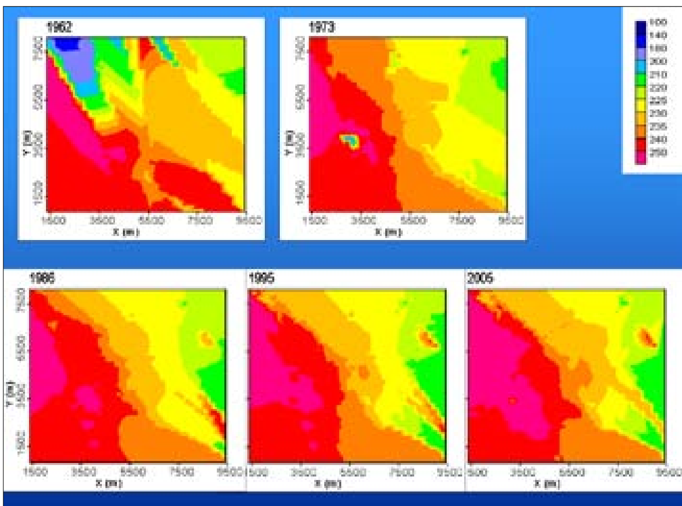


Error of estimation

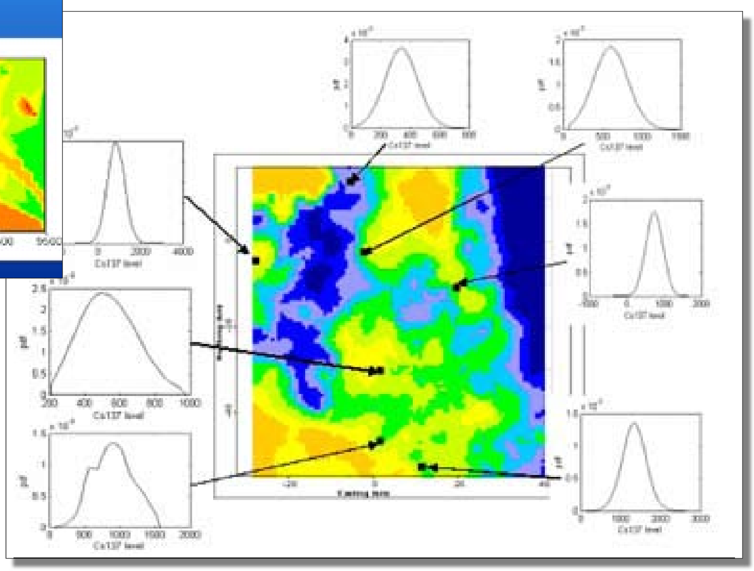
Owing to importance of adequate processing of environmental monitoring data, analysis based on machine-learning methods is relevant. We pay special attention to:

- possibility to use incorrectly specified data;
- possibility to estimate of uncertainty of the result;
- option of automatic operating mode.

The primary tools of such analysis are specially developed and verified methods, based on geostatistics and machine-learning methods. The methods are implemented in real applets, used, for example, for analysis of hydrologic situation in IE «Mayak» area and for modelling of Chernobyl precipitation.



Modelling of space-time dynamics of the level of subsoil waters



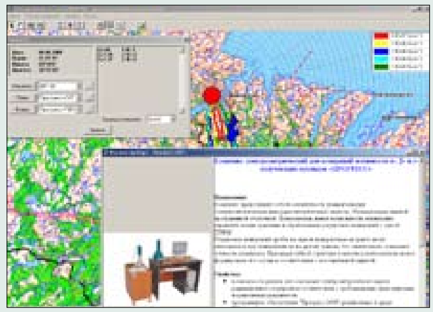
Example of estimation (soil contamination with ^{137}Cs in result of the Chernobyl accident)

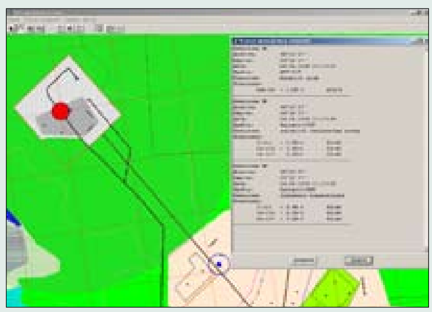
SYSTEMS FOR FULL-SCALE SIMULATION OF RADIATION ACCIDENT CONSEQUENCES

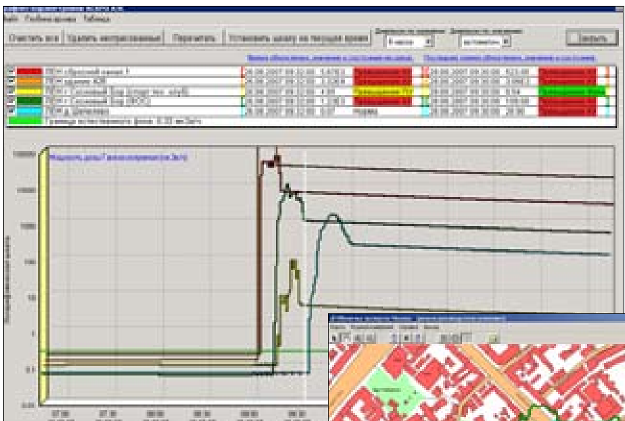
Models and geoinformation systems developed by the institute serve for scientific and technical support of protection of the population and areas in case of potential radiation accidents. IBRAE RAS (since 1993) and IBRAE RAS TCC participate in works on national system of emergency response in case of emergency situations at radiation and nuclear hazardous sites. For simulation of radiation situation we developed PARIS system for modelling of radiation situation after accident; ENVELOPPE system for simulation of measurement results of environmental contamination; «Convert» (new version – «Pioneer») system for simulation of results; simulation system of ARMS sensor data.

All the systems were tested at number of exercises («Bekkerel», «Aragatz-99»).

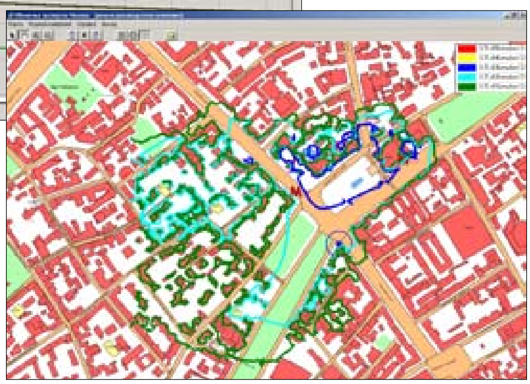
«Pioneer» system for dynamic modelling of primary measurements of radiation situation during the first day after the accident at the radiation hazardous object





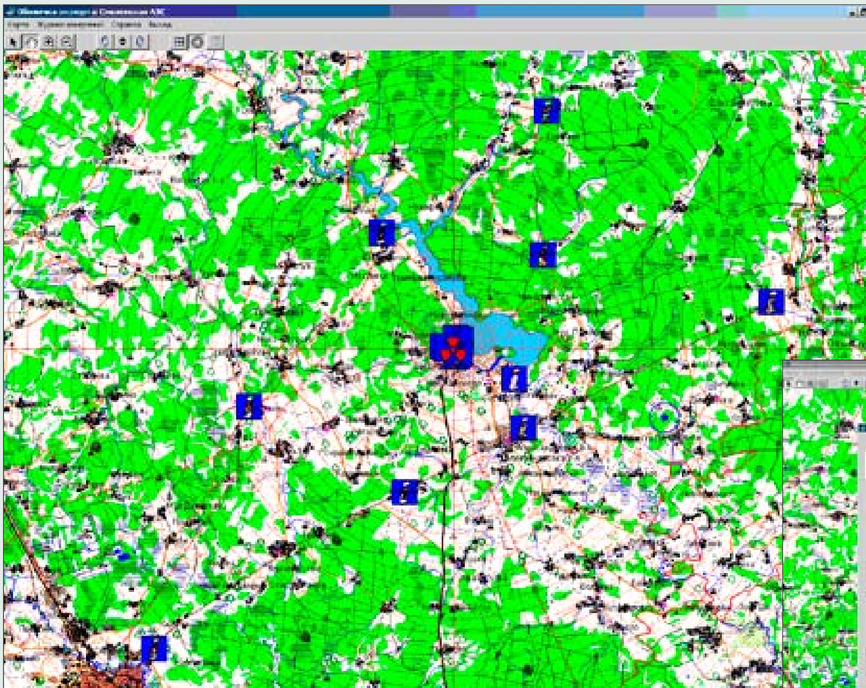


Simulation of ARMS sensors data under conditions of dynamic development of area contamination

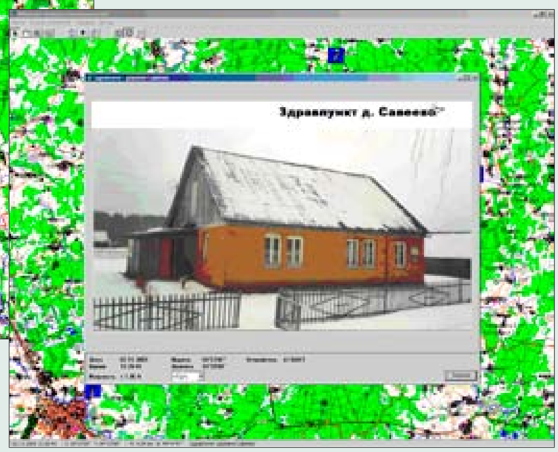


«Pioneer» enables obtaining of real-time measurement results of outdoors dose rate and contamination of soil and air in contaminated area

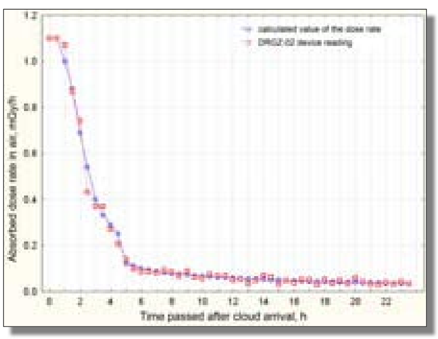
The basic module of «Pioneer» system enables upload and mapping in vector format, scaling operations and movements on the map, and algorithm of coordinate transformation enabling calculations for arbitrary wind direction. The system enables obtaining «envelopes», containing data on dose rate measurement, gamma-spectrometric analysis, samples of soil and air taken during the first day after the accident.



«Pioneer» system desktop snapshot. Map of a nuclear object neighborhood; the symbol ⌖ indicates the location of the radiation control group. The operator can move the symbol on the map according to actual location of the group at the site.



«Pioneer» system screenshot



Dynamics of dose rate in Semenovka settlement during the first day after the accident

Real-time simulation of ARMS sensors data at nuclear power plant according to scenario of potential accident, which is used for Rosenergoatom concern exercises over recent years. In 2007—2008, full-scale ARMS simulator developed by IBRAE RAS was used in exercises at Leningradskaya NPP and Volgodonskaya NPP. IBRAE RAS also uses this simulator for regular training of its own specialists.

DATABANKS AND DATABASES

As soon as IBRAE RAS was established, it performs works on analysis of the consequences of the Chernobyl NPP accident. Since 1991, the institute is the head organization of system analytic support of Chernobyl programme.

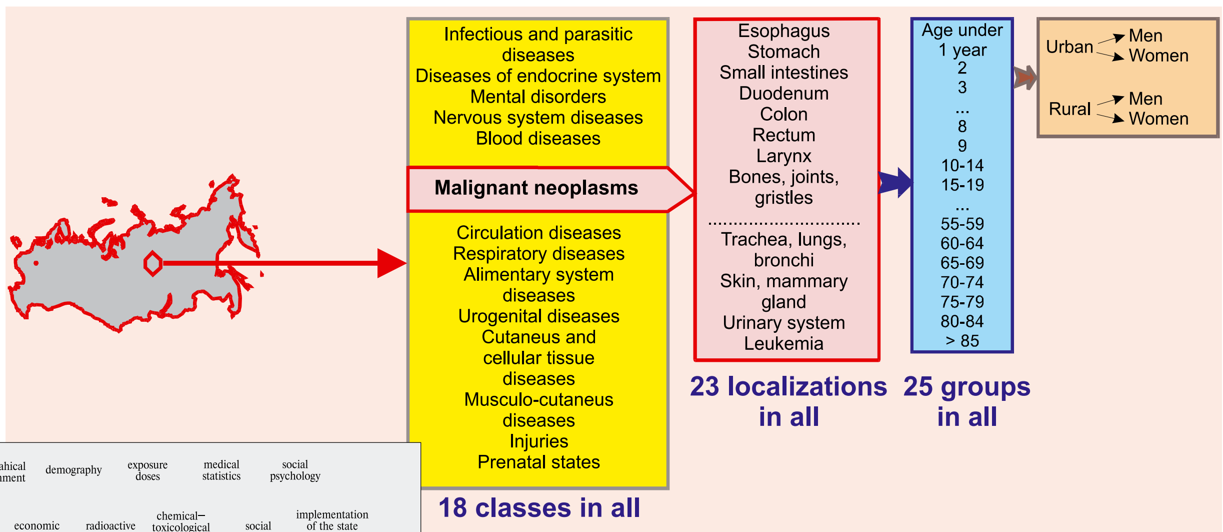
IBRAE RAS developed «Chernobyl» management infor-mation system in co-operation with dozens scientific organizations. The core of the system is the Central Bank of the Generalized Data that comprises of 18 sections.

The background of the Bank is the database on radiation and hygienic data. It contains the information on the soil radioactive contaminations, external and internal exposure doses for the population, food contamination, and other data. The databank contains data for over 12,000 settlements in Russia, examined in 1986–2006 through radiation monitoring.

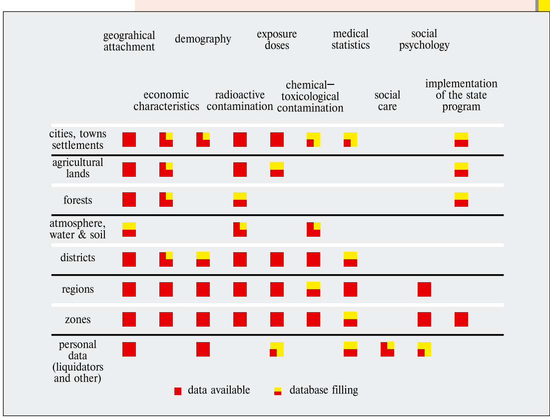
Using the experience of analysis of radiation accidents consequences, including Chernobyl accident, we developed databases for information support of IBRAE RAS TCC.

DATABASES:

- characteristics of radiation hazardous sites of nuclear power industry and areas of location, sites of NS decommissioning and infrastructure;
- radiation scenarios of potential accidents;
- map databank and geoinformation system on industrial sites, sanitary protective areas and monitoring areas



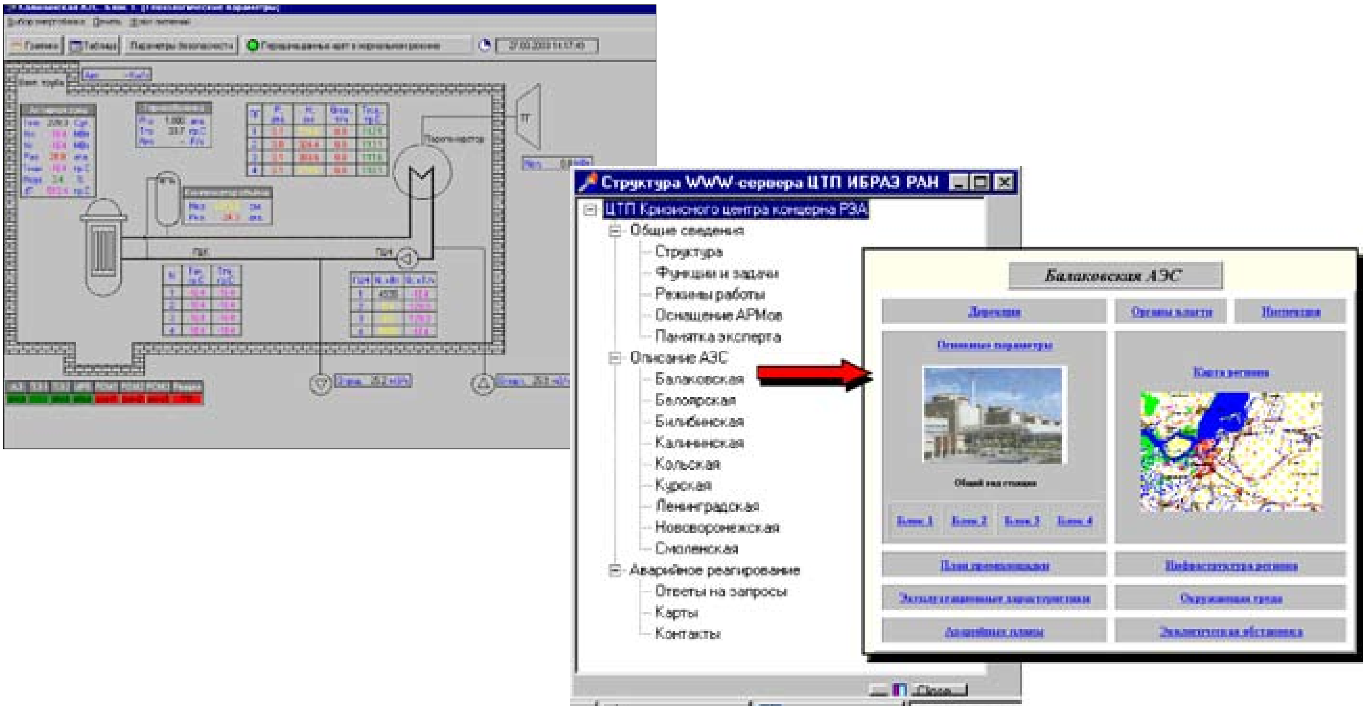
Structure of the cause-case mortality databank in 79 regions of Russia



Central Bank of the Generalized Data

Within the scope of Rosatom system of emergency response IBRAE RAS TCC has access to:

- Rosgidromet RECASS system containing meteorological data at the area of NPP location;
- SDC (technical and security parameters) of NPP of Rosenergoatom concern;
- ARMS subsystem of SC «Rosatom».



IBRAE RAS TCC SOFTWARE AND HARDWARE SYSTEM

IBRAE RAS TCC software and hardware system provides scientific, technical and expert support of Rosenergoatom concern CC, EMERCOM of Russia CMES, Rostekhnadzor IAC, Moscow EM MD MFC, existing and newly created regional crisis centres in emergency situations at radiation and nuclear hazardous sites. IBRAE RAS TCC works 24 hours a day seven days a week.

Communication options: owned and leased fiber-optic communication lines used for connection to Rosatom and Rosenergoatom data communication networks; connection to three local Moscow ATS and Rosatom private ATS; connection to ISDN network; reserve satellite terminal for voice and data communication; Internet connection; alternative communication channels.

Cluster computer

Diesel generator facility

Equipment and communication systems:

- modern computer-equipped desks;
- videoconferencing system;
- satellite communication system;
- equipment for audio and video presentations;
- server and communication equipment;
- IBRAE RAS cluster computer for resource-hungry calculations;
- uninterruptible power system switching on diesel-generator facility, dosimetry equipment sets.

Mobile ASF software and hardware system equipped with satellite and mobile data communication systems for operation at the area of radiation accident

GENERAL INFORMATION ON THE CENTRE

IBRAE RAS TCC SOFTWARE AND HARDWARE SYSTEM

TRAINING, EXERCISES

RADIATION MONITORING SYSTEMS

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Trainings and exercises are the major elements of maintaining preparedness and improving staff skills in routine operating mode of TCC. During the exercises, we rehearse alarm procedures and interaction between participants of emergency response at various levels, check preparedness of the staff and TCC hardware and software, train practical aspects of scientific and technical support of protection of the personnel, population, and territory.

TCC was an active participant of exercises organized by Rosatom, Rosenergoatom and EMERCOM of Russia, and international exercises since the date of foundation. Rosenergoatom organizes annual large-scale complex emergency response exercises at NPPs. TCC estimates the release source, provides estimation and forecast of radiation consequences of the accident, and recommendations on protection of the population and the environment. In addition, the concern organizes 5–6 trainings annually, participated by the personnel of certain NPP, Rosenergoatom crisis centre, and technical support centres.

IBRAE RAS TCC participates in exercises organized by Rosatom DNRS, Rosatom SCC, and enterprises aimed at maintaining preparedness of the Rosatom system for prevention and elimination of emergency situations (OSChS) personnel and equipment.

Long experience in emergency response activities gained by IBRAE RAS TCC was used for organizing of numerous Russian and international trainings and exercises.

TCC specialists participate in developing technological and radiation scenarios of emergency situations at radiation and nuclear hazardous sites and organizational preparing of trainings, develop special simulation programmes, and prepare staff for exercises.

In co-operation with IPSN (France), IBRAE RAS prepared and performed national exercise at research reactor «Bekkerel» (France, 1996). IBRAE RAS specialists also participated in preparation and implementation of exercises at Bilibinskaya NPP (2002) within the scope of co-operation with DOE (USA), exercises at BOR-60 reactor at FSUE «SSC RF NIIAR» (2003), emergency situation during reload of SNF from nuclear icebreaker at FSUE «Atomflot» (2005); exercises at FSUE «Zvezdochka» (2008).

Recently, TCC specialists participated in organizing and implementing exercises in interaction with regional CD ES bodies. In 2007, FSUE «SevRAO», local authorities of Murmansk region, regional branches of Rosgidromet, EMERCOM of Russia, Rospotrebnadzor (Federal Trade and Sanitery Inspection Authority), FMBA of Russia (Federal Medico-Biological Agency) and other bodies participated in complex emergency response exercises in Murmansk region. They rehearsed alarm plan and interaction of participants of emergency response at local, regional and federal levels, trained estimation of the situation and making decisions on protection of the staff and the population.

Complex emergency response exercise:

FSUE«Zvezdochka - 2008

Volgodonskaya NPP – 2008

Leningradskaya NPP – 2007

Novovoronezhskaya NPP – 2006

Kolskaya NPP – 2005

Beloyarskaya NPP –2004

Smolenskaya NPP - 2003

COMMAND AND HEADQUARTER EXERCISE «ZAPOLARIE-2007»

Command and headquarter exercise «Zapolarie-2007» took place on October, 2007 within the scope of the project «Upgrade of radiation monitoring and emergency response system in Murmansk region».

IBRAE RAS TCC developed radiation scenario in co-operation with FSUE «SevRAO» and participated in preparation of the exercise. Staff and equipment of FSUE «SevRAO», local authorities of the closed settlement Zaozyorsk, Murmansk region SD CDES and FS, MDHEM, Murmansk region MD EM, Murmansk region RSChS, and functional subdivisions of RSChS.

SD CDES and FS Crisis Centre, CDCP MDHEM, FSUE «Sevrao» Crisis Centre created within the scope of the project of Murmansk region Government operated in full power during this exercise.

IBRAE RAS TCC and Rosgidromet FIAC «Tayfun» provided scientific and technical support to the exercise.

TACTICAL SPECIAL EXERCISE AT FSUE «ATOMFLOT»

Emergency response exercise at FSUE «Atomflot» (Murmansk) took place on July 26, 2005.

The excersize was aimed at training activities in case of radiation accident at temporary storage facility for TUK containers. The exercise checked:

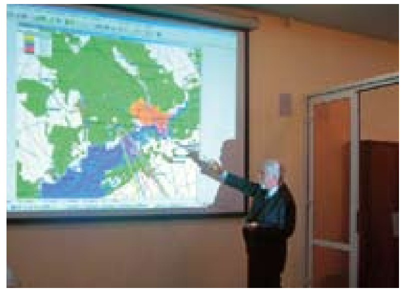
- operability of all communications lines (videoconferencing, e-mail, fax);
- operability of software used for forecasting of radiation situation and providing emergency protection of the staff and the population;
- interaction of TCC expert groups with each other, FSUE «Atomflot» and FSUE «SCC Rosatom».

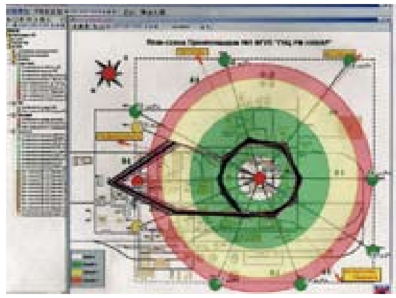
COMMAND AND HEADQUARTER EXERCISE AT FSUE «SSC RF NIIAR»

Command and headquarter exercise on potential radiation accident at research reactor BOR-60 of FSUE «SSC RF NIIAR» took place on December 9, 2003 within the scope of agreement between the Governments of the Russian Federation and the USA «On co-operation in research of radiation impact for minimization of radiation contamination impact on human health and the environment».

IBRAE RAS TCC prepared and organized the exercise in close co-operation with the specialists of Rosatom, Rosatom SCC and FSUE «SSC RF NIIAR».

Preparing the exercise, we upgraded automatic systems for monitoring safety parameters at the research facility and communication and data transfer systems, working in close co-operation with the specialists of FSUE «SSC RF NIIAR».





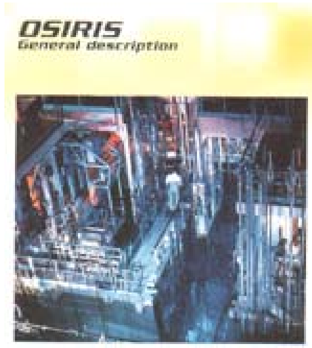
COMMAND AND HEADQUARTER EXERCISE AT BILIBINSKAYA NPP

Command headquarter exercise at Bilibinskaya NPP took place on August 21, 2002.

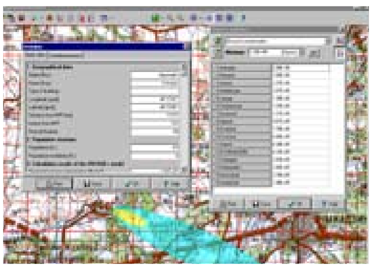
Specialists of IBRAE RAS, Crisis Centre of Rosenergoatom concern, and Bilibinskaya NPP prepared and organized the exercise. Representatives of DOE (USA), Department of Environmental Protection of Alaska state, Department of Emergency Response of Alaska, Pacific North-West National Laboratory, Sandia National Laboratory, and Alaska State University participated in the exercise as spectators. The real-time data communication channel for data exchange between TCC experts and American specialists was established during the exercise.

EXERCISE «SACLE-2000»

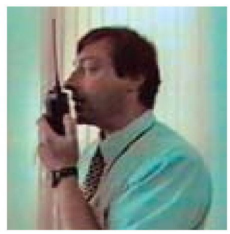
In 2000, TCC participated in the exercise on potential accident at the reactor «Osiris» of Sacle centre, France. TCC experts exchanged data with the specialists from Sacle Crisis Centre in remote access mode, staying at TCC.



EXERCISE «ARAGATZ-99»

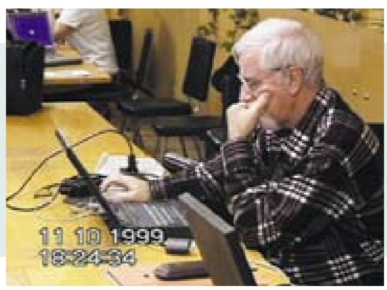


Armenian, Russian, American, British, and French specialists and IAEA experts participated in the international exercise «Aragatz-99» that took place at Armenian NPP on September 6—8, 1999 for training participants of emergency response. IBRAE RAS in co-operation with IPSN (France) developed two dedicated programme systems «Convert-Aragatz» and «ARMS-Aragatz» for simulation of radiation situation. «Convert-Aragatz» system enables obtaining real-time data on measurement of the outdoors exposure rate and contamination of air and soil samples taken in the contaminated area. «ARMS-Aragatz» system simulated operation of Gosatomnadzor ARMS system under conditions of dynamically developing contamination of the area.



EXERCISE «URAL-99»

Exercise «Ural-99» on elimination of consequences of the accident during RM shipping took place in October, 1999. In addition to testing new equipment, the excercise trained multilateral information interaction. TCC experts equipped with independent satellite communication system participated in the exercise on-site.



EXERCISE «BECQUEREL»

NATIONAL EXERCISE “BECQUEREL”

FRANCE, OCTOBER 1996

In 1996, IPSN involved IBRAE specialists in development of radiation scenario for national exercise on emergency response and protection of the population «Becquerel», which took place in October 1996. IBRAE developed two dedicated computer systems: PARIS for modelling of radiation situation after the accident and ENVELOPPE system for simulation of the measurement results of environmental contamination.

«POLYARNYE ZORI-95»

ПОЛЯРНЫЕ ЗОРИ - 95

COMMAND AND HEADQUARTER EXERCISE ON ACCIDENT AT NPP “POLYARNYE ZORI-95"

EMERCOM of Russia in co-operation with UN Office for the Coordination of Humanitarian Affairs, May-June 1995

IBRAE RAS participated in preparation and implementation of EMERCOM of Russia command and headquarter exercise «Polyarnye Zori-95» Experts, rescuers, spectators, and specialists from 10 countries participated in the exercise. In their opinion, scenario, computer databases and modelling systems, developed by IBRAE in co-operation with a number of Russian organizations, matched the best world practice

GENERAL INFORMATION ON THE CENTRE

IBRAE RAS TCC SOFTWARE AND HARDWARE SYSTEM

TRAINING, EXERCISES

RADIATION MONITORING SYSTEMS

PUBLIC SITE

INTERNATIONAL CO-OPERATION

UPGRADE OF RADIATION MONITORING AND EMERGENCY RESPONSE SYSTEMS IN THE MURMANSK REGION

In recent decade, the large-scale process of decommissioning of numerous nuclear hazardous Navy objects started in the North-West Russia. Provision of nuclear and radiation safety is one of the most important aspects of these works. Preparedness to emergency response to potential radiation accidents is one of the key safety elements of decommissioning of nuclear hazardous objects. Therefore, existing of modern emergency response system in the Murmansk region is a mandatory element of providing safety of the population and the territory in case of radiation accidents at NS decommissioning and RW and SNF management sites.

The project on development of radiation monitoring and emergency response systems in the Murmansk region is a part of the Priority Programme within the Strategic Master Plan for Decommissioning the Retired Russian Nuclear Fleet and Environmental Rehabilitation of Its Supporting Infrastructure in North-west Russia (SMP), developed on request of NDEP Fund in the frame-work of the Global Partnership Agreement. The implementation of the project started in 2005. On agreement with Rosatom, the Government of the Murmansk region was the project Customer, while Energy Safety Analysis Centre implemented the project.

The major target of the project is radical improvement of the radiation monitoring and emergency response system in case of radiation accidents at radiation hazardous NS decommissioning and RW and SNF management sites of the Murmansk region.

Meeting of the project management group

The aim of the project is to improve preparedness of staff and equipment of emergency response system and minimize the impact of potential radiation accidents and acceleration of making decision and taking measures on protection of the environment and the population.

MAIN WORK DIRECTIONS ON THE PROJECT:

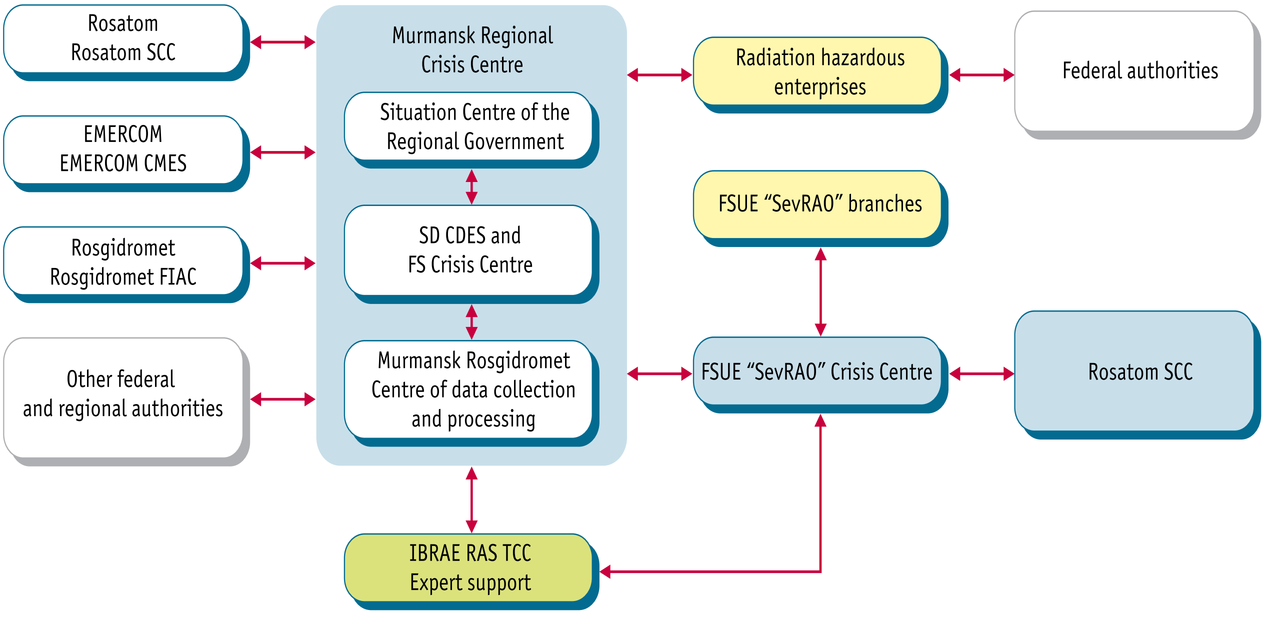
- development of existing ARMS systems and creation of new object and regional systems, including mobile complexes of radiation survey;
- establishment of Murmansk Regional Crisis Centre and FSUE «SevRAO» Crisis Centre (FSUE «SevRAO» CC);
- creation of communication systems and lines for data collection, processing, storing, transfer and distribution among emergency responce participants at regional and federal levels;
- creation of system for on-line expert support for Murmansk region RCC.

The project is unique in Russia with respect to covered territory rich of radiation hazardous objects and number of enterprises participating in Russian and international projects on NS decommissioning and SNF and RW management.

Implementation of the project provides Murmansk region with modern systems of radiation monitoring, information, analytic and expert support of regional authorities in planning and executing activities on protection of the population in case of radiation accidents.

Situation centre, general view

Expert's desk

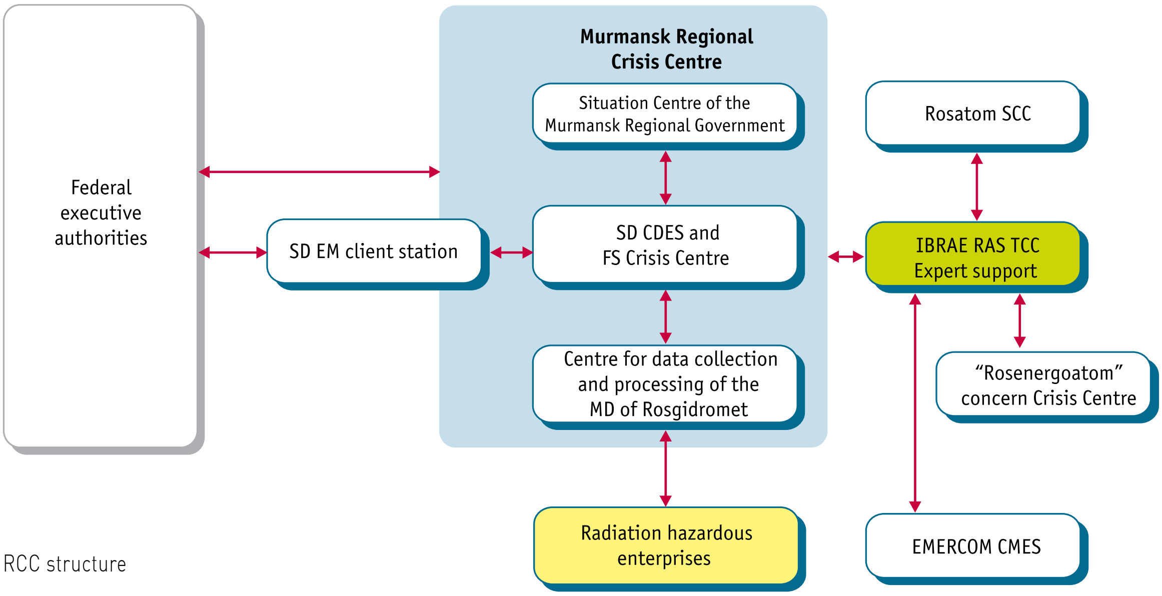


Functional chart of Murmansk region emergency response system

REGIONAL CRISIS CENTRE (RCC)

RCC was created for information and technical support of making decisions on protection of the population and the territory in case of emergency situations at nuclear and radiation hazardous sites. In routine mode, RCC performs radiation monitoring of the region, planning and managing ES preventing activities.

RCC comprises three bodies – Situation Centre of the Murmansk Region Government, SD CDES and FS Crisis Centre or the Murmansk region, Centre for data collection and processing of the MD of Rosgidromet. The centres areequipped with modern communication systems and communication channels, enabling information co-operation with enterprises in the region, regional and federal authorities.



RCC structure

RCC MAIN RESPONSIBILITIES:

- information and technical support of Murmansk Region Government and authorities in making decisions on elimination and minimization of consequences of radiation accidents;
- planning and control of implementation of emergency response activities in the region;
- monitoring of the main parameters of radiation situation in the region;
- coordination of interaction between emergency response participants at local, regional and federal levels;
- information, methodological, and technical support of activities on ensuring preparedness of emergency response staff and facilities in the Murmansk region.

SITUATION CENTRE OF THE MURMANSK REGION GOVERNMENT

MAIN RESPONSIBILITIES OF THE CENTRE

- providing Murmansk region government with data on current situation in the area of emergency situation, co-operation with regional Commission for ES, regional and federal authorities and enterprises;
- providing Murmansk region government with routine information on implementation of activities on ES preventing, monitoring and control of the situation at potentially hazardous sites and the environment in the region;
- holding events on public informing.

- staff – 4 specialists;
- software for viewing and analysis of radiation monitoring data; databases, digital map databank; reference systems, providing access to the data on the situation at radiation hazardous sites and information on estimation of the ES impact and emergency response activities;
- equipment – videoconferencing system, equipment for audio and video presentations, modern computer-equipped desks, server and communication equipment, uninterruptible power supply.

MURMANSK REGION SD CDES AND FS CRISIS CENTRE

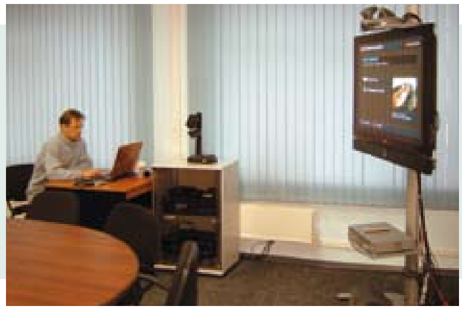
MAIN RESPONSIBILITIES OF THE CENTRE

- information and technical support of regional EMERCOM commission and the Government of Murmansk region in routine operating and emergency mode;
- planning, control and implementation of emergency response activities for the whole region;
- real-time monitoring of the main parameters of radiation situation in the region, including the data obtained from the mobile laboratories of radiation survey;
- development and maintenance of information and IT resources, maintenance of communication and data exchange systems.

- staff – 12 specialists;
- software for viewing and analysis of radiation monitoring data; databases; reference systems providing access to the data on the situation at NS decommissioning sites and work state; scenarios of potential accidents; plans of protection of the population and the territory; digital map databank; modelling systems for estimation and forecast of the accident impact;
- equipment – videoconferencing system, equipment for audio and video presentations, modern computer-equipped desks, server and communication equipment, uninterruptible power supply.
- two mobile laboratories for radiation survey.

Meeting hall of Commission for ESI

Expert office



Operator desk

RADIATION MONITORING SYSTEM

MAIN RESPONSIBILITIES OF THE CENTRE

- collection, processing, analysis, presentation and EXCHANGE of data on radiation situation from local ARMS;
- collecting and processing of current data on meteorological situation in the region, meteorological forecast (in case of radiation accident);
- technical support and development of local ARMS;
- estimation and forecast of nuclide transport in water and atmosphere, including transborder transport (in co-operation with Rosgidromet FIAC).

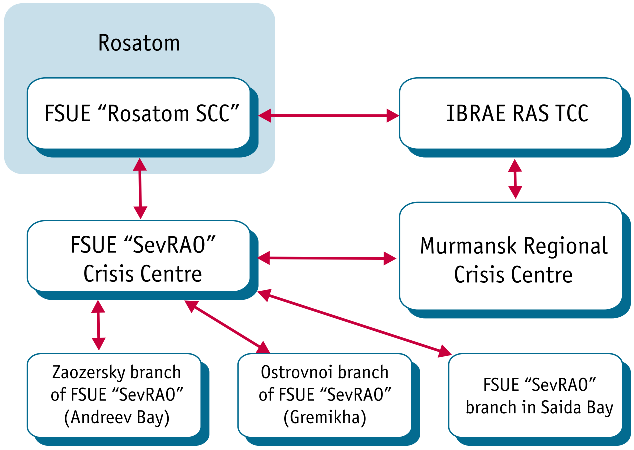
- staff – 5 specialists;
- software - programmes for: collecting, visualization and analysis of radiation monitoring data; management of the data collection system; preparing weather reports; digital map databank; modelling systems;
- equipment – videoconferencing system, equipment for audio and video presentations, modern computer-equipped desks, server and communication equipment, uninterruptible power system.

Meetimg room

Container with diesel-electric set

Murmansk regional ARMS server and communication equipment

FSUE «SEVRAO» CRISIS CENTRE



FSUE «SevRAO» interaction chart

FSUE «Northern Federal Enterprise for Radioactive Waste Management» (FSUE «SevRAO») provides infrastructure for NS decommissioning, RW and SNF management and remediation of radiation hazardous sites in North Russia.

The enterprise has three branches, former Navy coastal technical maintenance bases in Andreev Bay and Gremikha settlement, and long-term storage facility of reactor units in Saida Bay.

Software fragments: above – GIS operation screen, down – modelling of nuclide distribution

FSUE «SevRAO» Crisis Centre is established on the base of the managerial board of the enterprise in Murmansk and contains:

- software: databases and reference systems providing access to the data on the situation at NS decommissioning sites and work state; scenarios of potential accidents; plans of protection of the population and the territory; digital map databank; modelling systems – express system for estimation and forecast of radiation situation in case of atmospheric release, estimation of contamination of aquatic objects (coastal waters), engineering programs for estimation of exposure doses and contamination levels, programmes for vizualisation of radiation monitoring data;
- equipment – videoconferencing system, equipment for audio and video presentations, modern computer-equipped desks, server and communication equipment, uninterruptible power supply;
- communication options: private ATS, automatic alarm system,fiber-optic communication lines used for communication with RCC, connection to Rosatom satellite data communication system, alternative communication channels;
- two mobile laboratories for radiation survey.

TCC MAIN RESPONSIBILITIES

- real-time monitoring of the main parameters of radiation situation at the territory of enterprise branches;
- planning and supervising of commissioning and implementation of emergency response activities at the area of the enterprise branches ;
- sitation assessment, elaboration of recommendations and technical support of emergency response commissions of FSUE «SevRAO» and branches in emergency situations;
- communication with Rosatom;
- information exchange between the participants of emergency response system, including cooperation with Murmansk regional RCC, Rosatom Situation Crisis Centre and IBRAE RAS TCC.

INFORMATION AND SOFTWARE SUPPORT OF CRISIS CENTRES

Research and software system supports making decisions on protection of the staff, population and the territory in case of radiation accidents.

The system comprises of databases, information and geoinformation systems, model-based analysis systems, software manuals and engineering codes for estimation and forecast of the accident impact; as well as the systems providing access to the reference data and on-line information on the enterprises related to NS decommissioning, SNF and RW management activities.

Databases and reference systems:

- current state of activities on NS decommissioning, SNF and RW management;
- thelocalisation areas of the enterprises and branches (region, bordering areas, monitoring areas);
- current radiation situation in the Murmansk region, monitoring areas of the enterprises involved in NS decommissioning, SNF and RW management activities;
- possible scenarios of radiation accidents, parameters of potential releases/spew and impact on the population and the environment;
- plans of protection of the staff and the population, emergency structures, units, and equipment in the Murmansk region, federal structures and enterprises;
- regulations on emergency situations, nuclear power usage, protection of the staff and the population, radiation and environmental safety.

Bank of digital maps:

- bitmap and vector maps of various scale, including maps of monitoring areas of the enterprises involved in NS decommissioning, SNF and RW management.

Geoinfromation systems, containing data on maps and reference data on the region and location of radiation hazardous enterprises.

Modelling systems:

- systems for estimation and forecast of radiation situation;
- systems for estimation and forecast of nuclide travel in the air and aquatic systems;
- systems for estimation and forecast of contamination of the territory and the environmental objects;
- systems for estimation of exposure doses for the population.

Computer manuals and engineering codes for estimation of consequences of radiation accidents and making decisions.

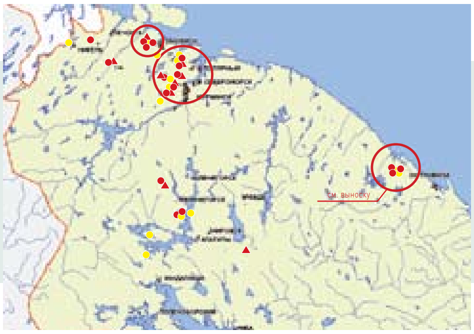
The set of used programs and information resources depends on the tasks of the crisis centre. For example, the FSUE «SevRAO» CC uses systems for estimation of impact of radiation accidents for the staff, industrial sites and sanitary zones. MDHEM Centre of data collection and processing provides quick processing of radiation monitoring data and forecast of air and water cross-border contamination transport. SD CDES and FS Crisis Centre uses computer systems for elaborating recommendations on protection of the population and the territory.

DEVELOPMENT OF MURMANSK REGIONAL ARMS

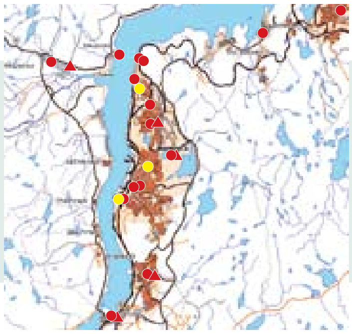
Murmansk regional ARMS is designed for obtaining real-time data on radiation situation in the Murmansk region, provision of information for regional and federal authorities and the population. Murmansk Department of Hydrometeorology and Environmental Monitoring is the centre of collection, storing and primary data analysis, as stipulated by corresponding regulatory acts.

WORKS IMPLEMENTED WITHIN THE SCOPE OF THE PROJECT

- installing of 23 automatic gamma-exposure dose rate monitoring stations in the region;
- installing of 9 automatic meteorological stations;
- installing of modern computer and communication equipment at the Murmansk Department of Rosgidromet and local centres of data collection in CATU;
- development of new software and upgrade of existing software;
- integration of two sensors at the board of industrial site of FSUE «Atomflot» into the regional system;
- integration of three sensors in Ostrovnoy CATU into the regional system.



Location of regional ARMS monitoring stations in the Murmansk region



Location of regional ARMS monitoring stations in Murmansk

Location of radiation data sensors at the territory of FSUE SRP «Nerpa»

OBJECT SYSTEMS OF RADIATION MONITORING. FSUE SRP «NERPA»

Since 1995, SRP «Nerpa» is involved into decommissioning of nuclear-powered Navy vessels.

The object system of radiation monitoring is created within the scope of project on monitoring of radiation at SRP «Nerpa» in the zone of radiation-hazardous activities for timely protection of the staff and the population in case of emergency situation.

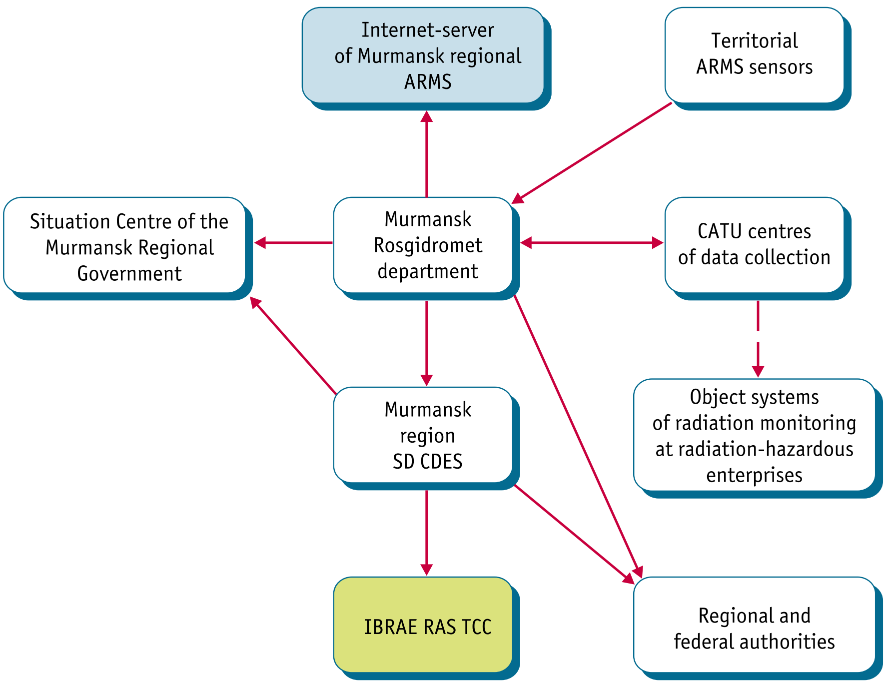


Chart of local ASRSC dataflows

INTEGRATION OF KOLSKAYA NPP ARMS

ARMS comprising of 25 gamma-exposure dose rate monitoring stations operates within 30-km monitoring area of the Kolskaya NPP and sends data measurement to Rosenergoatom Crisis Centre, Rosatom Crisis Centre and IBRAE RAS TCC. In 2006, Rosenergoatom concern put forward an initiative on creation of system of data exchange between Kolskaya NPP and Regional Crisis Centre, providing option of data communication between Kolskaya NPP ARMS and Regional Crisis Centre. At the same time, the staff of the NPP local crisis will get access to measurement data of Murmansk regional ARMS.

System of data presentation of Kolskaya NPP ARMS in the monitoring zone

Kolskaya NPP

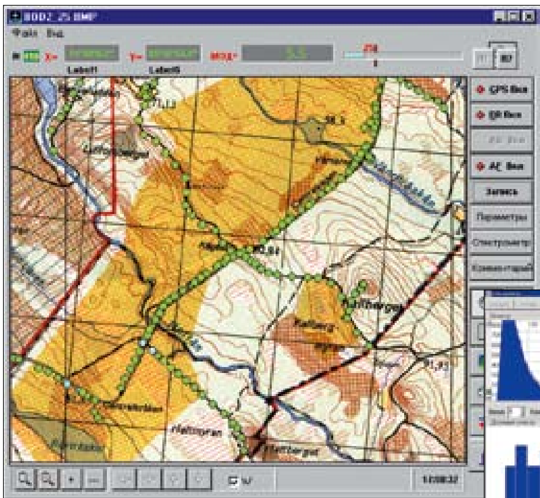
MOBILE RADIATION LABORATORIES

Mobile laboratories for radiation survey (MRL) provide radiation survey in case of radiation emergency situations.

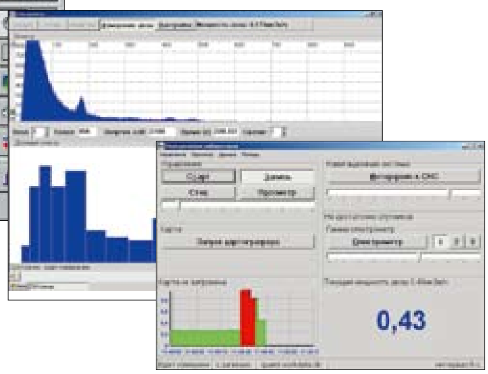
Mobile radiation laboratory: left – general view of MRL, right – operator's desk

MRL EQUIPMENT INCLUDES:

- measuring equipment – stationary and portable gamma spectrometers, dosimeters and alpha-, beta- and gamma-radiometers, samplers;
- computer and communication equipment – «Inmarsat» satellite communication terminal, cellular phones, VHF communicators, GPS equipment, industrial and auxuliary portable computers, equipment for photography and video filming;
- special software;
- auxiliary systems – power supply for the car equipment, including petrol generator, protection from severe arctic climate conditions;
- protective clothing and radioactivity decontaminants.



Presentation of data on measurement of dose rate on the route

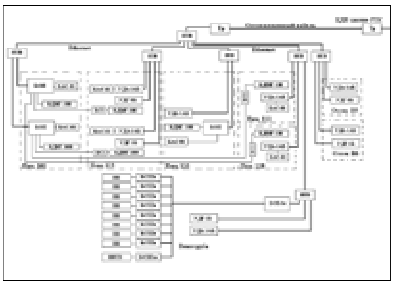


Measurement data

MAIN OPTIONS:

- discovery and localisation of radiation sources and contaminations spots;
- sampling and express analysis of soil, water, and air samples;
- determination of contamination characteristics;
- mapping of contaminated area;
- real-time transfer of the measurement data to crisis centres.

CREATION OF OBJECT AUTOMATED RADIATION MONITORING SYSTEM AT THE SITES OF NS DECOMMISSIONING AND SNF AND RW MANAGEMENT



Structure chart of radiation monitoring system of building No 5 at FSUE «Atomflot»

Since 1999, IBRAE RAS performs works on development and implementation of automated radiation monitoring systems for potentially hazardous sites of Navy, Rosatom, Rosprom (Rossudostroenie), Mintrans etc. We use equipment and detectors produced in Russia and modern computer and communication technologies.

Automated systems of radiation monitoring were developed in 2000—2005 for FSUE «Atomflot» (Murmansk) and FSUE «10 SRZ» (Polyarny) within the scope of international programme AMEC (Arctic Military Environmental Cooperation).

Radiation monitoring system at FSUE «Atomflot» provides radioecological safety for the NS SNF temporary storage site also created within the scope of AMEC programme.

Automated radiation monitoring system at FSUE «10 SRZ» shall provide radiation safety of NS decommissioning activities.

These automated systems contain detector blocks for gamma-exposure dose rate monitoring, waste water contamination monitoring, detectors of radioactive aerosol in the atmosphere and ventilation systems, and automated meteorological stations. IBRAE RAS developed software for data collection and communication, adapted and localised software system PICASSO-AMEC developed by the Institute for Energy Technology (Halden, Norway) for visualisation of the radiation monitoring data.

The figures show blocks and detectors installed at FSUE «Atomflot» and FSUE «10 SRZ».

In 2005—2006, FSUE «Atomflot» reconstructed building No 5 to create long-term storage facility for non-reprocessible SNF from ice-breakers.

Ra - BDMG-08

ПBS-01

UDA-1AB

Blocks and detectors at FSUE «Atomflot»

FSUE «VNIIPET» and IBRAE RAS developed radiation monitoring system for building No 5. IBRAE RAS performed works on the system in co-operation with SIE «Doza» (Zelenograd) and «TekhnoTzentr Service» Ltd (Murmansk). The system contains sensors of gamma-exposure dose rate BDMG-100 (7 units), facilities for monitoring radiation aerosol in the air of the work area and ventilation systems UDA-1AB (8 units), sensors of radiation of rare gases in work areas and ventilation system UDG-01 (5 units), and a detecting block for monitoring parameters of emission through airvent pipe (UPPVM).

Portal radiation monitor «Yantar-2L» installed at FSUE «10 SRZ»

BDMG-100

RSKV-1

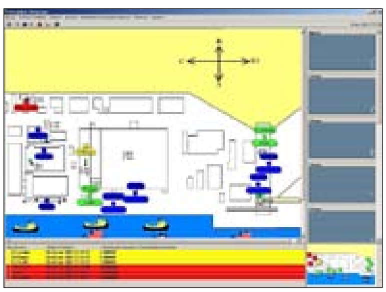
Detecting blocks at FSUE «10 SRZ»

The figures show pctures of measuring equipment of radiation monitoring system in building No 5 FSUE «Atomflot».

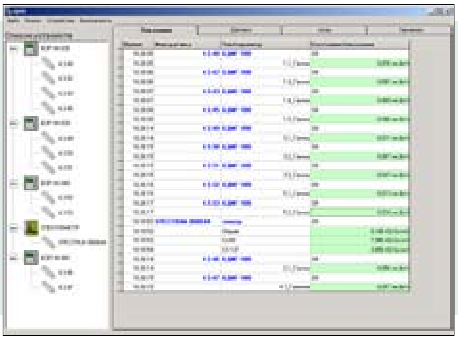
IBRAE RAS developed all application software of automated radiation monitoring system. Special software consists of two parts: Master Control Routine (MCR) for data collection and communication and the module for data visualisation «Operator's Monitor». Radiation monitoring data are stored in the MS SQL database. In addition, IBRAE RAS developed the required drivers for data administration and exchange with measuring equipment.

The figures display the screenshots of codes for data collection, communication and presentation.

Presentation of radiation monitoring data at FSUE «Atomflot». Central dosimetric at FSUE «Atomflot»

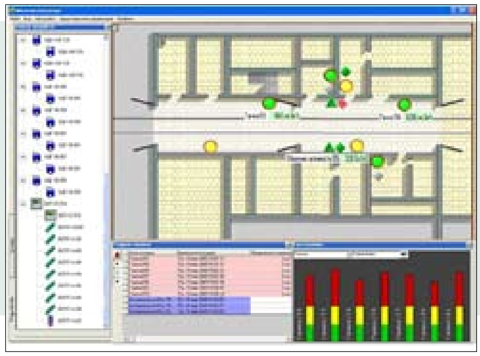


Presentation of radiation monitoring data at FSUE «Atomflot». Screenshot of PICASSO-AMEC application



Screenshot of MCR code package

Screenshot of «Operator's Monitor» module for radiation monitoring at RTG storage



Screenshot of «Operator's Monitor» module

Since 2003, IBRAE RAS also designs and creates automated radiation monitoring systems for FSUE «DalRAO» sites in Far East. We developed system designs and created pilot units for radiation monitoring. In 2006, ARMS sub-system for RTG storage was assembled at the maintenance area of Sysoeva Bay and commissioned by the state commission in October, 2006.

The upper figure shows a screenshot fragment of «Operator's Monitor» module for radiation monitoring system at the RTG storage. Object radiation monitoring systems for SRZ «Nerpa» and TSF «Saida» were created and Murmansk regional system of radiation monitoring was upgraded within the scope of international programme «Northern Dimension Ecological Partnership».

Detector BDMG-100

Facility UDA-1AB

Measuring equipment of radiation monitoring system in building No 5 FSUE «Atomflot»

Warning alarm block BAS, interface block BS-11, data processing and communication block BOP-1M

STAFF TRAINING

Directions of work:

- skill impovemnent of staff and managerial bodies of crisis centres in emergency response to radiation accidents;
- preparing staff of crisis centres to operation in emergency situations allowing for the developed emergency response system;
- training of experts in working with supporting software aimed at making decisions on emergency response activities;
- training of technical staff in working with equipment.

Training forms:

- special courses of lectures;
- practical seminars on working with equipment;
- perfecting individual elements of emergency response activity using computer simulators;
- situational training;
- complex emergency response exercise.

Emergency response exercise aims at:

- testing of alarm plan, training of interaction, data exchange, estimation of impact of the accident, providing recommendations on protection of the population and providing scientific and technical support by Rosatom SCC and IBRAE RAS TCC;
- testing of the system developed within the scope of the project.

Computer system for trainings:

- computer simulator of estimation of radiation situation by mobile radiation survey squads;
- computer simulator of emergency response group activity order in case of radiation accident during RM shipping;
- computer simulator of ARMS data in case of radiation accidents.

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INTERNET SITE «RADIATION SITUATION AT ROSATOM ENTERPRISE»

Public internet-site «Radiation situation at Rosatom enterprises» (www.russianatom.ru) was created according to the agreement between the State Corporation «Rosatom» and IBRAE RAS dated March 23, 2009. The interactive map of the Russian Federation shows location of nuclear and radiation hazardous Rosatom objects: nuclear power plants ( ) ion of nuclear and radiation hazardous Rosatom objects: nuclear power plants ( ).

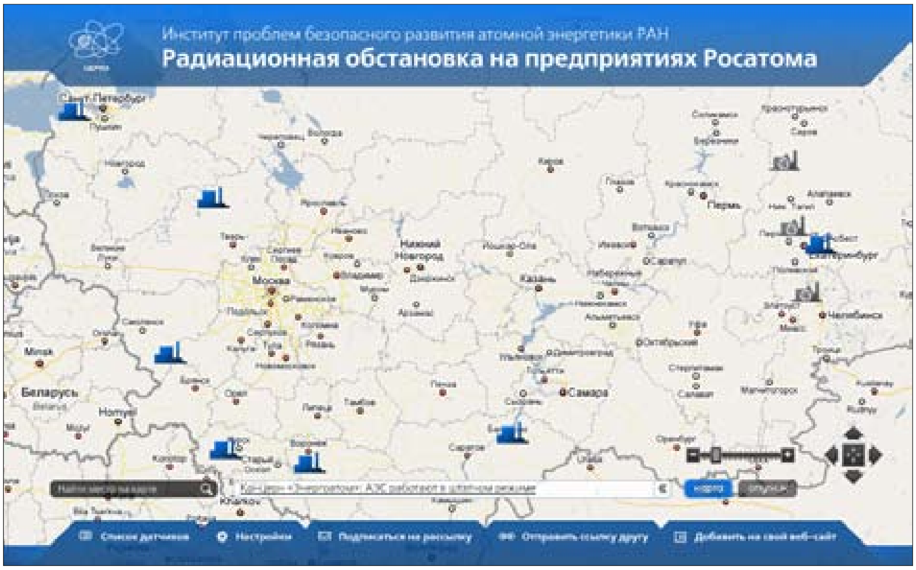

Fig. 1. The main page of the site www.russianatom.ru

After pressing the object icon, the map displays the bordering area and the location of ARMS sensors ( ), sensor colour indicates tge current radiation situation. User can read the data from any sensor for arbitrary period.

The site also contains reference materials on problems of radiation, Rosatom news feed and answers to users' questions. Well-built and friendly design of the site provides executing of the main task of the project — providing the Internet users with complete visual real-time information on current radiation situation.

Fig. 2.Sensors at Kurskaya NPP

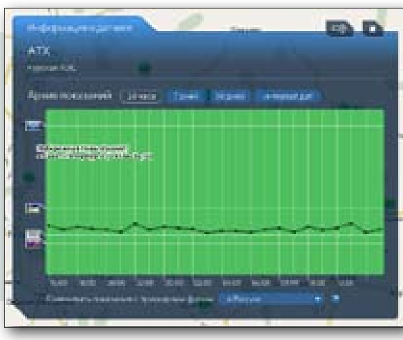

Fig. 3. Data chart of the ATKh sensor reading

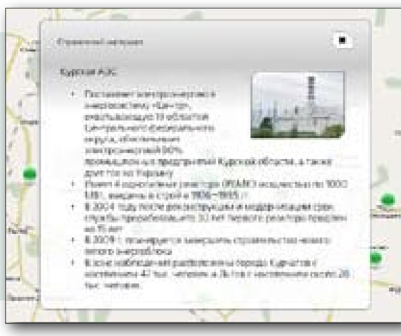

Fig. 4. Data on Kurskaya NPS

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PUBLIC SITE

INTERNATIONAL CO-OPERATION

IBRAE RAS maintains and develops international scientific and technical contacts with many national and international organizations. TCC participates in one of the most significant spheres of IBRAE RAS international co-operation, which is emergency response to radiation accidents and upgrade of emergency preparedness of nuclear industry specialists and enterprises. TCC experts participate in international projects being implemented within the scope of international programs (IAEA, MNEPR, AMEC, French-German Initiative for Chernobyl, TACIS etc.), and in bilateral projects in co-operation with Department of Energy, National Laboratories, Nuclear Regulatory Commission (USA), Commissariat of Atomic Energy (CEA) and Institute of Radiation Protection and Nuclear Safety (IRSN, France), Society of Reactor and Facility Safety (GRS, Germany).

For over fifteen years, IBRAE RAS and IRSN (former IPSN) collaborate in research into radioecology, organizing of exercises and provision of information on radiation risk to the public. Current Agreement on co-operation in nuclear safety research regulates scientific collaboration between IBRAE RAS and IRSN.

The Framework agreement between IBRAE RAS and CEA on co-operation in commercial nuclear reactors safety and management of risks related to nuclear power usage regulates co-operation in provision of information to the public, comparison of codes for estimation of impact of radiation accidents and making decisions.

TCC experts participated in research of radioecological impact of the accident at Chernobyl NPS within the scope of the French-German Initiative.

The project of development of Rosatom emergency response training Centre in Saint-Petersburg executed within the scope of Bratislava initiative by the Presidents of the USA and the Russian Federation occupies an important place in co-operation between US DOE and IBRAE RAS.

IBRAE RAS TCC specialists participate in upgrade of regional radiation monitoring and emergency response systems in North-West of Russia implemented within the scope of Multilateral Nuclear Ecological Programme in the Russian Federation (MNEPR) with support of the NDEP Fund («Nuclear Window») held by the European Bank for Reconstruction and Development as the Fund administrator. Unique system in Murmansk region, created within the scope of the programme, gained high appreciation of IAEA mission and experts. An agreement with EBRD was signed and creation of a similar system for the Arkhangelsk region started in 2009. The system shall be completed and commissioned in 2011. In both regional projects, IBRAE RAS TCC provides expert scientific support of regional emergency response systems.

Rosatom emergency response training centre

Discussion of development of MATI training centre with DOE representatives

IBRAE supports long-term productive co-operation with DOE. The Agreement on coordination of emergency preparedness signed in 2000 stipulates works in the following fields:

- preparation and organization of international emergency trainings (Bilibino-2002, Arctic-2005 at FSUE «Atomflot», «Arctic-2008» at JSC SC «Zvezdochka»);
- development of risk estimation methods for chemical and radiation hazardous enterprises (Project on hazard sources control at «Apatityvodokanal», FSUE SSC NIIAR, FSUE SC «Zvezdochka», FSUE«Atomflot»);
- development and adaptation of code packages (TRACE and NOSTRADAMUS) for estimation of radiation emission impact for particular enterprises;
- establishment and development of Training centre at NGEE MATI «Atomenergo», advanced training of heads of nuclear enterprises in emergency responce, implementation of ecological management systems based on ISO14001 standard;
- development and implementation of mobile radiation survey systems and on-line data transfer to crisis centres;
- development of simulators for training of radiation survey and radiation safety specialists with simulation of actual measurement data of environmental contamination;
- preparation of methodological and information materials for the public and mass-media, preparation of news releases and trainings of specialists of radiation hazardous enterprises press-centres, organization of public relations trainings;
- equipping of crisis centres, providing scientific and expert support to national crisis centres (Rosatom, EMERCOM);
- gathering and analysis of information, proposals on development of radiation monitoring and emergency response systems in the Far East region.