INSTITUTE OF RADIATION SAFETY AND ECOLOGY
NATIONAL NUCLEAR CENTER OF THE REPUBLIC OF KAZAKHSTAN

2018

ACTIVITIES of Institute of Radiation Safety and Ecology

Kurchatov, 2018

General Director — Director of the branch 'IRSE' of the RSE NNC RK
Batyrbekov E.G.
Ph.D. in Physics and Mathematics
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Branch 'Institute of Radiation Safety and Ecology' (IRSE) was established by the Resolution of the RK Cabinet of Ministers No. 1082 dated October 29, 1993 on the basis of military unit 52605.

Strategic focus areas of the institute:

- research into radioactive contamination of the land cover;
- radiation monitoring of water and air environment;
- assessment of impact of environmental factors on humans and wild life ;
- analytical services and improvement of available techniques;
- information activity.

Deputy Director for Scientific and Applied Research – **Aidarkhanov A.O.,**
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Chief Operating Officer – **Dmitropavlenko V.N.**
Dmitropavlenko@nnc.kz

Academic Secretary – **Larionova N.V.,**
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Department for Radiological Research and Ecosystem Restoration (DRRER)
Basic areas of activity:
- Areal studies of radioactively contaminated soil cover.
- Research into radioactively-contaminated objects.

Head of the department **Umarov M.A.**, Ph.D. in Chemistry, Umarov@nnc.kz

Department for Integrated Ecosystems Research (DIER)
Basic areas of activity:
- Studying the nature of radionuclides redistribution among different natural environmental components.
- Assessment of environmental factors impact on humans and wild life.

Head of the department **Panitskiy A.V.**, Ph.D., Panitskiy@nnc.kz

Department for Development of Environmental Monitoring Systems (DDEMS)
Basic areas of activity:
- Researching into the radiation state of air and water environment.
- Radiation monitoring.

Head of the department **Lyakhova O.N.**, Ph.D., Lyahova@nnc.kz

Analytical Research Department (ARD)
Basic areas of activity:
- Determining concentrations of radionuclides and elements (including heavy metals) in environmental objects and materials.
- Assessment of doses for personnel and population.

Head of the department **Kashirskiy V.V.**, Kashirskiy@nnc.kz

Training and Information Center (TIC)
Basic areas of activity:
- Geoinformatics.
- Training and public awareness activities.

Head of the center **Strilchuk Yu.G.**, Strilchuk@nnc.kz

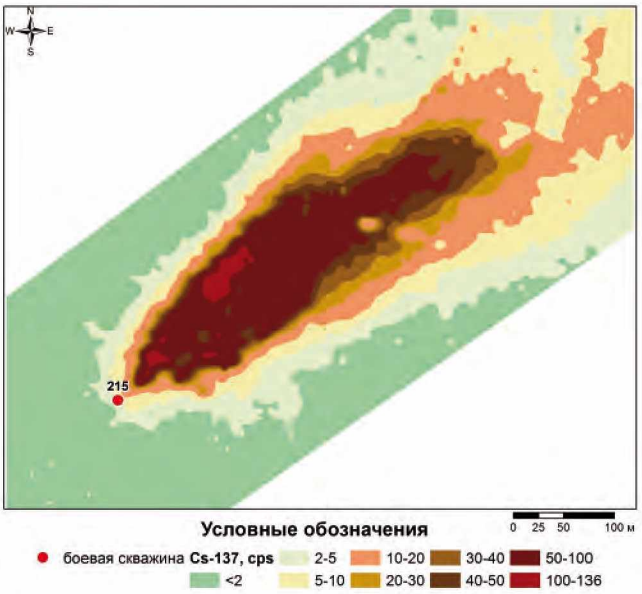
The equipment available in the department allows to measure a full range of radiation parameters regulated by applicable legislation and regulatory documents:

- Control over the equivalent dose rate.
- Control over the flux density of alpha-, beta- particles.
- Determining radon and thoron progeny in the air.
- Determining radon content in water.
- Surveying sites for constructing residential houses and buildings.
- Providing operational radiological control of scrap metal.
- Assessing radioactivity in solid fuel (coal).
- Providing control over radiological situation when working with ionizing radiation sources and in conditions of radiation accident.
- Measuring levels of contamination for working surfaces, equipment, vehicles, personal protection equipment, personnel skin and clothes with radioactive substances.
- Development of protective measures to reduce the effective dose rate of gamma-radiation and the amount of radon entering the premises.
- Development of operational radiation control systems.

Radiation control of equipment

Pedestrian gamma-spectrometric survey allows assessment of the content of ^{137}Cs, ^{241}Am, Eu isotopes, ^{40}K, U isotopes, ^{60}Co, ^{232}Th, and Pb isotopes in soil of territories surveyed without soil sampling or costly analyses within a short period and precisely delineate contamination. Survey results can be obtained in 15 minutes as maps of radioactive contamination.

Control of radiation state



Map of radioactive contamination of area

The equipment available allows a high-precision determination of coordinates afield accurate to 5 cm (coupling of cable channel locations, determining turning points of objects, exact coordinate setting for drilling points and etc.), determining elevation points.

Data obtained can be used for creating digital models of the landscape, 3D models of the area, creating topographic sheets.

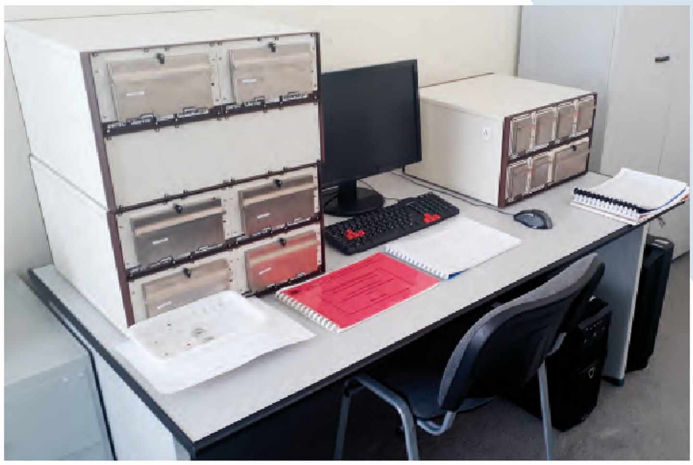
Conducting topogeodesic works

Analytical Research Department performs works on the following areas:

- Determining the ultimate composition of samples for various sites (water, soil, bottom sediments, vegetation, aerosols, biological substrates, agricultural and food products, construction materials and etc.) using a X-ray fluorescent analysis technique (XFA), atomic emission spectrometry (ICP-AES) and inductively-coupled plasma mass-spectrometry (ICP-MS). The range of identifiable elements involves elements from lithium (Li) to uranium (U). Determining isotopic composition of uranium.

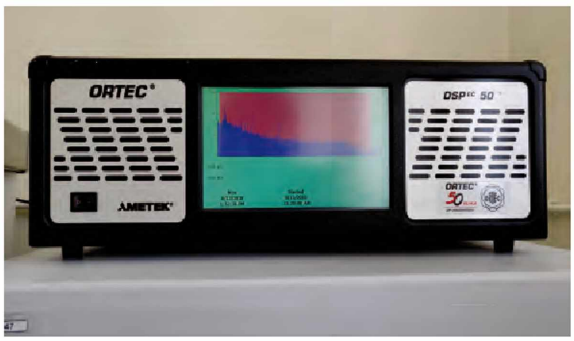
Conducting elemental analysis by inductively coupled plasma mass spectrometry on Agilent 7700x

- Radiochemical analysis. Radiochemical analysis of $^{238,\ 239+240}$Pu, ^{241}Pu, ^{90}Sr, ^{210}Po and ^{241}Am in environmental samples and biosubstrates. Spectrometric analysis of radionuclides using Alpha Ensamble, Alpha Analyst alpha-spectrometers and Tri-Carb 2910TR liquid-scintillation counter.
- Sensitivity of alpha-spectrometric and beta-spectrometric analysis is 0.2 and 7 Bq/kg respectively.



Alpha Ensemble alpha-spectrometers for specter analyses of plutonium and polonium-210 isotopes

Laboratory of radiochemical analysis



Multichannel analyzer of impulses of ORTEC gamma-spectrometry complex

- Determining activity of artificial (^{241}Am, ^{137}Cs, ^{152,154,155}Eu, ^{60}Co) and natural radionuclides (^{40}K, ^{226}Ra, ^{228}Ac, ^{210,212,214}Pb, ^{235,238}U) in environmental objects and biosubstrates using solid-state detectors based on hyperpure germanium by Canberra and Ortec, the world-wide leaders in this area. The gamma-spectrometric method provides sensitivity of approxi-mately 0.5 Bq/kg.

Quantulus 1200 Low-background liquid scintillation spectrometer for analysis of alpha-beta emitting radionuclides: tritium, carbon-14, strontium-90, plutonium isotopes

Automatic installation of Sample Oxidizer sample preparation for analysis of tritium and carbon-14 concentration in free and organically bound forms

- Determining activity of ^{3}H and ^{14}C isotopes in free and organically bound form. Preparing counting samples of tritium and carbon in organically bound form (plants, food products) using Sample Oxidizer automatic installation. The samples are analyzed using Quantulus 1220 low-background spectrometer. Tritium analysis sensitivity is approximately 5 Bq/l.

- Assessment of internal exposure doses using computational methods and biophysical methods of dosimetry. Biophysical methods are represented by the analysis of 24-hour urine samples (tritium, ^{238}Pu, $^{239+240}Pu$, ^{210}Po, ^{241}Am, ^{90}Sr, ^{137}Cs) and measurements by a whole-body counter (^{137}Cs, ^{241}Am). Doses are calculated based on the actual content of radionuclides in a body.

Radionuclides concentration measure in organism on whole-body counter

Equipment for production of standard samples of radionuclide and elemental composition

- Production of standard samples for the analysis of radionuclide and ultimate composition based on various natural matrices (plants, soil, bottom sediments). A wide range of certifiable parameters of standard samples (^{241}Am, ^{137}Cs, ^{152}Eu, ^{60}Co, ^{90}Sr, isotopes of Pu, Zn, Cu, Pb, Cd, Co, Fe, Mn, As) suitable for correction given customer's preferences. Certified values and indices characterizing standard samples are determined according to high-precision spectrometric research.

- Works on categorization of radiation hazard at objects. Tasks to calculate biological protection of sources and installations.

The main activity area of the Department for Development of Environment Monitoring Systems is radioecological monitoring of air and aquatic environment.

The quality of water objects is assessed using an up-to-date sampling and analytical equipment.

- Determining the content of natural and artificial radionuclides in surface and ground water in radioactively contaminated territories and adjacent areas.

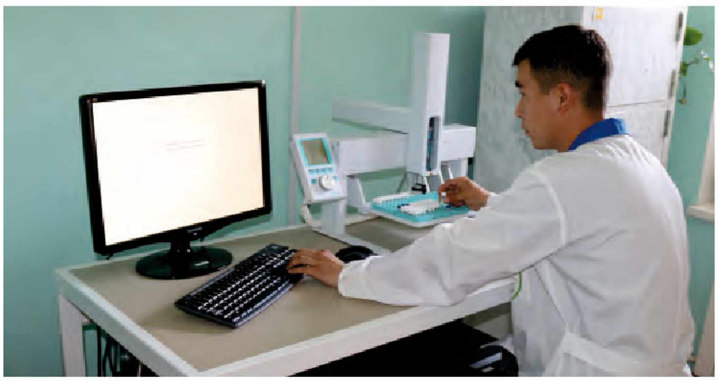
Quality assessment of surface water

Monitoring boreholes in the STS territory

Determining hydrogeological characteristics of a reservoir

- Quality control of objects of water use by radiation sign in places of economic activities and in the territory of residential complexes.
  Determination of general chemical composition of water at different water objects - natural lakes, rivers, streams, springs, wells, boreholes.

Determining mechanisms of surface and ground water formation and sources of their radionuclide contamination, isotope analysis of atmospheric precipitations and water using a method of isotope hydrology. This method is based on determination of stable $^{18}O/^{2}H$ isotope ratios in water using a LGR 912-0008 laser isotope analyzer. Measurement precision for ^{2}H is ±1 ‰, for ^{18}O - ±0.5 ‰.



Conducting isotopic analysis by LGR 912-0008 laser analyzer

***Geological engineering surveys*:**
Conducting a range of hydrogeological research (flow rate, level of surface water, flow direction, water discharge and hydraulic conductivity) into ground water.
Carrying out geological engineering surveys by sampling soil and water and drilling operations, auger-type borehole depth is down to 70 m, air-hammer drilling depth is down to 100 m.

Conducting drilling works

Quality assessment of the ambient air:

- Determining the content of natural and technogenic radionuclides in the ambient air.
- Revealing climate factors affecting contamination of the air environment.
- Researching into regularities of radionuclide migration processes in the air.
- Determining tritium content in the air environment in territories exposed to radiation hazardous objects.

Monitoring of air environment

AQM-60 monitoring station for determining gas composition of atmosphere

Determining gases on CHROMOS GH-1000 chromatography equipment

Research into hazardous natural and technogenic processes:

- Studying signs of running long-term destructive processes in venues of under-ground nuclear tests in the STS territory.
- Field and in-vitro research into the content of harmful organic substances and gases in water and ambient air.
- Modelling distribution of radioactive contamination in the air and aquatic environment.
- Developing quality assurance programs for radiation safety of activities performed by third-party organizations in the STS territory.

Radiation safety assurance of economic activities is to comply with 'Licensing regulations for activities in territories of the former nuclear test sites and other territories contaminated due to nuclear testing'. All types of activities in the STS territory must be performed with radio-ecological support.

Coal sampling for laboratory analyses

Radiation control of pit technical equipment

Radiation control during drilling-and-blasting works at the "Karazhyra" pit

- Radiation control of aquatic and air environment, daylight surface.
- Radiometric measurements of vehicles and equipment.
- Dosimetric control of personnel involved while performing economic activities.

Researching parameters of radionuclides migration in food chains

Experimental greenhouse

Laboratory equipment

The main scientific focus area of the department is research into characteristics of radionuclides redistribution between component of environment:

- Studying distribution of radionuclides in particle-size fractions of soil.
- Researching speciation (mobility) of radionuclides in soil.
- Determining physical and chemical properties of soil.
- Studying peculiarities in spatial and vertical migration of artificial radionuclides in the land cover.
- Experimental assessment of radionuclide intake by animal products produced in a radioactively contaminated territory.
- Experimental assessment of radionuclide transfer into crop products produced in a radioactively contaminated territory and studying factors affecting this process.

Types of physical and chemical analysis of soil:

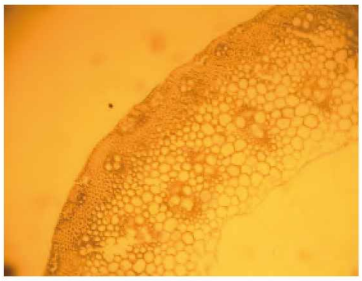
- determining organic matter content;
- determining particle-size and microaggregate composition;
- determining the content of exchangeable cations and water-soluble salts;
- determining moisture content;
- determining acidity degree (pH).

Field residential complex

Assessment of environmental factors impacting humans and wild life

The following types of works are carried out in this focus area:

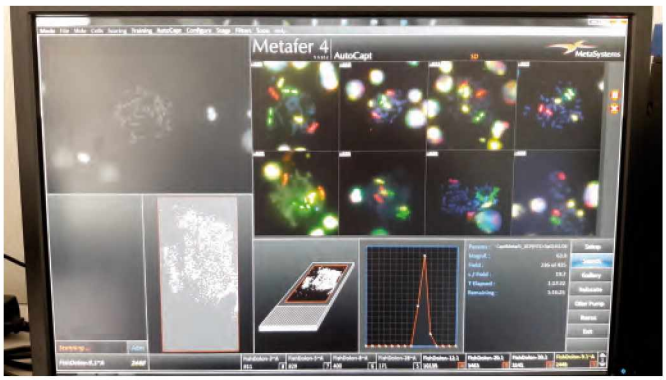
- morphoanatomical research of plants;
- cytogenetic research of plants;
- cytogenetic research of animal bone marrow;
- cytogenetic research of human and animal peripheral blood;
- dose reconstruction by biodosimetry techniques.



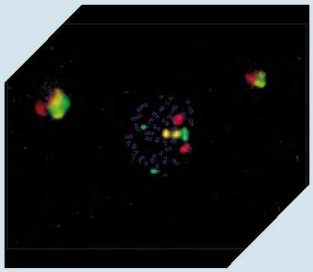
3 methods of cytogenetic dosimetry recommended by IAEA have been mastered - dicentric analysis, micronuclear test with blockage of cytocinesis and in situ fluorescent hybridization method.

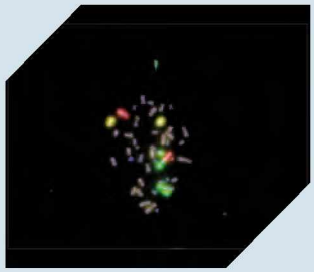
For works in this area there is an automated cytogenetic system based on electronic microscope made by Carl Zeiss (including different modifications, i.e.: AxioImager N2 (2012), AxioIm-ager Z2 (2016), Germany), an automated metaphase search system MSearch for 8 specimens, Metafer 4, Ikaros, Isis (MetaSystems, USA)software. This equipment allows to improve the quality and repeatability of research results, reduces statistical uncertainty at low doses being at the same time a high-performance instrument for executing and optimizing both routine karyotyping procedures and subtle analysis using CBMN, FISH, M-FISH methods. Thanks to digitizing images the total time needed for the analysis is reduced by several times. This is important in case of fast response to emergency situations involving a large number of people.

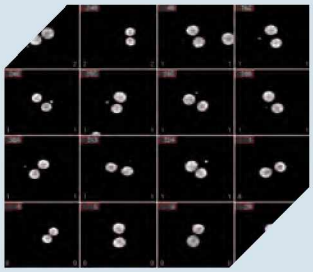
Automated cytogenetic system



Metafer 4, Ikaros, Isis software (MetaSystems, USA)



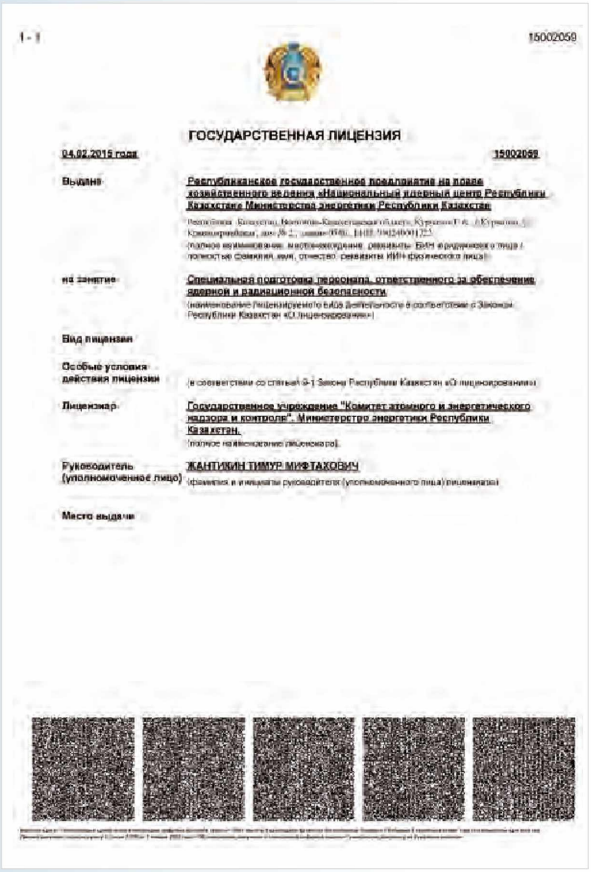




The main focus area of the training center is to train specialists in the field of radiation safety when using sources of ionizing radiation.

The State license No.15002059 has been issued by the Committee for Atomic and Energy Supervision and Inspection under the Ministry of Energy of the Republic of Kazakhstan for this type of activity called 'Special training for personnel in charge of nuclear and radiation safety assurance':

1. Special training for personnel in charge of nuclear and radiation safety assurance.
2. Radiation protection and safety.



15002059

ГОСУДАРСТВЕННАЯ ЛИЦЕНЗИЯ

04.02.2015 года 15002059

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на занятие Специальной подготовка персонала, ответственного за обеспечение ядерной и радиационной безопасности

Вид лицензии

Особые условия действия лицензии

Лицензиар Государственное учреждение "Комитет атомного и энергетического надзора и контроля" Министерства энергетики Республики Казахстан

Руководитель (уполномоченное лицо) ЖАНТИБИН ТИМУР МИФТАХОВИЧ

Место выдачи

For training purposes trainers are involved from among highly qualified employees of the Institute. Training staff of the center has a broad experience and they have completed special proficiency training as part of training courses, fellowships, scientific visits, arranged by the IAEA. Training courses can also be conducted on the customer's premises both in Kazakhstan and abroad.

TIC also provides 'Provision of radiation safety in X-ray diagnostics' training courses for medical workers and other specialists who deal with X-ray equipment.

As a result of training within the course program, the attendees gain knowledge and experience in normative, organizational and technical fundamentals of radiation safety assurance: regulatory acts of the Republic of Kazakhstan in the field of atomic energy use, general principles of radiation protection for personnel, control principles of normal professional exposure and control of population exposure from natural sources, principles of activity management in emergency situations, organization of radiation monitoring at the workplace, principles of radioactive wastes handling.

Lecture

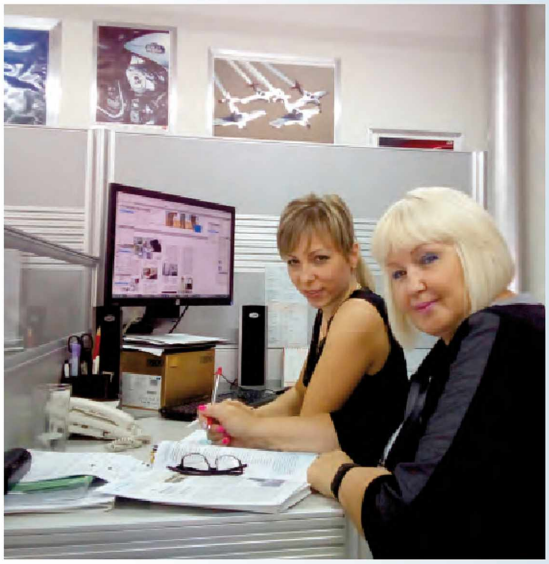
Practical training in the territory of the "Experimental field"

Bureau of Scientific and Technical Information

The main tasks in the Bureau of Scientific and Technical Information (BSTI) are:

- Holding meetings with the population and introducing them to radiation situation in territories they are living in and areas adjacent to the former STS.
- Arranging and conducting test site museum excursions for schoolchildren and students living in the areas adjacent to STS.
- Carrying out publishing activities.
- Organizing and taking part in conferences, workshops, exhibitions, junior scientist competitions both national and international.
- Providing the institute's specialists with research and development information.
- Acquisition and methodological assistance for the reference stock, library service for the Institute's staff members.
- Translation of scientific and technical literature and documentation to the state language and the English language.

All issues of books on "Topical issues in Radioecology of Kazakhstan" and booklets "Semipalatinsk test site. Present state" and "Institute of Radiation Safety and Ecology"



Arranging print publication at the Print House

IRSE library is the largest scientific library in Kurchatov city and provides services not only for the institute's staff members, but also for other NNC institutes as well as students from universities in Semey, Pavlodar, Ust-Kamenogorsk who do practical training. The library stock is about 50000 units of issue covering scientific, educational and reference literature in core are-as of the Institute. Currently some of the books are available in digital form.

IRSE library

UN scholars visit in museum

The Museum of the Semipalatinsk Test Site was founded in 1972 based on the military unit 52605. The museum stock includes about 100 units of issue (photographs, documents, models, pieces of equipment). The museum was established to disseminate information on STS among broad population. This is the only museum in Kurchatov city that is located on the Institute's premises. Excursions are conducted in three languages. The museum is open for everyone interested in the history and activities of the test site. By the 20th NNC anniversary, exhibits were renovated. Visitors to the museum can become familiar with one of the most interesting moments in the national history. Exhibits provide information on the main three testing sites at STS: 'Experimental Field', 'Degelen', 'Balapan' as well as an opportunity for the visitors to get familiar with the origin and development of the test site, features of nuclear tests conducted and nuclear effects, current radiation situation in the territory of the Semipalatinsk Test Site, life and activities of the outstanding experimental physicist I.V. Kurchatov.

Exhibits of the STS museum

BSTI specialists have developed an interactive map of the Semipalatinsk Test Site and test sites in other nuclear powers. The map provides historical data on nuclear tests as well as up-to-date information obtained as a result of research conducted by IRSE staff members.

Interactive map

Laboratory of Geoinformation Technologies

The Laboratory of Geoinformation Technologies performs works in the following areas:

Development of GIS-projects. The main aim of developing GIS-projects is to create a uniform informational module based on GIS-technology. The module serves for collection and systematization of the data obtained as a result of field works and laboratory analyses. Visualization and analysis of results allow to plan further works (plotting schemes, routes, complex maps). A complex analysis of data obtained allows to determine the nature and mechanism of contamination in territories of interest.

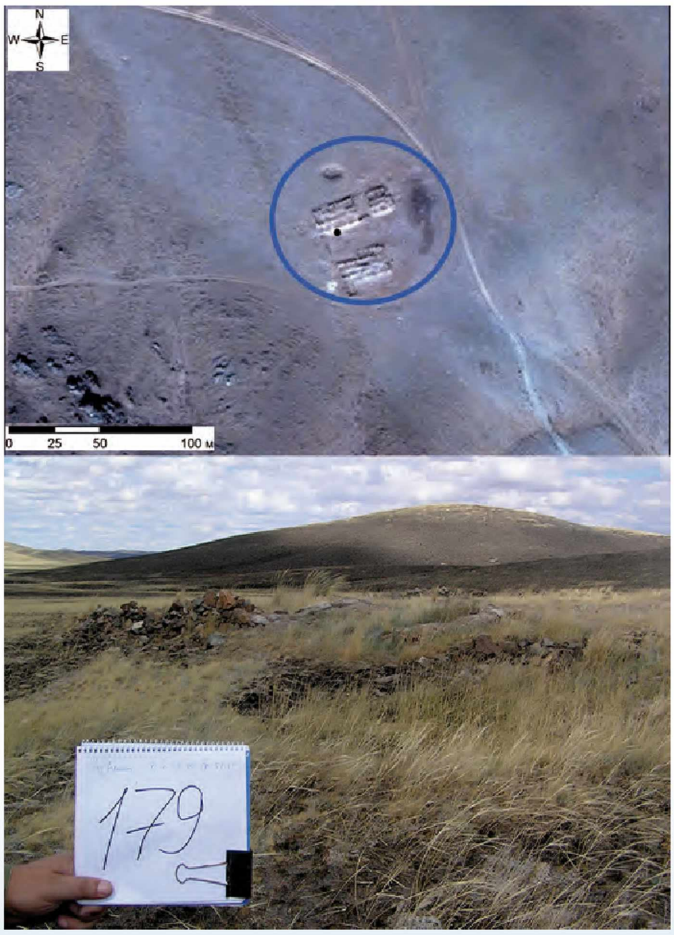
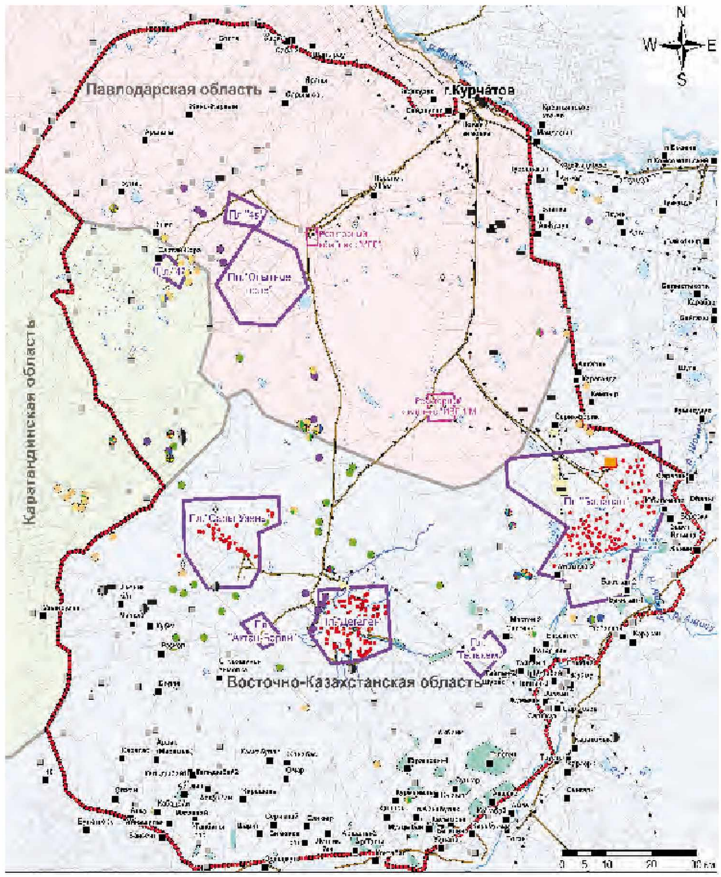


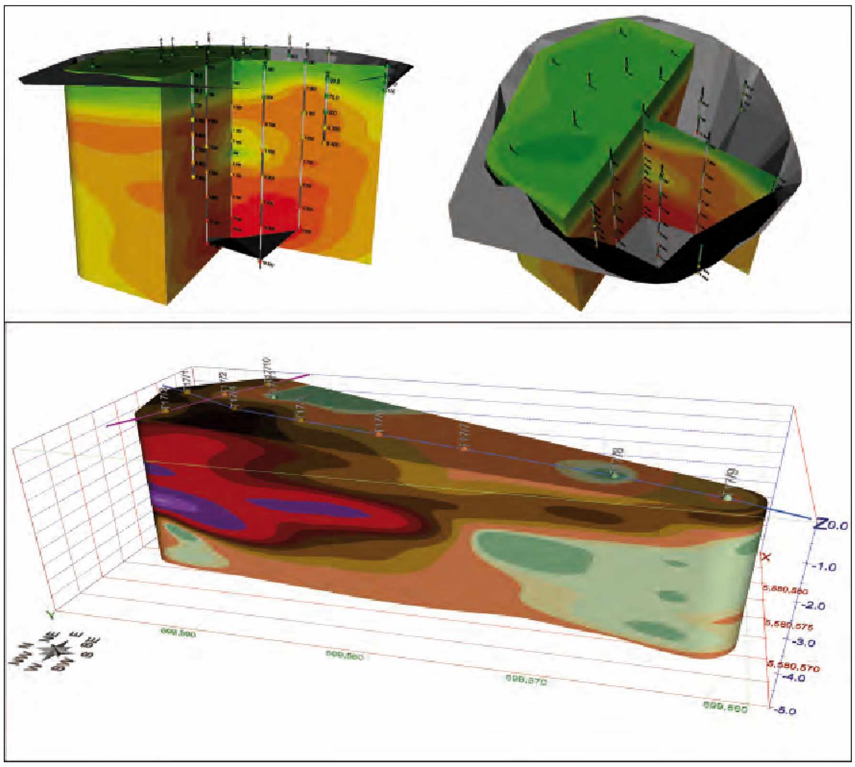
Photo and field decoding of satellite images



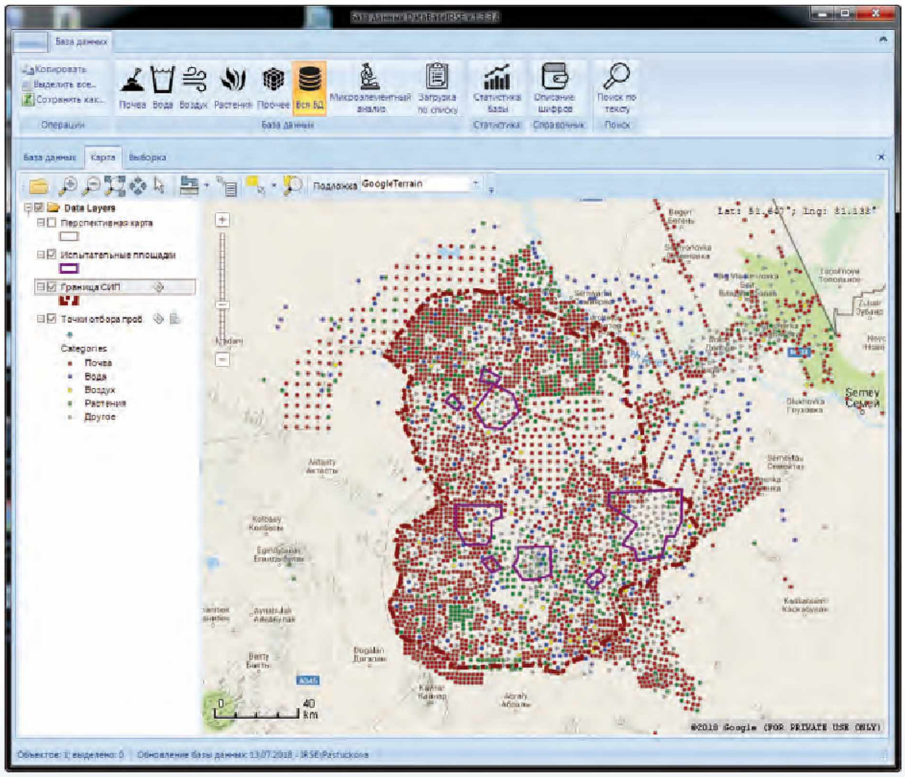
Schematic map of current state of the Semipalatinsk test site

Satellite image interpretation. The main aim of decoding satellite images is to identify sites being potentially radiation-hazardous for population. Interpretation is done to identify artificial objects in the area surveyed. This combines satellite image interpretation (office interpretation of terrain data) and field inspection (interpretation afield). Once interpretation is complete a catalogue of identified objects including photo images of objects and their brief descriptions is compiled.

3D-models of environmental sites. To analyze the results of radiological studies, 3D models of environmental sites are constructed. These models provide high clearness and interpretability of data which enables to transmit information on the medium of interest more completely as well as allows to implement a number of unsolvable applied tasks when using traditional 2D maps. In particular, for studying ecological situation at the STS, 3D models allow assessment of the distribution character of the major radionuclides in the ground or aquatic environment.



3D-models of environment objects



Sampling results on interactive map

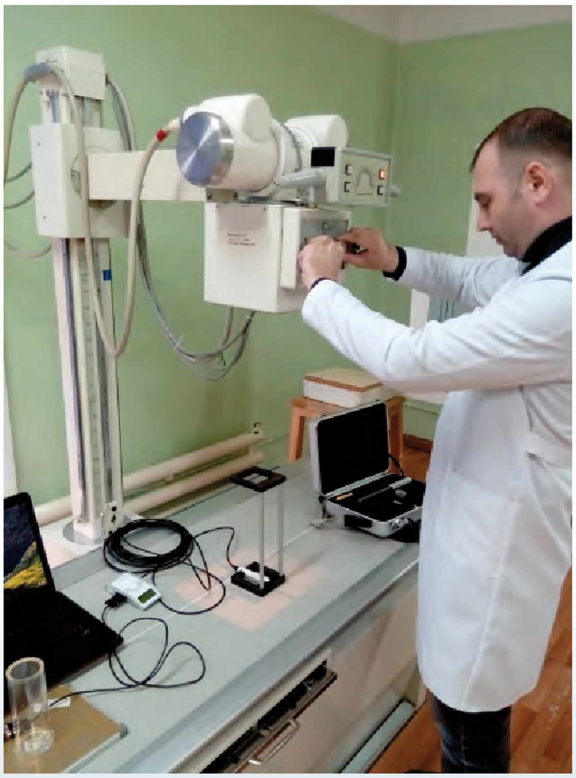
Maintaining the Institute's database of radiological research. The laboratory has developed a database of radiological research conducted by the Institute which includes information on general characteristics of samples collected as well as on gamma-spectrometric, radiochemical, chemical and other kinds of analyses. It allows to assess both the current state of the radioecological situation in the territory and to get the idea of any changes.

The database involves data gathered since 1997 and as of today it continues to expand.

In 2017, the Institute filed an application for intellectual property rights to "DataBaseIRSE" a developed database of radiological studies of the institute and in 2018 it obtained certificate of authorship of state registration of rights to the project of intellectual property rights.

Control over operating parameters of X-ray equipment implies measurements of the basic operation parameters of X-ray diagnostic units to reveal noncompliance of operating characteristics resulting in degradation of image quality and overexposure of the patients. All the research is conducted using up-to-date measuring facilities and test-objects that meet all of the regulatory-technical requirements. The X-ray equipment control team also performs the following kinds of work:

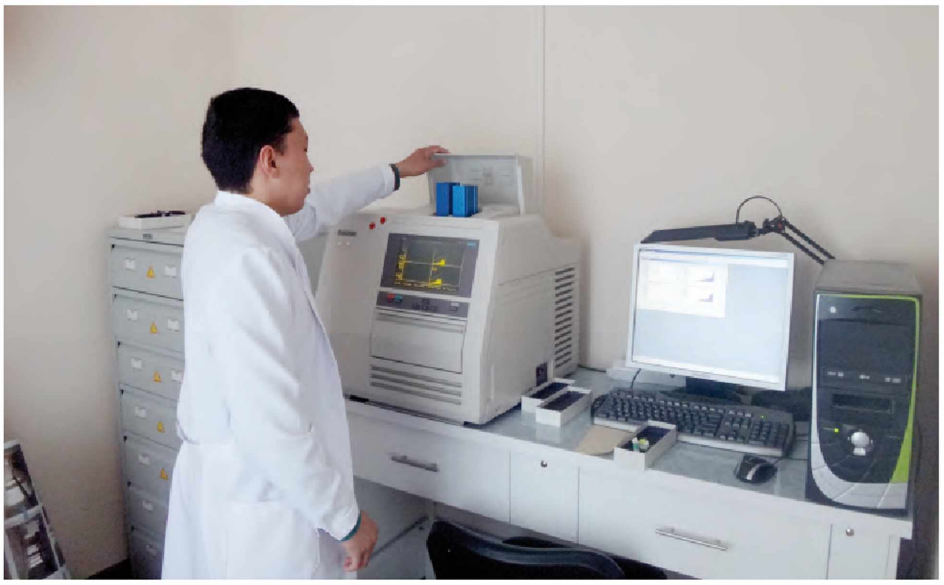
- Control over radiation protection equipment.
- Dosimetric control of workplaces.
- Hazard analysis of the X-ray diagnostics and X-ray therapy rooms.



Works on control of operating parameters of various medical X-ray equipments in healthcare centers of the Republic of Kazakhstan

Individual dosimetric control is provided for personnel working with ionizing radiation sources at:

- Mining, oil and gas extracting enterprises;
- Organizations dealing with disposal and transportation of radioactive wastes;
- Facilities carrying out radiation-hazardous works such as X-ray and radiological medical rooms, subdivisions of civil defense and emergency situations, customs and road committees.



Works on individual doses control

The individual dose control team have at their disposal a modern equipment allowing to register not only the effective dose but also equivalent doses on skin and crystalline lens.

Staff of the Institute of Radiation Safety and Ecology NNC RK

Branch «Institute of Radiation Safety and Ecology»
RSE «National Nuclear Center of the Republic of Kazakhstan»

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