REMEDIATION OF RADIOACTIVELY CONTAMINATED SITES — REVIEW OF PROJECTS SUPPORTED BY THE INTERNATIONAL SCIENCE AND TECHNOLOGY CENTER (ISTC)

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Abstract

The International Science and Technology Center (ISTC) is an intergovernmental organization founded in Moscow fifteen years ago by the European Union, Japan, Norway, the Russian Federation, Sweden and the USA. The ISTC has focused its mission on the human dimension of non-proliferation and global safety and security through international cooperation on science and technology. The ISTC has developed a broad spectrum of tools for advancing science, improving human health, stimulating economic growth, mitigating environmental damage and addressing other international global concerns. By January 2009, the centre and its partners had provided $815 million in grants, equipment, travel and training support for almost 2650 projects in diverse areas of civilian basic and applied research. These projects engaged over 71 000 scientists and engineers from 980 institutes, research centres and production facilities in collaborative work. This paper reviews the ISTC projects in the area of radioactive waste management and projects related to radioactively contaminated sites.

1. INTRODUCTION

The International Science and Technology Center (ISTC) is an intergovernmental organization founded by the European Union (EU), Japan, Norway, the Russian Federation, Sweden and the USA in 1992. Some time later, Canada and the Republic of Korea joined the ISTC. Presently, the ISTC 'family' consists of 39 members (27 from the EU). The ISTC defines its goals as follows:

- Addressing the human dimension of non-proliferation, including redirecting and engaging the intellectual potential of former weapons experts into challenging civilian projects;
- Support of basic and applied research and technology development;
- Contribution to the solution of national and international technical problems of global or regional dimensions;
- Contribution to the transition to market based economies;
- Assistance in the integration of scientists from the Confederation of Independent States (CIS) into the international scientific community.

The ISTC is a unique organization focused on the responsible use of sensitive knowledge and technology through international cooperative scientific and technical projects. Through these projects, based on scientific excellence, the ISTC has built up trust and confidence among scientific communities dealing with problems of global safety and security. The ISTC has developed a broad spectrum of tools for advancing science, improving human health, stimulating economic growth, mitigating environmental damage and addressing other global concerns.

The ISTC Secretariat has its headquarters in Moscow with branch and information offices in six CIS countries. An internationally recruited staff manages, oversees and monitors more than 680 active projects under the Science Project Programme, provides training and business support to CIS project managers and implements the programmes that support the integration of scientists into the international community.

The Science Project Programme is the most comprehensive activity conducted by the ISTC. Through this programme, the ISTC solicits scientific project proposals from institutes throughout the CIS and provides funding and logistic support to project teams. Ultimately, the Science Project Programme together with other supplementary ISTC programmes supports and enforces the transition to sustainable, innovation driven science and technology.

By January 2009, the ISTC and its partners had provided $815 million in grants, equipment, travel and training support for almost 2650 projects in diverse areas of civilian basic and applied research. These projects have engaged more than 71 000 scientists and engineers from almost 980 institutes, research centres and production facilities, involving many of the best scientists from the Russian Federation and other CIS countries, including many foreign collaborators.

Statistically, ISTC projects cover fourteen technology areas. The main areas are biotechnology and life sciences, environment, physics, fission reactors, materials, instrumentation, space, aircraft and surface transportation, and non-nuclear energy (Fig. 1).

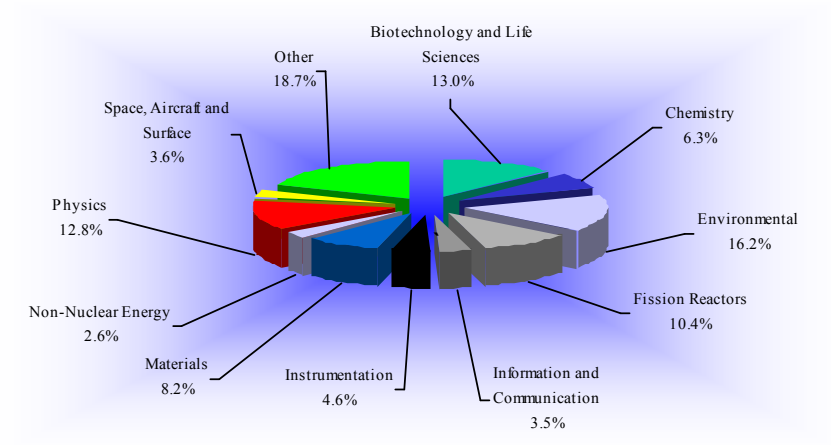

FIG. 1. Technology areas supported by ISTC projects.

In 1997, the ISTC launched the Partner Programme as a tool to provide long term cooperation between research and technology development communities in the Russian Federation/CIS and private organizations, research institutes and other entities in ISTC member states. Through this programme, the partners have funded and conducted science and technology projects using a very flexible and transparent ISTC framework which has minimized the risks of failure and also administrative and overhead costs [1].

By January 2009, the partner organizations had committed nearly $245 million to scientific research through 692 ISTC projects. The ISTC currently has more than 300 Partners. Among active ISTC Partners are such organizations as Areva, Airbus, Bayer, Boeing, the Commissariat à l'Énergie Atomique (CEA), Danone, Defense Advanced Research Projects (DARPA), European Organization for Nuclear Research (CERN), General Atomic, Cambridge Research Centre and others.

2. OVERVIEW OF ISTC PROJECTS RELATED TO RADIOACTIVE WASTE MANAGEMENT

One of the most complicated ecological problems in Kazakhstan, the Russian Federation and some other CIS countries is the management of radioactive waste accumulated as a result of past activities in the production and testing of nuclear weapons, the use of nuclear energy for peaceful purposes and as a result of reductions in nuclear arms.

The radioactive waste situation in the Russian Federation required immediate actions to achieve improvement. The safe management of radioactive waste is a challenge which is not limited to the Russian Federation alone; it concerns all states engaged in nuclear activities.

A number of countries and international organizations have started cooperative projects with the Russian Federation in the handling of accumulated radioactive waste and spent fuel. In order to promote and to coordinate these efforts, a special Contact Expert Group (CEG) for international radioactive waste projects in the Russian Federation was established under the auspices of the International Atomic Energy Agency in 1996.

The ISTC has worked in close cooperation with CEG and ISTC projects are included in the database of IAEA projects. New proposals are discussed at workshops of the CEG, and priorities for new projects are identified. The results of ongoing projects are presented at international conferences, seminars and workshops.

The ISTC projects in the field of management of radioactive waste and spent nuclear fuel are classified as follows:

(1) Management of radioactive waste and spent nuclear fuel:
- Treatment of high level waste (HLW);
- Treatment of low and intermediate level waste;
- Storage and disposal.

(2) Decommissioning of nuclear facilities:
- Decommissioning of nuclear power plants (NPPs);

- Decommissioning of nuclear submarines;
- Decontamination and remediation of nuclear sites.

The majority of ISTC projects in this field deal with the different techniques to be used for waste volume reduction. These include: HLW solidification technology; development of matrix compositions (glass, mineral-like and ceramic compositions) ensuring mechanical, chemical and radiation stability during long term storage and final disposal; technologies for incinerating the combustible part of waste; selection of geologically suitable sites; environmental monitoring; solidified radioactive waste condition monitoring; prediction of the environmental impact of radioactive waste storage facilities and burial sites throughout their entire operation; development of a computer based data system for the evaluation of the radiation legacy of the former Soviet Union; and evaluation and development of decontamination and rehabilitation techniques.

By January 2009, 140 projects had been funded by the ISTC parties (about $48.5 million in funds were provided). About 50 Russian and CIS institutions are involved as project leaders or participants. More than 75% of them are from the Russian Federation. The most active institutions submitting projects to the ISTC have been the following: Khlopin Radium Institute, St. Petersburg; A. Bochvar All-Russian Scientific Research Institute of Non-Organic Materials, Moscow; All-Russian Research and Design Institute of Production Engineering (VNIPIPT), Moscow; Russian Federal Nuclear Centre, Zababakhin; All-Russia Research Institute of Technical Physics (VNIITF), Snezhinsk; Russian Federal Nuclear Center; All-Russian Scientific Research Institute of Experimental Physics (VNIIEF), Sarov; A.I. Leypunsky Institute for Physics and Power Engineering (IPPE), Obninsk; Nuclear Technology Safety Center, Almaty, Kazakhstan; Institute of Atomic Energy, Kurchatov, Kazakhstan; Kurchatov Research Centre, Moscow; and the All-Russian Research Institute of Chemical Technology (VNIIKhT), Moscow.

About 350 institutes, companies, and governmental organizations from the European Union, Norway, Japan, the Republic of Korea and the USA have participated in the projects related to radioactive waste management as collaborators.

The unique role of the ISTC in the promotion of cooperation to resolve the most severe environmental problems is particularly visible in the ISTC Projects No. 245 (245, 245-2B, 245-2C) Radiation Contamination Database and No. 2097 Radio-Ecological Database. These projects, led by the All-Russian Research Institute of Chemical Technology, Moscow, were financially supported by the European Union and Sweden. Project No. 245 had three phases and the main result of the work was a database containing all potential and existing dangerous radiation sources spread over the territories of CIS countries. The project led to the formation of the 'RadLeg GeoInformational Center' under MinAtom of the Russian Federation, where the database is maintained. This comprehensive computerized database permits the prioritization of territories according to potential dangers. The implementation of this project involved 26 institutions, 7 ministries, and 2 State Committees in the Russian Federation. Scientists from Kazakhstan, Kyrgyzstan, Tajikistan, Ukraine and Uzbekistan were also involved in the expert evaluation process. The Radio-Ecological Database was developed under Project No. 2097 and this, together with the modelling of radionuclide migration processes, helped to start an assessment of the impact of the sources on the environment and population and the development of recommendations on countermeasures.

3. OVERVIEW OF ISTC PROJECTS RELATED TO THE REMEDIATION OF NUCLEAR SITES

Like many other countries, the Russian Federation faces the challenge of decontaminating and remediating its territories, conditioned by the ongoing process of nuclear power plant and nuclear site decommissioning. Recognizing the global scale of these problems, the ISTC has funded many projects in this field.

Some of the projects related to remediation of contaminated soil are:

No. 0016: Development of Electrokinetic and Chemical Methods for the Rehabilitation of Soil and Ground Water Contaminated by Radionuclides and Heavy Metals, with the N.A. Dollezhal Federal State Unitary Enterprise Research and Development Institute of Power Engineering, Moscow, as the lead institute. The aim of this project was to develop a new technology for the decontamination of sites. Successful application of the technique was demonstrated in the laboratory and at a site affected by 137Cs decontamination. A state of the art complexant for the selective removal of contaminants from soil was developed together with a mobile installation for removing contaminants from soil.

No. 1567: Use of IPEC for Remediating Soils Contaminated from Nuclear and Industrial Activities, with the A. A. Bochvar All-Russian Scientific Research Institute of Non-Organic Materials, Moscow, as the lead institute. The project was aimed at the development of technique for applying new polymeric stabilizers to protect soils against wind and water erosion and to restore plant cover. The project's results have shown that interpolyelectrolyte complexes (IPEC) based

polymers are suitable for preventing radionuclide spread by wind and water erosion by combining the most contaminated finely dispersed soil fractions into larger aggregates which are more stable against erosion processes. Accidental events leading to a real contamination require a combination of efforts directed to soil stabilization to prevent the spread of radioactivity in the shortest possible time and with minimum personnel exposure.

No. 2055: Development and Demonstration of Technology for the Decontamination of Solid Surfaces and Soils by Subcritical Carbon Dioxide, with the Khlopin Radium Institute, St Petersburg, as the lead institute. The main objective of the project was the development of a decontamination technology for soils and other solids (protective clothes, individual protection equipment) using subcritical CO2. The subcritical decontamination technology developed was tested on a large scale with the use of real contaminated samples, including soils.

No. 3189: The Development of Composition and Technology of Amendment Production for Rehabilitation of Soils Contaminated by Radionuclides and Assessment of Their Application Efficiency, with the Scientific and Production Association Typhoon, Obninsk, Kaluga, as the lead institute. This is an ongoing project; the project goal is to develop a technology for producing the most effective and ecologically safe additives and organo-mineral mixtures based on natural raw material and industrial waste and a method for forecasting their efficiency. The main applications of the project are the rehabilitation of soils contaminated by radionuclides in Belarus and the Russian Federation after the Chernobyl NPP accident. Recommendations on the production of additives for soil rehabilitation will be produced.

No. B-247: 'Rehabilitation of Environmental Objects Contaminated with Radionuclides', with the Joint Institute of Energy and Nuclear Research – Sosny, Minsk, Sosny, as the Lead Institute. The project is aimed at developing a decontamination method for soil and sewage water contaminated during the Chernobyl accident and as a result of other nuclear activities. Analytical and mathematical models were developed for the electrokinetic process of water and soil cleanup. A method of decontamination, with the use of special plants to accumulate radionuclides, was developed. Two Belarus patent applications were filed on the basis of the project results.

No. B-852: 'Development of Conversion Technology for the Isolation of Radionuclide-free Cellulose and Nitrolignin from the Straw of Agrocultures as a Method for Rehabilitation and De-activation of Territories', with the Belarusian State University/Institute of Physical Chemical Problems, Minsk, as the Lead Institute. This approach was suggested for the rehabilitation of radionuclide polluted lands based on the implementation of a specially developed technology for producing pulp and paper products and soil ameliorants. This approach not only minimizes the contamination levels of affected areas but also creates a potential market for materials produced in the affected areas.

No. K-237: 'Development of Methods for Remediation of Soils with Increased Contents of Heavy Metals, Radionuclides and Improvement of Soils for Ecologically Clean Agricultural Production Systems Taking into Account the Population Health Indicators', with the Kazakh Research Institute of Fruit Growing and Viticulture, Almaty, Kazakhstan, as the Lead Institute. The objective of this project was to develop methods for the remediation of polluted geosystems and for the improvement of soils for clean agricultural production and the prophylaxis of effects on the health of the population. A new amelioration scheme for technogenic polluted soil was developed based on the principles of antagonism–synergism of elements and a change of regimes of nutrition and irrigation of crops. For medium- and heavily-polluted soils, the best ameliorates were colloid sulphur, boron with aluminium and boron with magnesium on a bio-humus background. Recommendations were made for the rehabilitation of public and environmental health in affected regions of south and south-east Kazakhstan.

No. K-632: 'Genetic Overall Examination of the Ecological Situation at the Toxic Waste Storage Koshkar-Ata and the Development of Rehabilitation Actions', with the National Nuclear Centre of the Republic of Kazakhstan/Institute of Nuclear Physics, Almaty, Kazakhstan, as the Lead Institute. The purpose of the project was to investigate the current ecological situation in the territories adjacent to the Koshkar-Ata tailings pond and to develop rehabilitation measures, taking into consideration local soil/climatic peculiarities. A primary outcome of the project was the development of proposals for stage-by-stage rehabilitation of the land. Two control sites within the project are now also part of a special governmental programme on the full-scale rehabilitation of the tailings pond. The ISTC project was central in raising awareness among state and local authorities of the need to address rehabilitation problems at Koshkar-Ata. In 2007, the Government of the Republic of Kazakhstan allocated US $1 million from the state budget for the first stage of rehabilitation and restoration at the tailings pool Koshkar-Ata.

4. CONCLUSIONS

The ISTC has played a very important role in stimulating and supporting projects focused on environmental remediation in the Russian Federation, Kazakhstan and other CIS countries. Research teams have concentrated their attention and scientific efforts on technologies suitable for environmental remediation and protection.

For specific technical information on the projects, the project recipient institutes may be contacted [2].

REFERENCES

[1] INTERNATIONAL SCIENCE AND TECHNOLOGY CENTER, Annual Reports, ISTC, Moscow (1996–2007).

[2] INTERNATIONAL SCIENCE AND TECHNOLOGY CENTER, ISTC web site, www.istcinfo.ru.