

ISOTOPE PRODUCTS MANUFACTURE IN RUSSIA AND ITS PROSPECTS.

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At an up-to-date stage of the world economy development, stable and radioactive isotopes, preparations and products on their base accompany the mankind in many aspects of its activity.

Various nuclide products are widely used in many areas of developed countries' economy, such as health protection (diagnostics and therapy, sterilization of medical pharmaceuticals and instruments), agriculture (mutational selection, studying of biogenic processes of the "plant-animal-man" system, food products sterilization), municipal economy and fuel power engineering (signal lights, sanitation of sewages, gaseous discharges and solid wastes), autonomous naval, earth and space "small" energetics, manufacturing industry (technological and process quality control), environment protection (monitoring, control of pollution flows in biological and ecological systems. And it is not surprising, that the level of manufacture and application of isotopes in research, economical and social fields of economy of the particular country is now one of the most important factors featuring its scientific, technical and industrial development.

The Russian Federation is one of the first and largest world-wide producer of a variety of nuclide products on the base of 350 isotopes. There are following types of nuclide products manufacturing in Russia:

- radioactive isotopes,
- stable isotopes,
- radionuclide radiation and heat sources
- radionuclide light sources and luminous paints,
- organic and inorganic compounds labelled with radioactive and stable isotopes,
- radionuclide generators of short-lived isotopes,
- radiopharmaceuticals

The development of isotope production in Russia, which is now a separate industry, made its start from the fifties. Initiators in creating radioactive isotopes and isotopes based products manufacture were Radium Institute of the USSR Academy of Science, at present "Khlopin Radium Institute" - Research Production Association of Ministry for Atomic Energy of Russian Federation (Minatom), and "Mayak"-Production Association of Minatom, a leader of radioisotope products manufacturers in Russia, supplying now over 50% of the total volume.

Manufacturing of stable isotopes began in Kurchatov Institute of Atomic Energy, where the basis of future large-scale production with electro-magnetic method was found. Later this method was applied under the guidance of the specialists from the Kurchatov Institute in the "Electrochimpribor" Plant, Ekaterinburg. Nowadays, about 50 research and production groups from various branches and departments of Russia participate in development of nuclide products manufacture and assist in improvement of the quality of the products.

The isotope production developed actively in the former USSR within period from 1970 to 1990. At that time the sales of isotope products effected by the enterprises of Minatom, Ministry for Chemical Industry, Ministry for Public Health, Academies of Science of the USSR, Belorussia, Ukraine and Uzbekistan increased in more than 3 times and reached 68,7 million roubles in 1990, including export sales exceeding 10 million dollars. In this volume, the share of Minatom enterprises, located in Russia, amounted to approximately 68%. After disintegration of the USSR about 90% of all production capacities for nuclide products manufacturing remained in the Russian Federation. At present the production of radioisotopes in Russia is in progress, unlike the majority of other industries. A growth of the export sales of the isotope products, shown on Figure 1, proves it visually.

Russian Ministry for Atomic Energy coordinates activity for technical development and structuring of production and supply of isotope products for the economy of the country. During the years of isotope industry development, several production centers appeared in Russia, specializing in manufacture and supply of certain products. Structure of the main Russian producers of the radioisotope products is shown at Figure 2.

Chelyabinsk region

Production Association "Mayak", the largest Russian manufacturer of the radioisotope products, has a great scientific and technical potential. Over 50% of the total volume of the radioisotope products are produced at this enterprise. "Mayak" is specialized in manufacturing of reactor and fission isotopes, such as Carbon-14, Cobalt-60, Iridium-192, Krypton-85, Strontium-90, Caesium-137, Americium-241, Promethium-147, etc. Fission isotopes are isolated from aqueous solutions of tailings from the NPP Irradiated Fuel Regeneration Plant. "Mayak" is also the main producer of radiation sources on the base of Cobalt-60, Iridium-192, Caesium-137, Americium-241, Selenium-75 and other alpha-, beta-, gamma- and neutron-emitting radioisotopes. Besides, the enterprise supplies radionuclide heat sources on base of Strontium-90 and Plutonium-238, used in thermoelectrical generators for energy power supply in meteorological equipment and devices for navigation or space purposes.

Kaluga region

Another largest center of radioisotope products manufacture is situated in Obninsk, 100 km from Moscow. The center has reliable transport links with the biggest Russian airports (Sheremetjevo, Domodedovo and Vnukovo) as well as Moscow railway stations. It ensures effective supply of products, and short-lived isotopes in particular, to customers both within and outside Russia.

1. The largest production of cyclotron radioisotopes was created in Obninsk (Joint Stock Company "Cyclotron" established on base of Russian Institute of Physics and Energetics).

The cyclotron was put into operation in 1963. Since that time there were several reconstructions purposed to achieve more favorable conditions for production of radioisotopes and to improve reliability and stability of the cyclotron operation.

At present, the cyclotron allows to use either protons with energy up to 28 Mev or deuteriums with the same energy for radioisotope production. The highly intensive internal beam is used. Special target devices enable to irradiate initial material by

the internal beam with intensity up to 750 microamperes. As a rule, the enriched stable isotopes in metal form are used as the materials to be irradiated.

About 20 radioisotopes are currently produced at "Cyclotron". Among them Sodium-22, Cobalt-57, Gallium-67, Cadmium-109, Indium-111 and Thallium-201 are of the biggest demand. Manufacturing of these isotopes takes about 90% of the cyclotron operation time. Besides them, Beryllium-7, Titanium-44, Iron-55, Germanium-68, Strontium-85, Cerium-139, Tungsten 181, Bismuth-207 and other isotopes are produced and regularly supplied as well.

"Cyclotron" in Obninsk supplies radioactive isotopes in form of radiochemical preparations, moessbauer sources (Cobalt-57), sources for roentgen-radioluminescent analysis (Cobalt-57 and Cadmium-109) and for medical gamma cell calibration (Cobalt-57). At present this cyclotron completely meets the Russian needs for the above stated radioactive isotopes. A significant quantity of the cyclotron produced radioisotopes is supplied abroad (especially Cobalt-57).

The second cyclotron is planned to be put into operation in the same building in 1997, which will ensure further growth of production and application of cyclotron radioisotopes, including industrial production in Russia of Iodine-123 for medical purposes.

2. At the State Scientific Center of Russian Institute for Physics and Energetics, which is one of the largest nuclear research center in Russia with a number of Research Thermal and Fast Neutron reactors and significant radiochemical resources, the reactor production of short-lived and fission isotopes was arranged for manufacturing of medical and biological preparations, such as Molybdenum-99, Xenon-133, Phosphorous-32, Phosphorous-33. Besides, Technetium-99m generators and Xenon-133 radiopharmaceuticals as well as wide range of Phosphorous-32, Phosphorous-33, Sulphur-35 labeled compounds (nucleotides) for application in molecular biology and genetic engineering are produced there too. At present, the production of Indium-113m generators and radiopharmaceuticals with Gallium-67, Strontium-89, Phosphorous-32, Gold-198 and Thallium-201 is close to its start.

3. The Branch of Karpov Physics and Chemistry Research Institute has VVR-tape reactor with the flux 1.2×10^{14} n/cm² sec and radiochemical resources for manufacturing of radioisotope products. To provide regular production of Technetium-99m generators in cooperation with the Institute for Physics and Energetics, the Branch of Karpov Physics and Chemistry Research Institute arranged the manufacture of Molybdenum-99 and Technetium-99m generators on the base of its own reactor complex. Simultaneously, along with Molybdenum-99, the Branch of Karpov Institute produces Xenon-133 and supplies it to the Institute for Physics and Energetics, which in its turn makes radiopharmaceutical preparations with Xenon-133. But first of all, this Institute is the main Russian producer of Iodine-131 and radiopharmaceutical preparations on its base for the needs of medical institutions in Russia.

Uliyanovsk Region.

State Scientific Center of Russian Federation of Research Institute for Nuclear Reactors (RINR) is the leading Russian research nuclear center with up-to-date

reactor base, including CM-3 reactor with the density of neutron flux up to 25×10^{14} n/sm²sec.

Besides the high-flow reactor CM-3, this nuclear center has a loop channel reactor MIR, 3 pool-reactors RBT and a fast-neutron reactor BOR-60. All these reactors are used in one way or another for radioisotopes production. There is a complex of radiochemical and technological equipment in the Institute, including the hot chambers patterns for radioisotopes manufacturing too. RINR, possessing a unique research reactor base, is specialized first of all on production of the wide range of transplutonium elements beginning from Plutonium to Fermium, which may be accumulated in practically considerable quantities only in high-flux reactors.

Over the last 10-12 years the Center has been carrying out the work on making some radioisotopes with high specific activity: Phosphorous-32 and 33, Cobalt-60, Iron-55 and 59, Nickel-63, Tin-112 and 119m, Strontium-80, Gadolinium-153, Iridium-192, etc.

Apart from the preparations of high activity, the Center stock-produces unique sources on base of Californium-252, Curium-244, Cobalt-60, Gadolinium-153, Iridium-192, Selenium-75 and others. These sources are used industrial radiography, technological control devices, medicine, etc.

Leningrad Region.

1. "Technochim" Pilot Plant of the State Institute for Applied Chemistry (SIAP) is the largest producer of labelled compounds. It is specialized in production of preparations, containing radioisotopes, organic and inorganic compounds, including biological active ones, labelled with Tritium, Iodine-125, Phosphorous-32, Phosphorous-33, Carbon-14, Deuterium and also radioactive sources with Cobalt-57, Cadmium-109, Iron-55, Tin-119 m, Nickel-63, Gadolinium-153 and other isotopes for radiography fluorescent analysis and nuclear gamma resonance. Radioactive isotopes for manufacturing of SIAP's production are supplied from Minatom's enterprises.

2. "Khlopin Radium Institute", Research Production Association of Minatom also produces a number of complex organic Tritium labelled compounds, such as nucleotides and sugar nucleosides, used in molecular biology and experimental medical researches. The Institute also supplies radiopharmaceutical preparations with Iodine-123 and Technecium-99m for St.-Petersburg region.

Nizhny Novgorod Region.

Electromechanical Plant "Avangard" is specialized in production of preparations and sources of ionized irradiation with Polonium-210. Besides, a unique base for testing of heat sources on base of Polonium-210 and Plutonium-238 for space and navigation, is created here.

Moscow

There is a number of Institutes and enterprises involved in manufacture of radioisotope products in this region as well.

1. In the former Soviet Union "Medradiopreparat" Plant of the Russian Ministry for Public Health was the only producer of radiopharmaceuticals, such as: Technetium-99m and Indium-113m generators, preparations on the base of Iodine-131, Iodine-125, Gallium-67, Indium-111, Gold-198, Mercury-197 and other isotopes. However,

since 1986 taking into account the ecologically unfavourable location of the plant in the populous area of Moscow, Minatom of Russia started the planned transference of the radiopharmaceuticals production to Obninsk enterprises, which have high-capacity resources for manufacturing of cyclotron and reactor short-lived isotopes. The systematic actions of Minatom to this purpose allowed yet in 1990 to transfer completely the production of Molybdenum-99, Technetium-99m generators, and later of radiopharmaceutical preparations with Xenon-133 and Iodine-131 to the Institute of Physics and Energetics and to the Branch of Karpov Institute. At present this work is going on, and it is planned in 1997-1998 to run in the wide range of radiopreparations with Iodine-131 in the Branch of Karpov Institute, and Indium-113 m generators as well as radiopharmaceutical preparations with Gold-198, Mercury-197, Gallium-67 and Indium-111 - in the Institute for Physics and Energetics. Realization of these projects will enable to move radiochemical production from Moscow with a 9 million population to the enterprises, which have their own reactors, cyclotrons and radiochemical resources.

2. At the Institute for Molecular Genetics of Russian Academy of Science, more than 200 most complex Tritium labelled biological active substances, including nucleotides, nucleosides, amino-acids, peptides and others, are produced. These products are supplied to Russian research centers.

Additionally to the above stated enterprises of some regions of Russia, some short-lived medical radioisotopes (radiopharmaceutical preparations with Thallium-199, Sodium Pertechnetate, Technetium-99m and Iodine-123) are produced in Tomsk and St.Petersburg.

Russia parallel with the USA is the world's largest producer and supplier of stable isotopes. The ancestor of stable isotope production in the USSR was Kurchatov Institute for Atomic Energy, where in the fifties the first experimental installations were created, technological principals and method of molecular division were developed. Later in city of Ekaterinburg in "Electrochimpribor" Plant the industrial production of stable isotopes by means of electrochemical method was created.

At the present time, there are four main producers of stable isotopes in Russia : "Electrochimpribor" in Ekaterinburg, Electrochemical Plant in Krasnoyarsk, Kurchatov Institute for Atomic Energy in Moscow and Centrotech in St.Petersburg, which produce in total more than 200 stable isotopes. Considerable part of them is exported.

On the basis of SSC RF of Physics and Energetics Institute in Obninsk, Scientific Technical Center of Stable Isotopes (STC SI) was established. It possesses a Fund of 49 isotope elements, which was created within last 30 years. The Fund is widely used by scientific and research centers of the country for various researches in nuclear physics with employment of targets with enriched stable isotopes, granted by STC SI on lease. A certain part of the Fund is used for deliveries of the enriched stable isotopes to the enterprises both in Russia and abroad.

Thus the established structure of radioisotope production allows completely to meet the needs for radioisotopes and products on their base within Russia and to export these products as well.

In accordance with "The Federal Law on the Nuclear Energy Employment", the government of the Russian Federation sanctioned a procedure for export and import of radioactive materials and products, based on them. According to these rules, import and export of radioisotopes is carried out under the licences of Ministry for Foreign Economic Relations and Trade of Russia (MFERT). In its turn the MFERT issues these licenses only on the ground of applications of the companies, agreed with Ministry for Atomic Energy of RF (Minatom) and in some cases with Committee for Export Control of RF and Federal Supervision of Russia for Nuclear and Radiation Safety (Gosatomnadzor).

To obtain a licence for import of radioisotope products for medical purposes, it is necessary to apply to Ministry for Public Health of Russia as well, providing all the documents and licenses of the above stated responsible bodies, and besides, the statement of Minatom of Russia about impossibility to manufacture the similar products by Russian enterprises.

No licences are required for export and import of radioisotope products with half-life period less than 10 days as well as of the products with small content of radioactive materials, which not subject to the State Safety Rules for Transportation of Radioactive Materials, except import of products for medical purposes.

It is necessary to note, that any radioactive isotopes, materials and depended products, either exported from the Russian Federation, or imported to it, subject to customs control and official registration in accordance with the Russian legislation.

Ministry for Foreign Economic Relations and Trade issues both general and individual licences for enterprises. At present time, Production Association "Mayak" has general licences for export of the products, manufactured in its own facilities, and the Foreign Trade Company "Techsnabexport" has general licences for export of the most of radioactive products, manufactured by different producers in Russia.

"Techsnabexport", now the main exporter of isotope production, is one of the oldest foreign trade companies in Russia with more than 30-year experience of active work on the world market. "Techsnabexport" is a joint-stock company and among its main shareholders are the largest production enterprises of nuclear fuel power cycle of Minatom. Ministry of Finance and Ministry for Foreign Economic Relations of Russia are the main founders and shareholders of "Techsnabexport" too.

The annual turnover of "Techsnabexport" exceeds 1 billion US Dollars.

Thus "Techsnabexport" is the leading foreign trade company working in close contact with Minatom and other main state ministries and presenting interests of Minatom's production enterprises on the world market.

"Techsnabexport" has long-term firm business relations with all manufacturers of isotope production, listed above.

The cooperation forms are constantly in process of changing and reflect quick alterations in the economy of Russia and international practice of foreign trade.

Thus for example in 1992 "Mayak" and "Techsnabexport" together with British company "Amersham" organized Russian-British joint-stock company "Reviss", which is specialized in export of radioisotope production of "Mayak". The annual volume of trade transactions through this company has increased from 6,0 million USDollars in 1992 to 13,0 US Dollars in 1994.

With other enterprises "Techsnabexport" works as foreign-trade intermediary-commissioner. In that way the production enterprises enjoy the possibility of using the many years experience and knowledge of foreign trade activity, branched distribution and agency network of "Techsnabexport" all over the world. Besides, "Techsnabexport" as the company, specializing in export of isotope production, has general licences of state bodies that speed up considerably the process of concluding contracts and fulfilling of physical deliveries to end-users of such specific products as isotopes.

The dynamic of export volume increase under direct contracts of "Techsnabexport" with foreign consumers, looks as follows:

1992	1993	1994
10,0 million \$	10,5 million \$	12,1 million \$

The nomenclature of export production consists of the whole range of above mentioned radioactive and stable isotopes, the main of which are: Cobalt 57 and 60, Phosphorous-33, Nickel-63, Germanium-68, Iridium-192, Cesium-137, Thallium-203, Zinc-68, Cadmium-112 and 114, Krypton-82 and 85, and also "Depleted zinc".

In 197-1998 we expect considerable growth of isotope products' export from Russia, connected with broadening of traditional spheres of application and industrial use of isotopes in new high-technological branches.

Russian manufacturers of isotope production are, as they were before, on the leading positions among the same enterprises of the world. High production quality and authority of reliable business partners attract foreign consumers and allow to establish strong and close connections.

From this point of view strengthening and development of partnership, exchange of scientific and technological knowledge,, cooperation in different forms - are main tasks and purposes of all Russian Minatom's enterprises. We welcome such cooperation and are open for it.

Thus, as you can see, Russia has large realistic technical potential for production of stable and radioactive isotopes, and also of various products on their base. Export of these products is in dynamic progress, as it is shown at Figure 1. The scientific and technical potential of the country allows to increase their export some times as large. We are open for discussing of concrete orders for deliveries of all the types of isotope products, manufactured by Russian enterprises.

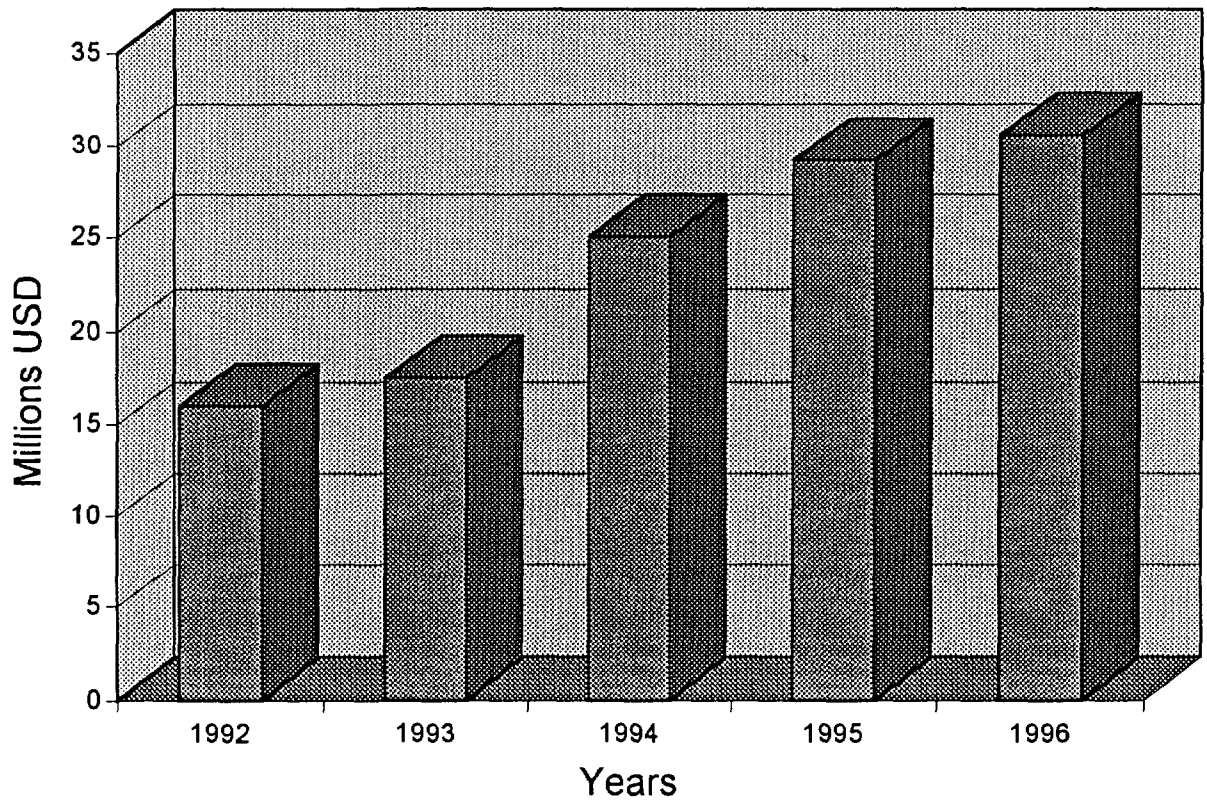
Figure 1: Isotope Products Export Sales

Figure 2: Russian Manufacturers of Radiosotope Products

