

Transformation of the Vinča Institute of Nuclear Sciences into the Vinča Science and Business Park

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Abstract

We describe here the idea to transform the Vinča Institute of Nuclear Sciences (VINS) and the public corporation Nuclear Objects of Serbia (NOS) into the Vinča Science and Business Park (VSBP). According to this idea, VSBP would be a business association of various institutions involved in research, development, production, and provision of services in the fields of natural and technical sciences, science with accelerators, nuclear energy, and radiation and nuclear safety and security. Its long-range objectives would be (i) to solve permanently the existing problems of radiation and nuclear safety and security in Serbia, connected to the nuclear reactors and radioactive waste in NOS and VINS, (ii) to complete the construction and begin the use of the medium and high energy parts of the TESLA Accelerator Installation, in VINS, in the fields of science and medicine, primarily for industrial production of radiopharmaceuticals for positron emission tomography in medical centers in Serbia, (iii) to contribute substantially to the strengthening of research and development in Serbia, especially with accelerators and nuclear reactors, and (iv) to enable the renewing of education in the fields of science with accelerators and nuclear energy in Serbia.

1. Introduction

In 1948 in the village in Serbia at the outskirts of Belgrade called Vinča, the Government of Yugoslavia founded the first modern research institution in the country. The mission that was conferred to it was to study the structure of matter. However, a few years after that, following the clear trends in similar institutions in developed countries, the institution began to direct its research to nuclear sciences. Today, the institution is called the Vinča Institute of Nuclear Sciences (VINS).

In Yugoslavia, there have been two nuclear programs – the first in the period between 1955 and 1970, and the second between 1978 and 1989. In both cases, the main objective was to develop nuclear technologies necessary for construction and use of nuclear power plants. In the former case, that should have been done independently, and in the latter case in collaboration with other countries. Within the former nuclear program, in 1958 in VINS, the RB reactor was commissioned. It was a zero-power research nuclear reactor constructed by the experts of VINS. Further, in 1959 also in VINS, the RA reactor was commissioned. It was a research nuclear reactor of the power of 6.5 MW constructed by the experts from the USSR. During the realization of the latter nuclear program, but independently from it, in 1981, the first nuclear power plant in Yugoslavia was commissioned – in the village in Slovenia near the border with Croatia called Krško. It was a plant of the power of 700 MW constructed by the US company *Westinghouse*. However, when one compares the results of those nuclear programs with their objectives, they can be evaluated as modest. In spite of the good initial conditions, the nuclear technologies were not developed. The former nuclear program was shut down soon after its financing had been transferred from the federal to republican levels, and the latter one immediately after passing the *Law on banning construction of nuclear power plants*.

In 1989, immediately after shutting down the latter Yugoslav nuclear program, the Government of Serbia made the decision on construction of the TESLA Accelerator Installation (TAI), in VINS, as a multipurpose facility for production, acceleration and use of ions in science and medicine. However, in spite of the fact that the construction and preparations for use of TAI had been put under the regular control of two highly competent international bodies, the financing of the endeavor was being insufficient and irregular. The main reason for that was the severe political and economic crisis in the country since the beginning of the 1990s. In 2007, the Government of Serbia made the decision to stop the financing of construction of TAI from the budget of Serbia and to continue the financing on the basis of the clearing debt of Russia to Serbia.

In 2009, the Government of Serbia founded the public corporation Nuclear Objects of Serbia (NOS). The task that was given to it was to govern the nuclear objects in Serbia, which had previously belonged to VINS. These objects are: the RA and RB reactors, three hangars for temporary deposition of solid radioactive waste, a temporary depository of high activity radioactive sources, four tanks for temporary deposition of liquid radioactive waste, and a facility for processing radioactive waste.

2. Problems

2.1. Problems of the Vinča Institute of Nuclear Sciences

The major current problems of VINS are: the lack of a clear concept of its development, and the financial resources needed for the completion of construction of the medium and high energy parts of TAI.

In about three previous decades, the development of VINS has been going on without a clear concept. Today, it is a loose association of 20 laboratories and centers without any larger scientific project of the strategic importance for Serbia. Also, almost all the laboratories of VINS are in fact the groups of more or less independent individuals that, in accordance with the existing rules of financing scientific work in the country, struggle for as good as possible quantitative results, which directly determine their salaries. As a consequence of such a heterogeneity, a large number of different and often opposing interests exists, and one cannot talk today about the joint scientific interests of VINS.

The current problems of TAI are the following:

- Completion of upgrading FAMA, being the low energy part of TAI
- Completion of equipping the H4 building, being the medium energy part of TAI
- Completion of construction and preparations for use of the VINCY Cyclotron, being the high energy part of TAI

FAMA is a user facility for basic and applied research in the field of modification and analysis of materials with ion beams. Its upgrading, financed on the basis of the clearing debt of Russia to Serbia, should be completed in 2013. In the H4 building, which has already been erected, the industrial production of cyclotron radiopharmaceuticals, primarily for positron emission tomography (PET), for medical centers in Serbia should be established. The production should be going on with a cyclotron delivering protons of the energy of 18 MeV. The VINCY Cyclotron should be delivering protons of the energies between 30 and 75 MeV to be used for routine therapy of eye tumors, for research in the field of radiation biology connected to proton therapy, for experimental production of radionuclides and radiopharmaceuticals for PET and therapy, and for research in the fields of materials science focused on analysis of materials and on channeling in thin crystals and nanotubes.

2.2. Problems of the public corporation Nuclear Objects of Serbia

In 2012, NOS successfully completed the job of transferring the used fuel of the RA reactor to Russia, as the country of its origin. The amount of the fuel was about 2.5 t. The realization of the job was organized by the International Atomic Energy Agency (IAEA), Vienna, Austria, and financed by the Government of Serbia, IAEA and US nonprofit organization Nuclear Threat Initiative (NTI).

The use of the RA reactor was stopped in 1984. In 2002, the Government of Serbia made the decision to decommission it. The RB reactor is still in use. However, its radiation protection system and control and safety system should be refurbished. After that, it would be a machine for applied research in neutron physics, metrology and radiation protection, and for development of nuclear techniques. It would enable NOS to form a team of scientists and engineers capable of a detailed following of research and development in the field of nuclear energy worldwide.

In NOS, there are about 850 and 280 m³ of processed and unprocessed solid radioactive waste, respectively, in the first and second hangars, and about 800 m³ of liquid radioactive waste, in the four tanks. Besides, in several laboratories of VINS there are certain quantities of irregularly stored unprocessed radioactive waste. In the process of decommissioning the RA reactor, these quantities of radioactive waste will increase significantly. All the existing and future radioactive waste should be deposited temporarily in the third hangar. According to the *Law on protection from ionizing radiations and on nuclear safety*, all the radioactive waste in Serbia must be transferred to a permanent depository of radioactive waste by 2019. However, its location has not yet been determined.

The major current problems of NOS are the financing and organization of the following jobs:

- Decommissioning the RA reactor
- Refurbishment of the RB reactor
- Use of the third hangar for temporary deposition of solid radioactive waste
- Use of the temporary depository of high activity radioactive sources
- Completion of construction and use of the facility for processing radioactive waste
- Decommissioning the first and second hangars for temporary deposition of solid radioactive waste
- Decommissioning the four tanks for temporary deposition of liquid radioactive waste
- Construction of the permanent depository of radioactive waste in Serbia
- Possibility of illicit trade of the deposited radioactive waste

The major joint current problems of VINS and NOS are the dilapidation and impossibility of regular maintenance of the infrastructure systems and communication lines as well as the regular transport of the employees.

3. Possible solutions

The crucial step to be undertaken with the aim to initiate the solving of the above described major current problems of VINS and NOS is the founding of the Vinča Science and Business Park (VSBP). It would be a business association of various institutes and companies involved in basic and applied research, development of methods and technologies, production, and provision of services in the fields of natural and technical sciences, science with accelerators, nuclear energy, and radiation and nuclear safety and security. The founder of VSBP would be the National Assembly of Serbia through a special law that would include

a series of measures for stimulating its fast expansion, primarily by including in it small and medium enterprises interested in development of accelerator and radiation technologies.

The first members of VSBP would be the following:

- VINS, renamed the Vinča Institute (VINI), which would be a research institute
- The part of VINS connected to TAI, named the Institute of Science with Accelerators (ISA), which would be a research and development institute
- NOS, which would be a public corporation for research, development and provision of services
- The parts of VINS and NOS connected to the infrastructure systems, named the Vinča Joint Services (VJS), which would be a public corporation for provision of services

In this transformation of VINS and NOS, each of the first three mentioned institution would become a member of VSBP on the basis of a long-range development plan, which has to be approved by a highly competent international body and the Government of Serbia. The long-range development plan of VINI would also contain the plan of its reorganization, prepared with the objective to make its laboratories and centers much stronger and capable of conducting well-organized advanced basic and applied research and intensive international collaboration.

VSBP would be responsible for the coordination of programs, projects and jobs realized by its members, independently or through their collaboration. This is related primarily to programs, projects and jobs connected to radiation and nuclear safety and security, and to industrial production of cyclotron radiopharmaceuticals. The activities of VSBP would also include the coordination of participation of its members in the realization of programs of universities in Serbia, primarily in renewing education in the fields of science with accelerators and nuclear energy.

VSBP would establish special relations with IAEA, the European Organization for Nuclear Research (CERN), Geneva, Switzerland, the Joint Institute for Nuclear Research (JINR), Dubna, Russia, and a few accelerator centers in Europe.

The problem of completion of construction of the medium and high energy parts of TAI would be solved through the state loan the Government of Russia approved to the Government of Serbia in October 2009. VINS and five major medical centers in Serbia have already applied for financing the realization of a scientific and medical infrastructure project from this loan. It would comprise (i) the industrial production of radiopharmaceuticals with an 18 MeV proton cyclotron placed in the H4 building, (ii) the forming of diagnostic PET units in the five medical centers, and (iii) the routine proton therapy of eye tumors as well as the research, development and experimental production in the fields of radiopharmacy, radiation biology and materials science with the VINCY Cyclotron. As a result, TAI would become a large scale scientific, medical and educational facility of South Eastern Europe.

The problems of decommissioning the RA reactor and of construction of the permanent depository of radioactive waste in Serbia, which are necessarily associated with very large financial resources, would be solved within the process of introducing nuclear energy in Serbia. Namely, the idea is to launch these two jobs as the preliminary jobs within the construction of a nuclear power plant in Serbia. The depository would be constructed in a way to enable its use for deposition of radioactive waste from the plant as well. The representatives of VINS have discussed this idea with the representatives of the Government of Serbia and of the multinational company groups *GDF Suez* and *Areva*. The representatives of *GDF Suez* estimated its participation in the realization of the idea as attractive and feasible.

4. Conclusion

Our conviction is that a successful founding and development of VSBP would lead to the following:

- Permanent elimination of the possibility of illicit trade of the radioactive waste deposited in NOS and VINS
- Initiating the process of introducing nuclear energy in Serbia
- Regular distribution and use of cyclotron radiopharmaceuticals in medical centers in Serbia
- Introducing proton therapy of eye tumors in South Eastern Europe
- Intensive scientific and educational collaboration in the fields of radiopharmacy, radiation biology and materials science in South Eastern Europe.