A. NUCLEAR ENERGY

A.1. THE FUTURE OF NUCLEAR ENERGY

NATIONAL NUCLEAR SCIENTIFIC PROGRAM

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ABSTRACT

National scientific program of the VINČA Institute NUCLEAR REACTORS AND RADIOACTIVE WASTE comprises research and development in the following fields: application of energy of nuclear fission, application of neutron beams, analyses of nuclear safety and radiation protection. In the first phase preparatory activities, conceptual design and design of certain processes and facilities should be accomplished. In the second phase realization of the projects is expected.

Key words: nuclear reactors, radioactive vwaste, scientific program, research and development

Introduction

National scientific program of the VINČA Institute NUCLEAR REACTORS AND RADIOACTIVE WASTE comprises research and development in the following fields: application of energy of nuclear fission, application of neutron beams, analyses of nuclear safety and radiation protection. In the first phase preparatory activities, conceptual design and design of certain processes and facilities should be accomplished. In the second phase realization of the projects is expected.

The program NUCLEAR REACTORS AND RADIOACTIVE WASTE encompasses the following tasks:

1. Final shut down of the RA research reactor;
2. Provision of long term storage for spent fuel from the RA research reactor;
3. Refurbishment of the RB research reactor and design of the new research reactor H5B;
4. Building of the final repository for low and medium level radioactive waste.

The aim of the program NUCLEAR REACTORS AND RADIOACTIVE WASTE is to maintain the existing and to form new scientific and professional manpower in different fields of sophisticated nuclear technologies and to provide possibilities for application of the acquired knowledge and the available facilities. Application of particular procedures, originating from nuclear

technology, in industry, medical sciences, biology and environment protection will result in the general technological development of the country and in intensification of the scientific and technical international cooperation.

1. Final Shut Down of the Research Reactor RA

The Research Reactor RA was shut down in August 1984 in order to refurbish and reconstruct some of its systems and components. Since for a number of reasons this reconstruction has never been completed, it is now proposed to make a decision about final shut down of the RA reactor. This proposal is primarily based on the fact that at the VINČA Institute of Nuclear Sciences it would be difficult to form a group of engineers willing to take a responsibility to start again the RA reactor. Besides, there does not exist a single group of scientists showing interest to equip an experimental channel at the reactor and to use it during a longer period of time. However, in spite of these difficulties, in the frame of the program of final shut down of the RA reactor it is planned to consider a possibility to transform RA reactor into a reactor of the power of several hundreds kW.

Before the decision about the final shut down of a research nuclear reactor is made, it is necessary to complete preparatory activities on the organization and planning of decommissioning, and before the reactor is finally shut down, detailed plans for its decommission should be prepared. Planning of the reactor decommissioning is performed in order to identify and to define basic requirements as: decommissioning options; advantages to be achieved by the decommissioning process; methods, means and procedures needed to realize these advantages; specification of financial sources, organization and responsibilities; time schedule for realization of the decommission in order to accomplish the specified goals. Once the global decommissioning strategy is defined, the detailed plan can be made, covering all aspects of decommissioning procedure.

Presently, one of the basic requirements already at the time of construction of new nuclear facilities, is the existence of the decommissioning plan. According to the experience from all over the world, for a nuclear facility as RA research reactor, which did not have an elaborated decommissioning plan at the time of construction, 5 to 10 years are needed to plan all the necessary decommissioning activities and procedures. After the final shut down of the RA reactor, it will be necessary to provide different technological procedures and activities, which will make the reactor building harmless to the environment from the point of view of radiological protection. If the reactor RA site and/or reactor RA building are not to be used for other purposes, activities and technological solutions have to be planned to provide the safe isolation of the facility. If it is planed to use at the reactor RA site for building a new or reconstructed reactor, or some other facility, it is necessary to plan a partial or total destruction of the RA reactor. Decommission of a research reactor to this phase results in a large quantity of radioactive waste which has to be conditioned and disposed in accordance with the national policy of final disposal of radioactive waste. From this it follows that existence of the possibility for final disposal of radioactive waste is a first prerequisite for implementation of a decommissioning plan.

In the mean time, before all requirements for implementation of a decommissioning plan are fulfilled, restarting of the RA reactor and operating at low power could be an optimal solution for the future status of this facility, taking into account the available fresh fuel and heavy water, the state of the reactor systems and components, as well as the existing reactor staff. Operating the RA reactor at low power (e.g. 250 kW) a small amount of additional spent fuel would be produced, which could be placed in the existing spent fuel storage pool for the next few years. It can be expected that in this period the problem of final or long term storage of the existing RA reactor spent fuel will be successfully solved.

2. Construction of the long term storage for spent fuel from the research reactor RA

While reconsidering the future status of the research reactor RA it was concluded that the state of the existing spent fuel storage pool can represent a serious safety problem which requires prompt

actions. The Project "Sanation of the spent fuel storage pool at the RA reactor" was formulated in 1996, and its realization started at the same time. The project comprised the following tasks: removal of sludge from the bottom of the pool; purification of the water in the pool and establishing regular monitoring of the radiochemical parameters of this water; visual inspection of the fuel in stainless steal channel type spent fuel containers and radiochemical analyses of the water samples from these containers; underwater drilling of the aluminum spent fuel containers, measurement of the internal gas pressure and radiochemical analyses of gas and water samples taken from the aluminum containers; on the basis of the above results, making plans for future management and storage of the RA reactor spent fuel. Most of these works are completed and finalization is scheduled for the end of this year.

The result of the above activities will be the increased safety of the existing spent fuel storage facility in the sense that strict monitoring and control of the radiological parameters will be established and that an uncontrolled release of the fission products into the reactor building or its surrounding will be minimized.

However, it is known that the only long term solution for storing the aluminum cladded spent fuel is reprocessing or provision of dry storage conditions. Since it can hardly be expected that in the immediate future the RA reactor fuel will be transferred back to the supplier, design and construction of domestic dry spent fuel storage facility are planned. Realization of this task is closely related to the decision about the future status of the RA reactor.

3. Refurbishment of the RB reactor and design of the reactor H5B

In the frame of the program of revitalization of the existing nuclear facilities and construction of the new ones, refurbishment of the zero power research reactor RB, built in 1958, is planned. By modernization of the technological systems of the RB reactor it is expected to achieve improvement of its performances, safety characteristics and availability. By improving the basic conditions for multipurpose experimental work, improved experimental possibilities will be offered to the potential users of the RB reactor.

At the same time the work has been started to construct a new subcritical reactor operated by a beam from the future TESLA accelerator installation. In the first phase, a conceptual design will be made for a subcritical low power reactor at the H5B channel of the TESLA accelerator installation, run by a beam of protons or deuterons from the cyclotron VINSY. The aim of this project is to provide conditions for theoretical and experimental work on the new nuclear technologies, known to be under development in the world for transmutation, i. e. burn up, of radioactive waste and for production of transuranium nuclides.

4. Construction of the central long term radioactive waste repository

Radioactive waste materials, resulting from operation and maintenance of the research reactors RA and RB, as well as from production and application of radioactive isotopes for medical, industrial and research purposes at the whole territory of the former and the present Yugoslavia, are all stored at the site of the VINČA Institute of Nuclear Sciences. These radioactive materials are conditioned and stored in such a way that presently they do not represent any threat to the environment or to the population. Safety requirements of storing the existing radioactive waste are satisfied in accordance with the legislation regulating radiological protection matters. However, with the present level of radioactive waste generation in the country, the capacity of the temporary waste storage at the VIN^A Institute is sufficient for maximum 4 to 5 years from now. Thus, building of a new, permanent radioactive storage facility at an appropriate location, will be mandatory.

The program of providing a national permanent radioactive waste repository comprises the following tasks: design and construction of the permanent radioactive waste disposal facility at an appropriate location; transformation of the low and medium radioactive waste materials into immobilized forms, the solidificated waste monolith; transport and storage of the solidificated radioactive waste matrix at the location of the permanent waste disposal facility; realization of

possibilities for permanent monitoring and control of the treated radioactive waste inside the permanent repository.

The basic prerequisites for design and construction of a national permanent radioactive waste repository are the decisions, at the level of FR Yugoslavia and R. Serbia, about the choice of the location for this facility and the choice of the type of the facility. Namely, potential locations for permanent disposal of the radioactive waste materials have to be specified in the General space plan of FR Yugoslavia and R. Serbia. Then follow investigations of the topography, surface characteristics, geology, hydro-geology, seismic, tectonics, geochemistry and geophysics, as well as socio-economical and demographic analyses for the potential micro-locations. According to the category and type of the radioactive waste material to be disposed, the supposed technological procedures for waste conditioning and the expected form of conditioned immobilized waste monolith, and having in mind the characteristics of the possible sites for the permanent waste repository, it is suggested to consider the surface type of the repository.

For conditioning the existing liquid and solid radioactive materials, having different levels of radioactivity, it is necessary to complete the facility at the VINČA Institute, built for this purpose. Radioactive waste materials stored at the VINČA Institute site should be converted into the form and composition which make possible their transmutation into inactive immobilized waste matrixes, either at the VIN^A Institute site or at the site of the permanent waste repository. The already conditioned waste should also be treated in order to transform it into matrixes resistant to chemical or mechanical damages.

CONCLUSIONS

The national nuclear scientific program is in the near future mainly oriented towards solving the problem of eventual decommissioning of the research reactor RA, long term storage of spent research reactor fuel and final disposal of radioactive waste. However, finding a solution for nuclear waste is a key issue not only for the protection of the environment, but also for the future of nuclear energy.
Five or ten years from now, when decisions about introducing nuclear power plants will have to be made, the general public will require to know solution for nuclear waste before accepting the new technology. Acceptable solutions for the management of nuclear waste and spent fuel, as well as continuous research activities in the field of reactor physics and safety, are the prerequisite for introduction of nuclear power.