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# ENRICHMENT REDUCTION PROGRAM ON THE TRAINING REACTOR VR-1

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The training nuclear reactor VR-1 "VRABEC" (means "SPARROW") is a relatively small experimental nuclear facility, which was started up on December 3, 1990 at the Faculty of Nuclear Sciences and Physical Engineering, CTU in Prague. Its main orientation is on education and training of students and experts in the nuclear fields of study.

The VR-1 reactor is a typical pool-type light demineralised water reactor with middle-enriched uranium as fuel. It is a doublepool reactor with open water surface and with vessels (pools) separable by means of watertight closure (gate). The active core is placed in one pool, the other pool is disposed for experimental equipment and for the storage of irradiated fuel assemblies unused at the moment [2].

The power of VR-1 reactor is: nominal 1 kW, for short period up to 5 kW (thermal).The fuel assembly, IRT-2M type (from the former USSR), consists of four concentric tubes with $UO_2$ dispersed in an aluminium matrix and covered with an Al layer. The fuel enrichment represents 36 % $U^{235}$.

The Reduced Enrichment Research and Test Reactor (RERTR) Program was established in 1978. The primary objective of the program is to develop the technology needed to use Low-Enrichment Uranium (below 20 % $U^{235}$) instead of High-Enrichment Uranium in research and test reactors, and to do so without significant penalties in experiment performance, economic, or safety aspects of the reactors. In Czech republic the RERTR Program will be realised in very efficient cooperation between VR-1 reactor and LVR-15 research reactor (operated in Nuclear Research Institute in Rez) [1].

The reactor LVR-15 is light water moderated and cooled, light water and beryllium reflected. The active core contains fuel of the ITR-2M type with enrichment of 80 % of $U^{235}$. The nominal power is 10 MW thermal. The operational core configuration has 28-36 positions occupied by fuel assemblies, 11 of them are occupied by control and safety rods, 10–15 positions are occupied by Be-block reflector and the rest is occupied by vertical irradiation channels pneumatic rabbits loops etc.

At the present time the reactor LVR-15 is operated with a mixed working configuration. This working configuration consists of two types of fuel assemblies. The fuel assemblies IRT-2M with 80 % $U^{235}$ and the fuel assemblies IRT-2M with 36 % $U^{235}$.

The strategy of conversion is the result of the requirements on the fuel enrichment reduction. We must also take into accout the possibilities on the nuclear fuel market. With respect to these restrictions fuel of a Russian producer has been selected. At present, this producer supplies fuel assemblies of two different types with partially by (36 %) reduced enrichment. The first type are fuel assemblies IRT-2M, which consist of four or three concentric tubes and the second type fuel asemblies IRT-3M, which consist of eight, six or

four concentric tubes. For the next period the producer prepares the fuel elements IRT-4M with reduced enrichment to 20 % $U^{235}$ [3].

These facts influence our procedure of fuel conversion for the LVR-15 and VR-1 research reactors. It is planned the conversion in Czech Republic will be done in the three steps.

The first step is being realized at the present time. The research reactor LVR-15 has a mixed working configuration consisting of fuel assemblies IRT-2M with 80 % and 36 % $U^{235}$. The training reactor VR-1 is operated on the fuel assemblies IRT-2M with 36 ,have bought fuel IRT-2M with 36 % $U^{235}$ and IRT-3M with 36 % $U^{235}$ in NRI. The fuel IRT-2M with 36 % $U^{235}$ that is now in reactor VR-1 will be exchanged for the fuel IRT-3M with 36 % $U^{235}$. Subsequently, the fuel from the training reactor will be consumed in the LVR-15 reactor.

The second step of coversion for the research reactor LVR-15 will be the transition to fuel IRT-3M. The reactor LVR-15 with this type of fuel assemblies will be able to work on the power 15 MWth. The fuel in the training reactor VR-1 will be exchanged for the fuel with enrichment 20 % $U^{235}$ (IRT-4M) at the same time. The fuel assemblies ITR-3M with 36 % $U^{235}$ enrichment will be consumed again in the research reactor LVR-15.

The third and last step in the process of conversion will be the transition of the LVR-15 research reactor to fuel with enrichment 20 % $U^{235}$. Both reactors will use fuel assemblies IRT-4M with enrichment bellow 20 % $U^{235}$ after the third step of conversion. The procedure of the individual steps consists of the assessment:

- of the neutron - physical calculations of all working configurations,
- of thermohydraulic calculations of working configurations,
- of safety analysis of suggested working configurations,
- of detailed calculations and detailed documentation worked out for the realization of the conversion.

Each step is subordinated to Czech State Office for Nuclear Safety.

We are sure that the commonly realized conversion for the training reactor VR-1 and for the research reactor LVR-15 has a big advantage. This advantage consist in the possibility to prepare special calculations and carry out special critical experiments on the training reactor VR- 1. The results of these calculations and experiments will be used for the fuel conversion in the LVR- 15. The start up operation of VR-1 reactor with IRT-3M 36 % $U^{235}$ fuel assemblies will be ready in spring 1997.

**References:**

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