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Devices Testing in Extreme Conditions and New Gamma Irradiation Facility at the Research Centre Rez Ltd

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Abstract: ***A new gamma irradiation facility was built in the valley of the Vltava River near the city of Prague in the Research Centre Rez (CV Rez). It is a unique workplace with its technical dispositions in the Czech Republic. In the recent article, new technological opportunities and their scientific research applications are described.***

Keywords: Gamma irradiation facility, experimental box, NPP applications, space applications

1. Introduction

Anew gamma irradiation facility was built based on its outdated predecessor. Original irradiation facility was founded in 1960 in cooperation with the Institute of Nuclear Research (nowadays ÚJV Řež, a.s.) and the Institute for Research, Production and Application of Radioisotopes (ÚVVVR).This facility was initially used in fields of chemical, physical and electronic applications and analyses(1).Ithas been used extensively for almost fifty years of operation until 2010.Reconstruction was necessary due to the unsatisfactory technical condition of the facility (see Figure 3).One of the main reasons were a need to modernize the technology and to replace the source of gamma radiation. For this reason, the design of a new gamma radiation facility has begun and comprised an implementation of extended technological possibilities. The reconstruction of the facility was supported by the SUSEN (SUStainableENergy project (2)) and its new operation was launched in September 2017.

2. Technological Configuration

Multifunctional device enabling irradiation in a wide range of predefined conditions.The new design and technical solution of the technology were developed in cooperation with CV Rez and VFa.s. Irradiation chamber with a gamma radiation source (in this case ^{60}Co) of the200 TBq activity was installed into the irradiation chamber. The unique part of the chamber is an irradiation experimental box.The experimental box consistsfrom double-skinned steel cylinder. The cylinder can be cooled using both water and liquid nitrogen to achieve temperature of -196 °C inside the box.Two-stage vacuum setup using a rotary and turbomolecular vacuum pump to create a high vacuum in the box at low temperatures.Heating cassette is installed inside the experimental box, so that it is possible to operate also under the elevated temperature conditions up to 400 °C. The dimension of the experimental box is on Figure 1. Profile of the facility is on Figure 2. The experimental box and vacuum technique have been customized, manufactured and delivered for CV Rez gamma irradiation facility after a mutual technical solution with CV Rezby VF a.s.

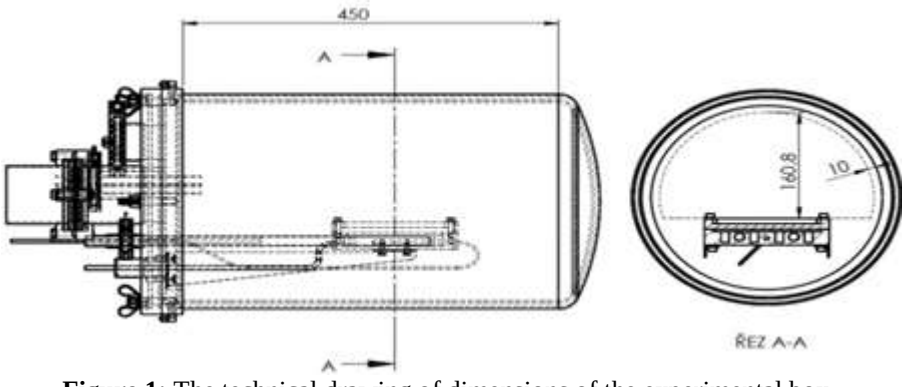

Figure 1: The technical drawing of dimensions of the experimental box.

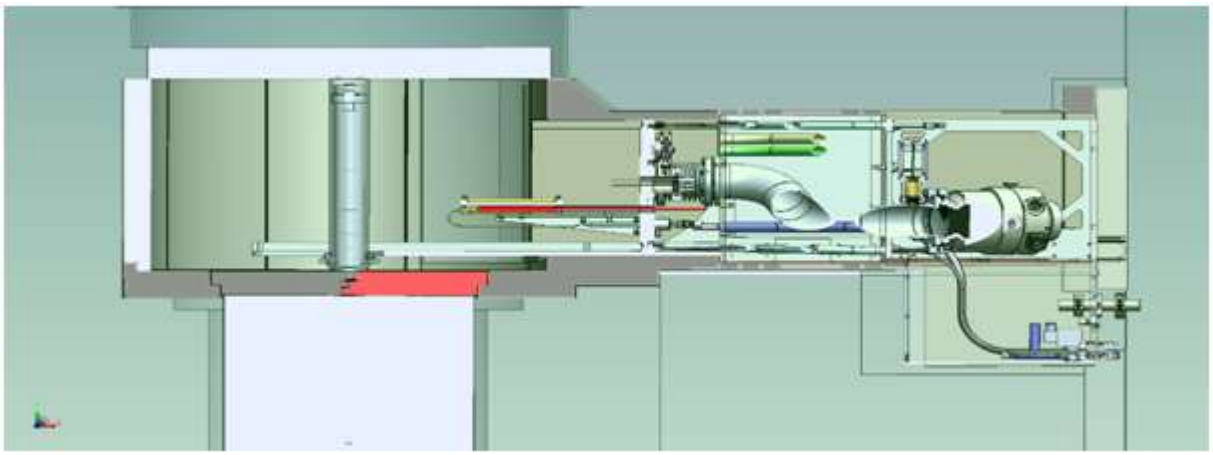

Figure 2: The profile of irradiation chamber with gamma source, experimental box and two-stage vacuum setup

Emphasis is also placed on the safety of the gamma irradiation facility, namely the protection against considerable gamma radiation.Gamma source is covered with a strong concrete and lead shielding. The facility contains several active and passive elements protecting the operator against the radiation (Figure 4).

Figure 3: The irradiation chamber before the reconstruction

Figure 4: Shielding of the entry to the irradiation chamber

3. Simulation of conditions in nuclear power plants and space

Cryogenic temperatures, radiation, and vacuum are parameters that characterize the conditions in the universe. All three parameters can be achieved in the experimental box described on Figure 5. The unique technology ranks to the top of laboratories in the Czech Republic.The facility is designed to study the influence of the environment on a degradation of orbital probes and satellites. This is perspective research nowadays.The variety of individual components such as solar cells, electronic components, outer shells, etc. can be tested at the facility.Gained information is very important for manufacturers to determination of the lifetime and reliability of the satellite-installed equipment.

Another important research aim is the testing of components under conditions of the reactor containment in the nuclear power plant (NPP).The gamma irradiation facility is a part of the Severeaccidents laboratories, department Diagnostic and Qualification, together with the LOCA stand (from English abbreviation Loss-of-Coolant Accident) and a high-voltage (HV) laboratory.These laboratories are designated for testing of selected components such as electrical cables, optical cables, bushings, etc. We are able to simulate radiation and thermal ageing of the components used in NPPs. Electrical devices are tested in HV laboratory before and after irradiation and LOCA test.

A wide range of possible scientificand research topics can be study at the gamma irradiation facility. It ispossible to perform experiments for physics, material sciences and alsofor a variety of applications in biology, medicine, electronics and electrical engineering, etc. Testing is demanded for research laboratories and also for the industry.

Figure 5: Detailed view of the heating cassette inside the experimental box

Figure 1: Experimental setup with the irradiation box

4. Conclusion

The variability and wide range of scientific and research tasks for a new gamma irradiation facility are significant.The variety of research and industry-relevant tasks can be performed in CVR. Innovative ideas can be discussed and implemented into the operation of the facility.The gamma irradiation facility is open for new discoveries.

5. Acknowledgement

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