SPREADING KNOWLEDGE ON RADIATION PROTECTION IN NUCLEAR TECHNOLOGY INFORMATION CENTRE

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ABSTRACT

Nuclear Training Centre was founded to support training of Krško NPP workers. In mid-nineties activities were expanded and Nuclear Technology Information Centre with permanent exhibition on nuclear technology was established. A vision was to become reliable and respected source of knowledge about nuclear technologies for general public. To compensate for deficient information about radioactivity and ionising radiation in primary and secondary schools, we added radioactivity workshop and hands-on experiments to our exhibition. In radioactivity workshop, we combine demonstrations and explanations about radiation, radioactivity, effects of radiation to human beings and radiation protection principles and practice.

We have also prepared “Mini Encyclopaedia of Nuclear Energy” which is freely distributed to our visitors. Significant part of Mini Encyclopaedia is devoted to radiation protection and related subjects.

More than 170,000 teachers, pupils, students and other people has visited our Information Centre till now and almost 100,000 visitors have seen our demonstrations and listened to our explanations about radioactivity, radiation and radiation protection. Almost 90,000 Mini Encyclopaedias were distributed since 2001. All these numbers show that the impact of our activities is significant.

1. Introduction

Nuclear Training Centre, which is a part of Jožef Stefan Institute, Ljubljana, was founded in 1989 to support training of Krško NPP workers. Number of courses for control room staff, system and equipment operators and other technical staff were prepared and implemented since then. Beside Krško NPP workers, members of Slovenian technical support organisations, authorities and experts employed by Krško NPP subcontractors attended these courses.

Soon after successful conclusion of the initial courses, the decision has been made to expand our activities. At that time, the public opinion in Slovenia was heavily influenced by Chernobyl accident and there were serious debates in media and among politicians about danger of nuclear energy and about the necessity to close Krško NPP. As a result of a change of political system, number of political parties were founded, among them also a Green party which became quite influential in parliament, mainly due to antinuclear position and request for immediate abandoning of nuclear energy in Slovenia. They have also demanded referendum about the closure of Krško NPP, but other parties were not prepared to support this radical approach immediately, also due to expert opinion that the similar accident cannot happen in our NPP. However, this opinion and explanations related to safety of our plant were originally targeted to decision makers, and less to opinion makers. The information was presented and distributed within limited circles, also due to limited interest of majority of media for, what was then called “biased” opinion of nuclear experts.

Our aim at that time was not to join those discussions, but to approach general public and to contribute to general opinion on long term basis. Since we were aware that the discussion on nuclear energy would follow into forthcoming years, we have decided to establish nuclear technology information centre with permanent exhibition on nuclear technology. The vision was to become reliable and respected source of knowledge about nuclear technologies for general public. Since we had free basement at our premises, we were able to commission big lecture room and exhibition with some posters without huge investments and lasting constructions.

At the beginning (in the mid-nineties), emphasise was given to the Krško NPP technology and operation, but later a part related to radioactive waste management was added to exhibition. In the last decade, exhibition was complemented with overview of nuclear fusion technology research.

From the very beginning of the Information centre operation, our most numerous and regular visitors are pupils and students from primary and secondary schools in Slovenia. In addition, other groups visit our Centre – groups of university students, teachers, members of different professional associations, firefighters, groups of retirees, etc. Annually, our Centre visit more than 150 groups and more than 6500 visitors. Altogether, more than 3,500 school groups and more than 170,000 pupils, students, teachers and other persons visited our information centre since 1993.

All these years we are trying to provide our visitors with honest, clear, thorough and attractive information about nuclear technology and related subjects. At the beginning of Information Centre operation, our lectures were concentrated on NPP operation and possible nuclear accidents. The main reason was short time distance to Chernobyl accident that occurred in 1986. With time, additional lectures on radioactive waste management, nuclear fusion and just recently, on isotopes in everyday use were prepared.

At the beginning of Information Centre operation, the exhibition was usually short addition to the lecture for our visitors. Posters with information were prepared to support lectures with some additional data or visual material, and to provide explanation of some concepts from physics or engineering which are important for understanding NPP operation. What we have discovered at that time is that explanations of basic concepts of radioactivity and ionising radiation have de facto disappeared from school programmes. They were either pushed in schedule somewhere at the end of school year, in parallel with final exams like filler, or were considered optional, leaving decision on presenting these contents to individual teacher.

It was also obvious that majority of teachers are not competent to speak about these subjects and they avoided it. Radioactivity used to be one of the subjects discussed in physics classes, but was later added to chemistry classes. It would work in "old" times, but after Chernobyl accident radioactivity and ionising radiation were considered result of reactor operation and considering the consequences of accident, also extremely dangerous. The other problem was that just few schools had any equipment that can be used for classroom demonstration, and if they had the equipment, teachers did not know how to use it properly.

What we have learned is that if we want to effectively transfer our messages to our visitors, especially pupils and students, and if we want them to become active subjects in debates and decision process related to nuclear energy in Slovenia, we have to provide them with basic information about radioactivity, radiation and radiation effects to human beings. This knowledge should serve as a tool for evaluation and judgment of problems and questions that must be resolved if we want to continue living with nuclear energy in near future.

We felt that adding or expanding existing lectures would not be productive, and we decided to add some hands-on experiments and to prepare small radioactivity workshop (Fig. 1) with practical demonstrations of ionising radiation properties, demonstration of natural background radiation and radon.

Fig. 1: Radioactivity workshop in Nuclear Technology Information Centre

We were also considering idea to prepare hands-on experiments for all our demonstrations, but it would be costlier and we also had to comply with limited time that participants spent at our site. Therefore we came to conclusion that the most effective approach would be to combine hands-on experiments at the exhibition with practical demonstrations in radioactivity workshop and to complement demonstrations with physical background explanation.

2. Radioactivity workshop

2.1 Demonstrations and hands-on experiments

We wanted to keep all our experiments and demonstration simple and clear, without any sophisticated equipment and detectors. Therefore, we decided for simple ratemeters with a large pointer and audible indication of detection event. The sound is very important since it reaches every person in vicinity regardless of person's attention and concentration. To avoid legal complications, we decided for small sources (i.e. sources under exemption level). At the same time, we wanted to have "strong" signal, i.e. high rate for every source. For that purpose high volume End Window GM tubes were chosen. They are sensitive to gamma radiation from the environment (natural background is not disturbance here and should be noticeable) and capable of detecting alpha, beta and gamma radiation. Therefore, same or similar detectors can be used for all demonstrations. We were able to buy suitable ratemeters and detectors and get additional equipment (holders for sources and detectors, absorbers/shields for alpha, beta, and gamma radiation, rulers) which is required for basic experiments and demonstration.
All equipment which we use for demonstration of properties of alpha, gamma and beta radiation is presented in Fig. 2.

For demonstration of radon progeny, we use End Window GM tube with ratemeter, and simple vacuum cleaner with a mesh fastened on the intake opening and a kitchen vents grease filters or pieces of filter cut from vacuum cleaner paper bag (Fig. 3, left). As alternative "catcher" for radon progeny, we use toy balloons (one for each experiment, Fig. 3, right). In our basement, demonstration of radon progeny with filter or balloon takes just a couple of minutes, which is more than suitable for demonstration.

Fig. 2: Equipment for demonstration of radiation properties

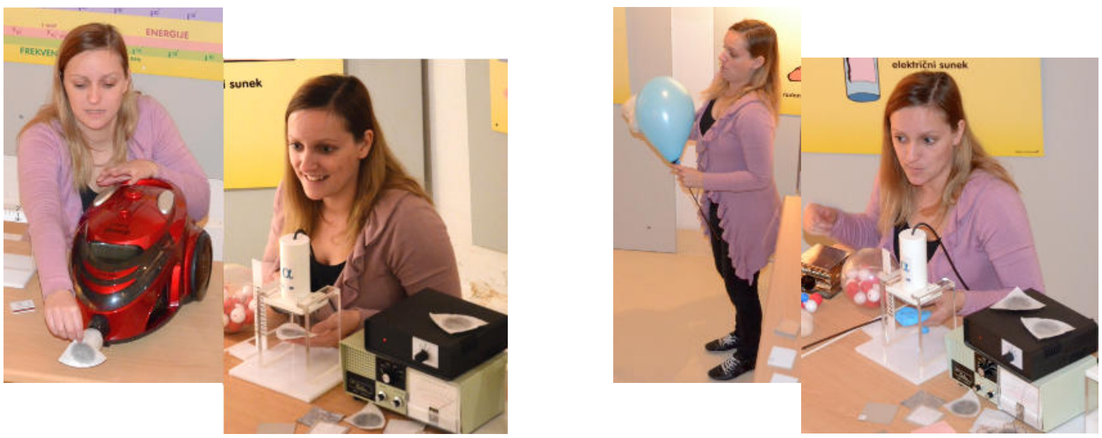

Fig. 3: Demonstration of radon progeny with filter and vacuum cleaner (left) and toy balloon (right)

As we mentioned, all our sources are under exemption level. Nevertheless, for demonstrations of properties of radiation, it is necessary to have “clean” sources with only one kind of radiation. Therefore, we bought set of small disk sources for alpha (^{210}Po), beta (^{90}Sr) and gamma radiation (^{60}Co). Instead of original alpha source (half-life of ^{210}Po is only 138 days and our first source have soon decayed) we now use ^{210}Po sources prepared by one of our colleagues from Nuclear Chemistry Laboratory. For all other demonstrations, we use consumer products with elevated activity: radioluminescent wristwatch, thoriated welding rods or thoriated gas mantle.

Listed equipment and sources enable us to perform following demonstrations [1]:

1. Demonstration of natural background (some additional “check” source should be also used to verify operation of instrument and different dose rates),
2. Demonstration of alpha radiation and alpha radiation range in air, paper, kitchen aluminium foil,
3. Demonstration of beta radiation and beta radiation range in cardboard, aluminium and acrylic glass,
4. Demonstration of gamma radiation, attenuation of radiation in lead, and of half-value layers in aluminium, steel, lead, and concrete,
5. Demonstration of count rate over distance dependency,
6. Demonstration of radon progeny.

We have also prepared demonstration carousel ("Radioactivity carousel", Fig. 4) with different sources, which is used as hands-on experiment in exhibition. Samples were acquired from "environment": potassium chloride (KCl), fertiliser, uranium glass, radioluminescent wristwatch, thoriated welding rods, thoriated gas mantle and a piece of plate with radioactive (uranium) glaze. Samples are fastened on the round table and visitor turns the plate and observes the response from instrument with pancake GM tube.

Fig. 4: Radioactivity carousel

Next to the carousel is an instrument without any sample where visitors can check their own "samples" (Fig. 5). As could be expected nowadays, the instrument is mostly used for checking mobile phones, which is also instructive, since mobile phones are also sources of radiation and the difference between ionising and nonionizing radiation can be discussed.

Fig. 5: Instrument for visitor's samples

Our last acquisition is small cloud chamber. Unfortunately, the chamber cannot operate without operator's support and cannot be used as a hands-on experiment on the exhibition.

Therefore, cloud chamber is used as an addition to demonstrations in the workshop. We use small computer camera to project the image of traces on a TV screen.

2.2 Scope of presentations and explanations in workshop

Our workshop is not only devoted to demonstration of radioactivity, it is also intended to give basic explanations and to position radioactivity and ionising radiation in our life. Therefore, we start our demonstrations with general explanation of expression “radiation” and different kinds of radiation. We use big poster with list of different types of electromagnetic radiations and we describe and distinguish the effects of different types. Our typical visitors are already familiar with structure of the matter and atoms, so we can speak about radioactivity and describe what alpha, beta and gamma decays and radiations are. These explanations are combined with demonstrations of these nuclear radiations interactions with different absorbers, mostly to illustrate differences in penetrating ability of different radiations.

The most attractive for our visitors are demonstrations related to radon. As we have already mentioned, the concentration of radon in our basement is elevated and it takes just a few minutes to collect enough progeny on paper filter or balloon to get an impressive signal on ratemeter. Demonstration of radon and demonstration of background radiation are usually starting point for a description of effects of ionising radiation to human beings, without going into the discussion of biological particularities. We limit to basic explanations and use the term “dose” as a measure of irradiation and we state that biological effects are approximately proportional to dose. Depending on the visitor’s profile, we can go into more detail explanation, even describing the deterministic and stochastic effects and the short explanation of principles of protection, but this is exceptional. What we do regularly is explaining how to protect from radiation and demonstrate how shielding and distance can be used as an effective protection.

Our final message is that radioactivity and ionising radiation are natural phenomena that we may not be aware of, but we live with them. In addition, radioactivity and ionising radiation could be dangerous, but if we know how to protect ourselves from them we can even use them for our benefit.

3. Publications and other activities

Many of our visitors would like to learn more than just basic facts about nuclear technology and related subjects, also about radiation protection. For them and for others interested in status and future of nuclear energy, we have prepared “Mini Encyclopaedia of Nuclear Energy” [2], which is a freely distributed among visitors. The Encyclopaedia is bilingual (Slovene and English) and it covers following areas:

- energetics,
- radioactivity,
- nuclear power plants,
- fusion,
- uses of radiation in industry and medicine and,
- radioactive waste.

This Encyclopaedia was originally prepared as a compendium of posters from our exhibition, but later it was supplemented and expanded with additional subjects. Nine out of seventy pages in this publication are related to radioactivity, ionising radiation, measurement of radiation, background radiation, radon, effects of radiation to human beings and radiation protection principles and practice. Since 2001 we have prepared five editions of Encyclopaedia (originally, the title was “Atlas of nuclear technology”), 100,000 issues were printed and more than 90,000 distributed. Considering that in the same time we had approximately 120,000 visitors it means that three out of four visitors took their copy of Encyclopaedia home.

In addition to lecturing, performing demonstrations and providing a copy of Encyclopaedia, we also guide our visitors to TRIGA Mk II reactor, and TANDETRON accelerator. These are nuclear and radiation facility and can also be considered as practical demonstration of radiation protection practice.

We also encourage our visitors to keep in touch after they leave. They can either call us or submit a question through our homepage. We have also prepared basic instruction for teachers about detectors for ionising radiation and sources suitable for demonstration of radioactivity in schools taking into account legal requirements and available equipment [3].

4. Conclusions

Our Nuclear Technology Information Centre was established to become reliable and respected source of knowledge about nuclear technologies for general public. It seems that we succeeded in that respect since every year more than 7,000 visitors, mostly teachers, pupils and students visit our Centre.

Important part of the Information Centre are hands-on experiments and radioactivity workshop where demonstrations related to properties of nuclear radiations, demonstration of natural background and radon are performed. These demonstrations are combined with explanations related to radiation and ionising radiation, biological effects of exposure, dose and protection principles.

We also provide free bilingual “Mini Encyclopaedia of Nuclear Energy” to our visitors where significant part is devoted to radiation protection, especially to natural sources and principles of protection. We think that awareness of natural sources is essential for everyone who considers nuclear energy and nuclear technologies in general.

Altogether, almost 170,000 visitors have visited our Information Centre since mid-nineties and almost 100,000 visitors have seen our demonstrations and listened to our explanations about radioactivity, radiation and radiation protection.

5. References

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