SPREADING KNOWLEDGE ON RADIATION PROTECTION IN NUCLEAR TECHNOLOGY INFORMATION CENTRE

MATJAŽ KOŽELJ, VESNA SLAPAR BORIŠEK

JOŽEF STEFAN INSTITUTE, LJUBLJANA, SLOVENIA

matjaz.kozelj@ijs.si

Introduction

Nuclear Training Centre is a part of Jožef Stefan Institute's Reactor Centre in village Podgorica near Ljubljana.

Centre was founded in 1989 to support initial training of Krško NPP workers.

Workers of TSOs, authorities and experts from Krško subcontractors also attend these courses.

Introduction (cont.)

Soon after successful conclusion of the first courses, decision to expand activities has been made

At that time:

- public opinion was heavily influenced by Chernobyl accident,
- there were serious debates in media and among politicians about the danger of nuclear energy and about the necessity to close Krško NPP,
- expert explanations related to the safety of Krško NPP were originally targeted to decision makers, and less to opinion makers,
- there was also a limited interest of most of the media for, what was then called “biased” opinion of nuclear experts.

Introduction (cont.)

We wanted to approach general public and to **contribute to general opinion on long term basis**.

Decision to establish **nuclear technology information centre** has been made

- 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 permanent exhibition on nuclear energy.

We also started with regular “tours” to TRIGA reactor.

First visitors

Our first visitors were pupils and students.

Lectures were related to NPP operation and possible nuclear accidents at the beginning, but later we have also added lectures about radioactive waste management, nuclear fusion and isotopes in everyday use.

Exhibition

At the beginning, 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.

What we have discovered

We have discovered 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.

It was obvious that majority of teachers did not feel competent to speak about these subjects and they were trying to avoid it.

- There was also problems with equipment for classroom demonstrations

What we have learned

- if we want to **effectively transfer our messages** to our visitors, and
- if we want **them** to **become active subjects in debates and decision process** related to nuclear energy,

We have to provide them with basic information about radioactivity, radiation and radiation effects to human beings!

What we decided

We felt that adding or expanding existing lectures would not be productive.

Combination of practical demonstrations with physical background explanations should be the most effective approach!

We decided to add some **hands-on experiments** to the exhibition and to prepare small **radioactivity workshop.**

Radioactivity workshop

Workshop is intended for practical demonstration of

i. radiation properties,

ii. natural background radiation, and

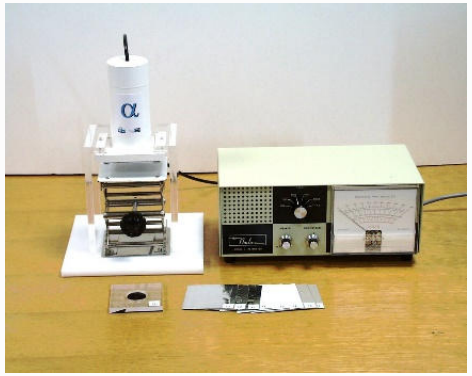
iii. radon.

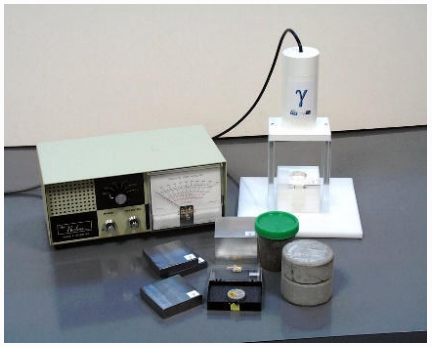
Equipment for workshop

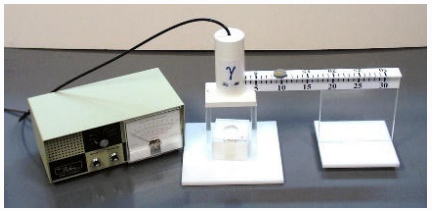
We wanted to keep everything simple and clear, without sophisticated equipment and detectors. We use:

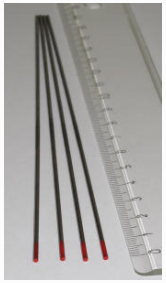
1) Simple **ratemeters** with analogue pointer and **audible indication** of detection event,
2) **Small**, "clean" sources (under exemption level, we use ^{210}Po, ^{90}Sr, ^{60}Co),
3) **Large** detectors (EW GM tubes),
4) Different holders, absorbers, rulers,
5) Additionally **vacuum cleaner**, kitchen vents grease **filters** or vacuum cleaner **bags**, and **toy balloons** for radon,
6) Small **cloud chamber** (this is new!).

Demonstration of radiation properties









Demonstration of radon

List of demonstrations

1) Demonstration of natural background,
2) Demonstration of alpha radiation and alpha radiation range in air, paper, kitchen aluminium foil,
3) Demonstration of radon progeny,
4) Demonstration of beta radiation and beta radiation range in cardboard, aluminium and acrylic glass,
5) Demonstration of gamma radiation, attenuation of radiation in lead, and of half-value layers in lead, aluminium, steel, and concrete,
6) Demonstration of count (dose) rate over distance dependency.

Hands-on experiments

Radioactivity carousel with samples from “environment” (KCl, fertiliser, uranium glass, radioluminescent wristwatch, thoriated welding rods, thoriated gas mantle and a piece of plate with uranium glaze) + instrument for visitors.

Scope of demonstrations

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**:

- we also explain **term** "**radiation"**, and differences between non-ionising and ionising radiation,
- we explain what alpha, beta and gamma **decays** are and what is **half-life**,
- using radon demonstration we **briefly describe effects of radiation on human beings**; we introduce the **term "dose"** as a measure of irradiation. Depending on visitor's profile, we can go into more details.

Scope of demonstrations (cont.)

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:

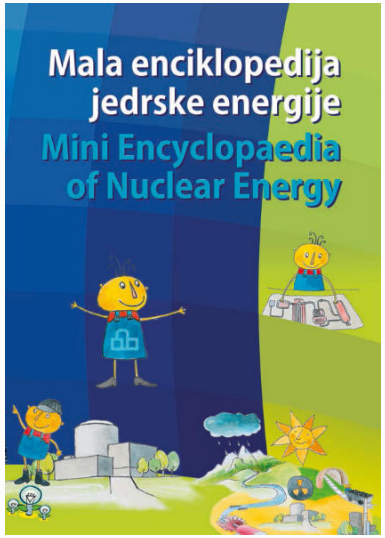
- radioactivity and ionising radiation are natural phenomena, and
- radioactivity and ionising radiation could be dangerous, but if we know how to protect, we can safely use them for our benefit.

Mini Encyclopaedia of Nuclear Energy

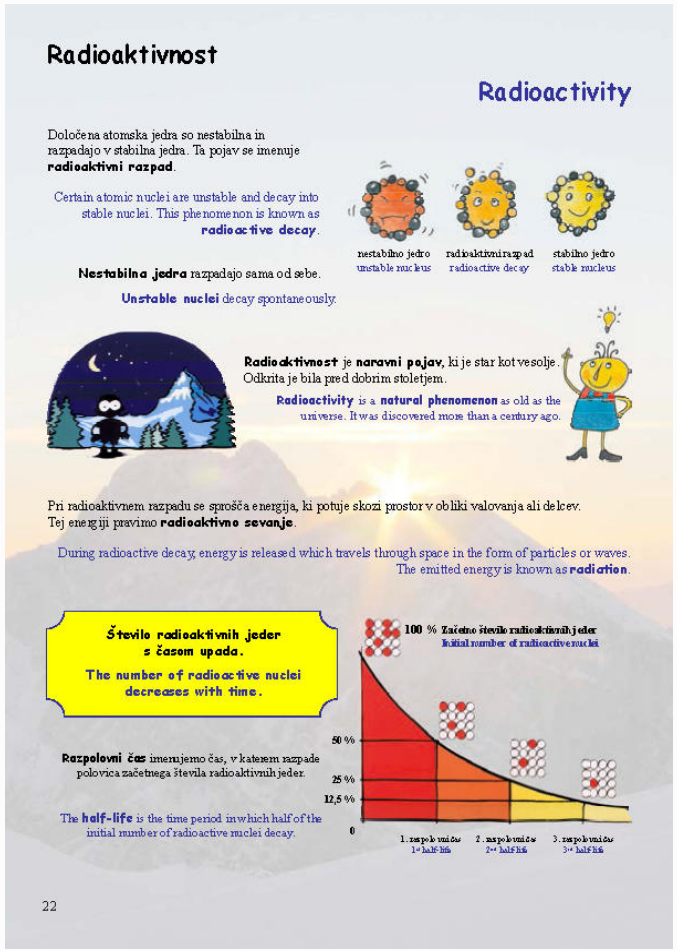
It is bilingual (Slovene and English) and covers energetics, radioactivity, nuclear power plants, fusion, uses of radiation in industry and medicine and radioactive waste.

Nine out of seventy pages are “radiation protection related”.

Since 2001 we have prepared **five editions** of Encyclopaedia, **100,000 issues were printed** and more than **90,000 distributed**.



Example pages from Mini Encyclopaedia of Nuclear Energy



Radioaktivnost

Radioactivity

Določena atomska jedra so nestabilna in razpadajo v stabilna jedra. Ta pojav se imenuje **radioaktivni razpad**.

Certain atomic nuclei are unstable and decay into stable nuclei. This phenomenon is known as **radioactive decay**.

nestabilno jedro unstable nucleus | radioaktivni razpad radioactive decay | stabilno jedro stable nucleus

Nestabilna jedra razpadajo sama od sebe.

Unstable nuclei decay spontaneously.

Radioaktivnost je **naravni pojav**, ki je star kot vesolje. Odkrita je bila pred dobrim stoletjem.

Radioactivity is a **natural phenomenon** as old as the universe. It was discovered more than a century ago.

Pri radioaktivnem razpadu se sprošča energija, ki potuje skozi prostor v obliki valovanja ali delcev. Tej energiji pravimo **radioaktivno sevanje**.

During radioactive decay, energy is released which travels through space in the form of particles or waves. The emitted energy is known as **radiation**.

Število radioaktivnih jeder s časom upada.

The number of radioactive nuclei decreases with time.

100 % Začetno število radioaktivnih jeder / Initial number of radioactive nuclei

50 %

25 %

12,5 %

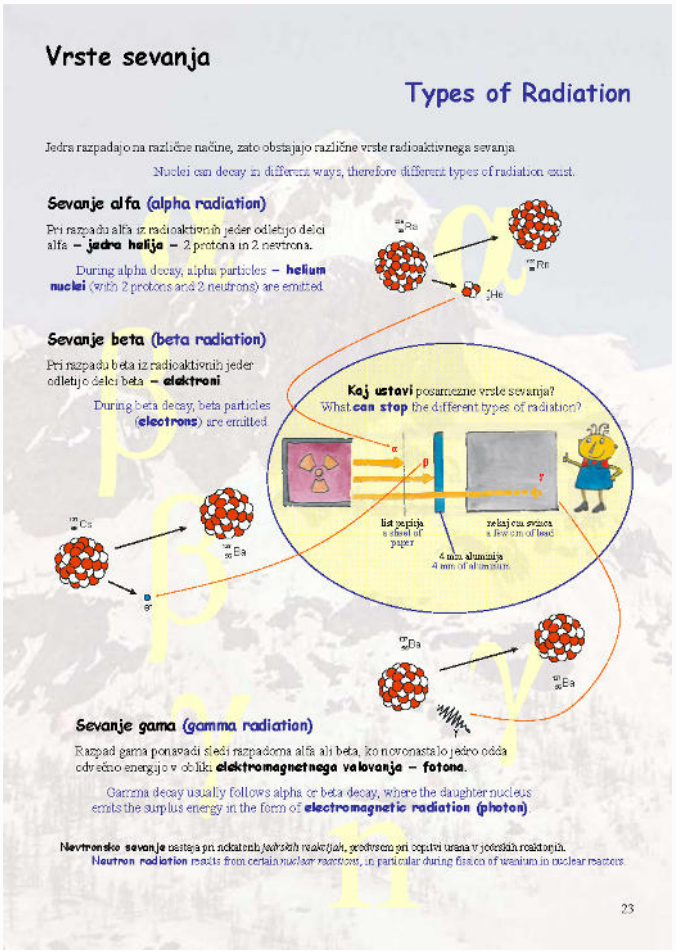
0

1. razpolovnični čas 1st half-life | 2. razpolovnični čas 2nd half-life | 3. razpolovnični čas 3rd half-life

Razpolovni čas imenujemo čas, v katerem razpade polovica začetnega števila radioaktivnih jeder.

The **half-life** is the time period in which half of the initial number of radioactive nuclei decay.

22



Vrste sevanja

Types of Radiation

Jedra razpadajo na različne načine, zato obstajajo različne vrste radioaktivnega sevanja

Nuclei can decay in different ways, therefore different types of radiation exist.

Sevanje alfa (alpha radiation)

Pri razpadu alfa iz radioaktivnih jeder odletijo delci alfa – **jedra helija** – 2 protona in 2 nevtrona.

During alpha decay, alpha particles – **helium nuclei** (with 2 protons and 2 neutrons) are emitted.

Sevanje beta (beta radiation)

Pri razpadu beta iz radioaktivnih jeder odletijo delci beta – **elektroni**

During beta decay, beta particles (**electrons**) are emitted.

Kaj ustavi posamezne vrste sevanja?

What **can stop** the different types of radiation?

list papirja a sheet of paper | zelo tanka plast a few cm of lead | 4 mm aluminija 4 mm of aluminium

Sevanje gama (gamma radiation)

Razpad gama ponavadi sledi razpadoma alfa ali beta, ko novonastalo jedro odda odvečno energijo v obliki **elektromagnetnega valovanja – fotona**.

Gamma decay usually follows alpha or beta decay, where the daughter nucleus emits the surplus energy in the form of **electromagnetic radiation (photon)**.

Nevtronsko sevanje nastaja pri nekaterih *jedrskih reakcijah*, predvsem pri cepitvi urana v jedrskih reaktorjih.

Neutron radiation results from certain *nuclear reactions*, in particular during fission of uranium in nuclear reactors.

23

Visitors

From the beginning, our most numerous and regular visitors are pupils and students from primary and secondary schools in Slovenia.

Other groups visit our Centre – groups of university students, teachers, members of different professional associations, firefighters, groups of retirees, etc.

In numbers:

- **more than 150 groups and more than 6500 visitors annually**, and
- **more than 3,500 groups and more than 170,000 visitors since 1993.**

Conclusions

Information Centre was established to become reliable and respected source of knowledge about nuclear technologies for general public.

- Considering the number of visitors, we have succeeded to reach that goal.

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.

- Demonstrations should be combined with explanations related to radiation and ionising radiation, biological effects of exposure, dose and protection principles.

Conclusions (cont.)

We have also distributed almost 100,000 copies of free bilingual "Mini Encyclopaedia of Nuclear Energy" where significant part is related to radiation protection subjects, 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 technology 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.

Thank You for Your Attention!