

## **The Activities of Nuclear Training Centre Ljubljana in the Area of Radioactive Waste Management**

I. Jenčič  
Jožef Stefan Institute  
Jamova 39, 1000 Ljubljana  
Slovenia

### **ABSTRACT**

Nuclear Training Centre Ljubljana has several activities related to radioactive waste management. These activities include training of professionals in the area of nuclear physics and nuclear technology, radiation protection courses, organization of international courses and workshops in the area of radioactive waste management, and public information on radioactivity and waste management. The paper will describe the specifics and the extent of training related to radioactive waste. Recently we have participated in a European coordination action CETRAD and an overview of the results of this project will also be presented.

Very important component of our activity is public information that is based on an information centre and live lectures to organized groups of visitors, mostly schoolchildren. About one half of one school generation of Slovenia visits the Information centre every year. A poll is conducted among visitors every year and its results are a very useful tool to follow the evolution of public opinion on nuclear energy and radioactive waste disposal. The latter is, at least in Slovenia, still considered as the major obstacle against the use of nuclear energy.

### **INTRODUCTION**

#### **The nuclear program in Slovenia**

Slovenia has a small nuclear program with one nuclear power plant (Krško, 676 MW<sub>e</sub> PWR, owned jointly with Croatia), one research reactor (TRIGA, 250 kW), an interim radioactive waste storage for small producers, and a former uranium mine, which is currently in the process of decommissioning. The radioactive waste from NPP Krško is still at the plant site and the low- and medium-level radioactive waste repository location procedure is currently under way.

The responsibilities and competences in the nuclear field are clearly allocated, but regulatory and government organizations have numerous complementary radioactive waste management (RWM) responsibilities. The Agency for Radioactive Waste Management is the national RWM organization responsible for the disposal of radioactive waste and spent fuel and management of RW from small producers. The Jožef Stefan Institute and the Institute of Occupational Safety are technical support organizations authorized to oversee radiation protection practices and measurement and the transport of sources of radioactive waste.

#### **Jožef Stefan Institute and the Milan Čopič Nuclear Training Centre**

Jožef Stefan Institute (JSI) is the largest research organization in natural sciences in Slovenia [1]. Its research activities cover wide areas of physics, chemistry, information technologies and

environment, but a significant part is also related to nuclear energy. Among other nuclear-related activities, JSI was involved in the training of nuclear professionals from the early days of the construction of the Nuclear Power Plant Krško. In 1989 the Nuclear Training Centre (NTC) [2] was formed as an organizational unit of the JSI and was named after Milan Čopič, a distinguished reactor physicist who died that year. The idea for establishing a training centre and for the construction of a separate building was born in early eighties, when the nuclear program in former Yugoslavia was still very extensive. It was planned that this training centre would become the main training facility for the whole series of future nuclear power plants in the country and also a regional nuclear training centre. Later the plans for new nuclear power plants were gradually scrapped. At the time of the construction of the present building it was already clear that it would serve primarily for one and only NPP Krško.

The training centre is located 12 km from Ljubljana on the site where also the research reactor TRIGA is located. The building has about 1600m<sup>2</sup> in two floors. In the ground floor there are lecture rooms with 75, 50, 25 and 10 seats, multifunctional NPP simulator training room, and offices of the staff.

The basement was originally constructed to host the full scope simulator. During the years the plans for the full scope simulator were changed and in within the scope of NPP Krško modernization in the year 2000 the simulator was purchased and located at the power plant. About 600 m<sup>2</sup> of the available space in the basement is now used for the public information purposes. In addition there is a big lecture room with 100 seats (which is also used for public information), a radiation protection training laboratory and a fitness room for our trainees.

NTC 9 full-time staff members: 6 lecturers (1 PhD, 1 MSc, 4 BSc), 1 computer technician and 2 administrators. In addition 4 NPP Krško employees work at the Training Centre and collaborate in its activities. Furthermore several researchers from other departments of JSI and also external professionals participate as lecturers at different courses organized at NTC.

Working in a country with a small nuclear program, NTC covers a wide range of activities connected with nuclear science and technology that go beyond pure nuclear training. Naturally, these activities have evolved from training of nuclear power plant personnel. Most of these activities are also related to radioactive waste management.

The vision of the centre is to be respected source of knowledge about nuclear technologies in the country and internationally. In order to be able to manage a large volume of work effectively a quality control and quality assurance system is in place. This system relies heavily on computer databases. The activities of NTC can be divided into four areas:

1. *Training of nuclear technology* is the basic activity of NTC. Future control room operators attend the 18-week (~ 600 hours) initial theoretical training. A shorter, 8-week course "Basics of Nuclear Technology" is intended for non-licensed technical staff of NPP, as well as for staff of regulatory body and technical support organizations. The training programs are in accordance with the Systematic Approach to Training (SAT).
2. *Radiation protection training*: JSI is authorized by the Ministry of Health for different activities related to radiation protection and safety of radiation sources, including education and training in the field of radiation protection. This training is carried out at NTC, divided into courses for unsealed sources, industrial sources and special topics.
3. *Professional training courses* for international and national participants are conducted in collaboration with several international organizations (e.g., IAEA, EU, US DOE etc.) and

domestic professional institutions, cover various aspects of nuclear technology, radiation protection, environment and power engineering.

4. *Public information* is based on a permanent exhibition about nuclear energy which is located in the basement of NTC. Visitors are mostly children from elementary and high schools. They attend a lecture about the nuclear energy or radioactive waste disposal and visit the permanent exhibition. The number of visitors (around 8000 yearly) is about one half of a school generation in Slovenia.

The following sections will describe how these four areas of Nuclear Training Centre Ljubljana are related to radioactive waste management.

## PROFESSIONAL TRAINING

### Training of Nuclear Technology

A course named "Basics of nuclear technology" is intended for other non control room staff of NPP Krško and personnel of regulatory body, technical support organizations, radwaste agency, subcontractors and research organizations (future NPP control-room operators attend a 18 weeks initial theoretical training which is usually not suitable for other profiles). This course is – though not dedicated to RWM – the most suitable also as the theoretical background for radioactive waste management issues.

The “Basics of nuclear technology” course is divided into two parts, Theory and NPP Systems, each lasting 4 weeks (total 250 hours). The subjects covered in this course are shown in Table I.

Table I. The Modules of the “Basics of Nuclear Technology Course”

<b>Theory</b>	<b>NPP Systems</b>
Nuclear and reactor physics	General description of NPP, Technical documentation
Thermohydraulics	Primary systems
Electrical engineering	Technical safety systems
Instrumentation and control	Secondary systems
Radiation protection	Control systems
Materials used in nuclear engineering	Electrical systems
Nuclear safety	Auxiliary systems
Nuclear chemistry	Operation of NPP

The course also involves classroom lectures and practical exercises in the lab, on TRIGA reactor and on the basic principles simulator, as well as a walkaround in the Krško NPP. Embedded in this course is also radiation protection module which satisfies the conditions for "Certified Radiation worker II". One or two such courses are organized yearly, with up to 16 participants per course. People working in RWM usually attend only selected modules of the course, with a total duration around 150 hours.

The Nuclear Training Centre also organizes a variety of short (from 1 day to 1 week) courses. The topics are usually quite specific and the content of the course custom made. Around 3 such

courses are organized per year and the number of participants varies from 6 to 40. Some of these courses were also related to RWM.

### **Radiological Protection Training**

Every person in Slovenia which is working with ionizing radiation has to have a license. Two institutions in Slovenia are authorized for organization of appropriate courses and licensing of personnel. Jožef Stefan Institute is one of them and the Nuclear Training Centre is actual performer of these activities. There is a variety of courses offered for professionals working in different areas of industry, medicine and research.

Since typically each professional working with ionizing radiation, has to be re-licensed every fifth year, in addition to standard/introductory courses also refresher courses are offered. Furthermore, responsible persons in each organization have to take additional training in radiological protection. All courses involve both classroom lectures and practical exercises. The contents of radiation protection courses depend on the type but typically they cover the subjects listed in Table II.

Table II. The Subjects of the Radiological Protection Training

- |  |
|--|
| <ul style="list-style-type: none"><li>• nuclear physics</li><li>• measurement and dosimetry</li><li>• biological effects</li><li>• principles of radiation protection</li><li>• internal/external exposure and protection</li><li>• properties of sources</li><li>• legal issues</li></ul> |
|--|

Around 15 radiation protection courses are organized yearly, with 6 – 15 participants per course. Nuclear Training Centre also supervises the radiation protection training in NPP Krško.

### **International Training Courses**

The expertise of the staff and quite suitable location and building form a good basis for organization of training courses for wider, international audience. International courses were occasionally organized since 1985. In the beginning these courses were part of technical assistance projects of the International Atomic Energy Agency (IAEA) to our country – lecturers and experts were international, while the audience was domestic. Since 1997 truly international courses are organized which means that also the majority of participants were international and on the other hand, also some domestic experts served as lecturers on these courses.

International courses are mainly organized in collaboration with the IAEA, some of them also with EC, US NRC etc. The topics of these courses cover areas of nuclear power, nuclear safety, radiation protection, radioactive waste management, combat against illegal trafficking of sources etc. Typically 6 to 8 international courses are organized per year, with around 20 participants per course.

## **The CETRAD Coordination Action**

The risk of losing nuclear knowledge accumulated in the past is being increasingly discussed in many countries. As part of this debate the knowledge of radioactive waste management is also being closely watched. The current position and future needs of education and training in radioactive waste management were investigated within the coordination action CETRAD as part of the 6th Framework Program of the EU [3]. Twenty partners from 17 European countries, including Slovenia, took part in this investigation. The review focused on geological disposal. It has considered the training and education needs of national radioactive waste management organizations, regulatory and government advisory organizations, and other nuclear industry organizations employing staff in this area, and also the provision of education and training by university and non-university organizations to address these needs.

The data on training and education needs and possibilities were collected through a set of questionnaires created on the relevant topics and distributed to the National Correspondents. In Slovenia, the Agency for Radwaste Management accepted the role of National Correspondent for the project. It was assisted by two experts from the Jožef Stefan Institute.

As a result, the survey has identified no courses in Europe providing a qualification in RWM, yet each country has RWM modules or lectures available (however a specific course, based in Germany, was planned to commence in late 2005). Across the participating countries, numerous courses are accepted, covering a wealth of disciplines which include elements of RWM teaching.

The survey has also confirmed previously identified shortfalls in the number of developing specialists (under 30 years old) within the European radioactive waste management industry. The results have also shown that on the providers' side there are sufficient RWM education and training facilities available in Europe for the present needs of the industry. There are 66 universities providing education in RWM via higher level degrees with a combination of MSc and PhD programs. Training needs are met via the non-university organisations, with 16 such organizations providing training typically via short courses.

The comparison of the results of the national survey with the results in other participating countries shows no significant differences or deviations from other countries or from average results at the European level. Due to the small size of the nuclear industry and rather unclear future development of the whole nuclear sector - and in particular long-term waste management - the demands for new recruitment of the staff and additional education and training in RWM are rather modest. For the next 5 years the need for only about 25 new specialists was identified, including both: new posts and replacements of retired specialists. The number may be underestimated because some vital organizations in the field did not provide their estimates and plans. There is also a fear that the problem of ageing of the workforce has so far not been addressed seriously in many organizations. Future retirement of experienced experts and specialists may create a gap that will require more intensive E&T. A systematic research or analysis of this problem should be performed to give more reliable predictions.

On a European scale, the study also revealed that the main features absent from the provision of education and training are co-ordination of educational and training needs at the European level, and mechanisms to allow recognition and accreditation of the training provided. Both of these factors inhibit cross-national use of existing educational and training facilities.

## PUBLIC INFORMATION

### The Logistics of the Activity

Public information about radioactivity, nuclear technology, and radioactive waste management is a very strong activity of the NTC. The location in the centre of Slovenia and availability of technological and scientific infrastructure is quite attractive for schools and other groups from everywhere in the country and also from abroad. Over 89.000 visitors came to the Information center since 1993 when it was opened. The growth of the number of visitors is shown in Fig. 1.

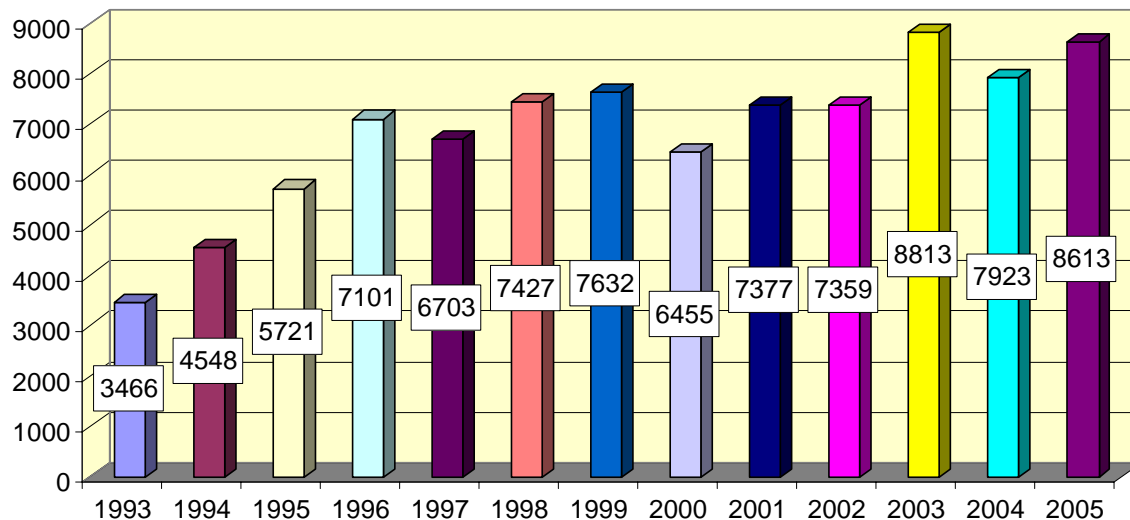


Fig. 1. The number of visitors in the Nuclear Information Center of the NTC Ljubljana

In the year 2005 there were 169 organized groups with 8613 visitors mainly from elementary and high schools. This represents more than one half of the total population of one generation of children, which in turn means that every second child has visited or will once visit our Information center. We believe that part of the quite favorable today's public acceptance of nuclear power in Slovenia is also due to these information activities.

Each visiting group can choose one of the three possible lectures:

- Electricity from Nuclear Energy
- Radioactivity and Radioactive Waste
- Fusion – Energy of Future

After listening to the lecture, visitors go to the permanent exhibition, which is set up in the basement of the NTC and presents the heart of our Information Center. There are around 90 panels which cover a broad range of topics such as general issues related to energy, energy production in Slovenia, nuclear physics, the greenhouse effect, NPP technology, worldwide NPP operation, the nuclear fuel cycle, nuclear fusion, ITER, and – last but not least – radioactive waste disposal. In addition to graphical and textual information there are several computer-based games and quizzes that are especially attractive to youngsters. There are also a mockup of a PWR fuel element, a complete never used core barrel of the TRIGA reactor, the barrel for the radioactive waste disposal, mockups of surface and underground radioactive waste disposal

repository, an interactive map of all NPPs around the world, the mockup of the NPP Krško control room in 1:2 scale and several types of radiation protection equipment. A notable attraction is the “human powered electrical power plant”, which consist of a bicycle coupled with a truck alternator lighting up an increasing number of bulbs in accordance to the power input of the cyclist.



Fig. 2. The permanent exhibition in the Nuclear Information Center of the NTC Ljubljana

The combination with the lecture prior to the visit of exhibition proved to be very effective. After sitting in the class, students can play with computers and at the same time test what they have just heard; they can also find all lectured data on the panels and study them more thoroughly or copy them for further use. Some groups visit also the TRIGA reactor or the Van der Graaf accelerator or the interim radioactive waste storage that is located on the site in the vicinity of the training centre, too. A set of free brochures (leaflets, booklets) is also available to all visitors and most of the information is published on the internet [2], as well.

All these activities make the visit more interesting, convey the visitors a message that nuclear technology is not a mysterious activity, contrary to that it is closely interlinked with other areas of science and engineering, and they also increase to interest of youngsters in natural sciences in general.

### **Public Opinion Polls**

A very important tool to guide our communication activities are opinion polls that we regularly conduct among our visitors [4]. Every year in the springtime, when we get the most visitors, we poll 800 - 1000 youngsters. We maintain essentially the same basic set of questions derived. Polling of the youngsters is done strictly at the beginning of the visit to obtain unbiased opinions based on the knowledge from everyday life. Using the same questionnaire, we have also polled professionals (our colleagues at the Jožef Stefan Institute), as well as visitors during “open day” of the Agency for Radwaste Management.

When interpreting the results one has to consider that the youngsters may have some more relaxed attitudes toward different risks, but their attitudes reflect opinions they hear in their families and information in the media. Similarly, polled professionals are also not representative of general (adult) public. It has to be stressed, however, that the great majority of them doesn't work in the field of nuclear energy. Finally, even the visitors during the "open day" are only those who have some interest to be informed about RWM activities and are also not representative of general public.

Despite all above deficiencies, the results of the polls still have significant value, because they allow us to monitor trends from year to year, and also comparisons between different social groups can be made. They also serve us to guide our information efforts into areas that are – based on opinion polls – least known or understood. There are 8 questions in our poll, and only most interesting results will be presented here.

Understanding some basic facts of nuclear energy, radiation and radioactive waste is the first segment we poll, because nuclear energy and radiation are not directly taught in the school or sometimes in a very limited extent. This question was put as a set of ten statements. The respondents were asked to check the true statements, but they were not informed about their total number. On average only 3.5 statements were identified as true by youngsters (instead of 5), so it is quite possible that non-checking a false statement (thus giving a correct answer) was guessed by chance. It may therefore be concluded that if false statements were formulated reversed, i.e., as true, the number of correct answers would be even lower. The results are shown on Fig. 3.

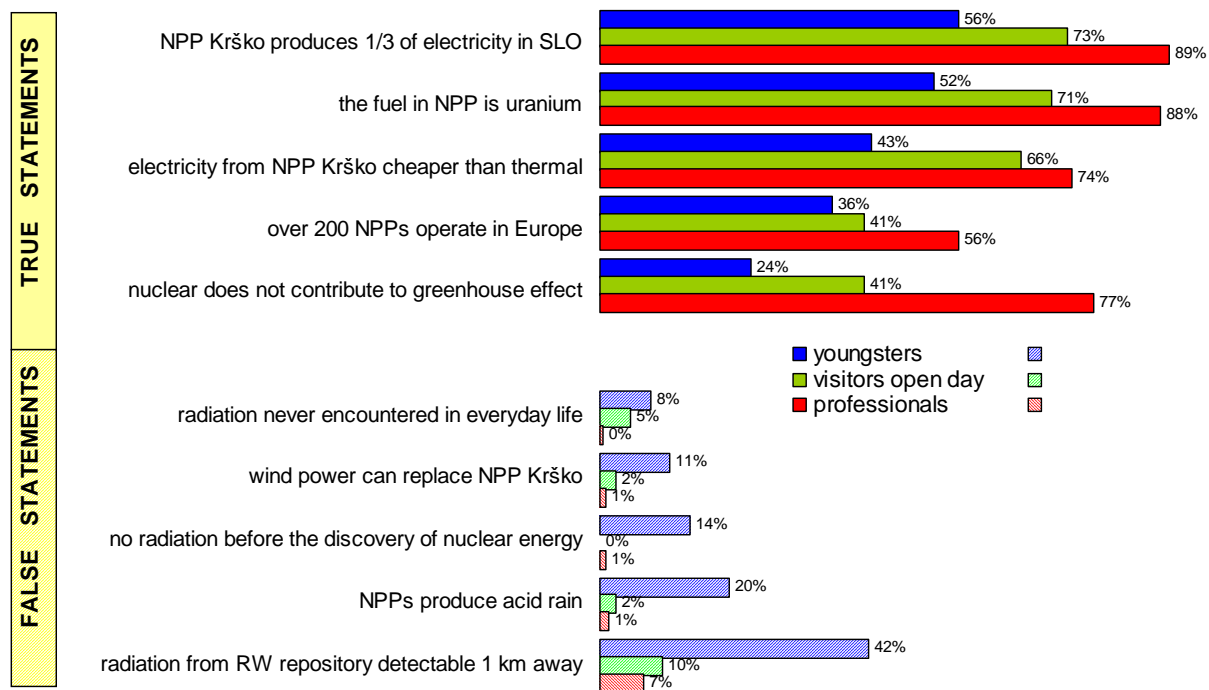


Fig. 3. Agreement with statements related to nuclear energy and radioactivity

As it can be expected, the overall share of right answers is the highest among experts, and the lowest among youngsters. Laymen adults (visitors during open day) are in the middle. Looking



at specific answers, it is worth noting that economical facts that are connected with the role of NPP Krško in Slovenia are known somehow better than the others because they are often present in the media as “commercial news”. On the other hand, almost one half of professionals are not aware that more than 200 NPPs operate in Europe. Facts connected with radiation are the least understood because they never appear in the media (in positive sense). We can not blame ourselves or attribute the deficient knowledge entirely to the school’s curriculum. We think that the deeper reason is most probably a waning interest for natural sciences and technology among the youngsters which is of course the reflection of the general situation in today’s society in Slovenia and wider.

Next segment is concerned with personal opinion on the use of nuclear energy and the results of one of the questions are shown on Fig. 4.

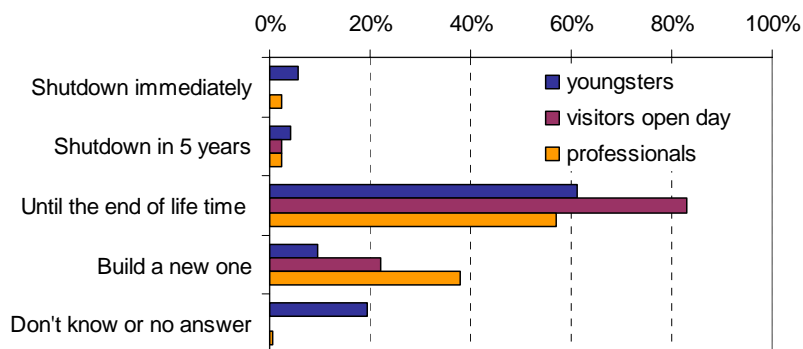


Fig. 4. Answer to question: *How long should NPP Krško operate?* (one answer allowed)

An analysis of the answers shows that the general support for continued (or even extended) nuclear power in Slovenia is quite high, at least based on the youngsters’ opinion. The results for open day visitors tell us something completely different, namely that, regrettably, “open days” and similar activities are too often a “persuasion of persuaded”, i.e., that only those who are favorably inclined towards nuclear power, attend such events in order to get better informed, but those who are opposed, don’t come or don’t want to come. This consideration certainly doesn’t imply that open days are useless; it only warrants that though they do contribute to a public communication, their reach is quite limited. Unfortunately there are no other shortcuts or easy ways for a more effective public communication.

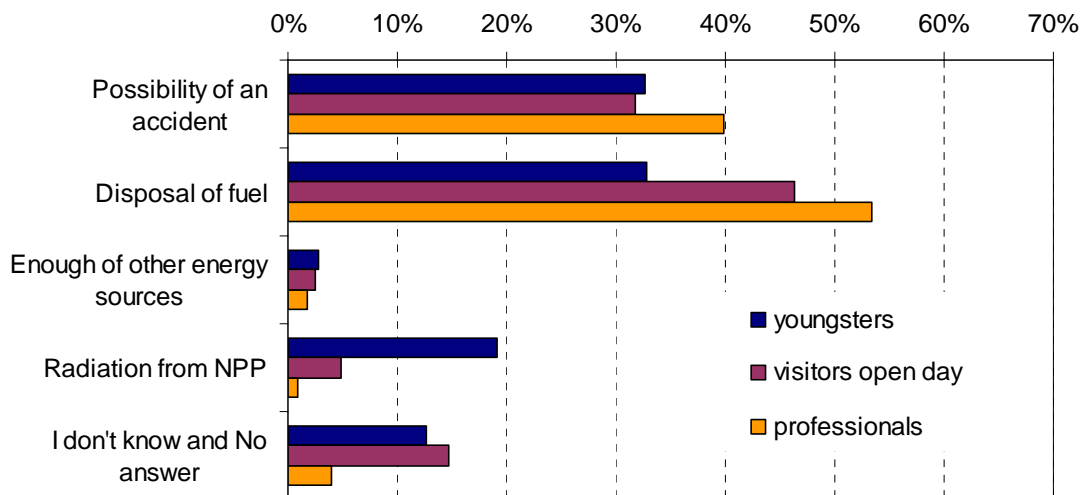


Fig. 5. Answer to question: *What is the reason against nuclear energy?* (one answer allowed)

All groups see disposal of spent fuel as a major obstacle, greater than the possibility of an accident. Surprisingly, this is the case also for the majority of professionals. It is unclear if this is their professional opinion or indication of their awareness of present low social acceptability. The answers to this question as well as some others (not discussed here) show that the radioactive waste issues are one of the most important topic in communicating and informing public about nuclear energy issues.

In the spring of 2005, a poll on the subject of nuclear energy, and radioactive waste in particular, was conducted by Eurobarometer in the 25 states of European Union [5]. The results show that 46% of Slovenes believe that they are well informed about radioactive waste which is the second best result (after Sweden, 51%; European average is 25%). This was confirmed also in the high actual knowledge about RWM, where Slovenia with an average of 64% correct answers to specific questions was again second in Europe (overall average 25%). We do believe that part this outcome is at least in part due to our public information efforts.

## CONCLUSIONS

In a country with a small nuclear program and correspondingly small nuclear community it is necessary that nuclear training center has a broad range of activities that go beyond pure nuclear training. Nuclear training center Ljubljana is, in addition to “core” training in nuclear technologies and radiation protection, engaged also in international projects and especially in public information.

There is no special RWM training but RWM specialist are rather trained in selected general nuclear engineering topics. This is not specific for Slovenia, but is quite a general practice across Europe. Public information is a very extensive activity of NTC, and it reaches around one half of one school generation in Slovenia. The knowledge and the attitude towards nuclear issues is monitored by opinion polls among visitors of the Information center. A pan-European poll has showed that certain success was gained by these public information activities.

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