

Basics of Nuclear Technology Courses in Nuclear Training Centre Ljubljana

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ABSTRACT

The paper presents experiences from performing nuclear technology courses at Nuclear Training Centre Ljubljana. There are two types of nuclear technology courses, conducted for Krško NPP staff and other organizations, dealing with nuclear technology. The first course is called NPP Technology (the acronym in Slovenian language is TJE) and is intended for future control room operators. This course is the first, theoretical part of the initial training of licensed operators (later stages – NPP systems and simulator training – take place at the location of the NPP). Approximately 5 months are devoted to different topics, such as nuclear and reactor physics, thermal-hydraulics and heat transfer, radiation protection, electrical engineering, materials, and nuclear safety.

The second course, Basics of Nuclear Technology (in Slovenian OTJE) is suitable for other NPP technical personnel, technical support organizations, regulatory body, etc. This course consists of two parts: theory (4,5 weeks) and NPP Systems (3,5 weeks). This year the 45th edition of the course was conducted.

The paper will present the Basics of Nuclear Technology course organization, materials preparation, course content and feedback from participants.

1 INTRODUCTION

The Nuclear Training Centre Milan Čopič (the acronym in Slovenian language is ICJT), a part of the Jožef Stefan Institute (IJS), started with the training of the nuclear workers at the beginning of commercial use of nuclear technology in Slovenia. Jožef Stefan Institute is also an authorised institution in the field of Radiation protection and Radiation protection training in Slovenia (authorisation was issued by the Radiation protection administration of the Republic of Slovenia). The Nuclear Training Centre has been certified according to ISO 9001:2015 quality standard since December 2006. ICJT already used several QA procedures before the certification process and therefore the whole certification process was easier.

In ICJT the most important course is NPP technology course (TJE), intended for training of future Krško NPP control room operators. The course is designed to give in 20 weeks the necessary fundamentals to ensure understanding of different topics. Most of the time is spent in the classroom, practical exercises are performed in the laboratory, on the simulator and on the research reactor TRIGA.

The second course, Basics of Nuclear Technology (in Slovenian OTJE) is suitable for other NPP technical personnel, for technical support organizations, regulatory body, etc. This course consists of two parts: theory and NPP Systems.


2 BASICS OF NUCLEAR TECHNOLOGY COURSE

The Basic of Nuclear Technology course consists of two parts: Basic of Nuclear Technology - theory and Basic of Nuclear Technology course - systems. At the beginning this course was called Basics of Power Reactor Technology (the acronym in Slovenian language was OTMRT(S) - T for theory and S for systems). Since the establishment of ICJT, there have been 45 OTJE courses and 680 trainees have successfully completed it.

2.1 Organisation of the course

Nuclear Training Centre has been certified according to ISO 9001 quality standard since December 2006 and now activities according to standard ISO 9001:2015 are performed. There are many other important tasks that are closely connected with training process, and different QA procedures for those tasks are used as well (e.g. lecture rooms supervision, inspection of training centre etc.).

The course organization procedure includes several steps, which are performed before the course, and steps or tasks during and after the course. A procedure is prepared for all kinds of training courses (Figure 1). Course coordinator and course administrator are responsible for course implementation. Supervision is carried out by the QA representative and the head of ICJT. After the end of the course a final report is prepared.

ZAGOTOVITVE KAKOVOSTI		Poslovna skrivnost	
 Inštitut "Jožef Stefan" Ljubljana, Slovenija	IZVEDBA TEČAJA	Postopek: ICJT-ZBC-600	
Večja od datuma odobritve	Delovni postopek	6. tedaja stran: 8 od 13	
Dejavnost	Rok	Narejeno	Opomba (z datumom in razlogom)
5.1.42 Tajnica tečaja obravni tiskilno o dogodku ter ji navedi bolj poglobljeno čiščenje avla, stimalič in predavalnice.	Z - 2 dni		
5.1.43 Vodja in Tajnica tečaja s pomočjo tehnika uredita prostor in predavalnico: - potrdijo se vsi napisi (glej 5.1.37, na vsa vrata, kjer je možna vstop v predavalnico), - na mizi se postavijo mape s prepričljivim gradivom, - nastavi se delovanje prezračevanja.	Z - 2 dni		
5.1.44 Vodja tečaja in tehnik preverita delovanje potrebne AV opreme: - LCD projektor, - računalnik, - orovčenje - plinca, pišala, palice, - ostala oprema po zahtevih predavateljev.	Z - 2 dni		
5.1.45 Vodja tečaja s pomočjo tehnika na računalnik tečaja prenese vse potrebne datoteke.	Z - 2 dni		
5.1.46 Vodja in Tajnica tečaja preverita pripravljenost pred začetkom tečaja ter se posebej prepričata čistoto (pred avlo, avla, WC, predavalnico).	Z - 1 dan		
8.2 IZVEDBA			
5.2.1 Tajnica tečaja na glavno mizo postavi vodo in kozarce.	Z - 1 ura		
5.2.2 Vodja tečaja ali tajnica tečaja prikaže udeležence na dogovorjenem mestu (glej: vrata hoda, vrata ICJT), preveri če so vsi, jim da osnovne napotke glede morebitnih prevozov tekoma tečaja in tuje opozori, naj imajo osebne dokumente vodno pri sebi.	Z - 30 min		
5.2.3 Tajnica tečaja opravi registracijo udeležencev v anki ICJT - udeleženci prejmejo priponko in izpolnijo prijavnico.	Z - 15 min		
5.2.4 Vodja tečaja poskrbi za točen začetek otvoritve tečaja, ki sestoji iz uvodnih predstavitev vodje ICJT, vabilnih gostov, predavateljev ter predstavitev udeležencev.	Z - 00		


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Večja od datuma odobritve	Delovni postopek	6. tedaja stran: 9 od 13	
Dejavnost	Rok	Narejeno	Opomba (z datumom in razlogom)
5.2.5 Vodja tečaja na knjižico uvodnega dela sporoči udeležencem informacije za lažje bivanje: - time, 9-5 pm - bar - 8:30 - unsecured - tokens for the coffee machine - lunch 12:30 with cash - can pay tomorrow - money exchange - Internet and e-mail - Wireless - AC power and network floor sockets for notebooks (same as P1) - cocktail party - national presentations (if todo) - NO SMOKING in the building - sightseeing in Ljubljana (kaj in kje, BTC, grad...) - ATM automatic teller machines - (bankomat) - wear badges & stay in/around the building	Z - 00		
5.2.6 Tajnica tečaja poskrbi za izplačilo morebitnih študentskih.	Z		tekom prvega dne
5.2.7 Tajnica tečaja vose v bazo ICJT morebitne spremembe o udeležencih tečaja na podlagi podpisanih prijavnice. Vodja tečaja seznanj udeležencev tečaja temeljito pregleh in ga primerja z morebitnim seznanom anketnika.	Z		
5.2.8 Vodja tečaja poskrbi za fotografiranje udeležencev in za izdelavo ustreznega števila fotografij. Vodja tečaja poskrbi, da je datoteka slike shranjena v podzorno tečaj "tikar" in v mapo G:\na\doc\FO\XG\RA\IE\TECAJ\<Imena tečaja>_<ime tečaja>.	Z		tekom prvega dne ali prvi primern dan glede na vreme za fotografiranje (znoj), ticer se slika na nastavi
5.2.9 Vodja tečaja shranj spremlja potek tečaja glede na program: - preverja pripravnost in prihod predavateljev in slišateljev, - skrb za upravljanje in prilagajanje tiskala, - naredi razumevanje dokumentov za tečajnike, - skrb za delovanje AV tehnika, - pozna udeležence pri vsah reševanju osebnih problemov, - poskrbi za odhod vseh udeležencev (da kdo ne zamudi avtobusa).	Z - K		

Figure 1: A training course implementation procedure

2.2 Content of the course

The course is designed to give in 8 weeks the necessary fundamentals training to ensure an understanding of each object shown in the topic area table (Table 1). During the first theoretical part of the course most of the time is spent in classroom and practical exercises on the simulator and in the laboratory are performed. A visit to the research reactor TRIGA is organised as well.

During the second part of the course (NPP systems) the time is spent in classroom (lectures) and on the visits to the location of Krško NPP (2 days). Topic area of Basics of Nuclear Technology course – Systems are presented in Table 2.

Table 1: Topic area of Basics of Nuclear Technology course – Theory

Theory topics	Topic Area	Duration (hours)
Classroom	Basics of nuclear technology	3
	Basics of nuclear physics	11
	Basics of reactor physics	10
	Basics of radiological protection	22
	Basics of chemistry	7
	Basics of thermo and hydro-dynamics	17
	Basics of electrotechnics	17
	Basics of instrumentation and control	9
	Basics of materials	4
	Basics of nuclear safety	9
Exercises - laboratory - simulator	Nuclear physics	8
	Radiological protection	7
	Reactor physics	7

Exercises on nuclear physics (BF3 counter, gamma rays attenuation, radioactive decay) and exercises in radiological protection are performed in laboratory (Figure 2).



Figure 2: Nuclear physics exercises in the laboratory

Table 2: Topic area of Basics of Nuclear Technology course – Systems

NPP systems topics	Topic Area	Duration (hours)
Classroom	Introduction	4
	Primary systems	10
	Auxiliary primary systems	4
	Engineering safety features	18
	Secondary systems	22
	Control systems	5
	Electrical systems	6
	Reactor protection systems	2
	Other support systems	16
	NPP operation	8
NPP visit		10

2.3 Materials

Each copy of printed material consists of copies of certain course topic and a USB stick with the course material (Figure 3). Very important are permanent revisions of lecture materials; according to the questionnaire results (comments from participants) the contents of different topics and a number of hours dedicated to certain topics were optimized in the past.



Figure 3: Course materials

For better understanding of the nuclear power plant to all lectures simplified schemes of NPP systems and a number of pictures from the plant were added (Figure 4).

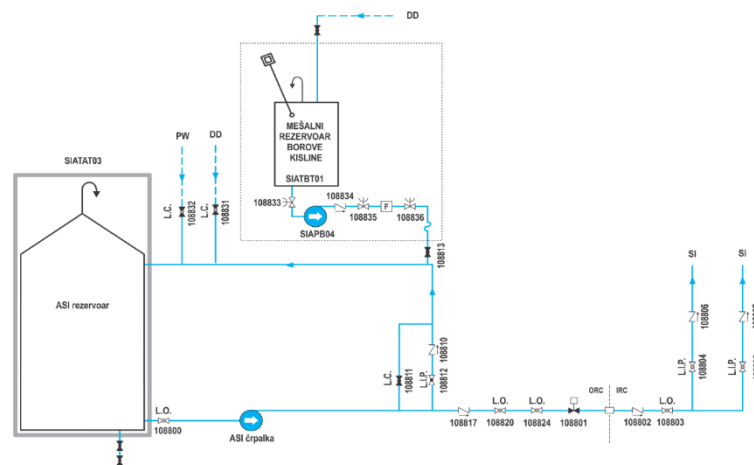


Figure 4: An example of simplified scheme (Alternative Safety Injection - ASI)

After the course participants are able to understand the basic operation of particular system and connectivity between different systems.

Course materials for all courses are regularly updated. Materials preparation process consists of several steps, which are supervised by the project leader and approved by the head of ICJT. All materials have specific name and a specific code. In Figure 5 a lecture material (Turbine and auxiliary systems) preparation procedure is shown. At the end all materials are archived by the secretary as a computer file with a specific name on the ICJT server and as a hard copy.

Revizija OTJE 2023

Stanje revizije posamezne lekcije

Naslov lekcije: TURBINA IN POMOŽNI SISTEMI	Vodja projekta: Tomaž Skobe
Datoteka: OSM23_STU1.docx	Revizor: Tomaž Skobe
Koda: TT-STU.01.C1-3	

Komentar:

- Skrajšanje dela o teoretičnih osnovah delovanja turbine (že del OTJE teorije)
- Popravki pri visokotlačni turbini zaradi zamenjave med remontom 2022 (nov tekst, slike)

Stara datoteka: OSM16_STU1.docx
Stara koda: TT-STU.01.C1-2

Naloga	Odgovorni	Datum	Podpis
1. Star material oddan revizorju	Vodja projekta	10.1.23	T. Skobe
2. Material revidiran	Avtor	23.1.23	T. Skobe
3. Pregled učnega materiala	Recenzent	24.1.23	R. J.
4. Vneseni popravki	Avtor	N.O.	
5. Pregled učnega materiala	Vodja projekta	N.O.	
	Vodja ICJT	25.1.23	(i.j.) POPRAVKI
6. Vneseni popravki	Avtor	?	
7. Pregled učnega materiala	Vodja projekta	26.1.23	T. Skobe
8. Material odobren	Vodja ICJT	27.1.23	J. J.
9. Original materiala arhiviran	Tajnica ICJT	30.1.23	J. J.

Kazalo OTJE tečaj Arhiv Giten Projekt zaključen

Stanje revizij

\\GiteV\Doc\U\CNL\MATERIAL\OTJE_SISTEMI\REVIZIJE\2023\Vodja_revizije\Stanje_lekcije\Stanje_lekcije_STU1.docx
Prepravil: T. Skobe, 10. 1. 2023 ICJT

Main elements of revision / comments

Author/revisor

Reviewer

Project leader

Head of ICJT

Figure 5: Procedure for course materials

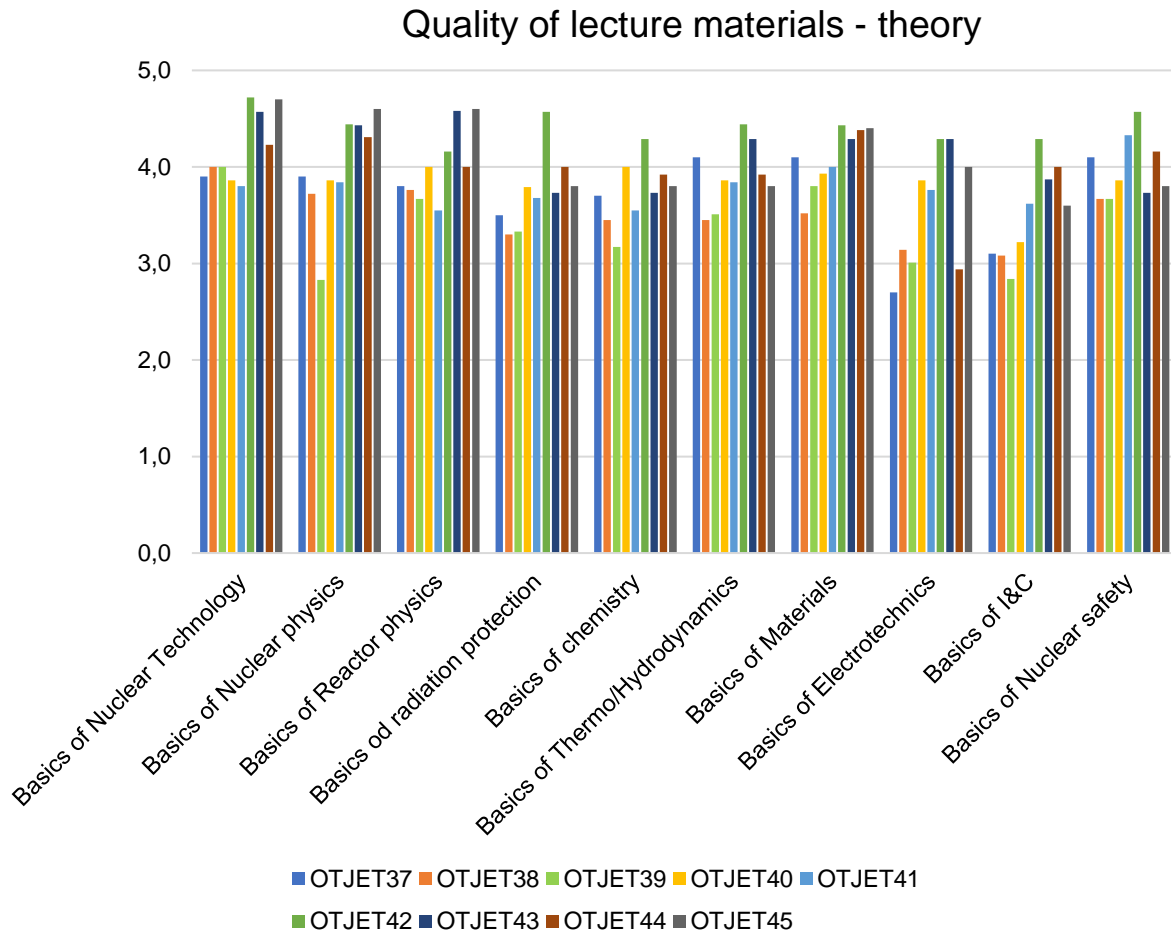
2.4 Evaluation of the course

Participants are requested to answer evaluation questionnaire at the end of the first part (theory) and second part (NPP systems) of the course. Results are presented at the evaluation session before closing the course. All comments are distributed to lecturers and the plan of necessary improvements is made at the end.

From participant's questionnaires very valuable feedbacks are received. Four years ago, the format of questionnaires was upgraded. Intention was to receive more specific feedbacks. The questions are related to the difficulty and comprehensibility of lectures, difficulty and understanding of learning materials (Scripts), organization and transparency of learning materials, transparency and comprehensibility of power point presentations and to the conduct of the course. Some results from last nine courses are presented below (Figure 6). The

trainees' progress on nuclear technology courses is evaluated weekly by a written exam (test). Exams for nuclear technology courses are on schedule each Friday in the morning.

The experience in the past has shown that exam at the end of the week is the best solution since this enables participants to relax during weekends.



The meaning of grades: Lecture materials are...

- 1 - Not transparent, I have problems at following lectures or studying them;
- 2 - Not transparent in places, occasionally I can't follow the lectures;
- 3 - Quite useful, but could be much better;
- 4 - Very good;
- 5 - Excellent, also as a reference for later work.

Figure 6: Quality of lecture materials from last nine editions of Basics of nuclear technology

There are still some problems with following and understanding of some topics, especially in the first part of the course - new topics for all are for example Nuclear and Reactor

physics. Problems are also with a lecture Electrotechnics. The lecture is still quite pretentious, and a thorough revision of material is planned.

Some feedbacks regarding difficulty and comprehensibility of lectures, difficulty and understanding of learning materials at Basics of nuclear technology course on NPP systems are presented on Figure 7.

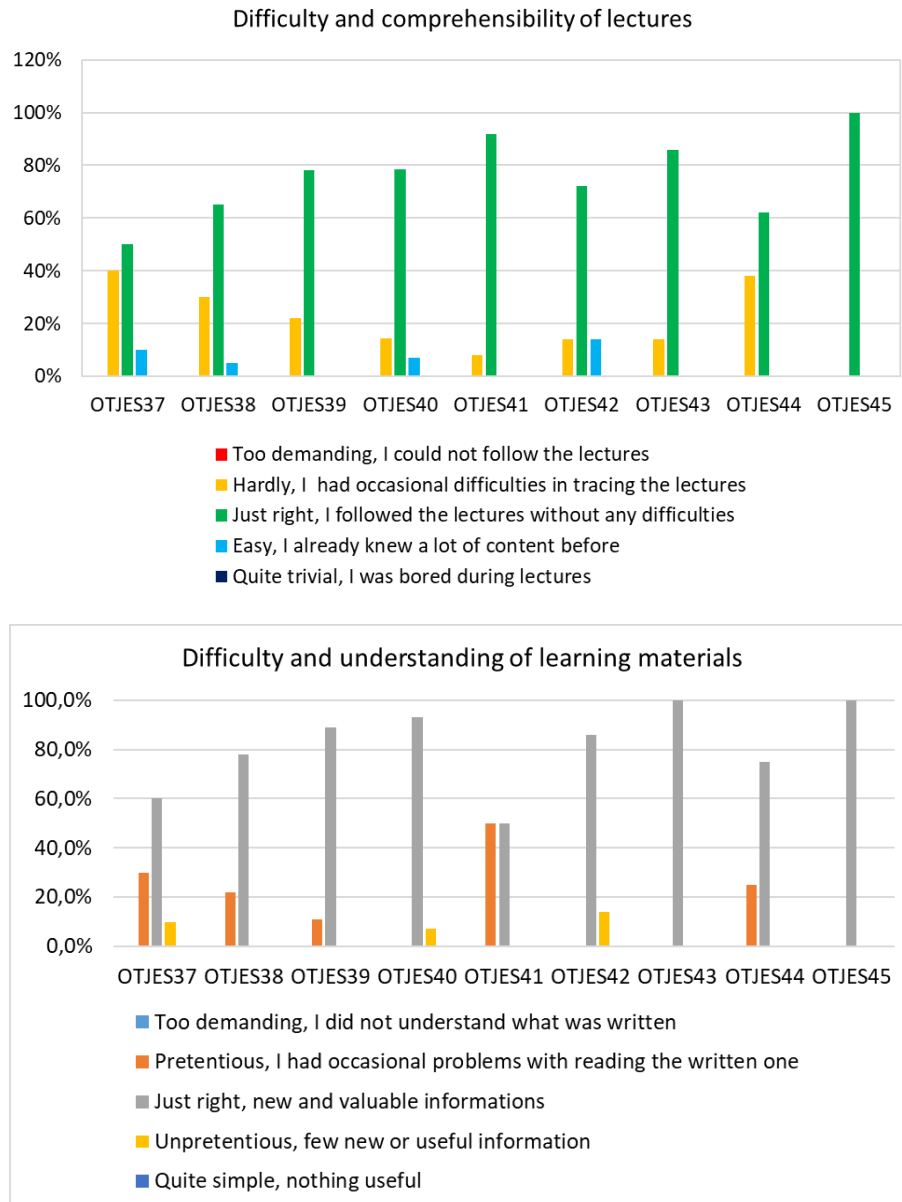


Figure 7: Feedbacks regarding the difficulty and understanding of written materials from Basics of Nuclear technology – systems courses

Very valuable are all written comments from participants and suggestions for improvements from lecturers. Some examples of good practices and major improvements are listed in Table 3.

Table 3: Examples of good practices and improvements on Basics of nuclear technology courses

Basics of nuclear technology course	Examples of good practices (feedback from participants)	Improvements
Theory	<ul style="list-style-type: none"> • Emphasis on important things; • A dynamic and interesting approach to the lecture; • Real examples; • Explanation by drawing; • Calculating practical examples; • Additional material - sheets for repetition. 	<ul style="list-style-type: none"> • Three additional days for lectures; • Combining lectures (e.g. Nuclear physics in the morning and Materials in the afternoon); • Repetition of important subjects by using Turning point¹; • Constant revisions of lecture materials.
NPP systems	<ul style="list-style-type: none"> • Experienced lecturers - good examples; • Appropriate speed of delivery of material with emphasis on important things; • A detailed description of systems; • Use of all three panels (LCD, overhead projector + blackboard + thought patterns); • Punctuality at lectures schedule and breaks. 	<ul style="list-style-type: none"> • Simplified schemes of systems; • Optimisation of duration of lectures for certain systems; • New format of lecture materials; • Synchronization of lecture materials and lecture presentations; • Additional questions at the end of lecture materials.

3 CONCLUSION

In more than thirty years of Nuclear Training Centre 18 operator courses (NPP technology) and 45 Basics of nuclear technology courses were successfully performed. The organization, contents and materials of the course were constantly improved. Results of questionnaires from participants have shown that courses were performed on very high level and participants basic knowledge about nuclear technology was on very high level (according to exam results).

The introduction of ISO standard helped us to use a systematic approach for all ICJT activities. Improvements were introduced into all main and supporting working processes at ICJT as a result of ICJT staff suggestions, inputs from internal and external audits and from management reviews.

¹ Turning point is a software, integrated in Power point with questions and multichoice answers.