

MEET-CINCH

(Project Number: 754 972)

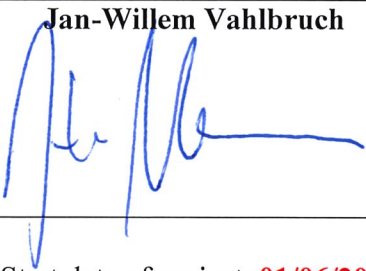


DELIVERABLE D3.3

**Tailored training event for members of regulators and
administrative bodies**

Lead Beneficiary: LUH

Due date: 30/11/2019

Released on: 18/11/2019

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Start date of project: **01/06/2017**

Duration: **36 Months**

Project Coordinator:

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Project Coordinator Organisation:

LUH

VERSION: **1.0**

Project co-funded by the European Commission under the Euratom Research and Training Programme on Nuclear Energy within the Horizon 2020 Programme		
Dissemination Level		
PU	Public	X
RE	Restricted to a group specified by the Beneficiaries of the MEET-CINCH	
CO	Confidential, only for Beneficiaries of the MEET-CINCH project	

Version control table

Version number	Date of issue	Author(s)	Brief description of changes made
1.0	14.11.2019	Jan-Willem Vahlbruch	First version

Project information

Project full title:	A Modular European Education and Training Concept In Nuclear and RadioCHemistry
Acronym:	MEET-CINCH
Funding scheme:	Coordination Action
ECGA number:	754972
Programme and call	H2020 EURATOM, Euratom Fission 2016-2017, NFRP-12
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Start date – End date:	01/06/17 – 31/05/20 i.e. 36 months
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“This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 754 972.”

EXECUTIVE SUMMARY

Education and Training (E&T) of members of authorities in Radiochemistry and Radiation Protection (RP) is one of the main issues to ensure a good practice of RP. MEET-CINCH took that in account by developing a tailored training event for members of regulators and administrative bodies. One difficulty foreseen was that attendees from administrative bodies from different European Countries would not be willing to participate in an English language pilot project. Additionally, national regulations concerning radiation protection differ in various countries and are written in national languages. To overcome that problem and inspired by a virtual experiment to determine the half-life of Ba-137m (which was produced by the German-Swiss Association for Radiation Protection (Fachverband für Strahlenschutz) in cooperation with the University of Mainz) an e-learning solution was developed. Core of that course was to decide from the perspective of the authority representatives for three different scenarios whether a (virtual reality) radionuclide-lab fulfills all the technical and structural requirements to be licensed according to German regulations. The virtual laboratory uses nearly no language; details of objects that cannot be visualized are described with few words which can be exchanged easily in order to enable the use of different languages, too. Necessary information like the set of handled radionuclides, the amount of activity and the way the nuclides are handled are described in separate documents. Hence, a solution was found to develop a course for members of regulators and authorities that can be adapted to national rules and languages very easily and therefore can be used in different countries.

A prototype of the course was conducted on 29.08.2019 at Leibniz University Hannover. Nearly 120 members of regulators attended the course; approximately half of them entered the virtual lab as part of pre course preparation and completed the course entirely. The results were evaluated and the feedback given was extremely positive. The virtual lab including all descriptions is still available and can be used to train member of regulators and competent authorities at any time.

CONTENT

1 INTRODUCTION..... 5

2 AN E-LEARNING SOLUTION FOR A TAILORED TRAINING EVENT 6

2.1 BASIC IDEA..... 6

2.2 IMPLEMENTATION 6

2.3 THE TASKS 9

2.3.1 Task 1..... 9

2.3.2 Task 2..... 10

2.3.3 Task 3..... 11

2.4 RESULTS 11

2.4.1 Task 1..... 11

2.4.2 Task 2..... 11

2.4.3 Task 3..... 14

3 EVALUATION..... 16

3.1 PREVIOUS KNOWLEDGE AND EXPERIENCE..... 16

3.2 THE TAILORED TRAINING EVENT 16

4 OUTLOOK 19

5 APPENDIX 20

1 INTRODUCTION

Since training and education of the competent authorities is a key requirement to ensure radiation protection, MEET-CINCH decided to develop a tailored training event for members of regulators and administrative bodies. One obstacle identified already when preparing the MEET-CINCH proposal was that especially members of regulators have to deal with national laws, regulations and technical rules written in the national language and including varying requirements in different EU member states. To overcome this obstacle, an e-learning solution was developed with the advantage, that the written language can be exchanged and adapted with minimum effort. The basic idea of the e-learning solution was an everyday but not trivial task in the professional life of members of the regulators, namely the assessment of an application for the license to operate a radionuclide laboratory. Since it was clear that the prototype of the course would be held in Hannover, Germany, the scenario took into account German regulations for operating a radionuclide-lab which are defined in the technical rule DIN 25425. The concept of the training event mainly based on three pillars:

1. For three different scenarios (different set of radionuclides, different amount of activity, different type of handling), the different requirements for the structural and technical equipment of the laboratory had to be determined according to DIN 25425.
2. The participants of the training event had to download and install the virtual laboratory on their computer, enter the virtual lab and check whether the requirements for licensing the lab are fulfilled or not. For each of the three scenarios, two virtual labs were developed: one that fulfilled all requirements and one that didn't. The first task required to identify as many "errors" as possible in the lab-version that included the mistakes. Subsequently, each participant entered the lab without errors to get aware of possible solutions. As support, a checklist was developed (see Appendix 1) to guide the participants during the virtual inspection. Additionally, members of the regulator should be trained to identify "wrong behavior" like the use of a cup of coffee in the lab.
3. In the last step, the training event was evaluated, pros and cons were identified and further possible developments discussed.

2 AN E-LEARNING SOLUTION FOR A TAILORED TRAINING EVENT

2.1 Basic idea

To train members of regulators in the field of radiochemistry, an everyday but not trivial task in the professional life of members of the regulators was defined, namely the assessment of an application for the license to operate a radionuclide laboratory. In Germany, the requirements for such a laboratory are described in the technical rule DIN 25425. According to this DIN 25425, the so-called room category must be calculated depending on the set of radionuclides, the amount of activity and the type of handling. DIN 25425 defines four room categories (RC0, RC1, RC2 and RC3), whereby the requirements for the laboratory also increase with increasing number of RC. Part 1 of DIN 25425 contains a list of requirements to be met depending on the room category. The task of the course participant is therefore to decide whether the laboratory would be eligible for a license for the described scenario depending on the room category that has been calculated. The assessment of the laboratory is carried out virtually, what means, that similar to a computer game, the participant can move through a virtual radionuclide laboratory, look around and check whether essential requirements are fulfilled or not. Afterwards, the participants came together in Hannover at 29.08.2019 (presence phase) to discuss the results of the online assessment, share experiences and evaluate this training event.

All the documents necessary to explain the scenarios and tasks are written in German language since most members of regulators speak mainly German and because the DIN 25425 is only available in German language, too. However, when developing the program, care was taken to ensure that even in the program itself German words can be exchanged easily. Therefore, it should be quite easy to adapt this tailored training event to different national regulations and other languages in order to ensure that it can be used in as many different EC member states as required.

2.2 Implementation

As the presence-phase of this tailored training event was held on 29.08.2019 in Germany organized by the Institute of Radioecology and Radiation Protection (IRS) at Leibniz University Hannover (LUH), all information was provided on the webpage run by the radiation course department of IRS (www.strahlenschutzkurse.de). All the information given there was sent to the participants of the tailored training events six weeks in advance (on 14.07.2019) via e-mail.

Using the following link (<https://seafiler.projekt.uni-hannover.de/f/a385be3a5c9047baac2c/?dl=1>) a packed .zip-file with the file-name "Radionuklidlabor.zip" was (and still is) provided as download. After saving and unzipping this file on the local personal computer, the participants found an executable file named "Radionuklidlabor.exe" in the folder into which the participant unpacked the files. Double-clicking the file-name started the program, in which a selection menu opened as shown in figure 1:

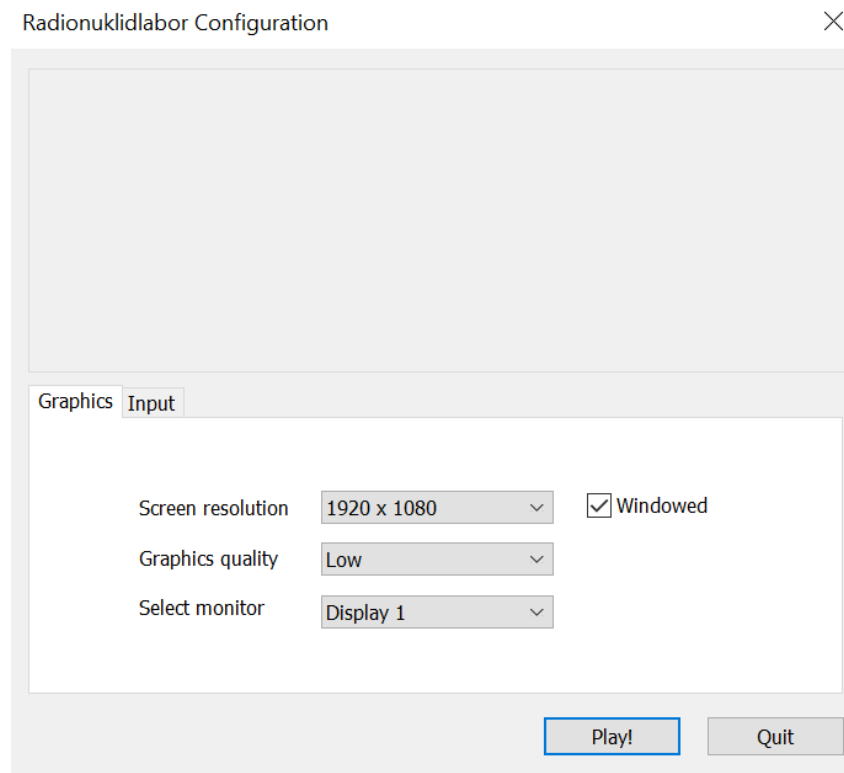


Figure 1: First menu after starting the program

It was recommended to select "Low" in the setting for "Graphics quality" in order to ensure that the program runs as smoothly as possible. After clicking "Play!", a selection menu opened in a separate window (see figure 2).

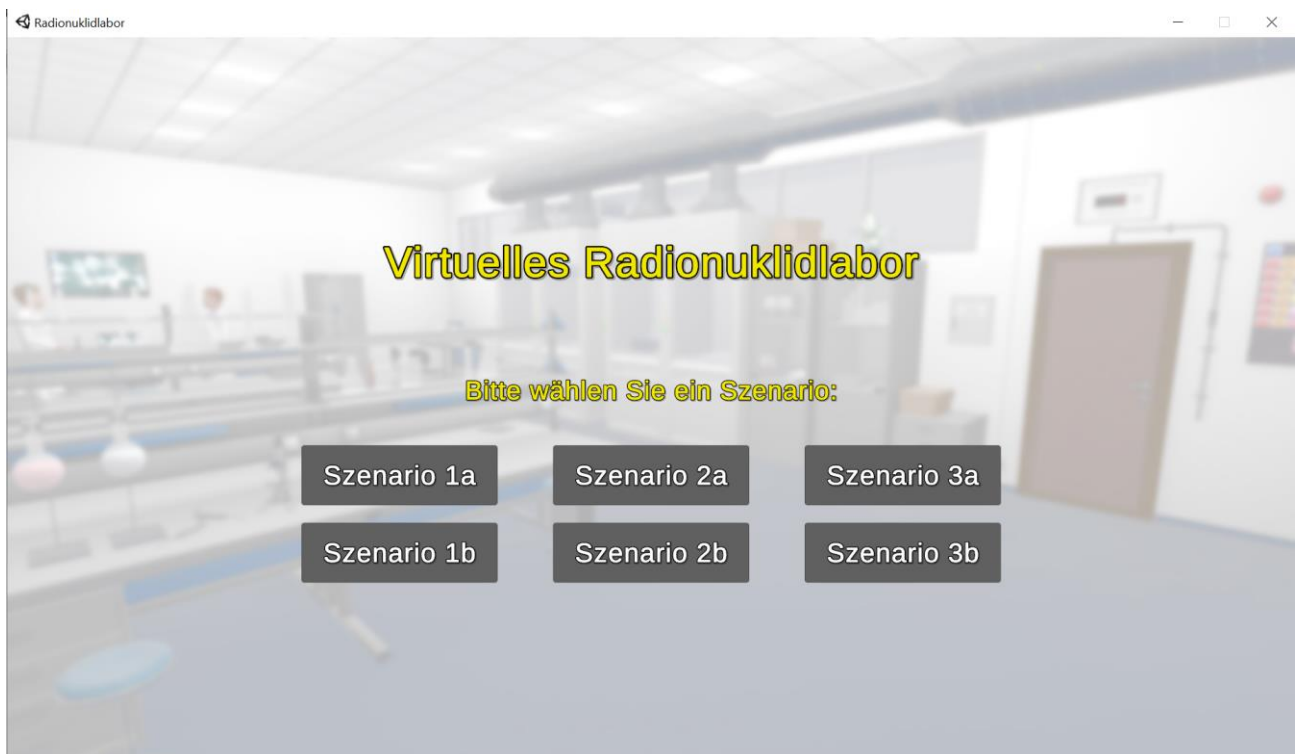


Figure 2: Menu to chose the lab

Here the participant had the choice between three scenarios, each in an "a"-version or "b"-version. The scenarios were based on those described as examples in the supplement to part 1 of DIN 254525 - but did not correspond exactly to them. Therefore, the participant had to calculate the room category (RC) according to DIN 25425 for the given three scenarios independently. Of course, it was also possible and allowed to solve the task for only one of the three scenarios, if the treatment of three scenarios seemed to be too time-consuming.

After choosing the scenario, the participant enters a radionuclide lab. The laboratories with the ending "b" contain errors, the laboratories with the ending "a" comply with DIN 254525. Depending on the chosen scenario, the participants should therefore search for errors in the laboratories "Scenario 1b", "Scenario 2b" or "Scenario 3b".

The user examines all laboratories from the "I"-perspective and consequently cannot see himself. He can move in the lab using either the cursor keys or the keys "W" (to the front), "A" (to the left), "S" (to the back) and "D" (to the right). The (virtual) head is moved by using the mouse - so a look around is possible without changing the position in the room.

Some properties cannot or only poorly be visualized. Therefore, text fields that describe objects in the laboratory have been implemented to provide additional information. Moving close to an object turns the color of the object yellowish when information about that object is available. Clicking the left mouse button opens a text field with the corresponding additional information. Figure 3 shows an example: A text superimposition provides the information of the tables surface being made of steel – this is highly relevant for decontamination purposes.



Figure 3: Additional information is supplied if necessary.

As mentioned above, for each of these three scenarios we developed two laboratories, one which does not fully meet the requirements (scenario 1b, scenario 2b, scenario 3b) and one that complies to the DIN 25425 (scenario 1a, scenario 2a, scenario 3a).

The task of the participant was

1. to calculate the room-category on the basis of the given scenario and
2. to identify in the relevant laboratory which did not meet the requirements ('b' laboratories) as many errors as possible. The requirements are defined in detail in chapters 8-12 of DIN 25425 and are summarized in table 2 in chapter 13 of DIN 25425. Additionally,
3. the participants were asked to identify further anomalies that could be criticized during an inspection of the lab.

The results had been presented and discussed at the presence phase of the course for members of regulators and administrative bodies in Hannover on 29.08.2019.

It was emphasized in the introduction to that event, that certainly things might be implemented in an unexpected way or even mistakes might occur as a result of wrong programming. However, discussion about these topics will contribute significantly to deepen the understanding of radiation protection in a radionuclide lab.

2.3 The tasks

The tasks for the participants of the tailored training event were described as follows and sent to them on 14.07.2019 via e-mail (direct translation of the tasks are given in italic letters):

“A new radionuclide laboratory has been built on the campus of the Technical University in Radium-city, for which a license for handling open radioactive materials is now being applied for. The laboratory consists of a room with a floor area of 85 m². The ceiling height is 3.7 m. For three different scenarios, it has to be checked whether the room and its equipment in principle meets the requirements of DIN 25425.

2.3.1 Task 1

“The following three scenarios have been defined. For each scenario, calculate the room category according to DIN 25425!”

2.3.1.1 Scenario 1

“It is intended to simultaneously handle the radioisotopes listed in Table 1 in a room of the radionuclide laboratory. For none of the radionuclides to be handled is the intended type of handling known or restricted. There are also two gas chromatographs with Ni-63 ECD in the laboratory.”

Table 1: Information on scenario 1

nuclide	activity in Bq	handling	intended method of handling
H-3	2,00E+10	unsealed	No restrictions
C-14	2,00E+09	unsealed	No restrictions
P-32	8,00E+08	unsealed	No restrictions
Sr-90	3,00E+08	unsealed	No restrictions
Cs-137	1,00E+08	unsealed	No restrictions

2.3.1.2 Scenario 2

“It is intended to simultaneously handle in the radionuclide laboratory the radiochemicals listed in table 2. The intended method of handling is defined exactly.”

Table 2: Information on scenario 2

nuclide	activity in Bq	handling	intended method of handling
H-3	1,00E+09	unsealed	Syntheses (organic compounds)
H-3	3,00E+09	unsealed	Evaporised (water)
C-14	1,00E+07	unsealed	Diluted (organic compounds)
C-14	5,00E+08	unsealed	Gaseous (dioxide)
P-32	1,00E+07	unsealed	Chromatography (all chemical compounds)
S-35	7,00E+08	unsealed	Examination with prefabricated test sets (all chemical compounds)

2.3.1.3 Scenario 3

“It is intended to simultaneously handle in the radionuclide laboratory the radiochemicals listed in table 3. The intended method of handling is defined exactly.”

Table 3: Information on scenario 3

nuclide	activity in Bq	handling	intended method of handling
Cs-137	1,00E+06	sealed	calibration
Am-241	6,00E+04	3 smoke detectors with 20 kBq each	
I-125	1,00E+07	unsealed	NaI in solution, not gaseous
I-125	5,00E+08	unsealed	methyl compounds
I-131	3,00E+08	unsealed	NaI and organic compounds, maybe gaseous

2.3.2 Task 2

“After you have calculated the room categories according to DIN 25425, enter and assess for each scenario the virtual laboratory that does not meet all requirements (laboratories with the suffix "b"). Find as many "errors" as possible!

As already mentioned several times, the basis of the assessment is DIN 25425 Part 1. We have therefore compiled a checklist for you, which you can go through and which contains the criteria of the DIN (see file "Checklist virtual laboratory authorities seminar.pdf"). Use of the checklist is not obligatory - it is only a suggestion.

After you have examined the laboratories with “errors” and found as many faults as possible, you can look around the laboratory where the requirements should be met (laboratories ending in "a") to check how such a laboratory should be equipped.”

Some requirements are hard to visualize. To enable the participants to check all requirements some additional information was provided in a separate description of the lab:

- The surfaces in the lab are basically made of liquid-tight materials. These meet the mechanical, thermal and chemical requirements of DIN 25425 and can be easily decontaminated. The walls have a waterproof coating and can get decontaminated easily. The surfaces of doors and windows are also easy to decontaminate.
- An emergency power supply is available.
- Also available are alarm devices that are operated in a power failure-proof manner.
- The airflow is guided in such a way that contamination of other parts of the air systems and supply air systems are excluded. The exhaust air ducts under overpressure were designed to be as short as possible and gas-tight.
- All venting devices are connected to an independent air system.
- A reversal of the airflow direction cannot occur.
- The ventilation system can be controlled centrally.
- In addition to the fume-hoods, there are two ventilation-channels in the wall near the floor, which each realize the same exhaust air capacity as a fume-hood.

2.3.3 Task 3

The last task was to identify errors based on wrong behavior of persons in the lab. These errors are not covered by DIN 25425 since in the DIN only structural and technical requirements are defined. Nevertheless it was one important objective of the training event to sensitise the participants to wrong behaviour in a lab.

2.4 Results

2.4.1 Task 1

For each of the three scenarios the room category (RC) had to be calculated according to the equations defined in DIN 25425. This calculations take into account the different radionuclides, different activities and different types of handling (sealed or open sources). The results are presented in table 4.

Table 4: calculated room-categories

Szenario	1	2	3
Room Category (RC)	RC3	RC1	RC2

2.4.2 Task 2

After the room categories had been determined, the participants had to enter the according lab in the “b”-version (the version including the errors) and try to find as many faults as possible. As support, the check-list in Appendix 1 was provided. Afterwards, the “a”-version of the labs could be inspected in order to verify the correct implementation of the technical or structural lab-components. Three examples may illustrate this:

2.4.2.1 Example 1 – contact free water taps

A contact-free water tap is not necessary in labs of RC0 or RC1, but recommended for RC2 and obligatory in RC3.

In Figure 4 the (wrong) water tap implemented in the “b”-version of scenario 1 (RC3) and the correct one implemented in the “a”-version of scenario 1 are shown.



Figure 4: contact-free water tap compared with usual water tap

2.4.2.2 Example 2 – Windows secured against unauthorised opening

In scenario 3 (RC2) the windows must be secured against unauthorised opening in order to prevent an exchange of lab-air with air outside the building. In the “b”-version of the scenario the windows were equipped with usual window-handles (see figure 5) while in the “a”-version window-handles covered by a protection-cap were implemented (see figure 6).



Figure 5: window with window-handle not secured against unauthorised opening



Figure 6: window with window-handle secured against unauthorised opening

2.4.2.3 Example 3 – air change rate

DIN 25425 demands a sufficient air ventilation. In particular, while handling unsealed radioactive material, the air change rate must be at least 25 m³/h for each m² usable laboratory area. The air exchange rate had to be calculated by using the given room-volume and the air flow rate shown at the displays on the top of the fume hoods. In scenario 1 (RC3) the “b”-scenario showed no sufficient ventilation as shown in figure 7. In the “a”-version of the scenario ventilation-system works properly (see figure 8).



Figure 7: air-flow rate too low (Scenario 1b)



Figure 8: air-flow rate sufficient (Scenario 1a)

In Appendix 2, the check list including all results is shown. This checklist was part of the course material given to the participant in the presence phase of the course in Hannover on 29.8.2019.

2.4.3 Task 3

The last task was to identify errors based on wrong behavior of persons in the lab. These errors are not covered by DIN 25425 since in this technical rule only structural and technical requirements are defined. A cup of coffee (see figure 9) and some plants were placed in the lab – obvious errors that were easy to find.

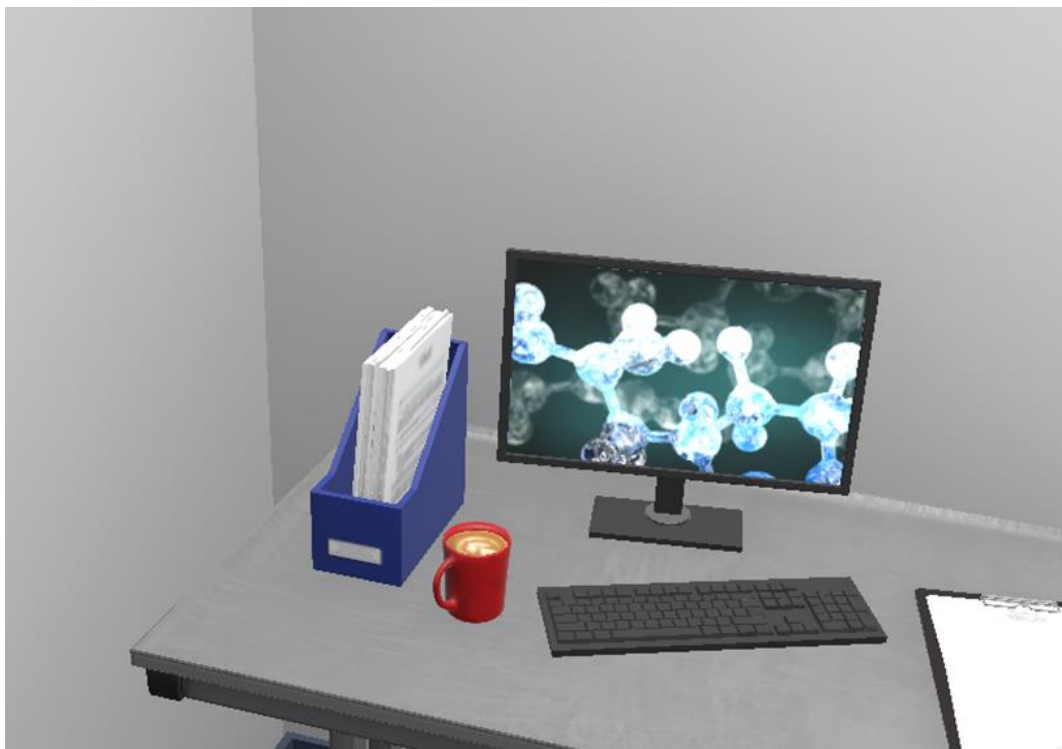


Figure 8: A cup of coffee in the radionuclide lab as example for an obvious error

More sophisticated was the fact that from time to time a person is entering the lab with a coat that is sometimes closed (right behavior, figure 9) and sometimes not (wrong behaviour, see figure 10).



Figure 9: A staff member is leaving the lab with a closed coat



Figure 10: A staff member is entering the lab with an open coat

3 EVALUATION

During the presence phase of the tailored training event on 29.08.2019 an evaluation of the course was conducted. A questionnaire with 10 questions concerning the previous knowledge, the training event itself and the further development of the virtual lab was handed out including the possibility for further remarks or suggestions (see Appendix 3). In total more than 40 completed evaluation forms were returned.

3.1 Previous knowledge and experience

Previous knowledge and experience of the participants before the tailored training event were evaluated with two questions (“I have been responsible for radionuclide-labs and have a lot of experience in handling radionuclides” and “I was already familiar with DIN 25425 before the course”). As shown in figure 11, the analysis showed a huge variance in the previous experience concerning the handling of unsealed radionuclides. While 22 out of 40 participants showed no or only few experience concerning the work in a radionuclide lab (“1”-“3”), 17 out of 40 stated to be quite experienced (“8”-“10”). Not very surprisingly, the data showed a similar distribution of experience concerning DIN 25425 with some more participants of the training event being familiar with DIN 25425 compared to those who had already own working experience in a radionuclide-lab.

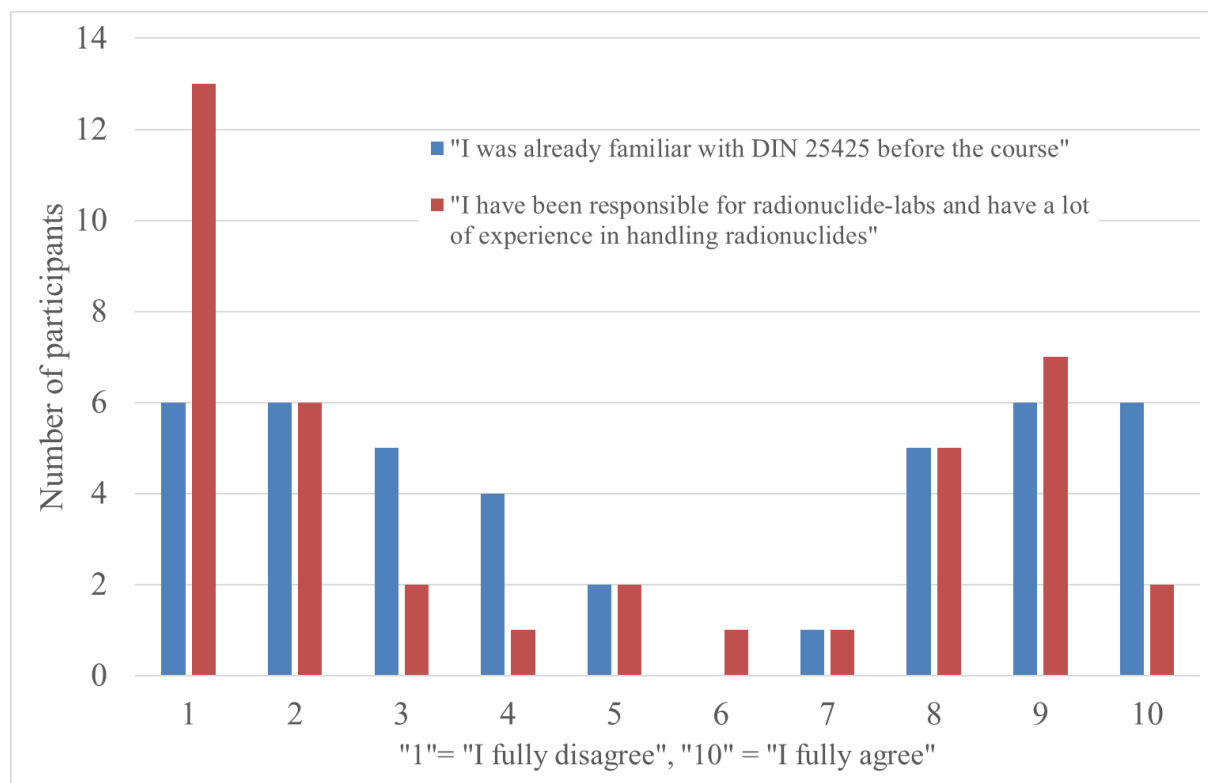


Figure 11: Previous knowledge and experience

3.2 The tailored training event

In order to evaluate the tailored training event itself eight further questions concerning the handling of the computer-program and the learning outcomes were asked. As shown in figure 12, the participants stated that the handling of the program was easy for most of them. Nevertheless, two aspects have to be mentioned:

1. Visualizing small details or structure of e.g. surfaces cannot be implemented sufficiently. 12 of 36 participants disagreed more or less (mark “1” – “5”) on the questions if they were able to see the necessary details easily. However, two thirds of the participants still agreed that details could be seen easily.

2. A major problem was the installation of the program on authority's computers as most of the computers used by the administrative bodies are protected by special software to prevent the installation of external programs. In this case, the installation is either impossible or requires a lengthy application process. One possibility might be to develop a browser-based application.

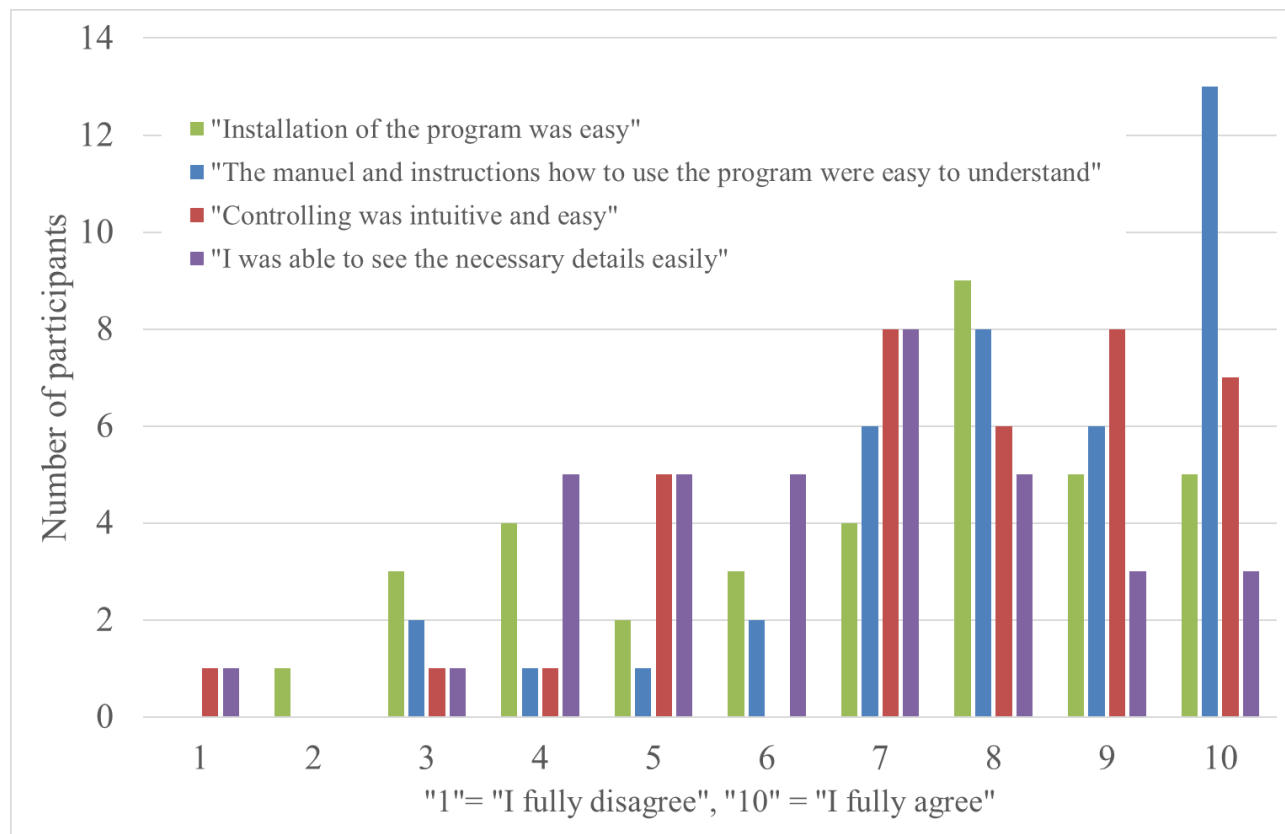


Figure 12: Evaluation of technical implementation

Concerning the learning outcome, figure 13 shows that the vast majority of participants agreed on the question “Concerning DIN 25425 I learned a lot” and stated that the duration of the course was reasonable. **Additionally an overwhelming majority of the participants enjoyed the course and would like to take a similar course again – a result that shows that using virtual reality for education and training in the field of radiochemistry or radiation protection can have a major impact.** Especially the fact that the usage of virtual reality can be very motivating should be used in further programs.

These results were supported by a large number of written comments in the evaluation sheets. Many participants stated that using the VR-lab helps very much to get a deeper understanding on how a radionuclide-lab should be equipped and to learn which details are important. More than this it was emphasized that this way of learning is not only reasonable but also makes fun and is therefore very motivating (a fact that is normally not linked to a technical norm concerning the structural and technical equipment of a lab). Additionally, the participants stated two further major advantages of this tailored training event:

1. Once the program is installed on the computer, it can be used at any time. While access to real radionuclide-labs is often limited to short periods of time and demands greater effort, the virtual lab can be easily visited and studied at any time.
2. It was emphasized that especially new members of authorities, who have never entered a radionuclide lab before, appreciated the virtual lab. This tailored training event is a perfect

possibility to prepare the first visit of a radionuclide lab in order to get familiar to the most important techniques, rules and the necessary equipment.

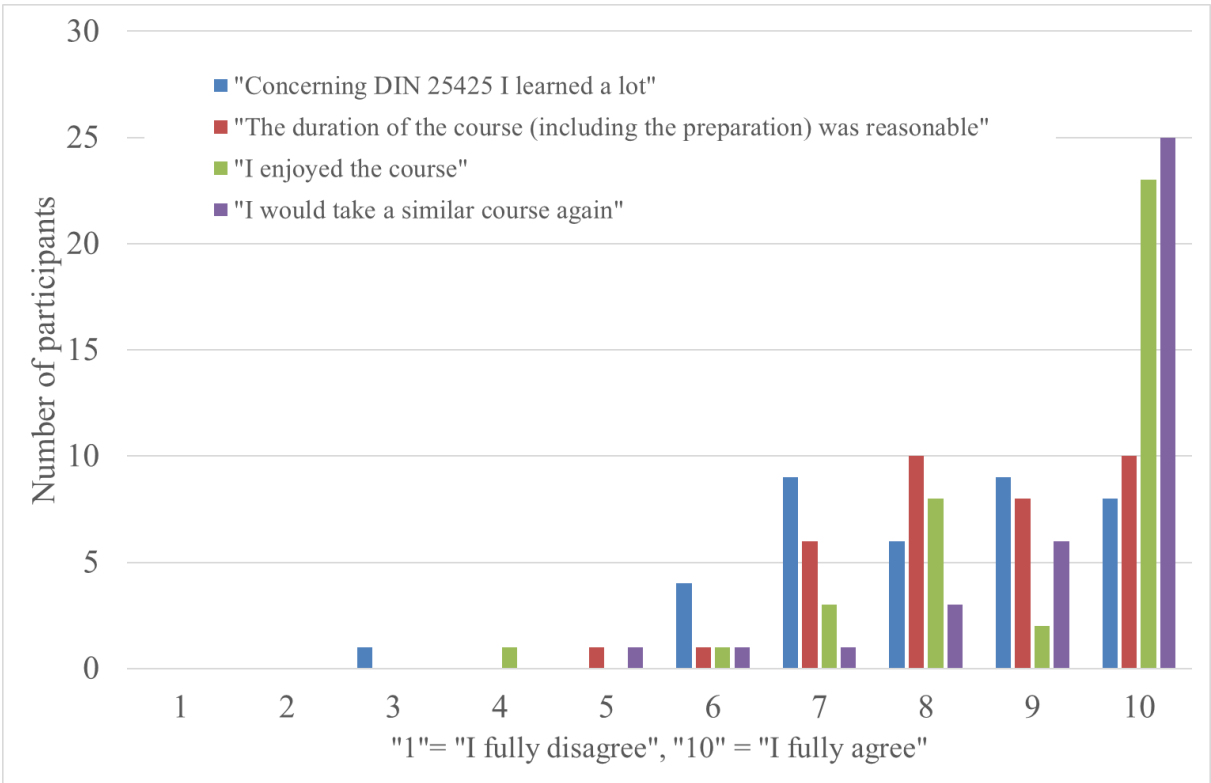


Figure 13: Evaluation of motivation and learning outcomes

4 OUTLOOK

All documents necessary to run the training event can be downloaded on www.strahlenschutzkurse.de including a detailed description of the tasks, the supporting check-list, the program itself including a description how to handle it and the solution of the tasks. By using all these documents, the training event can be repeated as often as wanted and members of the regulatory bodies who were unable to attend the presence phase on 29.08.19 can run the complete course whenever they want to for free.

As mentioned above, the documents used in that training event are all written in German language. Nevertheless, when developing the program, care was taken to implement as little text as possible, so that only the additional documents (MS-office © documents) have to be translated. Information about objects that are difficult to display (e.g. the texture of surfaces) is provided by pop-up windows that open when the object is clicked (see chapter 2.2). This text-information can be exchanged very easily, so that the use of this program in other EU countries with other languages should be very easy. An instruction how to change the text-information of subjects in the program is provided in Appendix 4.

As shown in figure 13, most members of regulators would like to take a similar course again. One option (if funding is available) would be to extend the use of virtual reality in the education and training in radiochemistry and radiation-protection. Based on the developed radionuclide-lab, many different applications would be attractive and the participants of the course expressed a number of ideas and wishes. Especially they asked for

- the implementation of the visualisation of radiation fields. One main advantage of VR is that things can be made visible that are invisible in real live. In the field of radiation protection this offers a huge variety of interesting and useful applications. If radioactive sources are placed in the lab, their radiation fields could be made visible in order to demonstrate e.g. wrong behaviour or missing shielding;
- the possibility to measure dose-rate and contamination with appropriate devices implemented in VR. Once the radiation fields are implemented, radiation protection measures could be performed and decontamination procedures could be trained. Additionally, lost or forgotten radioactive sources might be placed in the VR-lab to train the usage of devices to measure the ambient dose-rate and contamination monitors;
- the implementation of personal protective equipment. The correct use of coats, gloves, glasses and measuring devices should be trained as well;
- the possibility to touch and move objects. For example, the front-window of fume hoods should be moveable, shielding material could be used, and radiochemical procedures could be explained and trained in detail – including the handling of radioactive waste in a lab and
- the development of different environments and different labs; e.g. a radiopharmaceutical lab.

The feedback provided by the participants of this tailored training event was one major input for the proposal of A-CINCH, the follow-up project in a series of CINCH-projects, which is currently being under evaluation by the EU. In the case of funding, many of the mentioned ideas will be implemented and will for sure provide a major impact for the development of new tools used to train and educate staff in the field of radiochemistry and radiation protection.

However, the material (including the VR-lab) developed for this tailored training event has already been used outside MEET-CINCH since in the EU-project “JO3.01/13: Provision of assistance related to developing and strengthening the capabilities of the Energy and Minerals Regulatory Commission (EMRC) and related to radioactive waste management in Jordan“ (EuropeAid 137757/DH/SER/JO) the material was used in a workshop to train members of regulators in Amman (Jordan). The fact that the material of this training event is used few weeks after the first workshop in a second EU-program even outside Europe shows the versatility of the program and underlines the success of this tailored made training event.

5 APPENDIX

Appendix 1: Checklist according to DIN 25425 in order to evaluate the technical and structural lab-equipement

Requirement	Section in DIN 25425	Requirement is valid for	Scenario 1		Scenario 2		Scenario 3	
			fulfilled	not fulfilled	fulfilled	not fulfilled	fulfilled	not fulfilled
In all rooms in which unsealed radioactive substances are handled, surfaces must be made of liquid-tight materials and these surfaces must be easily decontaminable.	8.3	all						
Flooring must be without gaps.	8.3	all						
Floor: L-shaped upturn to the walls	8.3	all						
No gaps between flooring/walls and cabinets	8.3	all						
Heating radiators must have smooth surfaces and must be easily decontaminable.	8.3	all						
Walls must be provided with a water-resistant, easily decontaminable paint or other suitable water-resistant and easily decontaminable material.	8.3	all						
Work surfaces must be without any gaps, unbreakable and provided with an edge-bulge.	8.3	all						
Ceramic plates may only be used if the content of natural radioactive material is so low that contamination control measurements are not affected.	8.3	all						

Requirement	Section in DIN 25425	Requirement is valid for	Scenario 1		Scenario 2		Scenario 3	
			fulfilled	not fulfilled	fulfilled	not fulfilled	fulfilled	not fulfilled
When selecting the surface material, the chemical properties of the radiochemicals must be taken into account. For example, stainless steel surfaces must not be used when using radioiodine compounds and radiophosphorus compounds.	8.3	all						
Surfaces of doors and windows must be easy to decontaminate.	8.4	all						
Windows must be secured against unauthorized opening (inside and outside). But the guidelines for escape and rescue must be taken into account.	8.4	RC2 - RC3						
Sink with a special tap without manual operation, for example with knee, elbow, foot or non-contact operation	8.5	RC2 (should), RC3 (must)						
If there is a high risk of contamination and there is no other option for rapid decontamination, there should be a sink with a hand shower near the exit.	8.5	RC2 - RC3 (should)						
Emergency power supply	8.6.1	RC3 (must)						
Communication equipment must maintain its function for at least 30 minutes, regardless of the general power supply.	8.6.2.	RC1 (should), RC2 - RC3 (must)						
Alarm devices must maintain its function, regardless of the general power supply.	8.6.2.	RC2 - RC3						

Requirement	Section in DIN 25425	Requirement is valid for	Scenario 1		Scenario 2		Scenario 3	
			fulfilled	not fulfilled	fulfilled	not fulfilled	fulfilled	not fulfilled
The exhaust air duct must be conducted in such a way that contamination of other air systems is excluded. Pressurized exhaust air ducts must be as short and gas-tight as possible.	9.2.1	RC2 - RC3						
Venting devices must be connected to an independent exhaust air system.	9.2.1	RC2 (should), RC3 (must)						
Air venting: It must be ensured that a reversal of the flow direction can not occur.	9.2.2	RC1 - RC3						
While handling with unsealed radioactive substances the air change rate must be 25 m ³ /h for each m ² usable laboratory area.	9.2.3	all						
The function of the exhaust air system must be monitored by an display.	9.2.5	RC2 - RC3						
Displays for monitoring the negative pressure in the laboratory	9.2.5	RC2 - RC3						
Fume hoods according to DIN 25466 or gloveboxes according to DIN 25412-1 or process cells according to DIN 25481	9.2.6	RC2 (should), RC3 (must)						
The ventilation system must be accessible at representative points for testing purposes.	9.4.1	RC1 (should), RC2 - RC3 (must)						
Exhaust air system: There must be a port to take air samples (almost isokinetic); this port must be easily and safely accessible.	9.4.2	RC2						

Requirement	Section in DIN 25425	Requirement is valid for	Scenario 1		Scenario 2		Scenario 3	
			fulfilled	not fulfilled	fulfilled	not fulfilled	fulfilled	not fulfilled
It must be possible to control the ventilation system from one central location.	9.4.1	RC2						
A wastewater collection system is needed if the expected volume of contaminated wastewater is higher than 1m ³ per 3 months.	9.4.1	all						

Appendix 2: Checklist according to DIN 25425 in order to evaluate the technical and structural lab-equipment including the results

No.	Requirement	Section in DIN 25425	Requirement is valid for	Scenario 1		Scenario 2		Scenario 3	
				1a	1b	2a	2b	3a	3b
				fulfilled	not fulfilled	fulfilled	not fulfilled	fulfilled	not fulfilled
1	In all rooms in which unsealed radioactive substances are handled, surfaces must be made of liquid-tight materials and these surfaces must be easily decontaminable.	8.3	all	yes	yes	yes	yes	yes	yes
2	Flooring must be without gaps.	8.3	all	yes	yes	yes	yes	yes	yes
3	Floor: L-shaped upturn to the walls	8.3	all	yes	yes	yes	yes	yes	yes
4	No gaps between flooring/walls and cabinets	8.3	all	yes	yes	yes	no	yes	yes
5	Heating radiators must have smooth surfaces and must be easily decontaminable.	8.3	all	yes	yes	yes	yes	yes	no
6	Walls must be provided with a water-resistant, easily decontaminable paint or other suitable water-resistant and easily decontaminable material.	8.3	all	yes	yes	yes	yes	yes	yes
7	Work surfaces must be without any gaps, unbreakable and provided with an edge-bulge.	8.3	all	yes	yes	yes	no	yes	yes
8	Ceramic plates may only be used if the content of natural radioactive material is so low that contamination control measurements are not affected.	8.3	all	yes	yes	yes	yes	yes	yes
9	When selecting the surface material, the chemical properties of the radiochemicals must be taken into account. For example, stainless steel surfaces must not be used when using radioiodine compounds and radiophosphorus compounds.	8.3	all	yes	yes	yes	yes	yes	no
10	Surfaces of doors and windows must be easy to decontaminate.	8.4	all	yes	yes	yes	yes	yes	yes
11	Windows must be secured against unauthorized opening (inside and outside). But the guidelines for escape and rescue must be taken into account.	8.4	RC2 - RC3	yes	yes	no	no	yes	no

12	Sink with a special tap without manual operation, for example with knee, elbow, foot or non-contact operation	8.5	RC2 (should), RC3 (must)	yes	no	no	no	yes	no
13	If there is a high risk of contamination and there is no other option for rapid decontamination, there should be a sink with a hand shower near the exit.	8.5	RC2 - RC3 (should)	yes	yes	no	no	yes	yes
14	Emergency power supply	8.6.1	RC3 (must)	yes	yes	yes	yes	yes	yes
15	Communication equipment must maintain its function for at least 30 minutes, regardless of the general power supply.	8.6.2.	RC1 (should), RC2 - RC3 (must)	yes	yes	yes	yes	yes	yes
16	Alarm devices must maintain its function, regardless of the general power supply.	8.6.2.	RC2 - RC3	yes	yes	yes	yes	yes	yes
17	The exhaust air duct must be conducted in such a way that contamination of other air systems is excluded. Pressurized exhaust air ducts must be as short and gas-tight as possible.	9.2.1	RC2 - RC3	yes	yes	yes	yes	yes	yes
18	Venting devices must be connected to an independent exhaust air system.	9.2.1	RC2 (should), RC3 (must)	yes	yes	yes	yes	yes	yes
19	Air venting: It must be ensured that a reversal of the flow direction can not occur.	9.2.2	RC1 - RC3	yes	yes	yes	yes	yes	yes
20	While handling with unsealed radioactive substances the air change rate must be 25 m ³ /h for each m ² usable laboratory area.	9.2.3	all	yes	no	yes	yes	yes	yes
21	The function of the exhaust air system must be monitored by an display.	9.2.5	RC2 - RC3	yes	yes	no	no	yes	no
22	Displays for monitoring the negative pressure in the laboratory	9.2.5	RC2 - RC3	yes	yes	no	no	yes	no
23	Fume hoods according to DIN 25466 or gloveboxes according to DIN 25412 1 or process cells according to DIN 25481	9.2.6	RC2 (should), RC3 (must)	yes	no	no	no	no	no
24	The ventilation system must be accessible at representative points for testing purposes.	9.4.1	RC1 (should), RC2 - RC3 (must)	yes	yes	yes	yes	yes	yes
25	Exhaust air system: There must be a port to take air samples (almost isokinetic); this port must be easily and safely accessible.	9.4.2	RC2	yes	yes	yes	yes	yes	yes
26	It must be possible to control the ventilation system from one central location.	9.4.1	RC2	yes	yes	yes	yes	yes	yes
27	A wastewater collection system is needed if the expected volume of contaminated wastewater is higher than 1m ³ per 3 months.	9.4.1	all	yes	yes	yes	yes	yes	yes

Appendix 3: Evaluation sheet delivered during the training event on 29.09.2019

	
<h2>EVALUATION</h2>	
Bitte bewerten Sie folgen Aussagen („1“: stimme überhaupt nicht zu; „10“: stimme vollkommen zu):	
Vorkenntnis	1 2 3 4 5 6 7 8 9 10
Ich war bereits vor dem Kurs mit der DIN 25425 vertraut	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Ich habe schon häufig Radionuklidlabore betreut oder selbst darin gearbeitet	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Durchführung des Kurses	
Die Installation des Kurses war einfach	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Die Anleitung zur Durchführung war verständlich	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Die Steuerung im Programm war intuitiv und problemlos	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Die notwendigen Details konnte ich gut erkennen	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Ich habe durch den Kurs viel gelernt in Bezug auf die DIN 25425	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Die Kursdauer (mit Selbstlernphase) war gut so	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Die Durchführung des Kurses hat mir Spaß gemacht	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Weiterentwicklung	
Ich würde an einem ähnlichen Kurs wieder teilnehmen (z.B. wenn auch Gegenstände bewegt oder Strahlungsfelder im Labor gemessen werden könnten)	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>
Bei einer Weiterentwicklung wäre es sinnvoll, folgende Aspekte zu integrieren:	
<hr/>	
<hr/>	
<hr/>	
	
	

Appendix 4: Instruction how to change description of objects in the virtual lab.

- Inside the Main directory, open the file „Radionuklidlabor_Data“. Then open the TextDocument „ObjectDescription“
- The lines that start with a „#“ define the titles of the objects. They are necessary for the program to assign the different descriptions to a specific object. So never ever change these!!
- Beneath every line with a „#“ you can find the description. That can be changed any way you want.