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CINCH

CINCH-II

(Project Number: 605173)

DELIVERABLE D2.1 AND D2.2

VET Requirements in NRC for a fully developed nuclear state
Overview of the potential VET requirements in NRC to meet future needs

Lead Beneficiary: **UNIVLEEDS**

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Relevance

This deliverable contributes to the following Work-Packages and Tasks:

☐ ALL

WP 1

☐ Task 1.1 ☐ Task 1.2 ☐ Task 1.3 ☐ Task 1.4

WP 2

☒ Task 2.1 ☒ Task 2.2 ☐ Task 2.3 ☐ Task 2.4

WP 3

☐ Task 3.1 ☐ Task 3.2 ☐ Task 3.3 ☐ Task 3.4 ☐ Task 3.5

WP 4

☐ Task 4.1 ☐ Task 4.2 ☐ Task 4.3 ☐ Task 4.4

WP 5

☐ Task 5.1 ☐ Task 5.2 ☐ Task 5.3 ☐ Task 5.4

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EXECUTIVE SUMMARY

This report is a review of the current and potential future requirements for Vocational Education and Training (VET) in Nuclear Chemistry (NRC). It forms deliverables 2.1 and 2.2 of Task 2.1 in WP2 of CINCH-2.
Analysis was done at the national level for the UK and France. Both of these countries are considered a developed state in regards to nuclear power, and therefore are considered to have a mature view on requirements for VET in this area. Consequently, the results of this review can be applied to the broad EU community.
The current and future demand for VET in NRC in the UK and France were identified using a survey and historical data, respectively. The information was analysed to determine the subjects that should be covered by the VET courses developed as part of CINCH-2, and to identify what delivery and training method is preferable by end-users.
In the UK there is currently no collaborative approach taken to provide these courses for customers of end-users; whereas the INSTN at CEA has been providing these types of courses for a number of years. For both countries, it was concluded that it is vital to develop a robust syllabus that covers all aspects of nuclear chemistry in a variety of learning styles which maximize their availability for a varied group of end-users. This supports the initial objective of CINCH-2.
To ensure the applicability of this review to the broad European community, a peer review is now to be held with the End-users and Advisory Group within CINCH-II to endorse the requirements proposed and to incorporate any future VET needs that have been identified from specific national trends.

CONTENT

Acronyms

VET – Vocational Education and Training
NRC – Nuclear Chemistry

1 INTRODUCTION

The overall objective of WP2 is to devise a pan-European offer of modular training courses for customers, primarily coming from the end-users.

The aim is that non-academic end-users will propose candidates from their organisations to attend VET in NRC as research/industry professionals.

In order to develop and demonstrate these courses, the requirements of non-academic end-users (research institutes, industry, regulators, etc.) need to be understood, so that the courses on offer can directly meet the needs of the end users.

Task 2.1 is concerned with determining industry and national requirements for VET in NRC and task 2.2 is concerned with determining the potential for VET courses, i.e. the "market".

This report combines Deliverables 2.1 and 2.2 that result from Task 2.1:

- D2.1 - VET Requirements in NRC for a fully developed nuclear state
- D2.2 – Overview of the potential VET requirements in NRC to meet future needs.

The original CINCH-2 proposal stated that these two deliverables will be delivered individually.

However, when reviewing the objectives of the deliverables, the partners identified that the work overlapped, and that it was essential to identify what training courses in NRC are currently available, in order to identify future demand these types of courses. As a result, the work has been combined.

It was stated in the proposal that the UK would be used as a basis for this study. The UK is considered to be a fully developed state in regards to nuclear power, and consequently, is deemed to have a mature view of its VET needs. Nevertheless, input from CEA (France) has supported this document. France is also considered a nuclear state. It is assumed that the results from this review can be applied to the remainder of the EU community.

The overall objective of this deliverable was to identify current and future demand for VET in nuclear chemistry, and to identify what course formats are required by end-users. This information will feed into Task 2.2 and Task 2.3 of WP2, where the courses will be produced and demonstrated.

D2.1 VET REQUIREMENTS IN NRC FOR A FULLY DEVELOPED NUCLEAR STATE

2 OBJECTIVES

Deliverable 2.1 is an overview of the current VET in NRC requirements for a fully developed nuclear state.

This deliverable is based on end users within the UK and France.

2.1 The UK and Current Training

From discussions with partners, it was identified that there is currently no collaborative approach taken to provide nuclear chemistry VET courses in the UK. Some training courses have been provided on an ad-hoc basis. Before this deliverable, it was uncertain as to whether these types of courses are currently required in the UK. As such, further work was necessary in order to identify the current demand, if any.

2.2 France and Current Training

Organization in France of the nuclear industry, including organisms in charge, can be summarized in the following figure starting from the front end of the nuclear fuel cycle with i) the ore extraction and its treatment (AREVA); ii) the enrichment process (EURODIF-AREVA); iii) the fabrication of the fuel rods (FBFC, MELOX); iv) the use of fuel in the reactors (EDF); the back end of the cycle v) the treatment and recycling of the irradiated fuel (AREVA); vi) the nuclear waste management including disposal and storage (ANDRA).

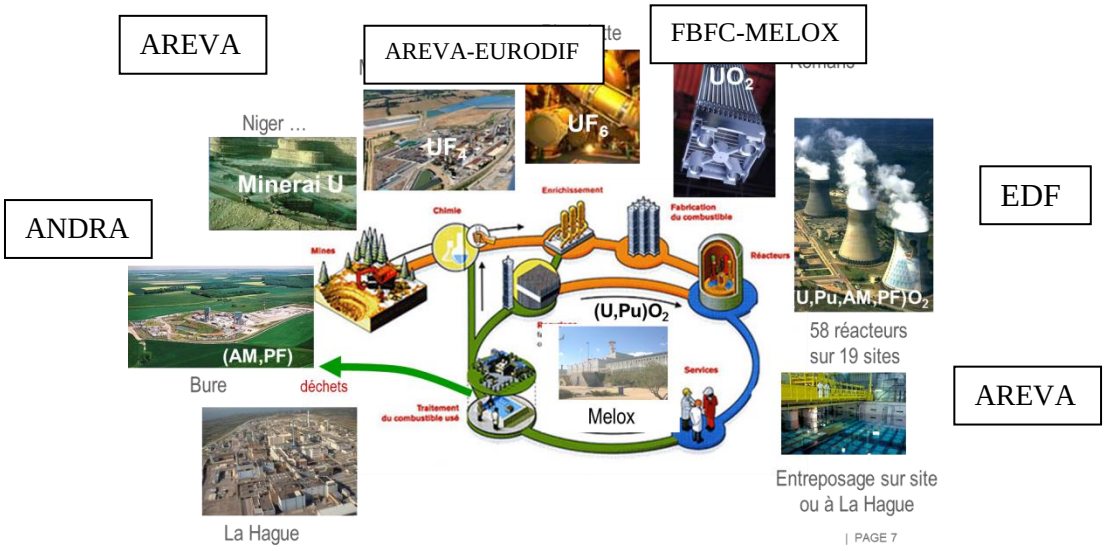

Figure 1 – France Nuclear State Structure

In front of or in parallel to this organization there are 3 other major institutes: i) ASN which is the French nuclear safety authority; ii) IRSN which is in charge of the radioprotection and the safety; and iii) the CEA which is in charge of the research in different fields (industrial nuclear system for the future, experimental tools and simulation, dismantling, materials, energy, fusion life-science…).

CEA is organized in different units related to Strategy and external Relationship, Risk, Defence, Matter Science, Life Science, Technology research, Information and has also a specific Institute (INSTN) in charge of the scientific formation and the teaching in relation with universities, engineering schools.

The INSTNs' vocation is to share the knowledge and know-how of the CEA through education and training and to organize in English: i) training courses ii) continuing education; and iii) international

schools based on a diverse set of topics: nuclear science and technology, nuclear dismantling, waste management, nuclear safety, radiation protection, applied statistics, health technologies, and nuclear chemistry.

This means that INSTN is in direct contact with all the actors of nuclear industry previously mentioned (EDF, AREVA, ANDRA, IRSN, ASN) and with the universities, or for the development of the Nuclear masters described in WP-1. When these nuclear industries have specific needs for the education or training of their workers, they contact INSTN which can organize specific training courses or seminars and schools.

2.3 Conclusions

It was agreed by UNIVLEEDS and NNL that the end-user market in the UK needed to be analysed, in order to determine whether or not there is a current demand for these types of courses. The results of this survey support Deliverable 2.2 and the results can be found in 3.1.3 of this report.

In France, there is a collaborative approach taken to provide VET in NRC to end-users. Courses have been provided by the CEA for some time, and there remains a demand for this type of training. Information regarding these courses support Deliverable 2.2 and can be found in 3.2.2 of this report.

D2.2 OVERVIEW OF THE POTENTIAL VET REQUIREMENTS IN NRC TO MEET FUTURE NEEDS

3 OBJECTIVES

Deliverable 2.2 is an overview of VET requirements in NRC to meet future needs.

A review was undertaken at the national level. Separate analysis was conducted for the UK (lead by UNIVLEEDS and NNL) and for France (lead by CEA).

The following deliverable objectives were identified:

- If VET is already offered, to accumulate historical data to quantify the demand for these courses, and to examine what formats these courses are offered in.
- To determine whether there will be a future demand for VET in NRC from end-users.
- If VET is not already offered, to identify what type of course delivery, what type of course training and what subjects should be developed.

3.1 Requirements for VET in NRC – UK

3.1.1 Methodology

An online survey was created on a free website (www.sogosurvey.com), a copy of which can be found in Appendix A and was circulated via email to a variety of non-academic end-users in the nuclear industry. The list of end users was drawn from existing contacts known by the partners, and via LinkedIn to reach new contacts. This was to ensure that all organisation types could participate in the survey, in order to achieve an accurate representation of the non-academic end-user community.

The survey was left online for several months and once it was closed the results were collated and analysed. Only responses from UK-based participants are considered below.
NB: The survey asked participants whether they would be prepared to be contacted for further information via email. Participants who provided this information can further support Task 2.1 where a peer review will be held with end-users to endorse the requirements proposed.

3.1.2 Online Survey Response

In total, 38 end-users participated in the survey. The greatest number of responses came from participants that are based in national laboratory or research organisations.
“Other” includes the following occupations/organisations:

- Government/site owner
- Nuclear consultancy
- Reactor plant designer and manufacturer
- Teacher

Table 1: Survey Respondents by Organisation Type

Organisation	Number of Respondents
Nuclear regulator	3
National laboratory or research organisation	11
Nuclear contractor	6
Nuclear site operator	7
University or higher education institution	6
Other	5

UNIVLEEDS and NNL believe that the survey was successful, and that the responses received provide an accurate overview of the UK non-academic nuclear industry.

3.1.3 Results

A raw copy of the survey results can be found in Appendix B. An Excel version is available upon request.

The key results of the survey are listed below.

3.1.3.1 The Importance of Nuclear Chemistry in End-User Organisations

- 42 % of respondents believe that their organisation views nuclear chemistry as an integral part of the organisation.
- Out of the organisations surveyed, nuclear chemistry is the least important in University of higher education institutions.

3.1.3.2 Recruitment in End-User Organisations

- None of the participants indicated that their organisation does not have a need for people with nuclear chemistry skills.
- 61% of respondents believe that their organisation always has a need for people with nuclear chemistry skills.
- Employment opportunities for post graduate chemists and radio/nuclear chemists exist over the next year, with 47% and 50% of organisations planning to hire nuclear chemists and chemistry post graduates in the next year, respectively.
- There is a slight preference for chemistry post graduates to nuclear chemist post graduates. The results can be found in the table below.
- This supports the need for VET in NRC; organisations can employ chemistry post graduates and provide training to allow them to be involved in work related to this field.

Table 2: A summary of plans to employ post graduates students by subject

Answer	Nuclear chemistry PG (Number of Respondents)	Chemistry PG (Number of Respondents)
Yes: within the next 5 years	3	4
Yes: within the next year	18	19
Possibly: within the next 5 years	9	11
Unlikely: within the next 5 years	3	1
Very unlikely: within the next 5 years	5	3

3.1.3.3 The Current Status of VET in NRC in End-User Organisations

- 55% of respondents answered that chemists employed by their organisation are involved in work related to nuclear chemistry all or most of the time.
- Over a third of respondents are currently offered VET courses by their organisation.
- 13% of respondents answered that they are always offered VET courses in NRC.
- Interestingly, no participants from a national laboratory or research organisation, or a nuclear site operator, answered that they always receive the opportunity to attend VET in NRC.
- 11% of respondents are never offered VET in NRC. When asked how important their organisation views radio/nuclear chemistry, these respondents answered “slightly” or “not part of organisation, only required on an ad-hoc basis”.

3.1.3.4 The Future Demand for VET in NRC in End-User Organisations

- Only 5% of respondents indicated that their organisation is not interested in VET in NRC.
- This indicates that, in the UK, there will be a future demand for the courses being developed as part of WP2.

3.1.3.5 The Preferred Format for VET in NRC

Overall, 29% of respondents answered that “All” delivery methods, “All” training options and “All” subject areas would be preferred by their organisation.

Type of Delivery

- Overall, there is a demand for all types of VET delivery methods.
- 50% of respondents answered that “All” methods would be welcomed by their organisation.
- When analysing the demand for each type of delivery method, “Attend series of 1 day courses, up to 1 week” is the favoured option.
- 53% of respondents indicated that E-platform or MOOC delivery methods would be required. This result can be fed into WP3, where the objective is to develop E-Learning Tools to Enhance Teaching in Nuclear.

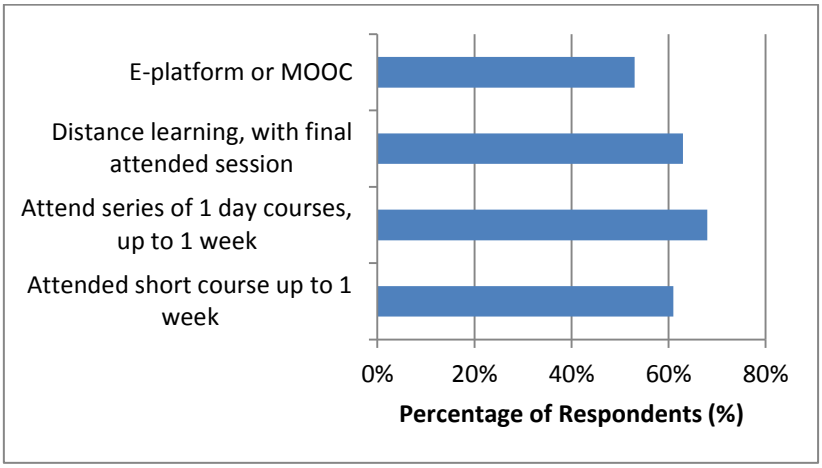

Figure 2: Type of VET delivery preferred by responding organisations, as a percentage of total number of participants.

Type of Training

- Overall, there is a demand for all types of VET training.
- 58% of respondents answered that "All" training options would be welcomed by their organisation.
- When analysing the demand for each type of training option, "Taught lectures with notes" is the favoured option.

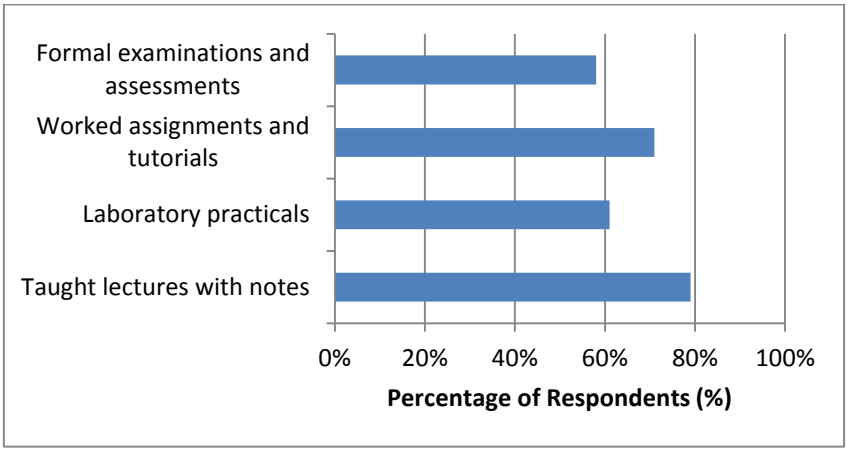

Figure 3: Type of VET training preferred by responding organisations, as a percentage of total number of participants.

Subjects to be Included

- Overall, there is a demand for all subjects to be covered in a VET in NRC.
- 71% of respondents answered that "All" subjects should be included into a VET in NRC.
- When analysing the demand for a particular subject, "Fundamentals of nuclear chemistry" is the favoured option.
- A summary of subject by preferred delivery method and training option can be found below.

Table 3: A summary of preferred delivery methods and training options

Subject	Preferred Training Option	Preferred Delivery Method
Fundamentals of nuclear chemistry	Attend series of 1 day courses, up to 1 week	Taught lectures with notes
Radiation detection, dosimetry and protection	Attend series of 1 day courses, up to 1 week Attended short course up to 1 week	Worked assignments and tutorials
Separation methods in radiochemistry	Attend series of 1 day courses, up to 1 week Attended short course up to 1 week	Worked assignments and tutorials
Radioanalytical Methods	Attend series of 1 day courses, up to 1 week	Taught lectures with notes

3.1.4 Conclusion

It is clear from the results that nuclear chemistry skills are in demand in all non-academic organisations involved in the nuclear sector, and that the subject areas for training are an integral part of many organisations. This means that demand is driven by specific company or organisational needs for trained personnel, rather than a regulatory requirement.

Only 15% of the participants always provided VET in NRC to their staff. However, a greater amount (37%) always provided VET in other subjects. This relatively low proportion is partially due to the lack of provision for nuclear/chemistry courses, as skills in demand. We can conclude that there is a demand for the courses being developed as part of this programme, as 95% of participants indicated that their organisation would be interested in VET in NRC.

Overall, the results show that in the UK there is a demand for all delivery methods, training options and subjects covered in a VET in NRC.

As such, whatever courses that are developed as part of the CINCH-II programme will be well received by the non-academic end-user community in the UK.

3.2 Requirements for VET in NRC – France

3.2.1 Methodology

The CEA Institute (INSTN) already provides a number of training courses for non-academic end-users in the area of nuclear chemistry.

As such, information regarding these courses was collated to determine the subjects that are currently covered, and what type of delivery vehicles have proved successful.

Historical data regarding the attendance at the courses was used to analyse the potential future demand for VET in NRC.

3.2.2 Results

A list of theoretical courses currently offered by the INSTN at CEA can be found in Appendix C. The course subjects range from “Introduction to the use of the plutonium and actinides” to

"Detection and measurement".

These courses have been run annually and have received attendance of approximately 20 individuals at each course. Detailed data regarding the attendance at these courses is not normally collated, but could be provided if necessary.

A variety of methods have been used to deliver these courses, typically:

- 1 day courses
- Week long courses
- Seminars

The INSTN also provides tailored courses to meet the specific requirements of nuclear industries based in France.

The CEA believes that there will remain a future demand for these types of courses in France, based on the success of the current courses that it provides.

3.2.3 Conclusion

It can be concluded that there already exists a demand for VET in NRC in France that is being met by provision of a range of courses delivered by INSTN.

One area of further development is the implementation of practical based courses. The INSTN only provides theoretical courses, and therefore the courses developed by CINCH-2 could enhance the VET market in France.

The courses provided by the INSTN are given in English, and the success of these courses can greatly be used to support the formation of VET courses as part of CINCH-2.

GENERAL CONCLUSIONS

It is clear from the results that in countries, such as the UK and France, with mature nuclear industries and multiple academic institutions that have nuclear expertise, nuclear chemistry skills are still in great demand in all non-academic organisations involved in the nuclear sector, and that these subjects are an integral part of many organisations. If an obvious demand for VET courses in NRC exists in these countries, then for less mature and smaller nuclear nations in the EU, the demand will only be greater.

In the UK, there remain very few VET courses in NRC for non-academic end-users. This review showed that there is a current and future demand for these courses, with only 5% of surveyed respondents indicating that their organisation is ***not interested*** in VET in NRC.

Demand currently exists in France, and the INSTN at CEA has been successful in providing a variety of theoretical VET courses in NRC. It expects that demand for these types of courses will continue in the future.

A matrix of topics aligned with the appropriate delivery vehicle was created for the UK; however, the results show that there is a strong demand for all delivery methods, training options and subjects covered.

A variety of delivery methods, training options and subjects covered are provided by the INSTN at CEA. As a result, CINCH-2 should build on this success and provide a variety of delivery vehicles in a broad variety of subjects.

This demonstrates that, as part of CINCH-2, it is vital to develop a robust syllabus that covers all aspects of nuclear chemistry in a variety of learning styles which maximize their availability for a varied group of end-users. This supports the initial objective of CINCH-2 to develop a range of delivery styles.

Overall, a need for training courses in NRC is required by end-users in the EU community.

We recommend that the next step for the partners involved in WP2 is to collectively establish which CINCH-2 partners are best placed to guarantee and co-ordinate the individual course development and demonstration.

APPENDIX A

A reproduction of the online questionnaire used in the survey.

page 1

*** 1. In which EU country do you work?** (Select one option)

- ○ Austria
- ○ Belgium
- ○ Bulgaria
- ○ Croatia
- ○ Cyprus
- ○ Czech Republic
- ○ Denmark
- ○ Estonia
- ○ Finland
- ○ France
- ○ Germany
- ○ Greece
- ○ Hungary
- ○ Ireland
- ○ Italy
- ○ Latvia
- ○ Lithuania
- ○ Luxembourg
- ○ Malta
- ○ Netherlands
- ○ Poland
- ○ Portugal
- ○ Romania
- ○ Slovakia
- ○ Slovenia
- ○ Spain
- ○ Sweden
- ○ United Kingdom

2. What description best fits your organisation? (Select one option)

- ○ University or higher education institution

- ○ National laboratory or research organisation
- ○ Nuclear site operator
- ○ Nuclear regulator
- ○ Nuclear contractor
- ○ Other (please specify) _____

3. How important does your organisation view radio/nuclear chemistry? (Select one option)

- ○ Integral part of organisation
- ○ Very important part of organisation
- ○ Slightly important part of organisation
- ○ Not part of organisation, only require on an ad-hoc basis
- ○ Not part of organisation

4. Does your organisation currently have any need for people with radio/nuclear chemistry skills? (Select one option)

- ○ Always
- ○ Most of the time
- ○ Sometimes
- ○ Rarely
- ○ No

5. How many post graduate chemists are currently employed within your organisation? (Select one option)

- ○ >100
- ○ >10
- ○ A few
- ○ None
- ○ Don't know

6. What proportion of these chemists are or have been involved in work related to radio/nuclear chemistry? (Select one option)

- ○ All
- ○ Most
- ○ A few

- ○ None
- ○ Don't have any Post Graduate chemists

7. Does your organisation have any plans to recruit post graduate radio/nuclear chemists? (Select one option)

- ○ Yes: within the next 5 years
- ○ Yes: within the next year
- ○ Possibly: within the next 5 years
- ○ Unlikely: within the next 5 years
- ○ Very unlikely: within the next 5 years

8. Does your organisation have any plans to recruit post graduatechemists? (Select one option)

- ○ Yes: within the next 5 years
- ○ Yes: within the next year
- ○ Possibly: within the next 5 years
- ○ Unlikely: within the next 5 years
- ○ Very unlikely: within the next 5 years

9. Does your organisation arrange for employees to undertake VET (Vocational and Educational Training) or CPD (Continued Professional Development)? (Select one option)

- ○ Always
- ○ Often
- ○ Sometimes
- ○ Rarely
- ○ Never

10. Does your organisation arrange for employees to undertake VET/CPD in radio/nuclear chemistry? (Select one option)

- ○ Always
- ○ Often
- ○ Sometimes
- ○ Rarely
- ○ Never

11. What type of delivery for VET/CPD would your organisation prefer for training in radio/nuclear chemistry? (Select one option)

- ○ Attended short course up to 1 week
- ○ Attend series of 1 day courses, up to 1 week
- ○ Distance learning, with final attended session
- ○ E-platform or MOOC
- ○ All of the above
- ○ Not interested in radio/nuclear chemistry VET

12. What type of training would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry? (Select one option)

- ○ Taught lectures with notes
- ○ Laboratory practicals
- ○ Worked assignments and tutorials
- ○ Formal examinations and assessments
- ○ All of the above
- ○ Not interested in radio/nuclear chemistry VET

13. What subjects would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry? (Select one option)

- ○ Fundamentals of nuclear chemistry
- ○ Radiation detection, dosimetry and protection
- ○ Separation methods in radiochemistry
- ○ Radioanalytical methods
- ○ All of the above
- ○ Not interested in radio/nuclear chemistry VET

14. Would you be prepared to be contacted for further information via email? (Select one option)

- ○ Yes
- ○ No

15. If yes, please enter your details

(a) Name

_____
_____

(b) Role
_____ _____
(c) Organisation
_____ _____
(d) email
_____ _____

APPENDIX B

Full range of responses from the online questionnaire.

Response No.	Q1. What description best fits your organisation?	Q2. How important does your organisation view radio/nuclear chemistry?	Q3. Does your organisation currently have any need for people with radio/nuclear chemistry skills?	Q4. How many post graduate chemists are currently employed within your organisation?	Q5. What proportion of these chemists are or have been involved in work related to radio/nuclear chemistry?	Q6. Does your organisation have any plans to recruit post graduate radio/nuclear chemists?	Q7. Does your organisation have any plans to recruit post graduate chemists?	Q8. Does your organisation arrange for employees to undertake VET (Vocational and Educational Training) or CPD (Continued Professional Development)?	Q9. Does your organisation arrange for employees to undertake VET/CPD in radio/nuclear chemistry?	Q10. What type of delivery for VET/CPD would your organisation prefer for training in radio/nuclear chemistry?	Q11. What type of training would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?	Q12. What subjects would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?
1	Nuclear regulator	Very important part of organisation	Most of the time	Don't know	A few	Possibly: within the next 5 years	Possibly: within the next 5 years	Sometimes	Rarely	All of the above	All of the above	All of the above
2	National laboratory or research organisation	Integral part of organisation	Always	100	All	Yes: within the next year	Yes: within the next year	Always	Sometimes	All of the above	All of the above	All of the above
3	: Government/site owner	Slightly important part of organisation	Always	10	A few	Possibly: within the next 5 years	Possibly: within the next 5 years	Sometimes	Rarely	Distance learning, with final attended session	Taught lectures with notes	Fundamentals of nuclear chemistry
4	National laboratory or research organisation	Very important part of organisation	Always	100	Most	Yes: within the next year	Yes: within the next year	Often	Sometimes	All of the above	All of the above	All of the above
5	National laboratory or research organisation	Integral part of organisation	Most of the time	Don't know	Most	Yes: within the next 5 years	Yes: within the next 5 years	Always	Sometimes	All of the above	All of the above	All of the above
6	National laboratory or research organisation	Integral part of organisation	Always	10	Most	Yes: within the next year	Yes: within the next year	Often	Sometimes	Attend series of 1 day courses, up to 1 week	Taught lectures with notes	Radioanalytical methods

Response No.	Q1. What description best fits your organisation?	Q2. How important does your organisation view radio/nuclear chemistry?	Q3. Does your organisation currently have any need for people with radio/nuclear chemistry skills?	Q4. How many post graduate chemists are currently employed within your organisation?	Q5. What proportion of these chemists are or have been involved in work related to radio/nuclear chemistry?	Q6. Does your organisation have any plans to recruit post graduate radio/nuclear chemists?	Q7. Does your organisation have any plans to recruit post graduate chemists?	Q8. Does your organisation arrange for employees to undertake VET (Vocational and Educational Training) or CPD (Continued Professional Development)?	Q9. Does your organisation arrange for employees to undertake VET/CPD in radio/nuclear chemistry?	Q10. What type of delivery for VET/CPD would your organisation prefer for training in radio/nuclear chemistry?	Q11. What type of training would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?	Q12. What subjects would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?
7	National laboratory or research organisation	Integral part of organisation	Always	100	Most	Yes: within the next year	Yes: within the next year	Always	Sometimes	Attend series of 1 day courses, up to 1 week	All of the above	All of the above
8	National laboratory or research organisation	Integral part of organisation	Always	100	Most	Yes: within the next year	Yes: within the next year	Often	Often	All of the above	All of the above	All of the above
9	Nuclear contractor	Very important part of organisation	Sometimes	A few	Most	Yes: within the next 5 years	Yes: within the next 5 years	Always	Always	Distance learning, with final attended session	Worked assignments and tutorials	Radiation detection, dosimetry and protection
10	Nuclear contractor	Integral part of organisation	Always	100	All	Yes: within the next year	Yes: within the next year	Always	Always	All of the above	All of the above	All of the above
11	Nuclear regulator	Integral part of organisation	Most of the time	A few	Most	Yes: within the next year	Yes: within the next year	Always	Sometimes	All of the above	Taught lectures with notes	All of the above
12	Nuclear site operator	Integral part of organisation	Always	10	A few	Possibly: within the next 5 years	Possibly: within the next 5 years	Always	Often	All of the above	Taught lectures with notes	All of the above
13	Nuclear site operator	Integral part of organisation	Always	10	All	Possibly: within the next 5 years	Possibly: within the next 5 years	Often	Often	Distance learning, with final attended session	All of the above	All of the above
14	: Reactor plant designer and manufacturer	Very important part of organisation	Always	10	All	Yes: within the next year	Yes: within the next year	Always	Often	Attended short course up to 1 week	All of the above	All of the above

Response No.	Q1. What description best fits your organisation?	Q2. How important does your organisation view radio/nuclear chemistry?	Q3. Does your organisation currently have any need for people with radio/nuclear chemistry skills?	Q4. How many post graduate chemists are currently employed within your organisation?	Q5. What proportion of these chemists are or have been involved in work related to radio/nuclear chemistry?	Q6. Does your organisation have any plans to recruit post graduate radio/nuclear chemists?	Q7. Does your organisation have any plans to recruit post graduate chemists?	Q8. Does your organisation arrange for employees to undertake VET (Vocational and Educational Training) or CPD (Continued Professional Development)?	Q9. Does your organisation arrange for employees to undertake VET/CPD in radio/nuclear chemistry?	Q10. What type of delivery for VET/CPD would your organisation prefer for training in radio/nuclear chemistry?	Q11. What type of training would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?	Q12. What subjects would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?
15	Nuclear contractor	Integral part of organisation	Always	10	All	Yes: within the next year	Yes: within the next year	Always	Always	All of the above	All of the above	All of the above
16	: Nuclear Consultancy	Very important part of organisation	Always	10	All	Yes: within the next year	Possibly: within the next 5 years	Often	Always	Distance learning, with final attended session	Taught lectures with notes	All of the above
17	Nuclear contractor	Not part of organisation, only required on an ad-hoc basis	Rarely	A few	A few	Unlikely: within the next 5 years	Unlikely: within the next 5 years	Often	Rarely	E-platform or MOOC	Worked assignments and tutorials	Fundamentals of nuclear chemistry
18	Nuclear site operator	Integral part of organisation	Always	100	Most	Possibly: within the next 5 years	Yes: within the next year	Always	Often	All of the above	All of the above	All of the above
19	University or higher education institution	Not part of organisation, only required on an ad-hoc basis	Rarely	10	A few	Possibly: within the next 5 years	Possibly: within the next 5 years	Sometimes	Never	All of the above	All of the above	Radioanalytical methods
20	National laboratory or research organisation	Very important part of organisation	Always	100	A few	Yes: within the next 5 years	Yes: within the next 5 years	Often	Sometimes	Attend series of 1 day courses, up to 1 week	Taught lectures with notes	Fundamentals of nuclear chemistry
21	: Teacher	Very important part of organisation	Sometimes	None	Don't have any Post Graduate chemists	Very unlikely: within the next 5 years	Very unlikely: within the next 5 years	Often	Rarely	Attend series of 1 day courses, up to 1 week	Taught lectures with notes	Fundamentals of nuclear chemistry

Response No.	Q1. What description best fits your organisation?	Q2. How important does your organisation view radio/nuclear chemistry?	Q3. Does your organisation currently have any need for people with radio/nuclear chemistry skills?	Q4. How many post graduate chemists are currently employed within your organisation?	Q5. What proportion of these chemists are or have been involved in work related to radio/nuclear chemistry?	Q6. Does your organisation have any plans to recruit post graduate radio/nuclear chemists?	Q7. Does your organisation have any plans to recruit post graduate chemists?	Q8. Does your organisation arrange for employees to undertake VET (Vocational and Educational Training) or CPD (Continued Professional Development)?	Q9. Does your organisation arrange for employees to undertake VET/CPD in radio/nuclear chemistry?	Q10. What type of delivery for VET/CPD would your organisation prefer for training in radio/nuclear chemistry?	Q11. What type of training would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?	Q12. What subjects would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?
22	Nuclear site operator	Slightly important part of organisation	Most of the time	A few	A few	Unlikely: within the next 5 years	Possibly: within the next 5 years	Sometimes	Rarely	All of the above	Laboratory practicals	All of the above
23	Nuclear site operator	Integral part of organisation	Always	10	All	Possibly: within the next 5 years	Possibly: within the next 5 years	Sometimes	Sometimes	All of the above	Worked assignments and tutorials	All of the above
24	Nuclear regulator	Integral part of organisation	Always	10	Most	Yes: within the next year	Yes: within the next year	Always	Always	All of the above	All of the above	All of the above
25	University or higher education institution	Not part of organisation, only required on an ad-hoc basis	Rarely	100	None	Very unlikely: within the next 5 years	Yes: within the next 5 years	Never	Never	Not interested in radio/nuclear chemistry VET	Not interested in radio/nuclear chemistry VET	Not interested in radio/nuclear chemistry VET
26	University or higher education institution	Very important part of organisation	Most of the time	100	A few	Yes: within the next year	Yes: within the next year	Always	Always	Attend series of 1 day courses, up to 1 week	All of the above	All of the above
27	National laboratory or research organisation	Integral part of organisation	Always	100	All	Yes: within the next year	Yes: within the next year	Often	Rarely	All of the above	All of the above	All of the above
28	National laboratory or research organisation	Very important part of organisation	Always	Don't know	A few	Possibly: within the next 5 years	Possibly: within the next 5 years	Sometimes	Sometimes	All of the above	All of the above	All of the above

Response No.	Q1. What description best fits your organisation?	Q2. How important does your organisation view radio/nuclear chemistry?	Q3. Does your organisation currently have any need for people with radio/nuclear chemistry skills?	Q4. How many post graduate chemists are currently employed within your organisation?	Q5. What proportion of these chemists are or have been involved in work related to radio/nuclear chemistry?	Q6. Does your organisation have any plans to recruit post graduate radio/nuclear chemists?	Q7. Does your organisation have any plans to recruit post graduate chemists?	Q8. Does your organisation arrange for employees to undertake VET (Vocational and Educational Training) or CPD (Continued Professional Development)?	Q9. Does your organisation arrange for employees to undertake VET/CPD in radio/nuclear chemistry?	Q10. What type of delivery for VET/CPD would your organisation prefer for training in radio/nuclear chemistry?	Q11. What type of training would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?	Q12. What subjects would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?
29	: Nuclear Consultancy	Slightly important part of organisation	Sometimes	None	None	Very unlikely: within the next 5 years	Very unlikely: within the next 5 years	Sometimes	Never	Distance learning, with final attended session	Taught lectures with notes	Fundamentals of nuclear chemistry
30	Nuclear contractor	Integral part of organisation	Rarely	None	Don't have any Post Graduate chemists	Very unlikely: within the next 5 years	Very unlikely: within the next 5 years	Sometimes	Rarely	All of the above	Worked assignments and tutorials	All of the above
31	Nuclear contractor	Very important part of organisation	Always	10	All	Yes: within the next year	Possibly: within the next 5 years	Often	Sometimes	Attended short course up to 1 week	Worked assignments and tutorials	All of the above
32	University or higher education institution	Slightly important part of organisation	Most of the time	A few	A few	Yes: within the next year	Yes: within the next year	Sometimes	Sometimes	Attend series of 1 day courses, up to 1 week	All of the above	All of the above
33	National laboratory or research organisation	Integral part of organisation	Always	100	Most	Yes: within the next year	Yes: within the next year	Often	Rarely	All of the above	All of the above	All of the above
34	Nuclear site operator	Not part of organisation, only required on an ad-hoc basis	Rarely	10	None	Very unlikely: within the next 5 years	Yes: within the next year	Always	Rarely	Attended short course up to 1 week	All of the above	All of the above
35	University or higher education institution	Very important part of organisation	Always	100	A few	Yes: within the next year	Yes: within the next year	Often	Rarely	Attended short course up to 1 week	All of the above	All of the above

Response No.	Q1. What description best fits your organisation?	Q2. How important does your organisation view radio/nuclear chemistry?	Q3. Does your organisation currently have any need for people with radio/nuclear chemistry skills?	Q4. How many post graduate chemists are currently employed within your organisation?	Q5. What proportion of these chemists are or have been involved in work related to radio/nuclear chemistry?	Q6. Does your organisation have any plans to recruit post graduate radio/nuclear chemists?	Q7. Does your organisation have any plans to recruit post graduate chemists?	Q8. Does your organisation arrange for employees to undertake VET (Vocational and Educational Training) or CPD (Continued Professional Development)?	Q9. Does your organisation arrange for employees to undertake VET/CPD in radio/nuclear chemistry?	Q10. What type of delivery for VET/CPD would your organisation prefer for training in radio/nuclear chemistry?	Q11. What type of training would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?	Q12. What subjects would your organisation prefer to have included into a VET/CPD package on radio/nuclear chemistry?
36	University or higher education institution	Slightly important part of organisation	Always	10	A few	Yes: within the next year	Yes: within the next year	Always	Sometimes	Attend series of 1 day courses, up to 1 week	All of the above	All of the above
37	Nuclear site operator	Very important part of organisation	Always	A few	Most	Unlikely: within the next 5 years	Possibly: within the next 5 years	Sometimes	Sometimes	All of the above	All of the above	All of the above
38	National laboratory or research organisation	Slightly important part of organisation	Sometimes	A few	All	Possibly: within the next 5 years	Yes: within the next year	Sometimes	Never	Not interested in radio/nuclear chemistry VET	Not interested in radio/nuclear chemistry VET	Not interested in radio/nuclear chemistry VET

APPENDIX C

Summary of VET syllabus offered by INSTN

Introduction to the use of the plutonium and actinides

- Review of nuclear physics.
- Characteristics of Pu and actinides.
- Medical aspects.
- Pu and actinides risks: contamination, irradiation, criticality.
- Rules concerning the use of Pu and actinides: facilities and waste management.
- Use of Pu and actinides: premises, glove boxes, nuclearisation of equipment and manufacture of fuel elements.

Chemistry of uranium and plutonium

- Fundamental knowledge in solution chemistry applied to uranium, plutonium and other actinides Np, Am, Cm: hydrolysis, complexation, solubility, precipitation, oxydo-reduction, liquid-liquid extraction.
- Application to the better knowledge of main processes of the nuclear fuel cycle: treatment of the ore, irradiated fuel dissolution, extraction processes (Purex), metal plutonium chemistry.
- Modelisation of actinide speciation as a function of their physico-chemical environment.
- Chemical properties of actinides in relation with their toxicology and their decorporation.
- Physico-chemical and analytical methods of actinides in the nuclear fuel cycle and in the environment.
- Future processes of advanced separation

Behaviour of radionuclides in the biosphere

- Physico-chemical basis on the behaviour of RNs in the biosphere
- General information based on Mendeleyev periodic table
- Speciation of RNs
- General overview on human toxicology
- General overview on the effects of ionizing radiation
- General overview on the impact of RNs in the environment
- Specific data on RNs of interest (tritium, iodine, cesium, strontium, actinides…)
- Treatment of the contamination by RNs
- Data bases, speciation tools for RNs

Radiation protection basis

- Nuclear physics basis: radioactivity, ionizing radiations and their interactions with matter.
- Biological effects of ionizing radiations.
- Radiation protection quantities: equivalent dose, effective dose.
- Detection and measuring.
- External and internal exposure.
- International regulation in radiation protection, ALARA principle.
- Application of radiation protection in nuclear industry.

Detection and measurement

- Detection of ionizing radiation.
- Non destructive nuclear measurements.
- Basics on gamma spectrometry.
- Principles of gamma spectromecry; Spectra analysis.
- Analysis by alpha spectrometry.
- Practical neutron detection in nuclear reactors.
- Measurement by liquid scintillation (survey of facilities).
- Measurement by liquid scintillation (environmental survey).
- Nuclear electronics.

Radiobiology and radiotoxicology

- Basics on radiobiology.
- Physico-chemical phenomena induced by radiations.
- DNA lesions, repairing mechanisms, genetic and somatic damages.
- Effects of radiation on in utero development.
- Radionuclides radiotoxicology.
- Prevention and treatment.
- Survey of workers.
- Internal dosimetry
- Recent data related to natural (radon) or artificial irradiation.
- Interest of epidemiological studies.
- Radioprotection
- Principles and guidance of ICRP
- European guidance.