

09.07.2026
10th EUTERP WORKSHOP

Modular competence-based training in radiation protection for unsealed sources: combining e-learning, active learning and continuing professional development

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Special thanks to the driving force behind this work!



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Camille LEMESRE · 1°

Radioprotection | Qualité | Formation | Structurer
les processus | Transformer les pratiques |
Conduire le changement

CHUV / Centre hospitalier universitaire vaudois · École
Polytechnique de Montréal

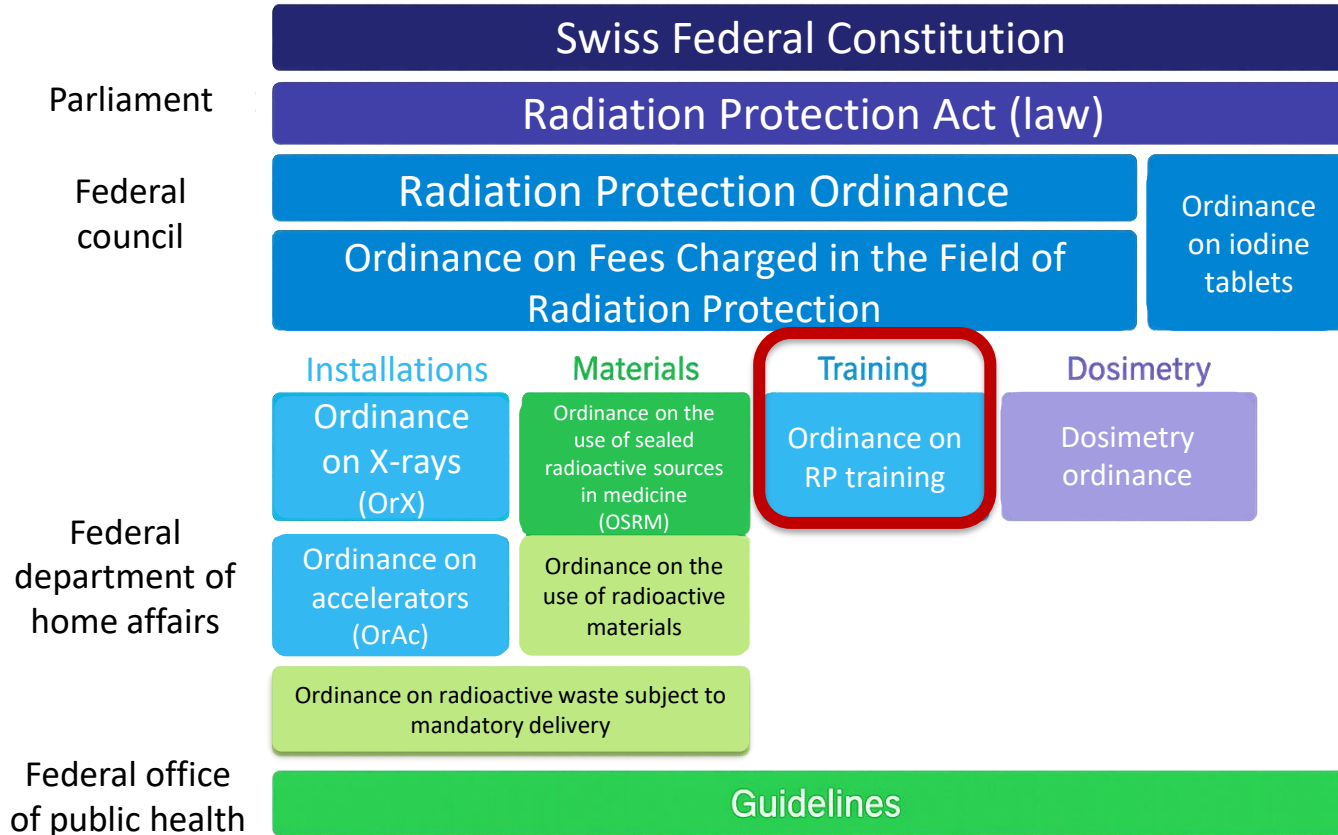
Losanna, Vaud, Svizzera

Institut de Radiophysique – IRA /CHUV:

- +50 years of experience
- Service, research and teaching
- Our trainers are field experts
- Coordinated by a trained pedagogical expert (←)
- Limitations : our personnel, instruments and infrastructures are shared with routine activities

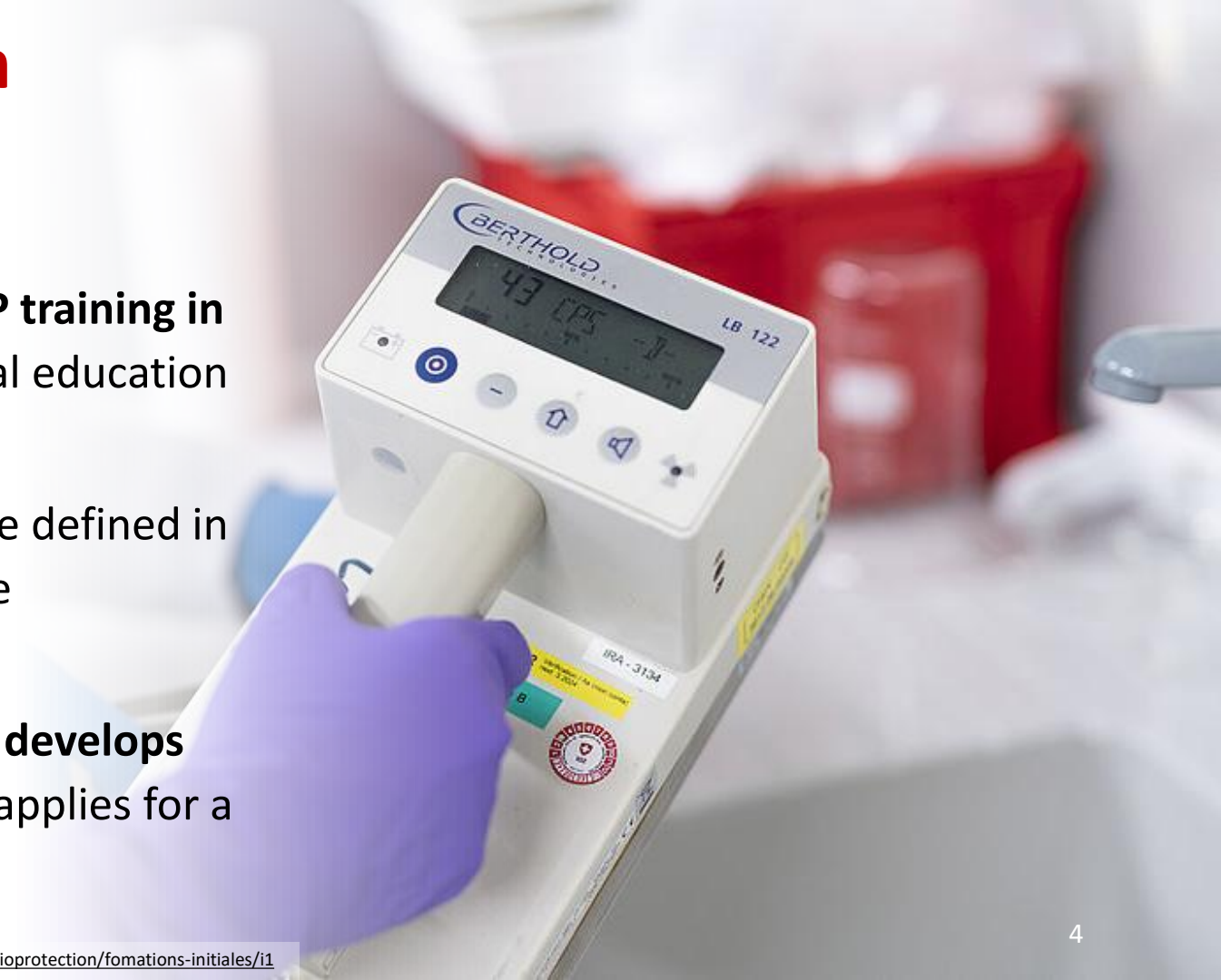


RP training in Switzerland – legal framework



RP training in Switzerland

- most of people get **RP training in addition** to their initial education
- **training objectives** are defined in a dedicated ordinance
- each **training centres develops** the course, and then applies for a **certification**.



RP training in Switzerland : officer / expert / competent person?

- Only one term is used in the legislation:

- *Strahlenschutz-Sachverständige*
- *Experts en radioprotection*
- *Periti in radioprotezione*
- *Radiological protection experts*



- **No formal distinction** between RP experts (RPE) or RP officers (RPO).
- In terms of competences, the training is comparable to that of **RPOs**, but
- It is **very specialized** and **detailed**, according to their domain of expertise
- They can be **granted legal responsibilities** (i.e. may be officially designated on a licence)
- Their **position can evolve** according to their responsibilities (local operational vs. broader and advisory)

Radiological Protection Ordinance, Art 2 : radiological protection experts means experts, as specified in Article 16 of the RPA, who have the knowledge, training and experience in radiological protection needed to ensure the effective protection of people and the environment; experts are responsible for implementation of the legal requirements in internal radiological protection directives and for monitoring compliance within the enterprise.

RP training in Switzerland

Structured according to professional categories

- Medical activities for physicians, dentists, chiropractors, and veterinarians
- Activities in the medical field (excluding physicians, dentists, chiropractors, and veterinarians) and in the medical industry
- Activities in the field of nuclear facilities
- Activities involving emergency situations, exposure, and management of radiations
- Activities in the fields of industry, crafts, education, research, and transport

Challenge: suitable for different professional backgrounds



RP training in Switzerland : initial and continuing training

Field of application	# of initial teaching units	frequency of required continuing education	# teaching units of continuing education	continuing education recognition obligation
I 1 - RPOs in the use of unsealed radioactive materials in B/C work areas	80	5 y	16	yes
I 2 - RPOs in the use of unsealed radioactive materials posing a low hazard	24	5 y	8	no
I 3 - RPOs for equipment analysis	40	5 y	8	yes
I 4 - RPOs in the use of sealed radioactive sources and facilities without full or partial shielding	24	5 y	8	no
I 5 - RPOs in the trade and shipment of radioactive sources	24	5 y	8	no
I 6 - RPOs for checking for the presence of radioactive materials	24	5 y	8	no
I 7 - RPOs in the use of facilities without full or partial shielding	16	5 y	8	no

RP training in Switzerland

Competences

Tabelle 2: Kompetenzen

Die anerkannten Ausbildungslehrgänge stellen sicher, dass die Personen folgende Kompetenzen, Fähigkeiten und Kenntnisse besitzen:

Kompetenzen / Berufsnummer	I 1	I 2	I 3	I 4	I 5	I 6	I 7	I 8	I 9	I 10	I 11	I 12	I 13	I 14	I 15	I 16	I 17	I 19	I 20
	SV in einem Arbeitsbereich B/C	SV mit offenem radioaktivem Material mit geringem Gefährdungspotential	SV bei der Materialprüfung	SV beim Umgang mit geschlossenen radioaktiven Quellen und Anlagen ohne Voll- und Teilschutzeinrichtung	SV beim Handel und Versand von radioaktiven Quellen	SV bei der Kontrolle auf Vorhandensein von radioaktivem Material	SV beim Umgang mit Anlagen ohne Voll- und Teilschutzeinrichtung	SV bei der Verwendung von handgehaltenen Röntgenanlagen mit geringer Leistung	SV beim Einsatz von Anlagen mit Voll- und Teilschutzeinrichtung	SV beim Einsatz von geschlossenen radioaktiven Quellen mit geringem Gefährdungspotential	SV beim Transport von radioaktivem Material	SV bei der Vermittlung von Fremdpersonal	SV beim Umgang mit NORM	SV bei erhöhter Radonexposition	SV bei Lehr Tätigkeiten an Lehranstalten	Fahrzeugführer von radioaktivem Material gemäss SDR	Fahrzeugführer von radioaktivem Material gemäss ADR	Laborpersonal	Radonfachperson
Operationeller Strahlenschutz																			
Die Einhaltung der Grenzwerte im Strahlenschutz sicherstellen	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	—	—	x
Strahlenschutzkonforme Arbeitsmethoden mit radioaktivem Material unter Berücksichtigung des Optimierungs-Prinzips festlegen und überwachen	x	x	x	x	x	x	—	—	—	x	x	—	x	—	x	—	—	x	—
Strahlenschutzkonforme Arbeitsmethoden mit geschlossenen radioaktiven Quellen unter Berücksichtigung des Optimierungsprinzips festlegen und überwachen	x	x	x	x	x	x	—	—	—	x	x	—	x	—	x	x	x	x	—

RP training in Switzerland

Content

Tabelle 4: Aus- und Fortbildungsinhalte

Es bedeuten:

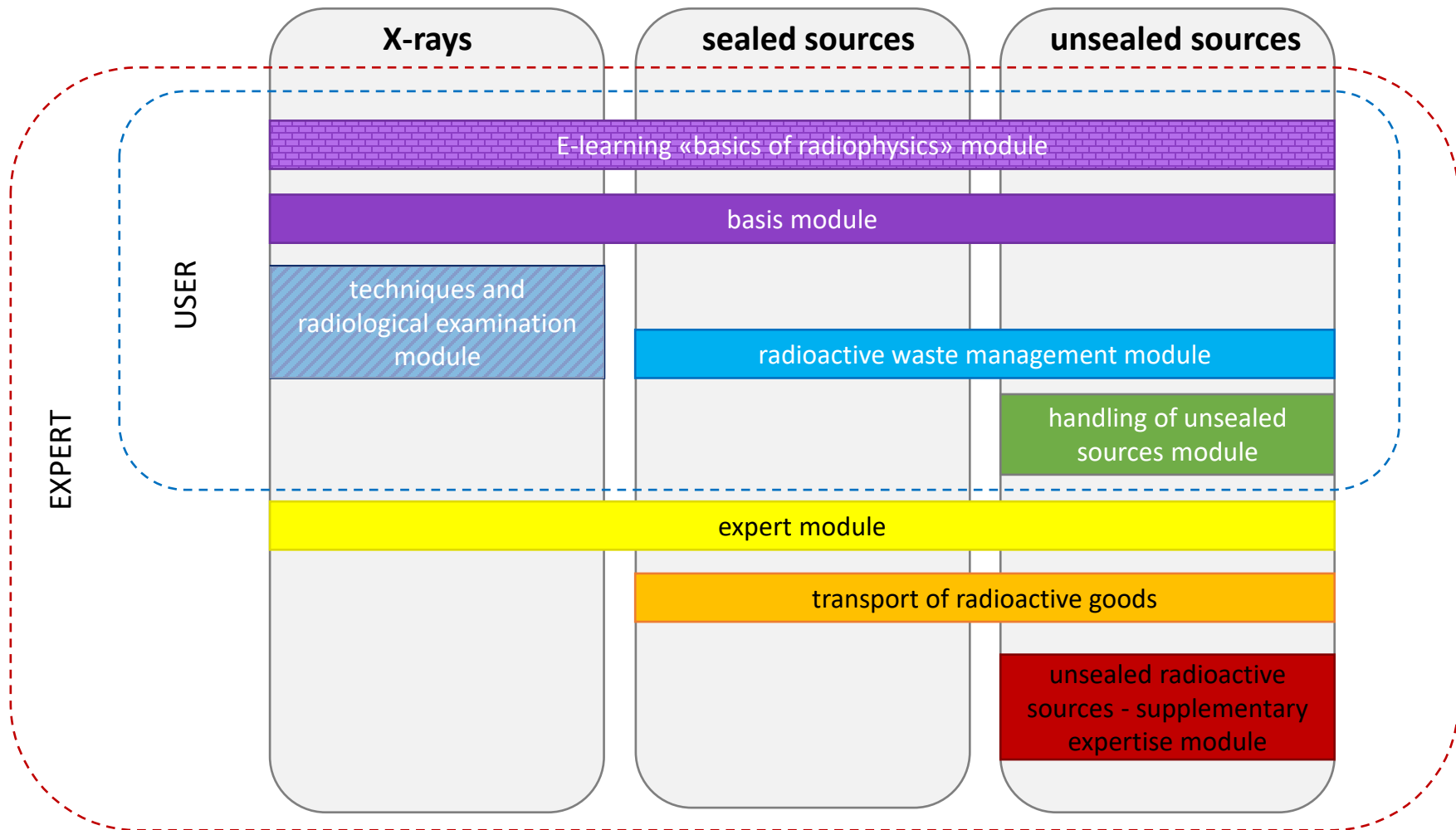
- 1: Kenntnisse: aufzählen, skizzieren, benennen, beschreiben, darstellen
- 2: Verständnis: interpretieren, erklären, erläutern, formulieren, präsentieren
- 3: Anwendung: anwenden, erstellen, lösen, durchführen, berechnen, gestalten, konfigurieren
- 4: Analyse: auswählen, einteilen, analysieren, vergleichen
- 5: Bewertung: beurteilen, entscheiden, urteilen, klassifizieren, evaluieren
(Der Vergleich der Gewichtung ist nur innerhalb der Berufsnummer möglich)

a) Die in der ADR festgelegten Anforderungen an die Ausbildungsdauer, die Lerninhalte und die Fortbildung sind zu berücksichtigen.

Berufsnummer	11	12	13	14	15	16	17	18	19	110	111	112	113	114	115	116	117 ^{a)}	119	120
	SV in einem Arbeitsbereich B/C	SV mit offenem radioaktivem Material mit geringem Gefährdungspotential	SV bei der Materialprüfung	SV beim Umgang mit geschlossenen radio-aktiven Quellen und Anlagen ohne Voll- und Teilschutzeinrichtung	SV beim Handel und Versand von radioaktiven Quellen	SV bei der Kontrolle auf Vorhandensein von radioaktivem Material	SV beim Umgang mit Anlagen ohne Voll- und Teilschutzeinrichtung	SV bei der Verwendung von handgehaltenen Röntgenanlagen mit geringer Leistung	SV beim Einsatz von Anlagen mit Voll- und Teilschutzeinrichtung	SV beim Einsatz von geschlossenen radioaktiven Quellen mit geringem Gefährdungspotential	SV beim Transport von radioaktivem Material	SV bei der Vermittlung von Fremdpersonal	SV beim Umgang mit NORM	SV bei erhöhter Radonexposition	SV bei Lehrsicherheiten an Lehranstalten	Fahrzeugführer von radioaktivem Material gemäss SDR	Fahrzeugführer von radioaktivem Material gemäss ADR	Laborpersonal	Radonfachperson
Ausbildungsinhalte																			
Strahlenphysik																			
Aufbau der Atome/Nuklidkarte	2	1	1	1	1	1	–	1	1	1	1	1	1	1	1	1		1	1
Radioaktive Zerfälle und Strahlenarten	3	3	2	2	2	2	–	–	–	1	2	1	2	2	1	1		1	2
Wechselwirkung Strahlung – Materie	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1

Modular competence-based training in RP

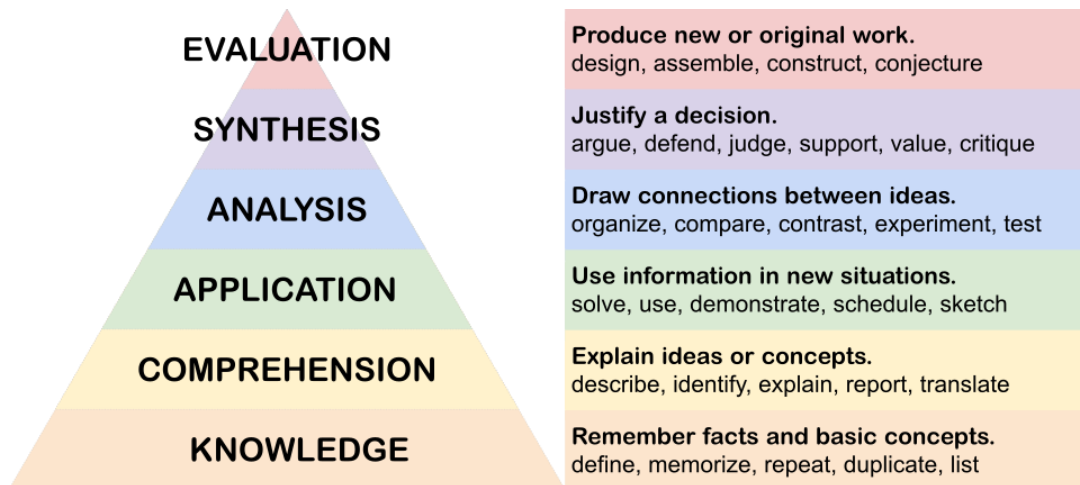




ALL THE MODULES = I 1 - RPOs in the use of unsealed radioactive materials in B/C work areas

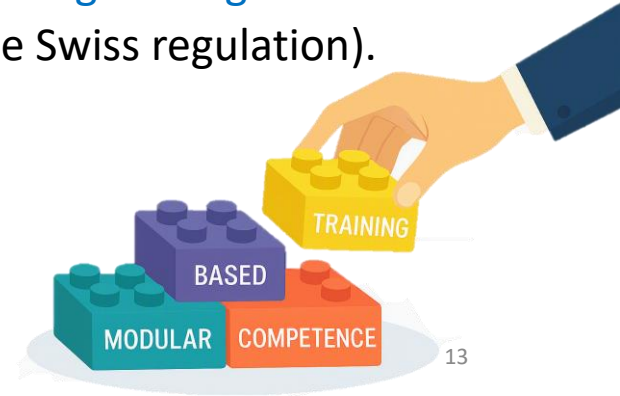
Modular competence-based training in RP

- Each module is associated with **clear and predefined learning objectives** (according to Bloom's taxonomy).
- These are **defined by the Institute**, translating the **requirements** set in the Swiss **Ordinance on RP training**.



Modular competence-based training in RP

- Each module is associated with **clear and predefined learning objectives** (according to Bloom's taxonomy).
- These are **defined by the Institute**, translating the **requirements** set in the Swiss **Ordinance on RP training**.
- Each module is made of different sub-modules (*building blocks*):
 - these are combined to create a **coherent and self-standing training**
 - according to the **required competences** (defined in the Swiss regulation).



Modular competence-based training in RP

Evolution of learning objective among sub-modules: practical example

	Dosimetry : level 1	Dosimetry : level 2	Dosimetry : level 3	Dosimetry : level 4
Appears in	<i>basis module</i>	<i>handling of unsealed sources module</i>	<i>expert module</i>	<i>unsealed radioactive sources - supplementary module</i>
Learning objectives	Differentiate between dosimetric quantities: absorbed, equivalent, and effective dose List the operational quantities Hp(10), Hp(0.07), Hp(3) Explain methods for external exposure monitoring (whole body, extremities, eye lens)	Explain committed and total effective dose Explain monitoring of internal exposure and radioactive intake Cite the Swiss regulation on internal monitoring and describe its main points	Assess employees' external radiation exposure within the company Identify occupationally exposed workers Organize and oversee individual dosimetry Interpret dosimetry reports	Assess internal radiation exposure of staff Identify workers requiring internal monitoring Manage internal monitoring Explain incorporation measurement and assumptions Explain how committed dose is computed

Training modalities: e-learning and in-person



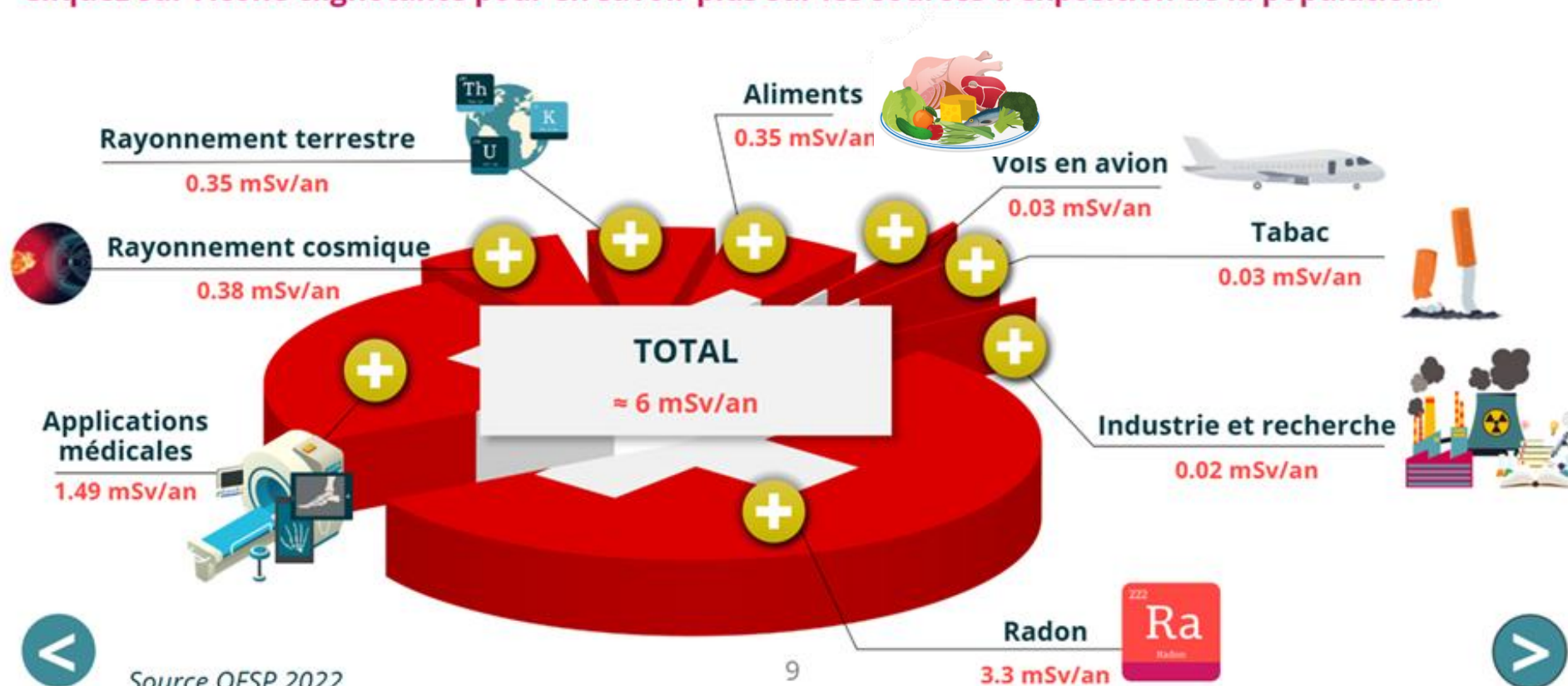
e-learning

- Prerequisite to follow the in-person training.
- Online (24/7), participants can follow at their own pace.
- Covers the basics of radiation physics, ensuring a common baseline for the participants:

it covers	it features
Introduction to ionizing radiation	theoretical concepts
Effects of radiations - basics of radiation biology	audio explanations
Exposure of the Swiss population to ionizing radiation	quizzes and exercises
Working sectors : supervised vs. controlled areas	pop-ups for additional reading

EXPOSITION DE LA POPULATION SUISSE

Cliquez sur l'icône clignotante pour en savoir plus sur les sources d'exposition de la population.





RADIONUCLÉIDES DANS L'ALIMENTATION

RADIONUCLÉIDES NATURELS



Émetteur β^- et γ

i



Émetteur β^-

i



EAU DE SOURCE :



NOURRITURE :



Les comparaisons entre les doses efficaces du chapitre 1 et les activités massiques ne sont pas données car cela nécessite des études approfondies et la prise en compte de nombreuses données.



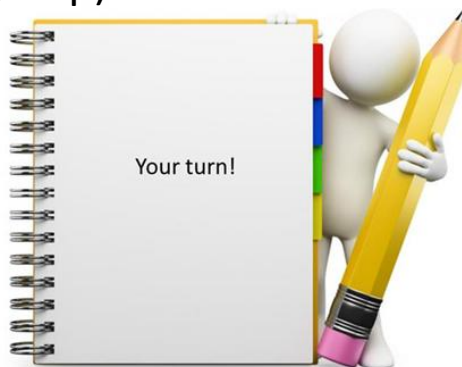
In-person training: a combination of pedagogical methods



In-person : combination of pedagogical methods

- Each sub-module features different pedagogical methods, including:
 - Guided exercises (individual and group)

Radio-nuclide	Half-life	Activity	LL (Bq/g)	1 kg*LL	10 kg*LL	Decision	Length of storage
I-123							
Lu-177							
Tc-99m							
C-14							



*more engaging for **legal** and **regulatory** aspects !*



Management of radioactive waste- Exercise

First part: Clearance from mandatory licensing and supervision or discharge to the environment

- 1) Refer to article 2 of the RPO and give the definition of "LL". Where are the LL values indicated?

In-person : combination of pedagogical methods

- Each sub-module features different pedagogical methods, including:
 - Guided exercises (individual and group)
 - Theoretical lectures

Legal framework: summary

Criteria	Specific activity (Bq/g)	Absolute activity (Bq)	Absolute activity (Bq)
Activity	$A < LL$	$A < 1 \text{ kg} \times LL$	$A < 10 \text{ kg} \times LL / \text{week/licence}$
Dose rate	$H^*(10) \text{ at } 10 \text{ cm} < 0.1 \mu\text{Sv/h}$		
Contamination	$< CS$		

If release is not possible:

$T < 100 \text{ days}$	$T > 100 \text{ days}$
Storage during decay then release as normal waste	Annual collection campaign by the FOPH and PSI



In-person : combination of pedagogical methods

- Each sub-module features different pedagogical methods, including:
 - Guided exercises (individual and group)
 - Theoretical lectures
 - Case studies



Institut
de radiophysique

Case study : waste management in nuclear medicine

1. Situation

You work in a nuclear medicine department equipped with a laboratory, an irradiator and treatment rooms for patients.

One of the radiopharmaceuticals used in this department is Lutathera® (Lu-177). The laboratory and treatment rooms waste water are collected in retention tanks of 600 liters each.

For safety reasons, the head of the department has purchased a new X-ray irradiator to replace the current one (Cs-137 source). **You are asked to:**

- Coordinate the disposal of this source;
- Decide what to do with the waste water retention tank;
- Manage the last waste generated by the laboratory.



In-person : combination of pedagogical methods

- Each sub-module features different pedagogical methods, including:
 - Guided exercises (individual and group)
 - Theoretical lectures
 - Case studies
 - Practical laboratory sessions



Examination - practical part

Sort a typical lab situation (in a controlled area)

- 17 minutes/participant
- score based on objective assessment grid
- limit bias and homogenize inter-examinator grading

low activity sources
embedded in epoxy resin
(= sealed)



Examination - written part

15 questions of **type A**

How should a radioactive waste containing 70 kBq of [REDACTED] be managed by a licensed laboratory?

- A. Directly eliminated as conventional waste A ☐
- B. Stored for 1 week and then eliminated as conventional waste B ☐
- C. Stored for 1 year and then eliminated as conventional waste C ☐
- D. Sent to PSI during the yearly campaign of collecting radioactive waste D ☐
- E. Stored while waiting for authorization from the FOPH to eliminate it as normal waste E ☐

2 hours (max)

Minimum
passing score
(both practical and written)
= 66%

15 questions of **type K'**

Handling a 4 MBq sealed source of [REDACTED] requires:

	True	False
a. A license from the FOPH	☐	☐
b. Notification to the FOPH in the event of loss or theft	☐	☐
c. An annual leak test	☐	☐
d. A controlled area	☐	☐

Modular competence-based training in RP

Conclusion

- Modular competence-based training in RP has proven to be:
 - effective and entertaining for **participants**
 - efficient for **trainers**
- Possibility to **leverage / reuse the material** for other continuous training
- Combination of **e-learning and in-person** approach
 - complementary
 - but even if no longer a full 2-week course, it can still be dense for participants
- Future challenges : **new infrastructures**

