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A plan for competence development in expertise of radwaste disposal safety

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Contents

1 Foreword

The objective of the FP7 program SITEX project is to set up a network capable of harmonizing European approaches with respect to the technical expertise needed to evaluate [the safety of?] geological repository projects, for the long term management (or disposal) of radioactive waste. Lasting 24 months, SITEX brings together 15 organisations representing technical safety organisations (TSOs) and safety authorities, as well as civil society outreach specialists.

SITEX plans to help establish the conditions required for developing a sustainable network of technical safety experts who have their own skills and analytical tools, are independent of implementers, and who are capable of conducting their own research programs.

2 Summary

The objective of Work Package 4 (WP°4) is to establish the conditions necessary for developing common technical review methodologies, which will enable the harmonisation of review methods. This will help to make the expertise function consistent throughout member countries. In 2012, a first step was taken and the participants of WP°4 elaborated a plan to develop harmonised methods for reviewing the safety case (Task 4.1). In a second stage, in 2013, participants devised a plan to organise training activities related to the technical review methodology (Task°4.2). The present report focuses on the outcome of the latter task. The results of the first task of WP°4 were used as input for this second task.

The following organisations contributed to this report: Bel°V (Belgium), Canadian Nuclear Safety Commission, CNSC (Canada), DECOM (Slovakia), Federal Agency for Nuclear Control, FANC (Belgium), Gesellschaft für Anlagen-und-Reaktorsicherheit, GRS (Germany), Institut de Radioprotection et de Sûreté Nucléaire, IRSN (France), Lietuvos Energetikos Institutas, LEI (Lithuania), Ministerie Van economischeZaken, Landbouw en Innovatie, ELI (Netherlands), Ustav Jaderneho Vyzkumu Rez A.S, UJV (Czech Republic), EidgenossischesNuklearsicherheinspektorat, ENSI (Switzerland), SträlSåkerhetsMyndigheten, SSM (Sweden) , Nuclear Research and Consultancy Group, NRG (Netherlands), European Nuclear Safety Training and Tutoring Institute, ENSTTI (Europe).

3 Concept

3.1 INTRODUCTION

SITEX project deliverable D2.2 (“Main key technical issues, expertise and support needed”), identifies several types of technical support areas that the regulatory body needs in order to

fulfil its mission (i.e. to verify compliance with safety requirements and eventually to be able to licence a facility for safe geological disposal) as follows:

- inspections,
- reviews,
- R&D activities.

Depending on the country, these three activities are not distributed the same way between the regulatory body and technical experts (see SITEX deliverable D4.1 "Available technical review guidance and further needs"). For example, the technical expert may have varying levels of responsibility depending on the inspecting organisation (D4.1, § 4.2.2). Whatever the level of implication for technical experts, the results of inspections and R&D are important elements that need to be brought into the technical review, which is the heart of the following training programme for developing expertise on the safety of deep geological repositories. With respect to inspections and R&D, this proposed training programme focuses on the methods to construct inspection and R&D programs and how to use the results in technical reviews, rather than focussing on the way to carry out R&D and inspections themselves.

Providing knowledge and support for technical reviews is the first objective of the training programme. The training programme also aims to provide support on the methods used to devise inspection and R&D programs, and will also demonstrate how the results of such programs should be used in technical reviews.

The main types of work being performed by experts ("profiles of experts") who do the technical reviews were identified in the D 4.1 report. These profiles are revisited and more deeply described in the following sub-section 3.1.1; this leads to the proposed training strategy with a specific program dedicated to each of the expert profiles (§ 4.2). Sub-section 3.1.2 proposes connections between the different expert profiles and the needed competences and R&D results for each phase of development of the safety case (summarized in tables).

The target audience of the training program is discussed in section 3.2.

The proposed approach for the organisation of such a training programme within the framework of the future SITEX network, with training modules and tutoring, is presented in section 3.3. Section 3.4 is dedicated to the plan for developing the training course.

3.1.1 Expert profiles of needed for technical reviews

The participants of SITEX WP4 compiled the information that competent experts require (deliverable D4.1 §4.4), with specific attitudes and general skills, a definition of generalist and specialist experts and their areas of competence. These competences are not reiterated in this report but are used to identify the different functions (or roles) being performed by experts in the review of the safety case for deep geological disposal projects. The different types of expert profiles may be organized in several ways, depending on the level of detail desired (number of identified profiles). The following list identifies a selection of possible profiles, and is not necessarily comprehensive. Each profile identified indicates the need for a specific training course. Each of these profiles is in reality a family of expert profiles.

The four main required expert profiles needed for evaluating the safety case for geological disposal -whatever the level of development of the disposal project, construction or operation- are defined below. Possible competences for each type of expert are given in non-exhaustive lists. One person may have competences in various profiles.

"Environmental experts"

This profile corresponds to environmental scientists and risk experts in long-term safety (including those examining the impact of construction or operational activities on host rock, …), who carry out R&D and are able to use their scientific knowledge in environmental science to argue their expertise.

The associated competences could include:

- Biosphere
- Radioecology
- Meteorology and environmental hazards
- Climatology
- Geochemistry
- Geology, structural geology, tectonics
- Hydrology, hydrogeology, flooding hazard
- Seismology & earthquake hazard
- Geotechnics
- Geomechanics…
- Geophysics

"Operational risk experts & material engineers"

This profile gathers a large variety of experts in construction and operational safety, including experts for any hazard during these phases, material & civil engineers, scientists as well as conventional underground experts; these experts may also carry out R&D and use it to argue their expertise.

The possible competences of these experts are:

- Waste expert
- Civil & materials engineers
- Radiochemistry
- Microbiology
- Nuclear physics
- Physical protection
- Radiation protection
- Human actions
- Fire & explosion
- Criticality
- Dynamic & static containment
- Radiolysis & thermal effects
- Handling
- Power supply

- Underground/mining hazard
- Reversibility
- Earthquakes / geophysicists
- Flooding
- Other environmental risks…

"Numerical modellers"

This profile correspond to experts in numerical simulation, in code development and mathematicians who support the work performed by other profiles of experts and who have a transversal role, carrying out modelling and implementing software programs matched to the needed expertise (including all types of models such as integrated models or process models, for long-term safety as well as for operational safety); these experts may also carry out R&D, not necessarily for use in the technical review but to improve the performance of a code.

The main associated competences are:

- Numerical modelling
- Mathematics
- Computational methods

"Non-specialized experts"

Non-specialized experts, or "generalist experts", and experts in safety assessment both have a central role in the expert team: generalists have high level expertise on different aspects of a safety case and coordinate the reviews performed by the other categories of experts. Thus, they possess a more global view of the review as a whole. This also includes experts in the assessment of long-term safety and operational safety (scenario development & evaluation of uncertainties) who need to integrate data and knowledge from other experts.

These experts may have the following competences:

- Scenario development
- Accident/incident occurrence (operational health and safety)
- Treatment of uncertainties
- Knowledge of national & international regulations/guidance:
    - for waste management
    - for radiation protection
- Inspection
- Management systems
- Knowledge of installations

The needed R&D and examples of activities associated with each of these profiles are developed in the following sub-section (in tables). The four expert profiles described above will be referred to as "environmental experts", "operational risk experts & material engineers", "numerical modellers" and "generalists" in the remainder of this report.

SITEX working group WP2 produced a list of needs for review in various fields (deliverable D2.2). This list could be used as a basis for the future development of the training modules for each profile of experts (modules B to E).

- Table 2 in deliverable D2.2 related to the needs for review in the field of safety strategy and policy while Table 3 related to the needs for review in management, which could help with the development of the training modules, in particular one dedicated to "generalists".
- Table 4 in deliverable D2.2 related to the needs for review in the field of waste, Table 7 related to the needs for review in engineering and Table 9 related to the needs for review in operational safety; these tables could help develop training modules, in particular one dedicated to "operational risk experts".
- Table 5 in deliverable D2.2 related to the needs for review on the site which could help develop training modules, particularly the one dedicated to "environmental experts".

3.1.2 R&D and various activities associated with the four profiles of technical experts

The outcome of working group WP3 of SITEX project (D3.3, "R&D orientations for Technical Safety Organizations") report identifies several R&D actions, summarized in section 6.4, around three topics: the quality of data, the understanding of complex processes, the processes resulting from the perturbation of the geological disposal system. In Table 1 below, these actions are related to the four profiles of experts identified in the previous section.

Table 1- R&D actions for the three topics identified by the SITEX WP3 and affected expert profiles. The most obvious related expert profiles needed are followed, in brackets, by profiles that may be needed or useful.

Quality of data
Data accuracy and relevance (methodology)
A1 *To assess the accuracy and precision of the methods available for evaluating the data used in long-term and operational safety demonstrations* → operational risk experts & material engineers, environmental experts, numerical modellers
Data representativeness (upscaling and extrapolation)
A2 *To assess if the data evaluated at small scale (in time and space) are representative of the in situ repository conditions and future evolution.* → environmental experts, numerical modellers, (operational risk experts & material engineers)
Understanding of complex processes
Processes that rely on the performance of individual components
B1 *To develop an independent understanding of the processes on which the performance of the waste form relies*

→ operational risk experts & material engineers, numerical modellers

B2 *To develop an independent understanding on the processes on which the performance of the waste canister and its overpack rely*
→ operational risk experts & material engineers, numerical modellers

B3 *To develop an independent understanding of the processes on which the performance of the Engineered Barrier System (EBS) relies*
→ operational risk experts & material engineers, numerical modellers, (environmental experts)

B4 *To develop an independent understanding of the processes on which the performance of the Geosphere relies*
→ environmental experts, numerical modellers

Processes resulting from the perturbation of the geological disposal (GD) system - Internal perturbations

B5 *To develop an independent understanding of the internal perturbations of the disposal system resulting from waste/host-rock and waste/EBS interactions*
→ operational risk experts & material engineers, environmental experts, (numerical modellers)

B6 *To develop an independent understanding of the internal perturbations of the disposal system resulting from EBS/host-rock interactions*
→ environmental experts, (operational risk experts & material engineers), (numerical modellers)

B7 *To develop an independent understanding of the internal perturbations of the disposal system resulting from potential operational transients*
→ environmental experts, (numerical modellers)

Processes resulting from the perturbation of the GD system - External perturbations

B8 *To develop an independent understanding of potential external perturbations on the disposal system*
→ environmental experts, numerical modellers

Verification of extent, intensity and importance of processes

Assessment methodologies

C1 *To evaluate the reliability of methodologies followed by the operators for the assessment calculations*
→ non-specialized experts

Model reliability

C2 *To develop independent models in order to evaluate the extent, the intensity and the radiological impact of processes resulting from internal and external perturbations of the repository*
→ numerical modellers, non-specialized experts

Management of uncertainties

C3 *To evaluate the methodology followed by operators for managing the uncertainties surrounding the safety assessments*
→ environmental experts, operational risk experts & material engineers, non-specialized experts, numerical modellers

Monitoring

C4 *To build confidence into monitoring methods in order to define the reference state of the system and its evolution during construction, operational and post-closure phases*

→ environmental experts, non-specialized experts, numerical modellers, (operational risk experts & material engineers)

This Table illustrates that the R&D activities needed for the regulatory review of the geological disposal project or development requires experts from all of the types of profiles identified.

During the implementation of a geological repository, the demand for experts with different profiles will vary during each phase. The following table provides examples of activities fulfilled by each profile of experts throughout the evolution of a disposal project.

Next page:

Table 2- Non-exhaustive illustration of activities needed for the expertise of the safety case of a geological disposal project, during each phase of its development and for each type of identified profile.

Profile \ Phase		Concept phase	Siting phase	Design selection	Construction	Operational phase	Monitoring and survey after closure
"Environmental experts"		First site investigations; "zero" point Collection of pre-existing data, Data acquisition	Site investigations, interactions with material, past and future evolution Data acquisition	Check the compatibility of the design with site (geometry of layers, rock characteristics, presence of discontinuities	Verify the expected rock characteristics during excavation Presence of unexpected characteristics Data acquisition	Effects of operation on host rock Follow up of impact on hydrogeology, on stresses Ongoing monitoring (reliability of methods, data to acquire…)	Environmental surveillance Data acquisition
"Numerical modellers"		Selection or development of the codes Development of rough integrated models	Development of detail models Meshing methods Process models (one physical phenomenon, interactions…) Mathematical development; Integrated models Integration of new data (site)	models to check the design options	Integration of new data (host rock)	Modelling of the impact of operation	update modelling with collected survey data Integration of new data (monitoring)
"Operational risk experts & material engineers"	Material & civil engineers, Experts in mining activities	Expected evolution of components Interactions, solicitations (FEPs)	Check the compatibility of excavation methods with site characteristics	Check the compatibility of materials with their expected safety functions; Check the compatibility between design and mining practices site-design compatibility	Civil engineering Coexistence of construction and nuclear activities	Maintenance, check the ageing of materials…	Expertise of monitoring techniques
	Experts in operational safety	/	First "rough" hazard assessment	Hazard assessment	Hazard assessment	Hazard assessment, feedback of incidents	Collection of the feedback from any incidents/accidents
	Experts in waste	First inventory; Waste characteristics	Refined inventory with scenarios of future production Waste characteristics and long-term evolution	Waste Acceptance Criteria Consistency of waste (chemistry, heat…) with design	Adjustment of limits, control and conditions	Control method Verification of waste characteristics and evolution	Monitoring of waste evolution
"Generalists"		Definition of scenarios	Use of integrated models Adaptation of scenarios to uncertainties	Adaptation of scenarios to design Management of uncertainties	Management of uncertainties	Impact of incidents or accidents on long-term safety Management of uncertainties Reversibility	Reversibility?

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To sum up, the Table 3 sketches the level of need for each type of expert profile for the expertise of the safety case.

Table 3- Profiles needed for the expertise of the safety case of geological disposal, during each phase of its development. ++: mandatory; +: increasing or decreasing need; -: less needed

Phase / Profile	Concept	Siting	Design	Construction	Operation	Monitoring & surveillance
"Environmental experts"	++	++	-	+	-	+
"Numerical modellers"	+	+	++	+	+	+
"Operational risk experts & material engineers"	+	+	++	++	++	-
"Generalists"	+	+	+	+	+	+

Target audience

The proposed Training Programme to be carried out by a future version of the SITEX network is aimed at all "independent experts" who fill a "technical expertise function" and are involved in the different steps of licensing of geological disposal facilities. The definition of this function, with respect to the "regulatory function", is defined in the SITEX project deliverable D4.1. Depending on the SITEX participant organisation (see D4.1 for details), the expertise function can be:

- Performed inside the regulatory body:
    - Expertise function is included within the national safety authority (NSA);
    - Expertise function is performed by a subsidiary of the NSA
- Performed outside the regulatory body:
    - Independent technical safety organization (TSO) officially responsible for supporting the authority;
    - Universities, research institutes or other external groups (NGOs, consultants) specialized in various disciplines relevant to safety.

The different training modules proposed, described in section 4, are designed to build-up the competences of experts participating in the review of the safety case for a deep geological repository.

3.2 Nature of the SITEX training programme

The design of the SITEX Training Programme will focus on the use of interactive teaching methods to involve trainees as much as possible in the learning process.

The SITEX network Training Programme will rely on existing training programmes organised by the European Nuclear Safety Training and Tutoring Institute (ENSTTI) and proposes a complementary step to achieve the complete professional development of experts in the geological disposal licensing process for new entrants in a safety organisation. Such a complete expert programme (Figure 1) may comprise the "Basic Training Programme"; the "Advanced Training Programme" and finally the "SITEX Training Programme".

Training courses corresponding to a "Basic Training Programme" and "Advanced Training Programme" (in blue on Figure 1) have already been proposed by various national and international institutions (IAEA, NEA, ENSTTI…). Two examples are developed below.

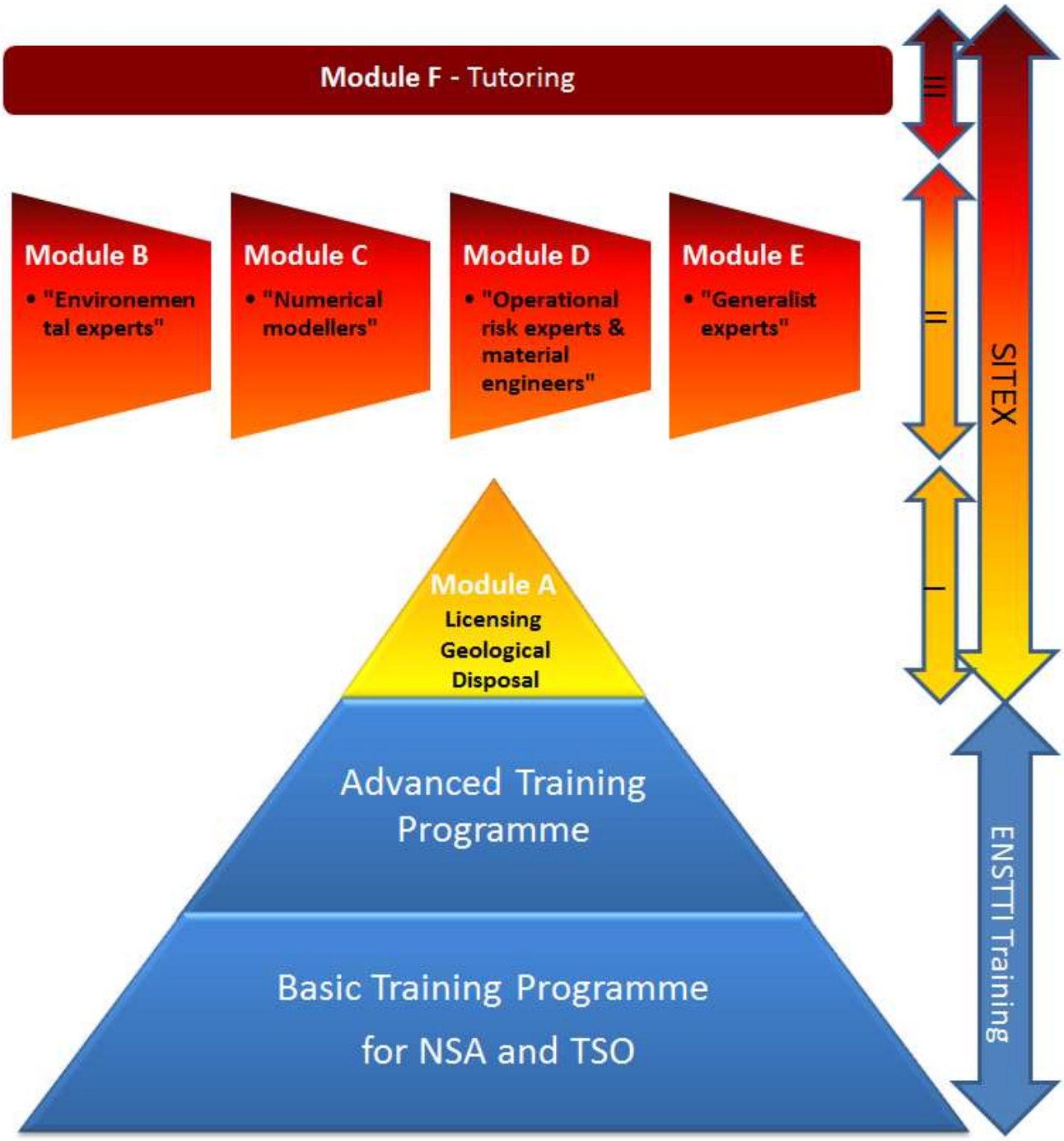
ENSTTI's training programme entitled "Induction to nuclear safety" is a 4 week-long programme that could be considered as a "basic training programme". ENSTTI's induction course includes:

- Nuclear safety infrastructure
- Reactor safety
- Incident & accident
- Fuel cycle
- Safety assessment.

The DEVCO training module for "Final Disposal Safety" has been developed using the framework of the INSC Programme 2011 - project MC3.01/10, which is about to be completed for June 2014. This 1 week-long training course corresponds to an "advanced training programme" that covers the following topics:

- Waste management in the pre-disposal stages (standards, overviews on waste generation, classification, characterization, conditioning, storage and focus on the Belgian case)
- Specific case of mining waste (regulatory framework, safety issues and feedback from French mining sites)
- Near-surface disposal (main safety issues, the French experience feedback, comparison between interim storage and near-surface disposal facilities, natural external hazards)
- Geological disposal (main safety issues, overview of the current international situation, outcomes of the French project evaluation, feedback from German facilities, experimental studies and modeling tools as support of safety evaluation, uncertainty management)
- Stakeholder involvement (main issues and regulatory framework, 2013 French public debate on geological disposal)

Figure 1


Module F - Tutoring
Module B
• "Environemental experts"
Module C
• "Numerical modellers"
Module D
• "Operational risk experts & material engineers"
Module E
• "Generalist experts"
Module A
Licensing
Geological
Disposal
Advanced Training Programme
Basic Training Programme for NSA and TSO
III
II
I
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ENSTTI Training

Even if a training programme developed by ENSTTI (founded by IRSN, GRS, UJV and LEI, plus contributors) were established, it would need to be extended at a European scale (or larger scale, including Canada, the only non-European participant to SITEX) to encompass the entire participating organisation of the future SITEX network. However, that is beyond the scope of this report, which focuses on training for the licensing of geological disposal.

The proposed "SITEX training programme" (in yellow to red on Figure 1) corresponds to a core curriculum training module on licensing geological disposal and to different training and tutoring periods that enable the transfer of know-how all along a carrier development; I is itself composed of 3 successive steps, including:

I. a "Common Core module" for all experts engaged in the licensing review process of a safety case for geological disposal ("A") (see section 4.1 of the present report);

II. one about the four training "specialization modules" ("B" to "E") dedicated to the different experts profiles (B- environmental experts; C- numerical modellers; D- operational risk experts; E- generalists) (see section 4.2 of the present report);

III. a module of tutoring, corresponding to work placement of trainees in another team of experts of the SITEX network a ("F") (see section 4.3 of the present report).

3.3 Steps for the setting up of the training programme

For the Module A, the programme is still under development. It will be issued during the follow up period of SITEX. A pilot session could be organised by the end of 2014-2015.
For the Modules B, C, D and E, the syllabus must be developed further; this is a task for a future SITEX network.
The extent of the Module F, corresponding to tutoring, needs to be further defined within the SITEX network. It depends on the existing competences and the level of interaction between organisations belonging to the SITEX network. This is also a follow-up task, for a future SITEX network.

4 Overview of the standard syllabus

The *Standard Syllabus* consists of a "basic" module (A, Licencing Geological Disposal; see section 4.1) followed by one of the specialization modules (B, C, D or E, see section 4.2) and a tutoring period (Module F, see section 4.3) with another expert team participating to the SITEX network.

4.1 Module A - Licencing Geological Disposal Facility

4.1.1 Brief description of the module

Module Code	A
Prerequisite	"Basic Training Program" and "Advanced Training Program" modules dispensed by ENSTTI, or other equivalent ones delivered by other institutions
Module Description	Basic knowledge needed to review the safety case for a geological disposal facility submitted with a licence application, Common Core knowledge for all expert profiles
Duration	1 week
Teaching & Learning	- Defining the conditions of the review- transparency, independence and competence - Familiarization of experts with the content of the safety case and its stepwise development - Introduction of the different steps of the technical review - Support to exchange experiences and best practices

Macro Learning Outcomes	
Core Knowledge	**Demonstrated or Assessed by/through:**
On successful completion of this module, the learner will have: - Knowledge on the content of the safety case and its stepwise development - Knowledge of the progression of a technical review , also informed by exchanges with various representatives	Learning Outcomes will be tested by one exercise (yet to be developed).
Skills	

On successful completion of this module, the learner will be able to verify the completeness of a safety case for any phase of development of a geological disposal project	
Competence On successful completion of this programme, the trainee will identify their own position in the review (their competences and profile(s))	

4.1.2 Main Sessions

Session	Content	Teaching & Learning Activities		Refs
		Theory Input	Practical Exercises	
A.1	Definition of independent expertise (independence from WMOs, transparency and openness to civil society, competences and expert profiles)	0.5 d	/	[4]
A.2	Content of the safety case, the different parts, and details of each part; Phases of development of the SC	1.5 d	"Dissection" of an implementer's report - 0. 5 d	[1-2]
A.3	The different technical review steps and types of exchanges with various representatives (implementer, safety authority, public…)	0.5 d	first steps of the technical review of a SC in support of a licence application (orientation of analysis, acceptability…)- 0.25 d	[1,4]
/	Debriefing	0.25 d	Final test – 0. 5 d	

4.1.3 The SITEX network's development needs for the organisation of this training module

- Compilation of the review grids for each phase of safety case development; an example is developed in SITEX project deliverable D4.1, for analysing the safety case at the end of the site investigation and selection phase (submitted by the implementer for the regulator's decision on the selection of the site and the beginning of the reference design phase).
- Development of the 4 identified expert profiles, with one or several "description cards" or "CVs" for each one.
- Selection of a table of content of an implementer's report (safety case) which is publically available and could be analysed during training; alternatively, a fictive table of contents could be developed.

- Definition of the learning outcomes for each of the three proposed training sessions.
- Development of a final test to evaluate knowledge transferred on the learning outcomes.
- Repartitioning of the training courses between SITEX participants.

4.2 Modules B, C, D and E for different types of expert profiles

4.2.1 Module B – "Environmental experts"

4.2.1.1 Brief description of the module

Module Code	B
Prerequisite	SITEX Module A- Basic knowledge required by an expert to assess a Licence application for Geological Disposal
Module Description	Safety case expertise for a geological disposal - environmental experts
Duration	1 week
Teaching & Learning	Description of a research and development program in the earth sciences (session B.1) Explanation on how and when to use the knowledge and results of R&D to develop expertise relevant to the different parts of a safety case (session B.2) A focus will be given on the safety case at site investigation and selection phase (but not exclusively) (session B.3) Support the exchange experiences and best practices

Macro Learning Outcomes	
Core Knowledge	**Demonstrated or Assessed by/through:**
On successful completion of this module the learner will have knowledge of the R&D programs that relate to environmental aspects, which are needed to fulfil the expertise function at each stage of safety case development	Test of Learning Outcomes (to be developed)
Skills On successful completion of this module the learner will be able to use scientific knowledge and the results of experts R&D on environmental aspects to support the review of the safety case	
Competence On successful completion of this programme the trainee	

will be able to carry out the review (on environmental aspects) of a safety case accompanied by a senior expert, through mentoring or tutoring	

4.2.1.2 Main Sessions

Session	Content	Teaching & Learning Activities		Refs
		Theory Input	Practical Exercises	
B.1	Research and development program in earth sciences in support of the safety case (for any phase of its development)	0.5 d	0.5 d	[7,8]
B.2	How to use knowledge and R&D results to carry out expert reviews (for the review of any phase of safety case development)	0.5 d	0.5 d	[9]
B.3	Focus on the site investigation and selection phase	0.5 d	Review of a safety case for the site selection phase 1.5 d	[4, 2]
/	Debriefing	0.25 d	Final test - 0.25 d	

4.2.1.3 The SITEX network's development needs for the organisation of this training module

- Preparation of a safety case related to site selection (before starting reference design phase), (to make it public) or construct a fictional one.
- Definition of the learning outcomes for each of the three proposed training sessions.
- Development of an exercise or final test on the learning outcomes.
- R&D program needed on the environment aspects for each phase of the safety case (following the outcomes of the WP3 work within the SITEX project)
- Repartition of the training courses between SITEX participants

4.2.2 Module C – "Numerical modellers"

4.2.2.1 Brief description of the module

Module Code	C
Prerequisite	SITEX Module A- Basic knowledge needed to review a Licence application for

	Geological Disposal
Module Description	Expertise needed for the evaluation of a safety case of a geological disposal project - for numerical modellers & mathematicians
Duration	1 week
Teaching & Learning	Modelling program and development of codes for the safety case (session C.1) How to use knowledge and modelling results to carry out reviews (or develop expertise) (session C.2) Focus on the safety case at design development and selection phase (but not only…) (session C.3) Exchange of experiences and best practices

Macro Learning Outcomes	
Core Knowledge	**Demonstrated or Assessed by/through:**
On successful completion of this module the learner will have knowledge of the modelling program and development of codes needed to support the expertise function at each stage of the development of the safety case	Test of Learning Outcomes (to be developed)
Skills On successful completion of this module the learner will be able to use knowledge and modelling results to support the review of the safety case	
Competence On successful completion of this programme the trainee will be able to carry out the review of a safety case(as a "numerical modeller") accompanied by a senior expert through mentoring or tutoring	

4.2.2.2 NEEDS OF DEVELOPMENT IN THE SITEX NETWORK FOR ORGANISATION OF THIS TRAINING MODULE

- Defining the training sessions: several topics may be developed, such as:
  - Which types of models are used for doing what;
  - Processing uncertainties and sensitivity analyses;
  - R&D to improve codes, in particular, to represent both the micrometric scale and the scale of a repository (meshing improvement, increase of calculation speed…)

- Deterministic vs. probabilistic modelling;
- Complex physical processes (THM behaviour, multiphase flow…), and so on…

- Selection of a safety case related to design development and selection phase (before starting construction), and its modification (to make it public), or construct a fictitious one.
- Development of a modelling exercise and applying the results, as the final test on the learning outcomes.
- Repartitioning of the training courses between SITEX participants.

4.2.3 Module D – "Risk experts in operational safety"

4.2.3.1 Brief description of the module

Module Code	D
Prerequisite	SITEX Module A- Basic knowledge needed for evaluating a Licence application for Geological Disposal
Module Description	Expertise needed to evaluate the safety case of geological disposal - for construction and operational risk experts
Duration	1 week
Teaching & Learning	Main hazards usually examined in the safety case and their treatment (session D.1) [10, 11] R&D programme for the characterization of waste, including its evolution with time engineering components (backfill, still, concrete, slugs…) and how to use knowledge and the results of R&D (session D.2) Focus on the safety case at the construction phase and when the licence application is being submitted for operation (but not exclusively) (session D.3) Exchange of experience and best practices

Macro Learning Outcomes	
Core Knowledge	**Demonstrated or Assessed by/through:**
On successful completion of this module the learner will have knowledge needed to fulfil the expertise function at each stage of safety case development, on the characterisation and evolution of waste, and of engineering components, as well as on the method used to evaluate hazards during construction or operation of a	Test of Learning Outcomes (to be developed)

disposal facility	
Skills On successful completion of this module the learner will be able to use scientific knowledge and the results of expert R&D (on the characterisation of waste and engineering components, as well as on hazards) to support the review of the safety case	
Competence On successful completion of this programme the trainee will be able to carry out the review of a safety case (as a "risk expert in operational safety") accompanied by a senior expert, in a mentoring framework or through tutoring	

4.2.3.2 THE SITEX NETWORK'S DEVELOPMENT NEEDS FOR THE ORGANISATION OF THIS TRAINING MODULE

- Harmonization of expertise of implementers' hazard assessments: as concluded in SITEX D4.11, section 5.3.2, the diversity of approaches taken by implementers in Europe reveal the disparity that must be managed or resolved in order to reach a common technical review approach for technical experts.
- R&D program needed, for each phase of the safety case, on the characterisation and evolution of waste and of engineering components, as well as a program that deals with construction and/or operational hazards (following of the SITEX WP3 work).
- Definition of training sessions, and repartitioning between SITEX participants.
- Selection of a safety case related to the construction phase and a licence application for operation.
- Development of a modelling exercise and the application of the results to demonstrate expertise, as the final test on the learning outcomes

4.2.4 Module E – "Non-specialized experts"

4.2.4.1 BRIEF DESCRIPTION OF THE MODULE

Module Code	D
Prerequisite	SITEX Module A- Basic knowledge for the expert review of a Licence application for Geological Disposal
Module Description	Expertise on the safety case for geological disposal - for non-specialized experts and experts in long-term or operational safety assessment

Duration	1 week
Teaching & Learning	Analysis of management systems, organisation of inspections and the use of inspection results in developing expertise, national & international regulation and guidance (best practices)… (session E.1) Safety assessment through analysis of accident/incident occurrence, scenario development and treatment of uncertainties, surveillance (session E.2) Management of experts (competences) and of expertise (following review phases), relations with other stakeholders (session E.3) Focus on operational phase (but not exclusively) (session E.4) Exchange of experiences and best practices

Macro Learning Outcomes

Core Knowledge	**Demonstrated or Assessed by/through:**
On successful completion of this module, the learner will have an overview of the different aspects of a safety case and will have knowledge of long-term safety assessment in addition to operational safety (scenario development & evaluation of uncertainties). Methods to integrate data and knowledge from other experts will be given	Test of Learning Outcomes (to be developed)
Skills On successful completion of this module the learner will be able to review the quality of data from site investigations, to review the R&D carried out on natural and engineered barriers performed by implementer and the integration of the R&D results into the safety case, to evaluate the implementer's approach for the development of the safety case and the management of uncertainties, coordinate the review of the various parts of a safety case that could potentially be performed by other expert profiles	
Competence On successful completion of this programme the trainee will be able to review a safety case (as a "generalist") accompanied by a senior expert through a mentoring framework or through tutoring	

4.2.4.2 THE SITEX NETWORK'S DEVELOPMENT NEEDS FOR THE ORGANISATION OF THIS TRAINING MODULE

- Construction of a fictitious safety case related to the development of operational phase.
- Definition of the training sessions, and repartitioning between SITEX participants.

4.3 Module F - Tutoring

The tutoring module responds to specific learning needs and aims to help individuals become independent learners.

The learning that occurs during tutoring is not simply content-related. Ideally, tutors also model good learning habits as well as encourage learners to try out effective techniques or strategies/skills pertinent to learning the subject matter.

This module aims at providing learners with the opportunity to work together with inspiring tutors who are ready to share their expertise and experience and will assist them in meeting their specific learning needs.

This module proposes a tutoring period of at least several months, to take place at the 'home organization' of the tutor. Past experience has shown that a detailed syllabus significantly contributes to ensuring the successful outcome of tutoring sessions. Therefore, it is recommended that a structured syllabus be developed. The syllabus should be developed jointly by the tutor and learner, case by case, indicating main items such as, objectives, content, deliverables and assessment of this module. For this purpose, the template presented below should be used for this module, and can be adapted as needed. The intent of the template is to assist in providing a good overview about the tutoring module and its learning outcomes to learners, tutors and assessors. This template could be completed by the future SITEX network, as this will be in line with timelines for the establishment of this module.

Module Code	F
Module Title	Tutoring
Prerequisite	Module A + Module B or C or D or E
Expectations of learner & tutor	To be developed
Tutoring Sessions	Main phases of a tutoring period to be develop, if needed
Communication	To be developed
Description	To be developed
Objectives	To be developed
Teaching & Learning Approach	To be developed

Macro Learning Outcomes	**Demonstrated or Assessed by/through:**
On successful completion of the tutoring programme the learner will be able to carry out	To be developed

the review of a safety case as a generalist or specialist expert.	

In addition, the main need for organising this tutoring module in the SITEX framework is to identify the tutoring network (list of tutors and their areas of competence).

5 References

[1] SSR-5, Disposal of Radioactive Waste, 2011.

[2] SSG-23, The Safety Case and Safety Assessment for the Disposal of Radioactive Waste, 2012.

[3] PRISM draft report, The International Project on "practical illustration and use of the safety case concept in the management of near surface disposal". Overview report. Draft working material. 5 November 2012.

[4] SITEX deliverable D4.1

[5] EPG Report 2011-Draft, Report on the European Pilot Study (EPS) on the Regulatory Review of a Safety Case for Geological Disposal of Radioactive Waste. Version for consultation. EPG report, 26 November 2010.

[6] GEOSAF report, The International Intercomparison and Harmonisation Project on Demonstrating the Safety of Geological Disposal: draft final report 1; draft questionnaire, 2011.

[7] NEA n°6923, MeSA, Methods for Safety Assessment for Geological Disposal Facilities for Radioactive Waste (NEA), 2012.

[8] PAMINA report 1.1.4, Performance Assessment Methodologies in Application to Guide the Development of the Safety Case, Deliverable 1.1.4, 2011.

[9] SITEX deliverables D3.1, D3.2.

[10] GEOSAF companion report, Report on the GEOSAF Working Group on Operational Safety, draft version, July 2011.

[11] Tichauer M., Pellegrini D., Serres C. and Besnus F., 2013. "Operational Safety of a Geological Disposal: IRSN Project 'EXREV' for Developing a Safety Assessment Strategy for the Operation & Reversibility of a Geological Repository", extended abstract, AEN symposium "Safety Case", 2013.