SCK•CEN
STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

SCK•CEN ACADEMY
FOR NUCLEAR SCIENCE AND TECHNOLOGY

The ENEN-III project:
Technical Training on the Concepts and Design of GEN IV nuclear reactors

T. Berkvens - Belgian Nuclear Research Centre - Belgium
C. Renault - Institut National des Sciences & Techniques Nucléaires - France
M. Alonso - Universidad Nacional de Educación a Distancia - Spain
R. Salomaa - Helsinki University of Technology - Finland
C. Schönfelder - AREVA NP GmbH - Germany

FR13, 7 March 2013, Paris

thomas.berkvens@sckcen.be

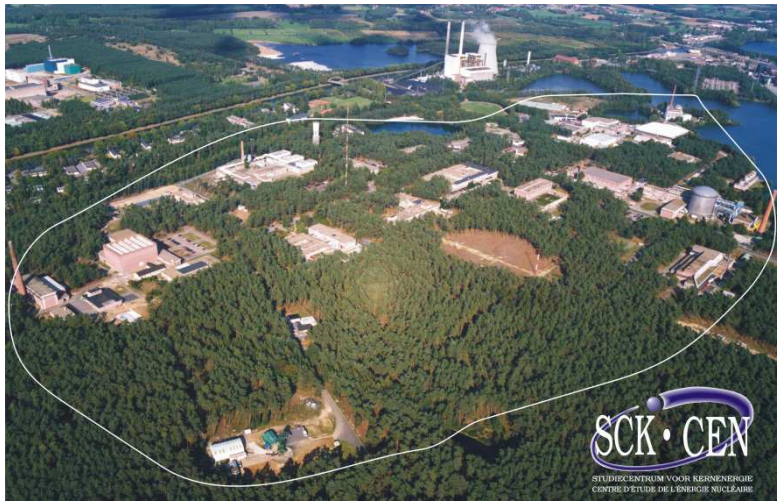
Slide 1

SCK3 aanpassen met geenral academy adres aub

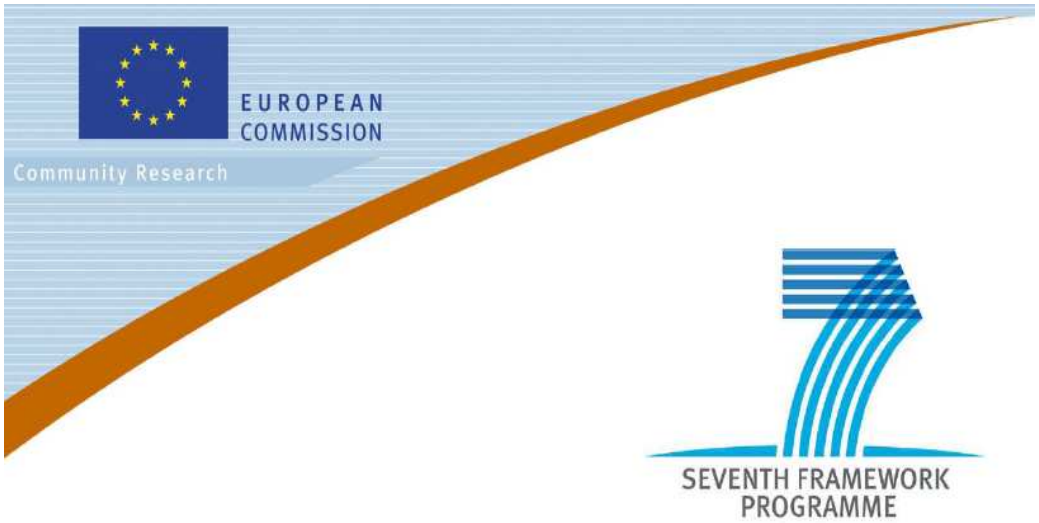
mcoeck, 2012-08-13

SCK•CEN in a nutshell

- Belgian Nuclear Research Centre: a foundation of public utility
- Created in 1952, cradle of nuclear research and energy development in Belgium
- Tutorship: Belgian Federal Ministry of Energy
- Now: 700 staff, 45% with academic degree
- Annual turnover 105 M€
  - 40% government support
  - 60% contract work
- Large and unique installations
- www.sckcen.be



Euratom Fission Training Schemes (EFTS)



SEVENTH FRAMEWORK PROGRAMME
THEME: Fission-2008-5.1.1

Theme Title: Euratom Fission Training Schemes (EFTS) in all areas of Nuclear Fission and Radiation Protection

- **ENEN-III**
- **ENETRAP-II**
- **PETRUS-II**
- **TRASNUSAFE**
- **CINCH**

EFTS

- Structuring training and career development of professionals in EU

- Life-long learning
  - Lack of young nuclear graduates
  - Ageing of the nuclear workforce

-> Preserve nuclear competences

- (borderless) Mobility
  - For the nuclear professional
  - For employers

-> Creation of a 'Training passport' recognised within the EU

Learning Outcomes and ECVET

- **Learning outcomes** are statements that specify what learners will know or be able to do as a result of a learning activity.

- Expressed in terms of **Knowledge**, **Skills and Attitudes**

The principal question asked of the graduate or the young professional will therefore no longer be ***"What did you do to obtain your degree?"*** but rather ***"What can you do now that you have obtained your degree?"***

- **ECVET** = European Credit system for Vocational Education and Training
  - Transfer, recognition and accumulation of assessed learning outcomes
  - "European passport", a portfolio of learning outcomes.

ENEN-III

- European Nuclear Education Network Training Schemes
- Area = **Nuclear Engineering**

- Coordinator = **ENEN**
  - European Nuclear Education Network: to promote nuclear education in an international context.
  - 64 members in 18 EU countries, South Africa, Russia, Ukraine and Japan
  - http://enen-assoc.org

- 19 Partners from 12 EU countries
  - 10 universities
  - 6 research institutions
  - 2 industry partners: **AREVA + TECNATOM**

Objectives

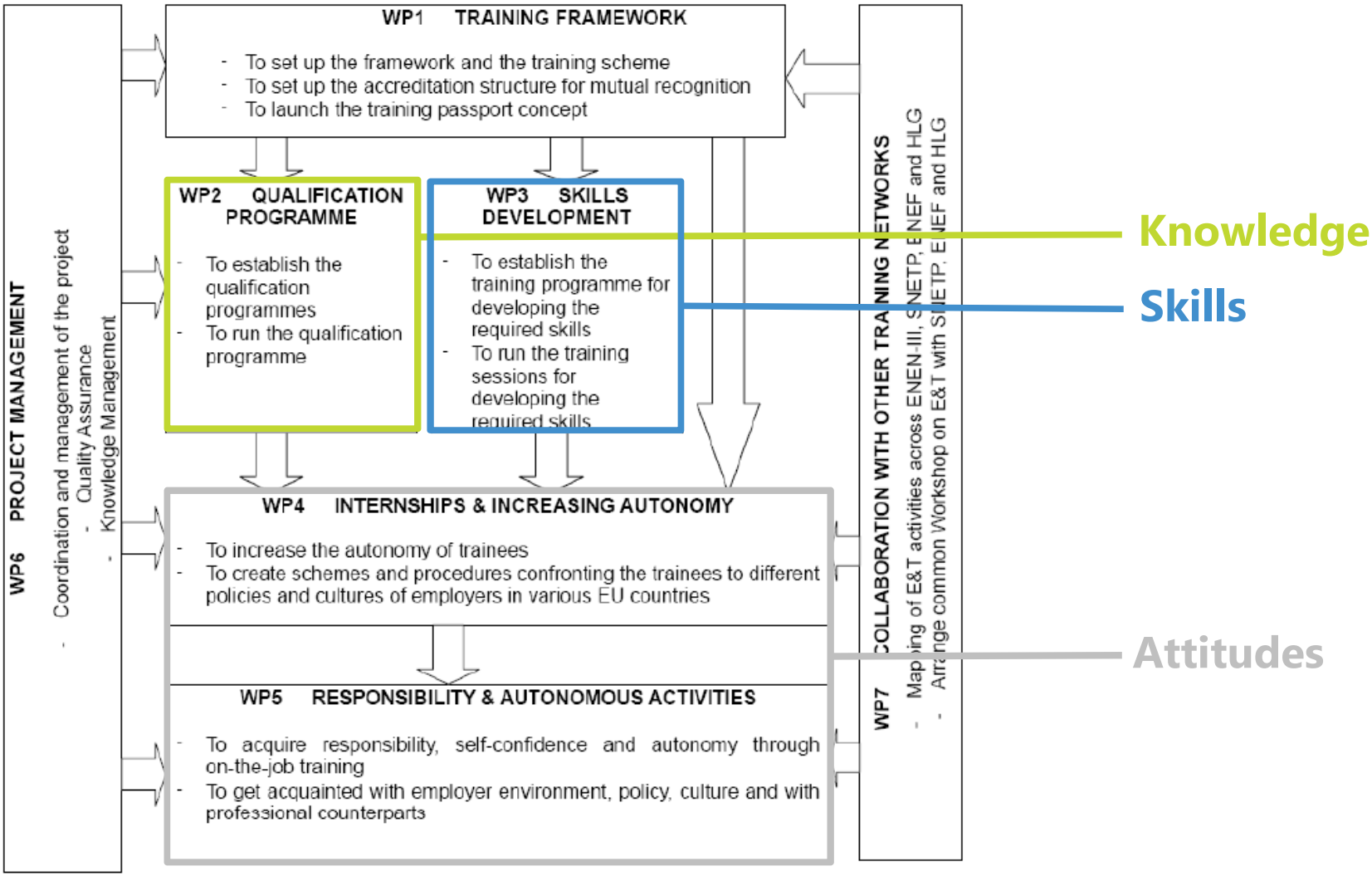
The project covers the structuring, organisation, coordination and implementation of training schemes in cooperation with local, national and international training organisations, to provide training to professionals active in nuclear organisations or their contractors and subcontractors…

The training schemes allow individuals to acquire qualifications and skills, as required by the specific positions in the nuclear sector, which will be documented in a training passport.

Selected training schemes

- **Type A)** Basic training in selected nuclear topics of non-nuclear engineers and professionals in the nuclear industry
- **Type B)** Technical training for the design challenges of generation III (GEN III) nuclear power plants
- **Type C)** Technical training for the construction challenges of GEN III nuclear power plants
- **Type D)** **Technical training for the development and pre-conceptual design of generation IV (GEN IV) nuclear reactors.**

Project structure

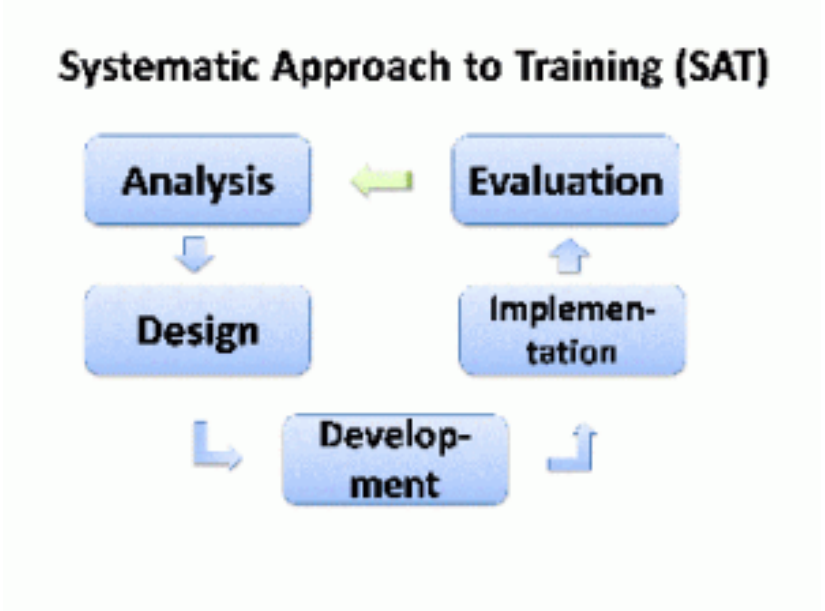


ENEN-III approach

Competency analysis

Writing of learning outcomes

Development of courses/training materials



GEN IV training scheme

- **More research oriented compared to GEN III**
- **Broader en less specialised**

- To respond to the needs to design / build the prototypes of the future
- In line with the SNETP Strategic Research Agenda

- **Covering the six designs proposed in the SRA**
  - LFR
  - SFR
  - GFR
  - VHTR
  - SCWR
  - MSR

Results of the competency analysis

Knowledge
General knowledge on GEN IV systems and technology
Design specific knowledge for the LFR
Design specific knowledge for the SFR
Design specific knowledge for the GFR
Design specific knowledge for the VHTR
Design specific knowledge for the SCWR
Design specific knowledge for the MSR

Skills
Developing engineering tools necessary for the analysis of the design
Working with Self-developed Engineering Tools or Off-the-Shelf Tools
Working with nuclear design codes
Cost Estimates (costs, time) for the Engineering Work
Order Processing (Project Management)

Refinement necessary

Attitudes
Self-reliant in gathering knowledge
Ability to transpose experience and knowledge from one specific technology to another technology
Formal Quality Control of Result Reports
Individual, Critical Examination of the Tasks
Presentation and Documentation of Work Results
Teamwork/Communication

Refinement of the competency analysis

General knowledge on GEN IV systems and technology
Introduction to GEN IV systems and technology
Introduction to the LFR
Introduction to the SFR
Introduction to the GFR
Introduction to the VHTR
Introduction to the SCWR
Introduction to the MSR
General safety features of GEN IV systems
Structural materials for GEN IV reactors
Fuels for GEN IV reactors
GEN IV and the closed fuel cycle

Design specific knowledge for the SFR
Core design
Material challenges
Primary circuit design
Instrumentation techniques
Safety issues related to the coolant

Design specific knowledge for the GFR
Core design
Material challenges
Primary circuit design
Instrumentation techniques
Safety issues related to the coolant

Design specific knowledge for the LFR
Core design
Material challenges
Primary circuit design
Instrumentation techniques
Safety issues related to the coolant

Example of learning outcomes

Area of interest	Learning outcomes
Introduction to GEN IV systems and technology	1. Describe the different generations of nuclear reactors 2. Explain the need for GEN IV reactors 3. List the main issues assigned to GEN IV reactors 4. Describe the 6 main concepts selected by the GIF. In particular, for each of them, indicate neutron spectrum and the nature of primary coolant. Comparison of the advantages and disadvantages of the different systems. Open issues in the development of the different technologies. 5. Compare GEN IV with GEN II and GEN III reactors. 6. Compare the potential of the 6 GEN IV systems in terms of economics, safety, sustainability and proliferation resistance. 7. Asses the economic aspects of GEN IV systems 8. Give an overview of international networks and research infrastructures for GEN IV systems 9. Discuss the different construction codes that can be used to design these systems with their advantages, disadvantages and shortcomings.

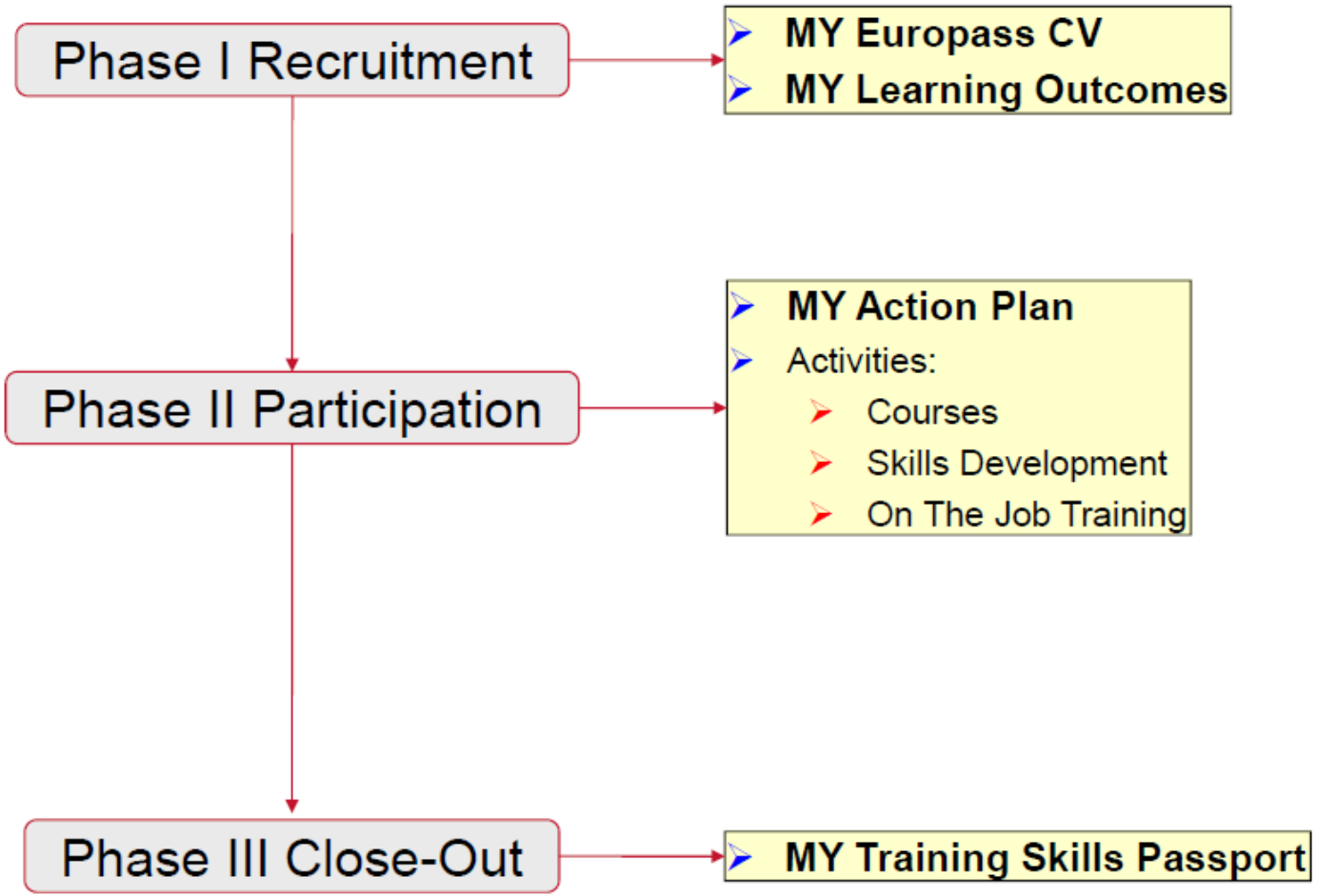
Identification/Development of training courses

- **Existing courses among project partners**
  - ENEN-database
  - Academic courses (for example BNEN)
  - AREVA professional school (in collaboration with KIT)
  - AREVA internal training programme
  - ISaR TGTP-NT
  - INSTN
  - Workshops
  - Practical training sessions
  - Site visits
  - Virtual plant visits
  - …

No registration fees!

- **Special courses created for the project**

Concept of an individual application



From: 6th Project Meeting – Dr. C. Schoenfelder – Concept of ENEN III Training Schemes

Example: MY Learning Outcomes

Project Title		ENEN –III
Training Scheme		Training Scheme D
Name		[redacted]
Current Position		Project Engineer
Future Position		
Organization		Belgian Nuclear Research Centre – SCK•CEN

My Learning Outcomes		Description	Yes/No/ Partially/Not Applicable	Notes
1. Knowledge	TSB.K001	Introduction to GEN IV systems and technology	Partially (50%)	
	TSB.K002-1	Introduction to the SFR	Partially (50%)	
	TSB.K002-2	Introduction to the LFR	Partially (80%)	
	TSB.K002-3	Introduction to the GFR	Not Applicable	
	TSB.K002-4	Introduction to the VHTR	Not Applicable	
	TSB.K002-5	Introduction to the SCWR	Not Applicable	
	TSB.K002-6	Introduction to the MSR	Not Applicable	
	TSB.K003	General safety features of GEN IV systems	Partially (50%)	
	TSB.K004	Structural materials for GEN IV reactors	Partially (70%)	
	TSB.K005	Fuels for GEN IV reactors	Partially (50%)	
	TSB.K006	GEN IV and the closed fuel cycle	Partially (20%)	
	TSB.K201	LFR Core design	Partially (80%)	
	TSB.K202	Structural material challenges for	Partially (70%)	

Summary of trainees and exchanges

Training scheme	Number of trainees	Number of exchanges
Type A	7	'Pilot case'
Type B	14	38
Type C	-	-
Type D – GEN IV	14	18
Total	**35**	**> 56**

- Testing the training schemes was harder than expected
- Still an interesting number of trainees and exchanges
- Exchanges are still taking place (until April 2013)

Evaluation of LO's

Domains of knowledge (K)	TSD	Areas of interest	Check LO before (%)	Check LO after (%)	Validation by SO
General knowledge on Gen IV systems and technology	TSD.K001	Introduction to Gen IV systems and technology			
	TSD.K002-1	Introduction to the SFR			
	TSD.K002-2	Introduction to the LFR			
	TSD.K002-3	Introduction to the GFR			
	TSD.K002-4	Introduction to the VHTR			
	TSD.K002-5	Introduction to the SCWR			
	TSD.K002-6	Introduction to the MSR			
	TSD.K003	General safety features of Gen IV systems			
	TSD.K004	Structural materials for Gen IV reactors			
	TSD.K005	Fuels for Gen IV reactors			
	TSD.K006	Gen IV and the closed fuel cycle			
Design specific knowledge for the SFR	TSD.K101	SFR core design			
	TSD.K102	Structural materials challenges for SFR			
	TSD.K103	SFR (primary circuit) design			

Some conclusions

- Not enough training courses to cover the LO's
  - Especially GEN IV
  - Many introductory courses, little specific courses
  - Reach out to other partners for more courses
- Skills and Attitudes
  - Much more difficult to train/measure
  - To be treated in a separate project
- Use of Learning Outcomes must be promoted
- Involvement of human resources necessary for the successful implementation of the schemes
  - End of project workshop

SCK•CEN
Studiecentrum voor Kernenergie
Centre d'Etude de l'Energie Nucléaire
Belgian Nuclear Research Centre

Stichting van Openbaar Nut
Fondation d'Utilité Publique
Foundation of Public Utility

Registered Office: Avenue Herrmann-Debrouxlaan 40 – BE-1160 BRUSSEL
Operational Office: Boeretang 200 – BE-2400 MOL