




This course is organised by SCK•CEN, in collaboration with EC-JRC-IRMM



<b>Intersemester course</b>			
<b>Nuclear Safeguards and Security</b>		<b>Contact hours:</b>	<b>35</b>
		<b>Assignment hours:</b>	<b>24</b>
		<b>Self-study hours:</b>	<b>0</b>
<b>Coordinator: SCK•CEN, Mol, Belgium</b>		<b>EQF 7</b>	<b>3 ECTS</b>
<b>Upon completion of this course, participants will be able to:</b>			
<b>Learning outcomes</b>	<b>Knowledge</b>	Recall the basis of safeguards	
		Explain the basic safeguards elements like significant quantity, etc.	
		Distinguish various safeguards measures and assess (dis)advantages of discussed measures	
		Apply gamma-ray spectroscopy to safeguards	
		Explain how neutron coincidence measurements are carried out	
		Categorize the complementary safeguards measures	
		Justify the use of the chosen measures in the developed safeguards approach	
	<b>Skills</b>	Execute U enrichment measurements	
		Manipulate with guidance neutron detectors	
		Design a comprehensive safeguards approach for a given nuclear installation	
	<b>Competences</b>	Support the safeguards culture of his/her organization	
		Formulate proposals to improve safeguards implementation	
		Balance the interests of safeguards and security implementation	
		Commit oneself to international values of safeguards	
Apply principles for protection of nuclear facilities to the development of an effective physical protection program for their facilities			
<b>Education method</b>			
Face to face lectures, hands-on laboratories exercise, participative workshop			
<b>Assessment method</b>			
Partly "on the spot" assessment, partly multiple choice and open questions, short essay			
<b>Pre-requisites and mandatory literature</b>			
Basic knowledge of nuclear fuel cycle, nuclear physics			

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<b>Topics</b>			
	<b>GENTLE Partner</b>	<b>hours</b>	
<b>1 Basic safeguards concepts</b>	<b>SCK•CEN</b>	<b>2,75</b>	
Course introduction		0,50	
Safeguards principles		1,00	
International treaties		0,75	
Safeguards approaches		0,50	
<b>2 Safeguards measures</b>	<b>SCK•CEN</b>	<b>4,25</b>	
Nuclear Material Accountancy		0,50	
NMA in security		0,25	
Containment & Surveillance		0,75	
Destructive Assay Methods		1,25	
Non destructive Assay methods		1,00	
Additional Protocol Measures		0,50	
<b>3 Hands-on exercises</b>	<b>JRC - IRMM</b>	<b>7,00</b>	
Use of Gamma NDA measurement equipment (IRMM)		1,00	
Gamma measurements and data analysis		2,50	
Use of Neutrons NDA measurement equipment (IRMM)		1,00	
Neutron measurements and data analysis		2,50	
<b>4 Complementary safeguards measures</b>	<b>SCK•CEN</b>	<b>3,50</b>	
Design Information Verification		0,75	
Import/export control		0,50	
Practice of export control (by export control officer)		0,50	
Nuclear material forensics OR detection techniques for security		0,75	
Issues in non-proliferation, like Iran, DPRK, Syria, ...		1,00	
<b>5 Conceptual workshop</b>	<b>SCK•CEN</b>	<b>3,50</b>	
<b>6 Nuclear security</b>		<b>12,50</b>	
Basic security concepts		1,50	
Graded approach: nuclear & radioactive material categorization		1,25	
Vital area's & access controlled area's		1,25	
Computer security		1,50	
Physical protection		1,50	
Nuclear Security Management		1,25	
Management of sensitive information		1,50	
Exercise 1 (discuss national regulations compared to the international guidance)		0,75	
Exercise 2 (PPS system design for hypothetical nuclear research facility)		2,00	
<b>References</b>			
Passive Nondestructive Assay of Nuclear Materials, 1991, NUREG/CR-5550, LA-UR-90-732			
Safeguards Techniques And Equipment: 2011 Edition, IAEA			

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<b>Main lecturers</b>			
<b>Klaas van der Meer (SCK•CEN)</b>			
<p><i>Klaas van der Meer holds a Master degree in physics from the University of Amsterdam and in engineering from the Technical University of Delft. He has more than 25 years of experience in safeguards, ranging from gamma spectrometry applied to inspections in Gas Centrifuge Enrichment Plants to more conceptual work in developing safeguards approaches for e.g. research reactors and geological repositories. He is president of the European Safeguards Research and Development Association ESARDA from 2013 till 2014. Since 1990 he works at the Belgian Nuclear Research Centre SCK•CEN.</i></p>			
<b>Riccardo Rossa (SCK•CEN)</b>			
<p><i>Riccardo Rossa got a Master Degree in Energy and Nuclear Engineering at the Polytechnic University of Turin in 2011. In February 2012 he moved to EC-JRC-ITU in Ispra in the Nuclear Security Unit, where he performed a feasibility study on the PDET detector for the partial defect verification of spent fuel. He was also part of the ITRAP+10 team for the detection of illicit trafficking of radioactive material. In October 2012 he started a 4-year PhD research at SCK•CEN with the Université Libre de Bruxelles on the topic of "Advanced non-destructive methods for criticality safety and safeguards of used nuclear fuel".</i></p>			
<b>Klaus Mayer (ITU)</b>			
<p><i>Klaus Mayer obtained his Ph.D. work in 1987 in the field of radiochemistry and analytical chemistry from the University of Karlsruhe. He then worked for two years at the Institute for Transuranium Elements as post-doctoral researcher. From 1990-1996, he was working for the European Commission at IRMM Geel (Belgium) on actinide isotopic reference materials, high accuracy mass spectrometric measurements of U, Pu and Th, the organization of an external quality control programme for nuclear material measurements and the coordination of support activities to Euratom safeguards office and to IAEA. In 1996, he started working at ITU Karlsruhe on the development and application of destructive analytical methods for nuclear safeguards purposes. From 1997 to 2010 he chaired the ESARDA Working Group on Destructive Analysis. Today, he is in charge of ITU's activities on combating illicit trafficking and nuclear forensics. Since 2004 he is co-chairman of the Nuclear Forensics International Technical Working Group (ITWG).</i></p>			
<b>Alessandro Borella (SCK•CEN)</b>			
<p><i>A. Borella holds a master degree in Nuclear Engineering from the Politecnico di Milano and a PhD in Physics from the Gent Universiteit. As a post-doc researcher he worked at Commissariat a l'Energie Atomique and at the Institute for Reference Material and Measurements, where he carried out neutron cross section measurements and data analysis. In addition, he contributed to the development of the neutron resonance analysis for the determination of the isotopic composition of objects. Since 2009, he is part of the scientific staff at SCK•CEN, where he works on</i></p>			

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	<i>NDA measurements methods and simulation techniques applied to material under safeguards with particular emphasis on spent fuel.</i>		
	<p><b>Peter Schillebeeckx (IRMM)</b>  <i>P. Schillebeeckx got his PhD at the university of Ghent in 1988. He started his professional carrier at the Institute Lau Langevin where he was scientific responsible for gamma-ray spectrometers installed at the high flux reactors. In 1989 he joined the EC-JRC at Ispra. At the JRC Ispra he was scientific responsible for the development of measurement techniques for the Non Destructive Assay (NDA) of nuclear material based on active and passive neutron assay, gamma spectroscopy and calorimetry. Since 2001 he is working at the JRC IRMM in Geel where he is the scientific responsible for measurements at the TOF-facility GELINA with an emphasis on capture and total cross section measurements in the resonance region.</i></p>		
	<p><b>Rožle Jakopič (IRMM)</b>  <i>Rožle Jakopič received his Ph.D. in analytical chemistry in 2008 at the University of Ljubljana. He joined the European Commission in 2006 and has been working in the Nuclear Safeguards of the Institute for Reference Materials and Measurements (IRMM) in Geel, Belgium. He is responsible for the nuclear chemistry laboratory where his main activities include managing and coordinating the preparation and certification of nuclear certified reference materials (CRMs). Before joining the IRMM, he was employed at Jožef Stefan Institute in Ljubljana.</i></p>		
	<p><b>Benny Carlé (SCK•CEN)</b></p>		