

Program Framework

Name of the theme block	Detailed topic	Number of hours			Form of credit
		Lecture	Exercise classes/ Field exercise (F)	Laboratory classes	
NORM Overview	<p>General information about NORM:</p> <p>1. Definitions, source of NORM, NORM industry, differences between NORM and TENORM,</p> <p>2. NORM vs. natural background, HBRA (high background radiation area)</p> <p>3. Bulk NORM/TENORM examples:</p> <ul style="list-style-type: none"> coal combustion products, radium rich brines from coal and oil/gas industry, phosphogypsum piles, <p>4. NORM/TENORM existing in minor quantities (e.g. abrasive and refractory materials, TIG welding rods)</p> <p>5. Implied environmental effects and possible mitigation methods</p>	4	-	-	Activity in class
Legal aspects of NORM	Regulation context (requirements resulting from the new European and IAEA BSS) – and overlapping regulation dealing with non-radioactive pollutants, i.e. organic and inorganic chemicals). Example: already developed end enforced national regulation.	2	-	-	Activity in class
	Graded approach to authority control: exemption and clearance, notification process, registration and licensing	2	-	-	
	<p>Graded approach: Exemption and clearance, notification process, registration and licensing based on examples:</p> <ol style="list-style-type: none"> Abrasive material use, Tin dust reprocessing, Cleaning of contaminated equipment from oil and gas industry 	-	3	-	
NORM Metrology	NORM metrology rudiments (alpha and gamma spectrometry, liquid scintillation spectrometry (LSC), radiochemistry, dose rate measurement – portable radiometers, track and TL detectors)	2	-	-	Activity in class
	Laboratory sample preparation (including biota)	1	-	-	
	Laboratory sample preparation (including biota)	-	-	2	
	High resolution gamma spectrometry (laboratory and <i>in situ</i>)	2	-	-	

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	High resolution gamma spectrometry - test specimen preparation, standards and calibration procedure, sample density and self-attenuation effect.	-	-	4	
	High resolution gamma spectrometry - direct measurement of radium 226, correction for lead 210, disequilibrium effects.	-	-	2	
	Application of high resolution gamma spectrometry for construction materials measurement – activity indexes calculation	2	-	1	
	Radium measurement - radiochemical procedure – measurement on LSC	-	-	4	
	Polonium measurement - radiochemical procedure – measurement on alpha spectrometry	-	-	4	
Field Measurement	Features of sampling and laboratory sample preparation in the context of sampling purpose (soil cores/profiles, soil gas/soil solutions, bottom sediments, water, atmospheric/indoor air, biota – including assumed way of accumulation/concentration – TF, Kd, intake: ingestion, accidental ingestion, inhalation, foliar interception), bio-accumulation, effective half life.	2	-	-	Activity in class
	An example of sampling plan: 1. For full characterization of a contaminated fresh water ecosystem 2. For land reclamation effectiveness evaluation 3. Occupational risk assessment in mining industry	-	3(F)	-	Written work
	Soil, soil solution and biota sampling – methodology & statistical rules – records and documentation	1	2(F)	-	Activity on field classes
	NORM contaminated sites identification - sampling of soil cores/profiles	-	2(F)	-	Activity on field classes
	Bottom sediments sampling (cores/profiles) and water sampling - water fractionation	-	3(F)	-	Activity on field classes
	<i>In-situ</i> gamma spectrometry and dose rate mapping	1	4(F)	-	Activity on field classes

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	Radon in soil gas measurement and radon exhalation measurement	-	3(F)	-	Activity on field classes
Radioecology Rudiments	Main processes (physical, chemical, biological/ecological) ruling behavior (migration in terrestrial and aquatic environment, atmosphere) of natural radionuclides and metals in environment (abiotic and biotic environment, TF and Kd measurement/calculation in particular ecosystems) – and sampling implications	2	2	-	Activity in class
	Radionuclides speciation, mobility and bioavailability and influence on its environmental behavior. Implied methods of measurement /assessment: sequential extraction procedure and fractionation techniques	2	2	-	
Radiation dose and hazard assessment	Occupational hazards caused by NORM: external gamma exposure, ingestion and inhalation of radionuclides, radiation dose measurements and calculations	3	2	-	Activity in class
	Exposure to radon and its progeny	2	1	-	Activity in class
	Dose (external, internal) to biota/humans calculation/assessment (ERICA, RESRAD)	2	2	-	Written work
Examples of practical solutions applied in cases of planned and existing exposure situations		4			
Total		30	29	17	-