CINCH-II

(Project Number: 605173)

DELIVERABLE D1.2

Evaluation criteria to obtain a NRC EuroMaster's status

Lead Beneficiary: **UH**

Due date: 30/11/2014 Released on: 04/12/2014

Authors:	Teija Koivula, Jukka Lehto

For the Lead Beneficiary	**Reviewed by Workpackage Leader**	**Approved by Coordinator**
Teija Koivula	**Jukka Lehto**	**Jan John**

Start date of project: **01/06/2013** Duration: **36 Months**

Project Coordinator: Jan John

Project Coordinator Organisation: CTU in Prague VERSION: 1.1

Project co-funded by the European Commission under the Euratom Research and Training Programme on Nuclear Energy within the Seventh Framework Programme		
Dissemination Level		
PU	Public	**X**
RE	Restricted to a group specified by the partners of the CINCH project	
CO	Confidential, only for partners of the CINCH project	

Version control table

Version number	Date of issue	Author(s)	Brief description of changes made
1.0	4th Dec 2014	Koivula T., Lehto J.	
1.1	27th July 2015	John J.	Possibility of DNRC raising additional requirements incorporated

Relevance

This deliverable contributes to the following Work-Packages and Tasks:

☐ ALL

WP 1

☒ Task 1.1 ☐ Task 1.2 ☐ Task 1.3 ☐ Task 1.4

WP 2

☐ Task 2.1 ☐ Task 2.2 ☐ Task 2.3 ☐ Task 2.4

WP 3

☐ Task 3.1 ☐ Task 3.2 ☐ Task 3.3 ☐ Task 3.4 ☐ Task 3.5

WP 4

☐ Task 4.1 ☐ Task 4.2 ☐ Task 4.3 ☐ Task 4.4

WP 5

☐ Task 5.1 ☐ Task 5.2 ☐ Task 5.3 ☐ Task 5.4

Project information

Project full title:	Cooperation in education and training In Nuclear CHemistry
Acronym:	CINCH-II
Funding scheme:	Coordination Action
ECGA number:	605173
Programme and call	FP7 EURATOM, FP7-Fission-2013-5.1.1
Coordinator:	Jan John
EC Project Officer:	Georges Van Goethem
Start date – End date:	01/06/13 – 31/05/16 i.e. 36 months
Coordinator contact:	+420 224 358 228, jan.john@fjfi.cvut.cz
Administrative contact:	+420 245 008 599, cinch@evalion.cz
Online contacts:	http://www.cinch-project.eu/

EXECUTIVE SUMMARY

Deliverable 1.2 covers the evaluation criteria to obtain NRC EuroMaster's status (WP1, Task 1.1). Candidate universities will be evaluated by comparing their NRC curricula to the minimum requirements for NRC EuroMaster's degree that are defined in D1.1. The NRC EuroMaster label is granted by the Division of Nuclear and Radiochemistry (DNRC) of the European Association for Chemical and Molecular Sciences (EuCheMS). Additional requirements may be defined by the DNRC.

CONTENT

1 INTRODUCTION

Development and implementation of the EuroMaster in Nuclear and Radiochemistry (NRC EuroMaster) is one of the main tasks in CINCH-II (Cooperation in education and training in nuclear chemistry - http://cinch-project.eu/) project. The aim of the NRC EuroMaster is to:

- give the European NRC students good common knowledge and skills in nuclear and radiochemistry;
- guarantee the minimum level and extent of knowledge of the graduates in nuclear and radiochemistry to their potential future employers
- thereby harmonize, at a minimum level, the teaching programmes in European universities.

The NRC EuroMaster label is granted to the universities by the Division of Nuclear and Radiochemistry (DNRC) of the European Association for Chemical and Molecular Sciences (EuCheMS). The Division will evaluate the candidate universities by comparing their NRC curricula to the minimum requirements that are defined in D1.1. Details of the evaluation process are described in this document. Additional requirements may be defined by the DNRC.

2 EVALUATION CRITERIA TO OBTAIN NRC EUROMASTER'S STATUS

2.1 Granting system of NRC EuroMaster label

The NRC EuroMaster label is granted to the universities by the Division of Nuclear and Radiochemistry (DNRC) of the European Association for Chemical and Molecular Sciences (EuCheMS). The Division will evaluate the candidate universities by comparing their NRC curricula to the minimum requirements defined in CINCH II project (D1.1). If the NRC curriculum fulfils the requirements by 90% with respect to topics covered the university will be given the right to grant NRC EuroMaster label to their NRC students and the university will become a member in the NRC EuroMaster Group of the European Network on Nuclear and Radiochemistry Education and Training.

2.2 Structure of EuroMaster in Nuclear and Radiochemistry (NRC)

Applicants are first asked to describe shortly their curricula in NRC as shown in Table 2.2.1. and attach detailed course descriptions.

Table 2.2.1. Curriculum in nuclear- and radiochemistry (NRC)

Content	**Extent (cu)**
Curriculum in NRC at **BSc level** - *degree content/examples of courses*	*180 – 240*
Curriculum in NRC at **MSc level**	*90 – 120*
Compulsory studies in nuclear and radiochemistry - *list of courses*	*Xx*
Optional studies in nuclear and radiochemistry - *list of courses*	*Xx*
Project work and master's thesis in nuclear and radiochemistry - *examples of research fields*	*Xx*
Elective studies - *examples of minor subjects and/or course modules*	*Xx*
In total	*270 – 360*

This information is compared to the Minimum requirements which define that the master's program should contain at least 60 ECTS credit units (50% in case of 120 ECTS cu master's program) studies in nuclear and radiochemistry in the following way:

BSc in chemistry	180 – 240 cu	
Compulsory studies in nuclear and radiochemistry (of which at least 10 cu exercises)	minimum	25 cu
Optional studies in nuclear and radiochemistry	minimum	10 cu
Project work and master's thesis in nuclear and radiochemistry	minimum	30 cu
Elective studies	rest	
In total	270 – 360 cu	

For master's programs having other volume than 120 ECTS credit units the workload of nuclear and radiochemistry studies should be equivalent to at least 60 ECTS credit units.

2.3 Evaluation criteria in details

Applicants are then asked to give a point-by-point answers how the topics listed in Minimum requirements are covered (**Tables 2.3.1-5**). Type of education is defined as ***l, ex, s, e or p*:**
l = lectures
ex=exam
s = seminar
Exercises are asked in separate column: *e = calculation exercises*: *p = laboratory exercises*

Table 2.3.1 RADIOACTIVITY, RADIONUCLIDES AND RADIATION– PRINCIPLES OF NUCLEAR PHYSICS TO RADIOCHEMISTS

TOPIC	INCLUDED [x/-]	IN WHICH COURSE/MODULE [title]	TYPE [l, ex, s]	[e, p]	EXTENT [h]
- structure of atom and nucleus, nucleons					
- nuclides, radionuclides, isotopes, isobars, nuclide charts					
- types and origin of radionuclides					
- stability of nuclei					
- modes of radioactive decay					
- rate of radioactive decay, half-life, activity units, activity concentrations vs. specific activity, activity vs. count rate, determination of half-lives, equilibria in successive decay processes					
- isotopic exchange - isotope effects					

Table 2.3.2 RADIATION SAFETY

TOPIC	INCLUDED [x/-]	IN WHICH COURSE/MODULE [title]	TYPE [l, ex, s]	[e, p]	EXTENT [h]
- types of radiation and their absorption processes by matter, range					
- radiation safety measures and their units					
- effects of radiation on DNA in cells					
- health effects of radiation					
- principles of radiation safety					
- radiation safety organisations and their recommendations and regulations					
- estimation and measurement of radiation doses					
- radiation safety practices, safe working habits in radionuclide laboratories and with radiation sources					
- safe handling and disposal of radioactive waste from radionuclide laboratories					
- measures during/after exceptional events					

Table 2.3.3 DETECTION AND MEASUREMENT OF RADIATION

TOPIC	INCLUDED [x/-]	IN WHICH COURSE/MODULE [title]	TYPE [l, ex, s]	[e, p]	EXTENT [h]
- interaction processes of radiation with matter					
- basic instrumentation in radiation measurements					
- pulse counting vs. spectrometry					
- pulse rate → counting efficiency → activity					
- factors affecting counting efficiency					
- energy resolution					
- detectors for radiation measurement					
- statistics and uncertainty calculations in radiometric measurements					
- interpretation of gamma, alpha, beta and X-ray spectra					
- energy and efficiency calibrations					
- liquid scintillation counting					
- radiation imaging					
- background formation and subtraction					
- quality control in radiation measurements					
- mass spectrometric measurement of radionuclides					

Table 2.3.4 CHEMISTRY AND ANALYSIS OF RADIONUCLIDES

TOPIC	INCLUDED [x/-]	IN WHICH COURSE/MODULE [title]	TYPE [l, ex, s]	[e, p]	EXTENT [h]
- chemistry (oxidation states, solubility, complex formation, hydrolysis, compounds), nuclear characteristics (half-lives, decay modes, emitted radiation) and measurement techniques of the most important radionuclides					
- special characteristics of the chemistry and separations of radionuclides (trace concentrations, radiation, use of carriers, adsorption of radionuclides)					
- needs and principles of radiochemical separations (alpha, beta and EC decaying radionuclides with no detectable gamma emissions, gamma emitting radionuclides of very low activities)					
- analytical methods used in radionuclide separations (precipitation, ion exchange, solvent extraction, extraction chromatography)					
- yield determination and counting source preparations					
- separation of long-lived					

radionuclides for mass spectrometric measurement					
- sampling and sample pre-treatment methods					
- speciation analysis of radionuclides					
- hot-atom chemistry					

Table 2.3.5 NUCLEAR REACTIONS AND PRODUCTION OF RADIONUCLIDES

TOPIC	**INCLUDED**	**IN WHICH COURSE/MODULE**	**TYPE**		**EXTENT**
	[x/-]	[title]	[l, ex, s]	[e, p]	[h]
- interaction processes of particles with nuclei					
- types of nuclear reactions and models					
- coulombic barrier					
- energetics of nuclear reactions					
- kinetics of nuclear reactions					
- cross-sections					
- excitation functions					
- induced fission					
- types of particle accelerators					
- production of radionuclides in cyclotrons					
- production of radionuclides in reactors					
- radionuclide generators					
- principles and uses of nuclear power reactors					

Detailed information on the NRC curriculum and course contents given in these tables (and possible other data) will then be evaluated carefully. The topics should be covered in the curriculum by 90%. In addition, the curriculum should include compulsory calculation and laboratory exercises equivalent to at least 10 cu. The minimum aims and topics for these exercises are described in **Table 2.3.6.** A more comprehensive list of recommended laboratory exercises is included in the Minimum requirements.

NRC curriculum should also include optional studies at minimum 10 cu. These course modules may cover various application fields of nuclear- and radiochemistry. Suggested topic areas are described in **Table 2.3.7** and detailed course contents in the Minimum requirements. Course modules will be evaluated by their extent and general contents; laboratory exercises are not required but they are recommended if possible. The applicants should describe their optional studies by workload (cu) and content and explain how much of these studies are required in their master's program.

Table 2.3.6 TOPICS OF NRC EXERCISES

Calculation exercises
- use of nuclide chart and data bases
- calculation of activities based on half-life data, including radiochemical equilibria
- calculation of irradiation yields based on cross sections and projectile flux
- calculation of irradiation doses
- calculation of required shielding for radiation protection
- uncertainty calculation in activity measurements

- conversion of count rates to activities

Laboratory exercises

- detection of surface contamination for radiation safety
- use of radiation dose meters for radiation safety to measure total dose and dose rates
- measurement of radiation with a simple detector, such as Geiger tube (e.g. dead-time, absorption of beta radiation, counting geometry etc.)
- measurement of radiation with a LSC
- measurement of radiation with a gamma spectrometer - energy calibration, interpretation of gamma spectra
- separations of radionuclides using various methods, such as precipitation/co-precipitation, ion exchange chromatography, solvent extraction and/or extraction chromatography

Table 2.3.7 SUGGESTED TOPIC AREAS FOR OPTIONAL NRC COURSES/COURSE MODULES

Chemistry of the nuclear fuel cycle
Radiopharmaceutical chemistry
Environmental radioactivity – radioecology
Chemistry of actinides and transactinides
Chemistry of radionuclides in geosphere related to final disposal of spent nuclear fuel or high-level waste
Radiation chemistry
Nuclear and radioanalytical methods

3 CONCLUSIONS

Evaluation criteria to obtain NRC EuroMaster’s status were defined. Master’s program eligible to NRC Euromaster should have at least 60 ECTS credit units (50% in case of 120 ECTS cu master's program) of its master’s studies on nuclear and radiochemistry. Of these 60 credit units at least 10 credit units should be practical exercises and at least 30 credit units should comprise of master’s thesis and project work. The educational program should cover most relevant aspects from the following five topic areas - Radioactivity, radionuclides and radiation - Radiation safety - Detection and measurement of radiation - Chemistry and analysis of radionuclides - Nuclear reactions and production of radionuclides as described in the Minimum Requirements. Applicants are asked to describe their curricula in NRC and give a point-by-point answers how the topic areas are covered. The Division Nuclear and Radiochemistry (DNRC) of the European Association for Chemical and Molecular Sciences (EuCheMS) will evaluate the curricula by the responses.

The DNRC may define additional requirements as felt necessary.