
COURSE MODULES ON NUCLEAR SAFEGUARDS AND NON-PROLIFERATION

Louis-Victor Bril
Joint Research Centre Ispra, Italy

Greet Janssens-Maenhout
docent University of Ghent, Belgium

Email address of main author: louis-victor.bril@jrc.it

One of major current concern in the nuclear field is the conservation of developed knowledge and expertise. The relevance of this subject is steadily increasing for several reasons: retirement of the generation of first industrial development of nuclear energy, only one new reactor under construction in Europe while several in Eastern and Asian countries, the public's concern on safety, radioactive waste and safeguards aspects, and some lack of interest common to many activities in engineering and physics. Moreover nuclear safeguards is nowadays characterised with an enlarged scope and no longer strictly limited to the accountancy of nuclear material; today it encompasses non proliferation of nuclear material, and deals with the control of dual use equipment and technologies, illicit trafficking and External Security.

Some higher education networks, such as the European Nuclear Engineering Network (ENEN), have been established to make better use of dwindling teaching capacity, scientific equipment and research infrastructure, through co-operation amongst universities and research centres. The European SAfeguards Research and Development Association (ESARDA) initiated the set-up of course modules under an e-learning medium, to preserve knowledge in nuclear safeguards. These course modules should be considered as basic pedagogical documentation, which will be accessible via the Internet. Monitoring or controlling of the accesses will be ensured.

The modules are structured with an increasing level of detail, in function of the audience. On one hand the course modules should be attractive to University students in nuclear, chemical or mechanical engineering, in radiochemistry, statistics, law, political science etc. at universities or specialised institutes. On the other hand the course modules aim to give professionals, working on specific safeguards or non-proliferation issues an overview and detailed technical information on the wide variety of nuclear safeguards activities and the large community active on this issue.

These courses aim at becoming, in the future, a European reference for the transfer of knowledge in the area of nuclear safeguards and non-proliferation. An important point is that this documentation will be "validated" by the European safeguards community.

1. INTRODUCTION

With the series of commercial nuclear power plants (NPP) established in the seventies, a large human potential was engaged for designing, running and maintaining those as well as the associated nuclear fuel cycle installations. For most of these, so-called Generation II reactors, the life-time has been extended to 40 years; for some of them, the extension until 60 years is even being prepared. The professional life being limited to about 35 years, the operating and managing personnel can obviously not run the NPP and perform the associated activities for this total period. A replacing generation is needed, which is appropriately educated and well trained for taking over the duties of experienced people facing retirement. The increased availability of existing reactors (+10% during the past 10 years [8]) demonstrates the continuous need of these duties, and so of specialists. The NPP are only one part of the

complete nuclear fuel cycle. Fortunately a strong infrastructure has been built up, guaranteeing a relatively high standard of nuclear safety and safeguards. The human element has been recognized relatively late and therefore new educational initiatives have to be launched.

Educational networks, such as the ENEN (European Nuclear Engineering Network, [1]) and the CAPITAN (Chemistry and Physics Integration and Training for Actinides Network, [2]) have been established. The underlying objectives of these networks are

- guaranteeing nuclear knowledge and expertise through the preservation of higher nuclear engineering education,
- optimally utilising the dwindling teaching capacity, scientific equipment and ageing research infrastructure through co-operation between universities and research centres.

Beside the education in nuclear safety also the education in nuclear safeguards has to be emphasized. The broad span of influence and control, direction and managing of nuclear materials, regulation and implementation of safeguards systems exhibited by a large number of professionals, nuclear facility managers, technical specialists, inspectors, diplomats, jurists, politicians, researchers and teachers, etc. has to be recognized. Moreover, Dickman [3] recently stated that, given the rapidly evolving world climate since the end of the cold war, our safeguards leaders and experts need education and training that will provide a well-developed understanding of the broader political dimensions of current non-proliferation challenges.

The public also receives, via the various media, a lot of information about the risks of proliferation, not always having the minimum necessary background knowledge at its disposition. One of the objectives of these courses is also to give to the public a minimum technical information, validated by the professionals and practitioners, enabling it to make its own judgment.

2. NEEDS

Traditionally the nuclear safeguards and non-proliferation programme of the past second half of the 20th century focused on treaties, security controls at export borders, nuclear material accountancy and control systems with regulations, instrumentation, data analysis, remote verification. Nuclear research centres steadily developed enhancements and modernisations in the various fields of Non-Destructive and Destructive Analyses, Solution Monitoring techniques and Containment Sealing and Surveillance Systems. Less emphasis has been placed on recognition of the human element as a primary component of the research infrastructure and the key to successful and sustainable implementation of safeguards programmes.

Until recently, the safeguards community was limited to a relatively small and homogeneous ring of informed specialists. This was simplifying the decisions making process and was enhancing the efficiency by more direct communication paths between its members. Now more and more people from various horizons have to deal with enlarged subjects and increased importance of the fields.

New European Union borders makes even more valuable the creation of homogeneous teaching material aiming at providing "European" approach to the various publics concerned. This EU harmonized material would also facilitate in medium term, a European approach to the nuclear non proliferation.

The replacement of a first wave of researchers and more generally technical people facing retirement becomes problematic because of lacking young graduates, engineers, physicists or technicians in the nuclear field. Moreover Universities are less and less teaching nuclear courses; university courses on the nuclear fuel cycle become rare. So the teaching community itself decreases in number.

Also the way of teaching and the contact student-professor at the universities has strongly evolved in the last decade. Nowadays, students are familiar with on-line classroom and are used to download the course syllabus from the university internet with their user ID and password. Exercises are becoming homework and the answers are commonly communicated by email. To look up something, young people do no longer consult an encyclopedia in the library but are utilising web-search-motors. Professors have to survey the quality of the information that students gather.

Especially in the nuclear safeguards field the information is exuberant and it has been recognised that open sources contain a lot of information. In order to control the impact of the information spread over the web, it is needed to assess its value. Moreover to invest in well-trained future professionals, it is of high relevance to provide the students with that knowledge that they can judge, evaluate and interpret the large amount of information. These courses aim to inform also the public with the minimum technical background, which is validated by the professionals and practitioners and which allows the public to understand statements and to make up his mind. So the availability of information “approved/validated” by nuclear specialists will give a reference point to students in fields where professors and specialists are becoming rare.

2.1. Horizontal spreading of training information

Given the needs, quality training material has to be provided to whom is interested, wherever and whenever but in a controlled manner. Therefore in 2003 the partners of ESARDA approved the launch of a course modules project, in which reviewed training information would be assembled in the form of different course modules. In that respect, ESARDA is in line with the OECD that recommends to develop “educational networks among universities, industry and research institutes” [7]. These course modules would have various levels of accessibility: free, monitored access (registration of users) and controlled (identification of users and control by password). An overview of the use of the course modules will be kept by registering all downloads. In this way, a centralised database of reference training material on nuclear safeguards and non-proliferation would be available, from which hands-on courses can be extracted.

2.2. Vertical spreading of educational material

The course modules will be structured with different degrees of depth. An overview of the structure with three degrees of depth is given in Fig. 1. Starting with a global overview the trainee can select then the level of detail upon his interest in the different fields specified. More and more interest is expressed in detailed, computerised based training and recognised by both the IAEA [9] and research centres [10].

The levels of detail are adapted as a function of the audience considered. The course modules are considered in a first instance as pedagogical documentation for teachers or those who have to make presentations in conferences, seminars or workshops to a more or less specialized audience.

The global overview or generic modules would be freely accessible for all publics. The specific modules would be accessible to students under declaration and password. The more complete academic modules would be made accessible only after checking the request and identification of the user.

3. FEATURES OF THE COURSE MODULES

The figure 1 gives the state of courses structure:

- generic modules, open to the public, give the fundamental of safeguards
- specific modules give a rather specialised information and applied techniques in the fields; this is typically directed to medium scientific student

- academic modules are giving the state of the art in the technologies used. These technologies can not be safeguards specific and can have fundamental features. These modules are designed for specialised people and practitioners.

3.1. Scope and Content

The basic information and subjects to be covered by the course/conference modules are:

- general background in legislation on safeguards relevant treaties and agreements in the EU and world-wide:
 - survey;
 - responsibilities of national and international institutions;
 - situating nuclear safeguards in the overall Non Proliferation system;
- the nuclear fuel cycle: survey of technologies from mining to the final repository;
- basic principles of nuclear safeguards:
 - accountancy and verification according to a structure of material balance areas;
 - containment & surveillance;
 - implementation of the safeguards principles in the nuclear fuel cycle;
- verification technologies (measurements and instrumentation): analytical techniques (destructive and non destructive assay), sealing, surveillance and monitoring techniques;
- evolution of safeguards approaches (strengthening of safeguards, integrated safeguards, Additional Protocol).

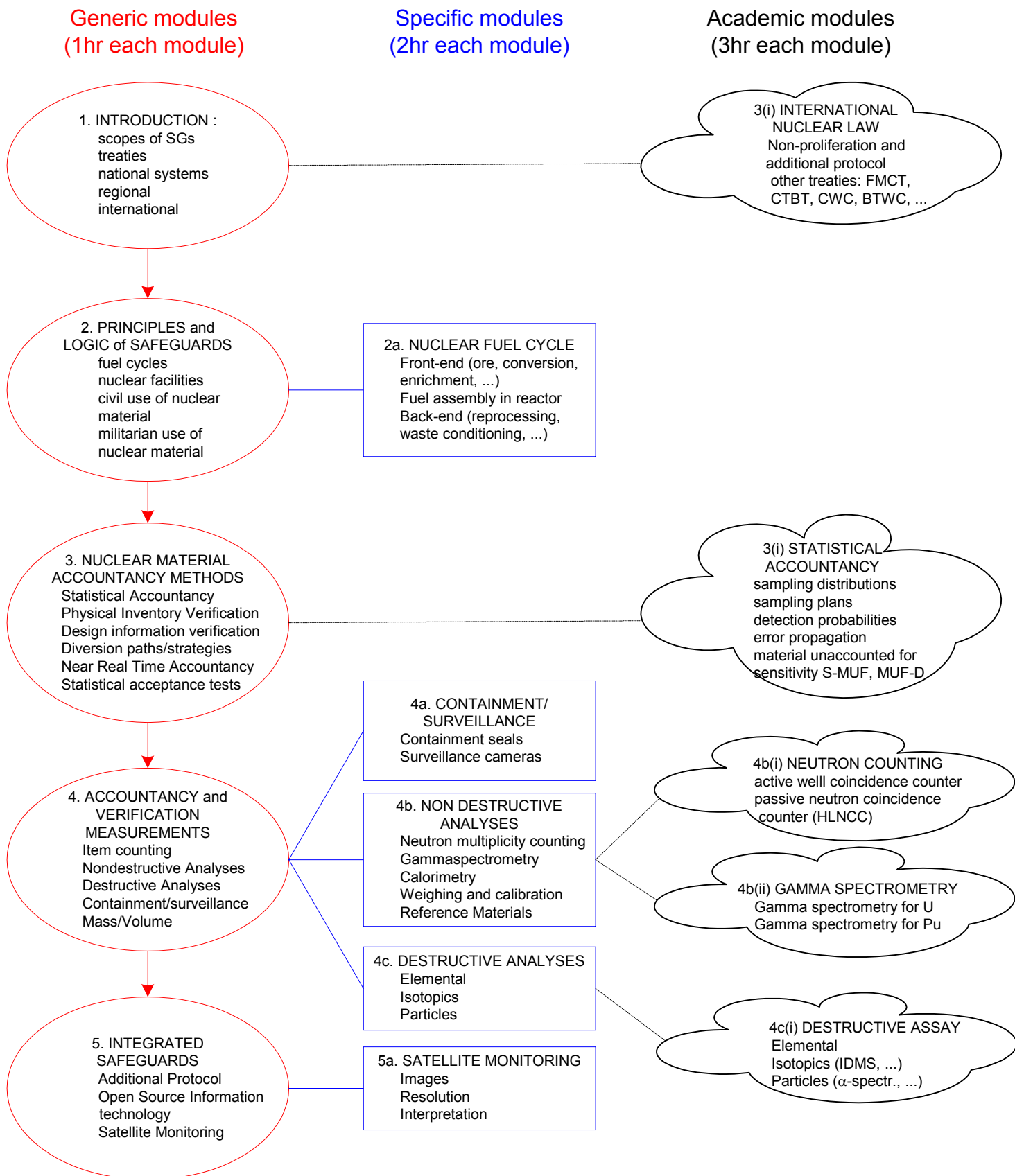


Fig. 1: Course modules structure with 5 consecutive chapters and with 3 levels of detail.

3.2. Audience

The target public envisaged depends upon the fields of specialisation:

- Students for e.g. in nuclear, chemical or mechanical engineering, in radiochemistry, could have access up to academic modules, while students in statistics, law, political science etc. at universities or specialised institutes could be satisfied with the generic modules;
- persons involved in the operation of nuclear facilities;
- persons involved in the verification of nuclear material inventory;
- responsible persons in the field of safeguards, safety and security of nuclear installations;
- persons involved in non proliferation issues;
- diplomats and central administrations officials, officials in assurances;
- administrations such as police, customs, justice etc. officials could need some ad hoc courses;
- media (journalists).

3.3. Duration of the course

The modular nature of the course should enable it to be used for a large spectrum of audiences. Taking a European University course of 3 ECTS (European Credit Transfer System, [4]) points¹ on the nuclear fuel cycle as a first reference, a minimum module on safeguards should cover 1 ECTS point or one third of this nuclear fuel cycle course. This module should also give a lecturer enough information for establishing a special presentation in the safeguards fields.

4. RECOMMENDATIONS FOR THE WEBSITE BEYOND

At European universities, master students can perform a practicum, which counts equally to a normal course for 3 ECTS. A diplomé thesis is obligatory for all final year students and counts for 15 to 20 ECTS. Themes for practica, diplomé theses could be published ad valvas on Internet in a second window, coupled to the ESARDA training web site. This allows students to easily make their choice in the safeguards field. Moreover also the practicalities and administrative arrangements could be included so that the student gets an overview on the various possibilities offered by the hosting institutes (such as JRC, SCK•CEN Mol and FZ Jülich etc. which are also members of ESARDA).

Even more important are PhD students and the discussions with and amongst them. Although a PhD study is to be carried out independently by the PhD student, a forum for questions, reference documents and other exchanges on literature is highly welcome. An Internet Forum could be established in a third window, coupled to the ESARDA training web site. Information on the practical modalities can be included by inserting links to Marie-Curie Fellowships, JRC category 20 grants, INTAS trainee positions etc.

Further development could also consist in adding didactic modules such as evaluation/tests enabling the student to know how much he learnt and how well he did.

5. CO-OPERATION

Good course modules require different reviewers. Similar initiatives have been developed in Europe (IAEA, ESARDA, World Nuclear Association), US (PNL, LANL etc.) and in the RF (IPPE, MIPhI etc.) then it is of mutual interest to co-operate and to bring together the existing available information of high quality. Specialised institutes might have interest in detailed

¹ At European Universities 1 academic year = 60 ECTS. Each course of 3 ECTS counts 15 times 1h30 theory and 15x3h exercises. This means for the student a package of 3 times 25-30 studying hours.

course modules, which will be added in a second and third step. Some institutions such as Los Alamos in Non Destructive Assay [5] or Monterey in Non Proliferation [6] have already developed detailed didactic material. Through adequate collaborations, the ESARDA Working Group on modules of courses will create a network of links with the appropriate institutions and associated websites. It is envisaged to include list with common nomenclature and symbols.

This collaboration will facilitate the conservation of knowledge and will put it at disposal of safeguards and non proliferation experts in an easily retrievable or centralised way.

Acknowledgement

The authors want to thank Mrs. Dickman for her interest in the ESARDA initiative and for communicating us all information on this International Conference on Nuclear Knowledge Management.

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