IAEA
International Atomic Energy Agency
Atoms For Peace

REPORT

Consultancy Meeting on

"Education on Radiation Sciences and Technologies"

13 - 16 November 2017
IAEA Headquarters Vienna, AUSTRIA
(Meeting Room – M0E18, VIC)

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1. INTRODUCTION

The objective of the present consultancy meeting was to review the recent evolutions of education on radiation sciences and technologies in IAEA Member States since the previous technical meeting held in Vienna in July 2015, and to provide strategic orientations together with a realistic roadmap for future initiatives.

The on-going actions and planned initiatives reported by the participants were analysed in the light of previous recommendations. A positive evolution was recorded, considering tangible achievements in various types of action:

- books and reports made available under IAEA's impulsion and support for providing an open-sourced and up-to-date knowledge on specific topics of prime interest,
- e-learning experimentation for introducing food irradiation to high school students and joint academic training,
- regional training initiatives in Africa (joint and transnational actions between Universities and national atomic energy commissions) and Europe (Erasmus+ key action 2, TL-IRMP),
- scientific fellowships hosted at research institutes and IAEA collaborating centres,
- new proposals for pre-conference and post-conference training courses intended for students as well as for young professionals that will be organized under IAEA guidance and with its support.

The discussions were driven to clarify the global educational demand by segmenting the needs in terms of professional levels in the various domains of applications.

Existing education programs were reviewed for proposing harmonized syllabi targeted at knowledge acquisition, considering also the development of experimental skills, social competence, management, reporting, scientific communication as well as responsible behaviour.

2. SUMMARY OF PRESENTATIONS INCLUDING AN OVERVIEW OF THE STATUS OF CURRENT EDUCATION PROGRAMS WORLDWIDE

In Brazil there are several programs of studies related to radiation technologies. Graduate programs on Nuclear Science and Technology are provided by universities in Minas Gerais, Pernambuco, Rio de Janeiro and Sao Paulo. In the latter case, M.Sc. and PhD programmes in Nuclear Technology is offered including the topics of radiation chemistry and technology, dosimetry, effects of ionizing radiation on matter, etc. Specific elective courses are offered on radiation chemistry, applications of ionizing radiation and radioisotopes in industry and environment. These courses are performed in co-operation with IPEN. Other educational activities in the field of radiation technology are regional courses organized by IAEA, as well as actions related to the World Nuclear University such as World Radiation Technology School. There are initiatives to develop and introduce modern teaching techniques, in particular e-learning tools. An example of e-learning course on food irradiation was presented and discussed.

In France, due to highly developed nuclear energy program, many related programs of studies are provided at Universities, Grands Ecoles and via high-level technician curricula. Important R&D and industrial players (like CEA, INSTN) cooperate with universities in this field. Study programmes are offered in nuclear physics, nuclear engineering, nuclear medicine, radioprotection and materials sciences. M.Sc. and Ph.D. programmes are based on co-operation with well-established radiation chemistry & technology research centres (e.g. in Orsay and Saclay on general radiation chemistry and e.g. in Clermont-Ferrand, Paris, Caen, Chatenay-Malabry, Palaiseau, Montpellier, Grenoble and Reims in radiation chemistry and processing of polymers and natural materials). These study programmes usually encompass specialized courses on radiation chemistry (an example of such a course may be that led at the Universite de Franche-Comte). French universities play important role in educating students from abroad, both at M.Sc. and Ph.D. levels. A successful example of international co-operation in the field of education on radiation science and technology was the course organized within the Erasmus + Key Action 2 “Joint innovative training and teaching/learning program in enhancing development and transfer knowledge of application of ionizing radiation in materials processing”. The idea, objectives, details of curriculum, learning outcomes, logistics as well as assessment of two series of these intensive courses held in 2015 and 2016 have been presented in detail.

In Ghana the activities related to radiation science and technology are co-ordinated by Ghana Atomic Energy Commission (GAEC). Five institutes lead research- and technology-oriented activities in the radiation science and technology. Education and training for the personnel (responding both to the national and regional needs) is provided by Graduate School of Nuclear and Allied Sciences at the University of Ghana. This School is supported by GAEC and IAEA. Facilities required to provide practical training are provided, such as a research reactors, gamma irradiator, dosimetry laboratory, etc. Regional Designated Centre for Higher and Professional Education provides post-graduate programmes in Radiation Safety, Nuclear Science and Technology and Medical Physics. M.Sc. and Ph.D. programmes in radiation processing are currently offered and actually run. Training activities are also provided within the IAEA TC Projects and projects of AFRA. Strategies are being developed to further extend and improve educational activities related to radiation science and technology.

In India, at 15 universities (out of 789 existing in the country, educating 29 million students) programmes related to nuclear science and technology are offered. This includes 3 B.Sc. programmes in Nuclear Engineering, 13 M.Sc. programmes in Nuclear Engineering, 2 M.Sc. curricula on Nuclear Science and Technology, as well as 2 Ph.D. programmes in this field. India has very good facilities where practical training in radiation research and technology can be performed, first of all the premier scientific institute BARC and smaller centres at other sites (like e.g. the National Centre for Free Radical Research in Pune). There is also industry utilizing radiation technologies. Taking all this into account, still the availability of education in nuclear and radiation science and technology is not considered as fully satisfactory and efforts are made by DAE, BRNS, IANCAS and BARC to encourage universities to include these topics into their curricula. At BARC, a one-year orientation course is provided to all incoming scientific personnel. This course is also available for candidates from other centres and institutions. This programme includes a core course on radiation chemistry and photochemistry. Important role of IAEA in supporting education in this field is recognized, for instance by organizing regional courses, CRPs and consultant meetings.

In Poland development of educational activities dedicated to radiation technology is somewhat limited by relatively low number of companies and institutions acting in this field and also by lack of final decision on launching the national nuclear power programme. Basic elements of radiation physics and chemistry are included in general physics and chemistry curricula. There are three programmes on Nuclear Power in Kraków, Warsaw and Gdańsk. However, there are no complete programmes dedicated to radiation technology. This is mainly caused by the fact that the number of professional positions open per year by the few companies & research institutions is low, while a certain minimum number of students is necessary to open a study programme. Partial solutions are B.Sc. Eng. and M.Sc. studies on Biomaterial- and Radiation Engineering at the Lodz University of Technology, albeit these are not launched every year, due to limited number of candidates. It is proposed that the idea of an international M.Sc. programme in Radiation Technology should be considered. International recruitment should provide reasonable number of candidates and at the same time studies performed at a number of leading centres would assure the diversity of topics covered by the curriculum. Ph.D. studies in radiation research and technology are run by Lodz University of Technology and Institute of Nuclear Chemistry and Technology in Warsaw. The latter has co-ordinated and co-hosted the Erasmus + Key Action 2 discussed above. Both institutions host many IAEA fellows and scientific visitors.

3. DISCUSSION ON THE OBJECTIVES AND CONTENTS FOR PROPOSED INITIATIVES

Radiation processing in form of wire and cable crosslinking, heat shrinkables, radiation sterilization of medical products, food preservation, plant mutation, wound dressings etc. is fast growing industry. In the power sector, the aging nuclear plants have to be decommissioned after their active life span, and used nuclear fuel has to be safely stored for long periods. The needs for scientific and technical input as well as for educated professionals in these sectors have provided impetus to train manpower, well versed with fundamental and applied aspects of radiation science and technology. Thus, education on radiation science and technology is necessary in member states. Essential features of the proposed program, irrespective of the professional level of the targeted personnel, should include:

- Basics of radiation processing (introduction to ionizing radiation, radiation sources and accelerators, radiation quantities and units, interaction of radiation with matter, basics of radiation protection and concept of dose measurement, an overview of applications).
- Advanced training emphasizing the domain of application would include.
    - Fundamental aspects: Radiation sources and their comparison for different applications, comparative aspects of radiolysis (of liquids, solids and gases), radiation chemistry at interfaces, radiation effects on materials (e.g. polymers), biological effects of radiation, dosimetry, industrial hygiene and safety in radiation processing units.
    - Applied aspects: Biomedical applications (tissues, synthetic materials, and drug carriers), environmental applications, electronics, sterilization, food preservation, cultural heritage.
    - Regulations, standards, metrology, QA-QC, validation, simulation of dose distribution.
    - Analytical and spectroscopic tools for radiation processed material characterization, simulation and modelling of chemical/biological processes
    - Rational search and analysis of scientific literature as well as patent data bases.

Tutorials, self-study material, problem solving exercises to be provided include:

- Developing experimental skills and practical understanding through lab exercises and research projects (traineeships, MSc and PhD research projects).
- Developing man-management skills for higher levels of professionals is desirable.

Essential features of the proposed program architectures

Independent of the professional level of the target audience, the programs should include:

- Basics of radiation processing (introduction to ionizing radiation, radiation sources and accelerators, radiation-matter interactions, dosimetry, safety, overview of applications)
- A Specialized training to the domain of application
  - Core knowledge
    - Radiation chemistry in liquid and gaseous states, at interfaces Radiation effects on polymeric materials, biological effects of radiation, advanced dosimetry, …
  - Application-oriented knowledge
    - Biomedical (tissues, synthetic materials, drug carriers), environmental applications, electronics, processing of nuclear fuels, sterilization, food preservation, cultural heritage ….
  - General tools
    - Regulations, standards, metrology, QA QC, validation, simulation of dose deposition,
    - Analytical and spectroscopic toolboxes, simulation and modelling of chemical / biological processes
    - Rational search and analysis of scientific literature as well as patent data bases.

4. SELECTED EXAMPLES OF PROPOSED SYLLABUS FOR TRAINING COURSES AND DIPLOMA

Training courses and diploma program are to be organized for three levels of personnel on the under-listed topics.

4.1. OPERATOR LEVEL

Elementary knowledge on radiation physics (photons and particles, penetration depth, radiation quantities and units); radiation chemistry (radiolysis, primary species, chain scission and crosslinking in polymers, as an example); radiation biology (direct and indirect effects, impact on microorganisms, cells, sterilization); Radiation sources and accelerators (design, principle of operation, specificities, elementary maintenance, control, …); General overview of radiation processing applications; Dosimetry (methods, accuracy, ….); Good irradiation practice and implementation of prescribed procedures for QA-QC; Safety, security measures, and regulations.

4.2. TECHNICIAN LEVEL

Training will be in the basic and more specialized areas of radiation processing.

4.2.1. Basics of radiation processing

Advanced knowledge on radiation physics (photons and particles, LET, dose-depth profiles, dose rate and units); elements of radiochemistry (stable/unstable isotopes, radioisotope production, basic reaction kinetics (1st order); radiation chemistry (radiolysis, primary species: time frame of their evolution, their characteristics in terms of chemical reactivity); G-values; influence of chemical structure on chain scission and crosslinking in polymers (influence of crystallinity, hydrogen evolution, radicals) and radiation biology (direct and

indirect effects, impact on microorganisms and higher cells, sensitizers and protectors, effects of whole and partial body irradiation, effects of fractionation and dose rates)
Radiation sources and accelerators (design, principle of operation, specificities, maintenance, control, influence of radiation source parameters on effects induced in processed materials); Overview of radiation processing applications; Dosimetry (spectroscopic quantification, chemical titration, calorimetry, accuracy, calibration, mapping, calculation, personal dosimeters, specific quantities for radiation effects on the body); QA-QC practices and awareness of quality standards; Safety and security measures, regulations, traceability, emergency procedures.

4.2.2. Specialized training to the domain of application

For example, in the field of "Polymers and materials", the topics to be covered are:
Polymers (physics, chemistry, molecular weight, properties, applications -lectures, lab exercises, tutorials and calculations); Radiation chemistry of polymers (crosslinking, scission, polymerization, oxidation); Advanced methods for studying radiation chemistry of polymers (pulse radiolysis, FTIR, ESR, SLS-DLS, SEC, calorimetric measurements - DSC, TGA); Advanced methods for tailoring polymer structure and properties (hydrogels, biomaterials, packaging plastics, thermo-shrinkable materials, composites, coatings, grafting, nanomaterials and nanocomposites); Ageing studies in irradiated polymer materials (immediate and long-term effects, monitoring, dose rate effects on oxidation, stabilization, prediction of properties)
Visit to industrial facilities processing polymer materials
Laboratory work on specific aspects of polymer materials (depending on feasibility at host institute)
Exercises (choice and application of relevant formalism, models or equations, verification of hypotheses, calculations)

4.3. RESEARCH SCIENTISTS AND ENGINEERS

4.3.1. Basics of radiation processing

Expert knowledge on radiation physics (photons and particles, LET, dose-depth profiles, dose rate and units)
Expert knowledge in radiation chemistry: fast reaction kinetics (diffusion kinetics, non-classical kinetics, non-homogeneous and homogeneous reaction stages, timescale of events in radiation chemistry, ion pairs, ion molecule reactions, time-resolved instrumentation); reactions in micro-heterogeneous media and ionic liquids, G-values (initial, average, steady-state), excited states and radicals, comparative aspects of radiolysis of gases, liquids and solids, influence of morphology, quenching methods;
Radiation sources and accelerators in radiation research and in industry (new design, principle of operation, specificities, maintenance, control, thermal effects, X-ray conversion, energetic efficiency, influence of radiation source parameters on the kinetics of the processes and their consequences on materials properties);
Simulation and modelling in physics, chemistry and biology relevant to radiation processes
Alternative methods for the generation of reactive chemical species (photochemistry 1 or 2 photons, plasma, sonochemistry, mechanochemistry); Dosimetry for research and industrial sources (spectroscopic quantification, chemical titration, calorimetry, accuracy, calibration, calculation, personal dosimeters, specific quantities for radiation effects on the body); Commitments to QA-QC objectives, IQ, OQ, PQ, good laboratory practices
Safety and security measures, regulations, traceability, emergency procedures; Management (project, team), reporting, state-of-the-art, intellectual property protection

Regulatory aspects
Economics of radiation processing
Communication and dissemination of results

4.3.2. Specialized training to the domain of application

For example, in the field of "Nanomaterials and nanocomposites" the topics to be covered are:

Properties of materials at nanoscale (metals, inorganic materials, polymers); Synthesis of nanoparticles (top-down and bottom-up approaches, chemical, physical and radiolytic methods); modification and isolation of nanomaterials (nanoclays, quantum dots, nanosilica and carbonaceous nanomaterials, cellulose nanocrystals); Handling of nanoparticles, colloidal stabilization, aggregation issues, strategies for dispersing nanoparticles; Nanostructuring of materials (lithography, swift heavy ions, self-assembling, nano-imprinting); Advanced analytical and imaging methods for nanomaterials characterization (SLS-DLS, zeta potential, AFM, TEM, new microscopy techniques, plasmon resonance, laser light diffraction); Advanced methods for nanocomposite synthesis (blending, in-situ generation of nanoparticles: metal NPs, polymerization-induced phase separation); nanoheterogeneous materials, holography; Properties of nanoparticles and composites in the various fields of application (nanocatalysts, nanostructured membranes, carriers for drug delivery, gene therapy and radiotherapy, nanoparticles and nanostructured devices for medical diagnostics and theranostics, nanorobotics, structural nanocomposites with improved mechanical properties and thermal resistance, nanosensors, nanoelectronics).; Biocompatibility vs biohazards: potential of nanoparticles in nanomedicine, HSE issues

Examples of the potential applications of radiation processing in those fields
Examples of industrial applications of nanoparticles and nanocomposites
Laboratory works on specific aspects (depending on feasibility at the host institute)
Exercises (choice and application of relevant formalism, models or equations, verification of hypotheses, calculations)
Training through research projects (MSc or PhD)

5. LEARNING INSTRUMENTS

5.1. INTRODUCTION

Various complementary means can serve learning strategies to enhance education in radiation sciences and technology, such as:

i. training courses (IAEA regional activity), summer schools and workshops (section's TO IAEA),
ii. academic curricula,
iii. scientific literature,
iv. e-learning,
v. scientific visits and fellowships,
vi. conferences and seminars.

5.2. IAEA SUPPORTED ACTIVITIES

Training courses under the TC programs provide the opportunity of training young professionals in the regional programs. These activities could be enhanced by designing

specific training courses wherein participants from member states across the world could be trained on the basis of a uniform identified program.
Scientific visits and fellowships (individuals or small groups) are considered as a useful tool for training engineers and research scientists.
Regular conferences and seminars supported by IAEA could be utilized to hold pre- and post-conference workshops for young professionals or newcomers to the field.

5.3. ACADEMIC EDUCATION PROGRAMS

Academic initiatives in this field are limited in most member states by the need for a critical number of registered students and opened professional positions in any given country.
New curricula can be proposed on an international basis as demonstrated by the Erasmus+ TL-IRMP project which was run for two years and may be used a basis for proposing an Erasmus Mundus MSc diploma. In the field of nuclear physics, the ICTP-IAEA sandwich education program is a new tool that could inspire a similar initiative adapted to the needs of education in radiation processing. The different meetings organized by IAEA will provide opportunities for identifying potential contributing institutions to work on such possibilities.

5.4. PRINTED MATERIAL

There is the need to have an inventory of existing materials such as list of recommended books, review papers, scientific journals covering the basics and specialized aspects of radiation processing.
Regular updates such as recommendations for new books and publications are necessary.
Additional materials for general exercises as well as laboratory and experiments are needed.

5.5. E-LEARNING MATERIAL

E-learning tools were discussed in detail to assess their applicability to training in radiation science and technology.

5.5.1. E-learning experience in Brazil

A web course on "Food irradiation: Nutritional, sanitary, economic and social aspects" was developed by initiative of the Food Irradiation Laboratory at IPEN/CNEN-SP. The presentation was produced by a specialist in Information and Communication Technologies with a PhD in Nuclear Technology. The course content was prepared and provided by researchers and professors from the Food Irradiation Laboratory.
This course was presented for the first time in 2016 to a target audience of senior high school students. Five different presentations were conceived and produced on this topic including: Fundamentals of food irradiation; food irradiation process and the facilities used: Co-60 gamma irradiator, electron beam accelerator; recommended doses for irradiation of various foods, biological effects associated with food irradiation; discussions on the applicability of food irradiation, examples of non-recommended and recommended food substrates; laws and regulations for food irradiation; sensory analysis of irradiated food; food irradiation and radiation protection, public acceptance of irradiated food in Brazil and worldwide. As a practical example, all experimental steps of the irradiation process of edible flowers are presented, from the harvest to the consumer, together with the biological and chemical-physical analyses that were carried out.
After each module, an evaluation test allowed assessing the students' level of understanding. The presentations were designed with limited amount of text and visually appealing with original pictures and illustrations.

Copyright issues were managed before disseminating the e-learning tool to high school teachers and students, using diverse connected devices, such as tablets, cell phones and computers.
After an experimental stage, the feedback from the students and teachers helped improving the presentation to be proposed to public schools in SP State.

5.5.2. Discussion on e-learning

The participants discussed the different aspects of e-learning, in terms of contents, form and requirements.
The current status should be established by taking an inventory of existing e-learning materials in distinct scientific domains related to radiation S&T (polymer materials, food science, pharmaceuticals, nuclear engineering, analytical sciences …).
The relevant material can be used for training students and young professionals. It can also be analysed for inspiring initiatives in the field of radiation science and technology (e.g. Macrogalleria developed by the University of Southern Mississippi http://www.pslc.ws/macrog/index.htm).
A roadmap is proposed for gradually introducing e-learning tools in this field.

- 2-year objectives:
  - Introductive presentations on the basics of radiation processing, radiation sources, dosimetry …
    - For operator level
    - For technician / engineer / research scientist levels

  - A limited number of case studies on some advanced concepts or domains of application of radiation processing, for example:
    - Radiation cross-linking of thermoplastics and rubber
    - Hydrogels
    - Sterilization
    - Food irradiation
    - Environmental remediation
    - Composites, nanocomposites
    - Cultural heritage

- mid-term objective
  - A complete set of e-learning lectures, tutorials and exercises
  - A global attractive and informative on-line tool, inspired, for example, from the Macrogalleria.

The development of e-learning tools should be proposed as a future activity supported by IAEA, following guidelines to be defined depending on the level of professional status and on the learning objectives (introductive presentation, advanced elementary concepts, complex systems, exercises, evaluation of acquired knowledge). The scientific and technological contents should be agreed on by experts in the specific domains.
Different approaches can serve the development of e-learning materials:

- through a CRP dedicated to the development of e-learning materials;
- by including systematically to CRPs a work-package dedicated to the production of e-learning materials in relation with the main topics covered by the project.

E-learning tools might be used as a means for qualifying applicants to IAEA training programs.

6. RESOURCES AND SUPPORT

The resources needed to implement education and training activities include intellectual input, infrastructure and financial support. IAEA's prime role is to coordinate the design of courses answering the needs of the member states and to support the different initiatives and instruments developed in section 5.
IAEA Collaborating centres will have a key position for providing specialized infrastructure and expertise in the perspective of specific training courses.
Universities are entitled to propose new curricula and to deliver suitable degrees and diplomas, yet limited by the need for a minimal number of registered students. Regional institutions (such as EU, AU, …) may offer a harmonized framework for organizing training instruments and delivering qualifications and diplomas recognized by the participating countries.
National agencies, professional bodies and learned societies (international such as iia, Society of plastics engineers, ACS, and at national level as the Polish Radiation Research Society), private companies (radiation service providers, chemical companies, plastic manufacturers, …) can contribute either by providing access to their facilities or by committing their expert scientists and technologists to education activities. Additionally, specific learning activities may require financial support from these bodies and companies.

7. CONCLUSIONS

Based on the status report established during the meeting, there is almost no specific education program dedicated to radiation science and technology, whereas the number of useful applications is dramatically increasing in domains such as agriculture and food, healthcare, environmental protection, cultural heritage preservation and advanced industries.
The participants have confirmed the need for up-graded and new education activities on fundamentals and applications of radiation science and technology.
Examples of curricula were discussed and proposed for three types of professional status, starting at operator level, technician level and researcher/engineer level.
The importance of self-learning and course assimilation through exercises and practical training was emphasized.
Complementary types of resources can be mobilized to implement education activities. Besides traditional learning tools, e-learning appeared as a most convenient, faster and cost-effective means for attracting a larger number of young trainees and providing a uniform scientific and technological content.
Short-term and mid-term actions are proposed accordingly, together with the following recommendations.

8. RECOMMENDATIONS

Consultancy meeting participants strongly support the idea of broadening the education activities of IAEA in response to real needs of member states for highly qualified personnel at all professional levels, both in radiation science and technology and in the specific domain of application.
It is recommended that, besides the existing well-established educations tools (training courses, fellowships, scientific visits, conferences, workshops), which should be further supported and developed, IAEA should seek new forms of activity in this field.

An inventory of PhD dissertations defended worldwide in this field would be very useful to assess more precisely the level and the specific domains of activities in radiation science and technology.

It should be considered to re-shape the education tools by developing two-step programmes, where the first step (easily standardized) would provide a basic, universal introduction to the field of radiation technology, while the second step would let the participants acquire specialized knowledge and skills focused on the specific field of application.

It is also recommended that educational activities are diversified to answer the complementary but different needs for education at various professional levels, i.e., operators of radiation equipment, laboratory/technical staff as well as researchers and engineers.

Target groups for educational activities should be expanded by including researchers, engineers and managers from industries and institutions not strictly related at present to radiation technologies, but having potential to become involved in radiation field in future, either by directly introducing radiation technologies or co-operating with radiation industry.

It is also recommended that IAEA considers the possibility to elaborate in detail the idea of an international graduate level study programme in radiation science and technology to provide top-class education for scientists and engineers who will be the future national and international leaders in the field. This would require a concerted action of universities (as institutions able to grant the degrees and their specialized research departments), IAEA, Collaborating Centres and other players (national governmental agencies, NGOs, industry) to support by providing logistics and funds.

Furthermore, whenever IAEA-supported conferences related to radiation science and technology are held, it is recommended to plan and organize short pre-conference courses for young researchers and engineers, as well as for newcomers to the field, to provide background knowledge which would allow better understanding of the presentations given at the conference. Post-conference courses could also be organized, to allow for further discussion on recent advances in emerging areas reported at the conference.

While meeting participants recognize the indispensable value of direct tutoring and hands-on training, which should form the core of educational activities, they propose IAEA to undertake a focused action on developing attractive and modern e-learning tools, for two main purposes: (1) to allow broad access to stand-alone self-learning, not necessarily linked to other educational activities of IAEA and (2) to supplement the planned IAEA activities in this field, e.g. by providing introductory and qualification material for the prospective participants of courses and workshops, as well as self-learning elements of the M.Sc. programme. This would require co-ordinated efforts of the involved experts and taking into account the copyright issues. IAEA is recommended to provide guidelines and means for professional development of e-learning tools.

Besides the literature already available on the IAEA website, the IAEA is recommended to develop a platform where more (peer-reviewed) educational materials will be available. In cases where no free access to a given material can be granted, respective references as a list of recommended reading material (books, review papers, scientific literature) should be presented and systematically updated.

It is recommended that the IAEA considers establishing a network of collaborating centres for education in radiation sciences and technologies for planning, co-ordinating, organizing and performing educational activities of IAEA. Such centres should be established at universities that have qualified scientific staff specialized in radiation physics, chemistry and technology and equipped with suitable radiation sources to meet the necessary expertise, logistics and essential facilities.

ANNEX I

IAEA
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Atoms For Peace

IAEA Consultancy Meeting on
'Education on Radiation Sciences and Technologies'

13-17 November 2017,
Vienna IAEA HQ (M0E18)

MEETING AGENDA

Monday, 13 November 2017

08:00 - 09:00	**Registration at the Gate 1, IAEA headquarters, VIC**	
Session I:	**Introductory Session**	
09.00 - 09.30	**Opening of the meeting by:** - **Ms Meera Venkatesh, Director of NAPC (IAEA)** - **Mr Joao Alberto Osso Junior, Section Head of RPRT (IAEA)** - **Mr Sunil Sabharwal, Scientific Secretary, RPRT (IAEA)** - **Mr Bumsoo Han, Scientific Secretary, RPRT (IAEA)** - **Ms Dinara Abbasova, RPRT (IAEA)** **Scope and Objectives of the Meeting, Adoption of the agenda** Election of the chairperson of the meeting, introduction of participant	
Session II:	**Participants' Presentations**	
09:30 – 10:20	Ms Margarida Mizue Hamada (**Brazil**)	Current Scenario of the Education on Radiation Sciences and Technologies in Brazil
10:20 – 10:50		*Coffee Break*
10:50 – 11:40	Mr Xavier Conqueret (**France**)	Education on Radiation sciences and technologies in France: current status and benefits arising from international initiatives such as the EU project "TL-IRMP"
11:40 – 12:30	Mr Abraham Adu Gyamfi (**Ghana**)	Education on Radiation Sciences and Technology in Ghana: Status, Strategies for Improvement and the Role of the IAEA

12:30 – 14:00		*Lunch Break*
14:00 – 14:50	Mr Yatender Kumar Bhardwaj **(India)**	Education on Radiation Science and Technologies: Indian Scenario
14:50 – 15:40	Mr Piotr Ulanski **(Poland)**	Education in radiation chemistry & technology in Poland. Problems and opportunities for international co-operation.
15:40 – 16:10		*Coffee Break*
16:10 – 17:00	Discussion on Current Status and Recent Issues on the Education on Radiation Sciences and Technologies in Member States	

Tuesday, 14 November 2017

Session III & IV: Status of the Education on Radiation Sciences and Technologies

09:00 – 10:30	Discussion on Current Status and Recent Issues on the Education on Radiation Sciences and Technologies in Member States
10:30 – 11:00	*Coffee Break*
11:00 – 12:30	Discussion on Current Status and Recent Issues on the Education on Radiation Sciences and Technologies in Member States
12:40 – 14:00	*Lunch Break*
14:00 – 15:30	Discussions on How to Provide the Hands-on Education on Radiation Sciences and Technologies both in Research Organization and Industries
15:30 – 16:00	*Coffee Break*
16:00 – 17:30	Discussions on How to Provide the Hands-on Education on Radiation Sciences and Technologies both in Research Organization and Industries
17:30 – 18:00	*Finalize and document the discussion*

Wednesday, 15 November 2017

Session V & VI: The Advanced Approaches in Education and the Role of the IAEA

09:00 – 10:30	Discussion on the Advanced Approaches on Educational Media Including Web-Based e-learning
10:30 – 11:00	*Coffee Break*

11:00 – 12:30	Discussion on the Advanced Approaches on Educational Media Including Web-Based e-learning
12:40 – 14:00	*Lunch Break*
14:00 – 15:30	Discussion on the role of the IAEA on Radiation Sciences and Technologies in International Collaboration and Networking
15:30 – 16:00	*Coffee Break*
16:00 – 17:30	Discussion on the role of the IAEA on Radiation Sciences and Technologies in International Collaboration and Networking
17:30 – 18:00	*Finalize and document the discussion*

Thursday, 16 November 2017

Session X:	**Final Review and Acceptance of Meeting Report**
09:00 – 10:30	Drafting of the meeting report (scope/contents/structure/conclusions/recommendations)
10:30 – 11:00	*Coffee Break*
11:00 – 12:30	Drafting of the meeting report (scope/contents/structure/conclusions/recommendations)
12:40 – 14:00	*Lunch Break*
14:00 – 16:00	Review and acceptance of the meeting report

Friday, 17 November 2017

Session X:	**Final Review and Acceptance of Meeting Report**
09:00 – 12:00	Final remarks *Closing of the Meeting*

ANNEX II

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Consultancy Meeting on Education on Radiation Sciences and Technologies in Member States
Vienna, Austria
13 -17 November 2017

List of Participants

(as of 2017-11-10)

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