Education and training in nuclear engineering and safety

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SUMMARY

The need to preserve, enhance or strengthen nuclear knowledge is worldwide recognized since a couple of years. Within the 5th framework program the European Commission supports the European nuclear higher education network. The ENEN contract started on Jan 1, 2002 and lasts for 24 months. The Commission support for this "accompanying measure" amounts to € 197 716.
Based upon a year-long extensive exchange of views between the partners of ENEN, consisting of a representative cross section of nuclear academic institutions and research laboratories of the EU-25, a coherent and practicable concept for a European Master of Science in Nuclear Engineering has emerged. The concept is compatible with the Bologna philosophy of higher education for academic education in Europe. Pursuing the sustainability of the concept, the ENEN partners organized themselves in a non-profit-making association.
Within the 6th framework program, the Commission services favourably evaluated the proposal: "Nuclear European Platform of Training and University Organisations". The objectives of the NEPTUNO co-ordination action are to establish a fair dialogue and a strong interaction between the academic and the industrial world and to bring all nuclear education and training activities under a common strategy of the ENEN type. The present proposal schedules for 18 months and the Commission earmarked a financial contribution of € 830 619.

A. INTRODUCTION

The need to preserve, enhance or strengthen nuclear knowledge is worldwide recognized since a couple of years.
"Although the number of nuclear scientists and technologist may appear to be sufficient today in some countries, there are indicators, e.g. declining university enrollment, changing industry personnel profiles, dilution of university course content, and high retirement expectations, that future expertise is at risk." (Ref. [1])
"Today, the priorities of the scientific community regarding basic research lie elsewhere than in nuclear sciences. Taken together, these circumstances create a significantly different situation from three to four decades ago when much of the present competence base was in fact generated. In addition, many of the highly competent engineers and scientists, who helped create the present nuclear industry, and its regulatory structure, are approaching

retirement age. These competence issues need to be addressed at Community level and a well designed Community research and training program should play a role that is more important than ever before. This is an area where the concept of an European research area should be further explored." (Ref. [2])
"In September 2002, the (IAEA) General Conference noted that the need to preserve, enhance or strengthen nuclear knowledge arises irrespective of the future expansion in the applications of nuclear technologies, and requested the Director General to note the high level of interest of Member States in the range of issues associated with preserving and enhancing nuclear knowledge in the process of preparing the Agency's programme. (Ref. [3])

B. FP5 PROJECT, ENEN – EUROPEAN NUCLEAR ENGINEERING NETWORK; FIR1-CT-2001- 80127

Within the 5th framework program the European Commission supports the European Nuclear Engineering Network. The ENEN contract started on Jan 1, 2002 and lasts for 24 months. 22 academic institutions and research laboratories participate in the project. The Commission support for this "accompanying measure" amounts to € 197 716. (Ref. [4])
The objectives of the ENEN-project are to produce a handbook of best practices defining the major elements for a European network for nuclear engineering education and to perform pilot sessions on nuclear engineering education. The project is a step towards farther reaching objectives e.g. the conservation of nuclear knowledge and expertise, the creation of a European higher education area and the implementation of the Bologna declaration and the enlargement of the European Union.

B.1 European Master of Science in Nuclear Engineering

Based upon a year-long exchange of views between the partners of ENEN, consisting of a representative cross section of nuclear academic institutions and research laboratories of the EU-25, a coherent and practicable concept, for a European Master of Science in Nuclear Engineering (EMSNE) has emerged. The concept is compatible with the Bologna philosophy of higher education for academic engineers in Europe (a Bachelor of Science after 6 full-time semesters, and a Master of Science after a further 4 full-time semesters). In addition, the EMSNE approach can accommodate the presently existing (variety of) educational systems in the EU-25 members and candidate-member states, as well as the Bologna implementation in some countries, where Master degrees will be granted after a 2-semester program beyond the Bachelor.
The full curriculum leading to the degree of Master of Science in Nuclear Engineering (MSNE) is composed of course units formally recognized by ENEN.

- A MSNE can only be granted after having obtained a full-time load of ten semesters beyond secondary level
- A minimum of two semesters equivalent must be obtained in strictly nuclear subjects composed of a set of core-curriculum courses complemented with nuclear electives and a project work/thesis in a nuclear domain

Students register in one ENEN-accredited "home" institution and acquire the required credits in ENEN-institutions of their choice. The home institution grants the formal degree of Master of Science in Nuclear Engineering, based upon the formal recognition of credits, very much similar to the ERASMUS philosophy. ENEN, on behalf of its members, grants the quality label *European* Master of Science in Nuclear Engineering if

at least on semester equivalent (might include project work or thesis) have been followed at an ENEN-member institution other than the home institution.

Because of the different meaning of the words "undergraduate, graduate and post-graduate" in UK and US contexts, these terms are preferentially not used in the ENEN terminology. It is advised to talk about Bachelor, first Master, additional Master always with the number of credits or full-time semesters required, mentioned.

B.2 Pilot sessions on nuclear engineering education

To demonstrate the feasibility of European nuclear education schemes, a three weeks course, called "Eugene Wigner" course for nuclear reactor physics experiments, was successfully organized from April 28 to May 16, 2003. Some 20 postgraduate students from about 10 different European, including accession countries, participated in nuclear reactor physics experiments, organized jointly by four universities. Students performed reactor physics experiments on research- and training reactors in respectively Vienna, Prague and Budapest. One week of theoretical lecturing at Bratislava university introduced or refreshed the knowledge to perform the nuclear reactor physics experiments. The ENEN partners rated the course between 6 to 8 credits or an equivalent student load of some 180 to 240 hours. Students got a certificate of participation. Individual marks are transmitted to the home professors.

The course on Nuclear Thermal Hydraulics organized within the Belgian academic postgraduate program in nuclear engineering, is organised in a highly modular way and taught in English to facilitate and exchange participation of European students. The course, scheduled for October 20-31, 2003, makes full use of the laboratory facilities and infrastructure of the Belgian Nuclear Research Centre. The course is rated 6 credits or an equivalent student load of some 180 hours. A written examination, prepared by the course staff, is foreseen at the home university on November 21, 2003. The copies are send back to and graded by the teaching professor, who transmits the individual marks to the home professors. The final mark remains the responsibility of the home professor.

In a similar way also the course on Nuclear Reactor Theory is organised from November 17-28, 2003. The course rates 8 credits or an equivalent student load of some 240 hours. The examination is scheduled for December 19, 2003. Mid September, some 20, about half regular Belgian Students and the other half "ENEN" students registered for each course.

B.3 The ENEN association

Pursuing the sustainability of the concept, the ENEN partners organized themselves in a non-profit-making association: the European Nuclear Education Network. The first General Assembly is scheduled for November 11, 2003.
The main objective of the ENEN network is the preservation and further development of higher nuclear education and expertise.

The basic objectives of ENEN are:

- to deliver a European master of science degree in nuclear engineering and promote PhD studies

- to promote exchange of students and teachers participating in the network
- to establish a framework for mutual recognition
- to foster and strengthen the relationship with research laboratories, industry and regulatory bodies.

To meet these objectives, the ENEN network

- promotes and further develops the collaboration in nuclear education of engineers and researchers for nuclear industry and regulatory bodies
- ensures the quality of nuclear academic engineering education and training
- has to increase the attractiveness for engagement in the nuclear field for studnts and young academics.

(Table I)

The ENEN network consists of effective and associated members. The effective members are academic institutions providing high level scientific education in the nuclear field. The associated members have a firmly established tradition of relations with members in the field of nuclear education, research and training. New members are elected by the general assembly, by a majority of two-thirds of the votes cast, on recommendation of the Board of Governors. The general assembly is made up of all members.

C. EDUCATION AND TRAINING IN NUCLEAR ENGINEERING AND SAFETY

Within the 6th framework program, the Commission services favourably evaluated the proposal: "Nuclear European Platform of Training and University Organisations". The objectives of the NEPTUNO co-ordination action are to establish a fair dialogue and a strong interaction between the academic and the industrial world and to bring all nuclear education and training activities under a common strategy of the ENEN type. The present proposal schedules for 18 months and the Commission earmarked a financial contribution of € 830 619.

In the area of knowledge management the Consortium considers:

- Workshops to disseminate the experience gained by the "education" community under FP5 and FP6, in particular, amongst the "training" community.
- Pilot sessions for education and training along the lines of what has been done under the ENEN project. To evaluate the pilot sessions and their funding scheme.
- To draft, edit and distribute a series of textbooks for education and training
- To produce guidance documents describing best practices for: qualification of common curricula, accreditation mechanism and mobility for students and teachers
- To perform consultancy services in connection with specific education and training activities proposed in other Euratom FP6 projects.

D. INTERNATIONAL CO-OPERATION

The International Atomic Energy Agency supports networking of education and training. The IAEA sponsored participants in the ENEN pilot courses and representatives participate in the ENEN progress meetings.

OECD-NEA recognises the ENEN achievements as relevant progress against the recommendations made in the publication, "Nuclear education and training: Cause for Concern?".

ENEN participates as a driving member in several of the working groups of the recently inaugurated World Nuclear University initiative. (Ref. [5])

E. FUTURE WORK

The "European Nuclear Education Network" association emerged as a non-profit common legal entity out of the FP5 ENEN project. The legal entity is open for academic institutions and corporate bodies committing themselves to support the ENEN association and having a firmly established tradition of relations with members in the fields of education, research and training. Within the project the ENEN partners came to a consensus on: qualification of common curricula, an accreditation mechanism inspired by the Bologna declaration and a mobility scheme for students and teachers. The present-day ENEN working field is nuclear engineering education. In the nearby future, ENEN pursues a closer interaction between education and training communities. Future extensions towards nuclear medicine and radiation protection, nuclear or radio-chemistry, nuclear applied sciences (accelerators, instrumentation and measurement) may be envisaged. A European Master of Science in Nuclear Science and Engineering may result. Likewise, ENEN promotes exchange of students and instructors for advanced courses in the framework of PhD programmes.

ANNEX

ENEN – partners: Belgian Nuclear Research Centre (B), Budapest University of Technology and Economics (HU), Check Technical University (CZ), Institut "Josef Stefan" (SI), CEA-INSTN (F), Kungl Tekniska Högskolan (S), K.U.Leuven Research and Development (B), Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare (I), Universiteit Gent (B), Slovak University of Technology (SK), Swiss Federal Institute of Technology Zürich (CH), Delft University of Technology (NL), Helsinki University of Technology (SF), Atominstitut der Österreichischen Universitäten (A), Université Catholique de Louvain (B), University of Birmingham (UK), University Politehnica of Bucharest (RO), Universidad Politecnica de Madrid (E), National Technical University of Athens (EL), Technische Universität München (D), Ustav jaderného vyzkumu REZ (CZ), Centre of Technology and Engineering for Nuclear Projects (RO).

Potential NEPTUNO – partners: Belgian Nuclear Research Centre (B), Budapest University of Technology and Economics (HU), Check Technical University (CZ), Institut "Josef Stefan" (SI), CEA-INSTN (F), Kungl Tekniska Högskolan (S), K.U.Leuven Research and Development (B), Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare (I), Universiteit Gent (B), Slovak University of Technology (SK), Swiss Federal Institute of Technology Zürich (CH), Delft University of Technology (NL), Helsinki University of Technology (SF), Atominstitut der Österreichischen Universitäten (A), Université Catholique de Louvain (B), University of Birmingham (UK), University Politehnica of Bucharest (RO), Universidad Politecnica de Madrid (E), National Technical University of Athens (EL), Technische Universität München (D), Ustav jaderného vyzkumu REZ (CZ), Centre of Technology and Engineering for Nuclear Projects (RO), Tecnatom (E), University of Stuttgart (D), VTT Technical Research Centre of Finland (SF), Lappeenranta University of

Technology (SF), Instituto Tecnologico e Nuclear (P), Nuclear Department, HMS Sultan (UK), Uppsala University (S), Technical University of Sofia (BG), University of Ljubljana (SI), ISaR Institute for Safety and Reliability (D), Paks Nuclear Power Plant (HU), GfS Gesellschaft für Simulatorschulung (D), PENTRAC Pan-European Nuclear Training Centers Association (HU), University of Manchester (UK), European Nuclear Society.

REFERENCES

[1] OECD/NEA, "Nuclear education and training: Cause for Concern?", OECD 2000, ISBN 92-64-18521-6

[2] "Strategic issues related to a 6th Euratom Framework Programme (2002-2006)". Scientific and Technical Committee Euratom. EUR 19150 EN. Pag.14.

[3] "Strengthening the Agency's Activities related to Nuclear Science, Technology and Applications". IAEA. GOV/2003/53-GC(47)11, August 11, 2003.

[4] http://www.sckcen.be/ENEN

[5] http://www.world-nuclear-university.org

Table I: A "Board of Directors" elected by the General Assembly and a "Management Committee" manage the ENEN association. The management committee is constituted by the General Secretary, appointed by the Board of Directors and the Chairmen of the five different working committees.