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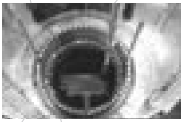 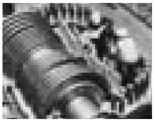 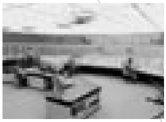 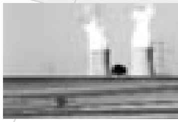

ILK Statement

on Maintaining Competence in the Field of Nuclear Engineering in Germany

Für deutsche Fassung bitte umdrehen!

March 2004
No.: ILK-17 E

Foreword

The International Committee on Nuclear Technology (Internationale Länderkommission Kerntechnik, ILK) was established by the three German states of Baden-Württemberg, Bavaria and Hesse in October 1999. It is currently composed of 12 scientists and experts from Germany, France, Sweden, Switzerland and USA. The ILK acts as an independent and objective advisory body to the German states on issues related to the safety of nuclear facilities, radioactive waste management and the risk assessment of the use of nuclear power. In this capacity, the Committee's main goal is to contribute to the maintenance and further development of the high, internationally recognised level of safety of nuclear power plants in the southern part of Germany.

The issue of maintaining competence in the field of nuclear engineering has become an important topic especially in Germany but also in other countries. The ILK has already addressed this issue at several occasions in the recent past. In the current statement which was adopted on the 28th ILK meeting on March 22, 2004 in Augsburg, the ILK recommends various measures based on relevant international and national developments for maintaining or even advancing competence in nuclear engineering in Germany. The statement is directed both at the universities, technical colleges and non-university research institutions, at industry and also at the German federal government and the individual German states.

The Chairman

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1 Reason for an ILK Statement

In many countries where nuclear energy makes a significant contribution towards power generation, the nuclear energy programs were built up over a relatively short time period. In Germany, where nuclear energy represents the largest contributor to electricity production with a proportion of 30%, most nuclear power plants were commissioned in the 70's and 80's. The rapid growth in this area was paralleled by an equally fast staff build-up for the design, evaluation, licensing, construction and operation of the plants with similar developments already occurring earlier in the research area. To meet these staff demands, many German universities built up education programs tailored towards nuclear energy technology. With the end of the expansion period, staff numbers started to fall, most noticeably in the manufacturing sector. The decline outweighed the demand for replacements, so that the nuclear industry as a whole had practically no recruitment needs. At a later point in time, the German reunification suddenly expanded the reservoir of well-trained recruits. All employers in nuclear engineering benefited from this development at least temporarily.
The necessary build-up of staff capacity in research and development on nuclear waste management has not been able to compensate for the decline in staff demand in nuclear energy generation.
German universities have responded to this development over the past 10 years by either closing or by considerably cutting back their nuclear engineering course offerings. A comparable development has taken place in other large industrial nations as well.

In Germany, this development has been considerably accelerated and reinforced by the nuclear phase-out strategy pursued by the federal government (amendment to the Atomic Energy Act dated April 2002) and by the consensus struck with the licensees (consensus agreement dating from June 14, 2000). It needs to be remembered, however, that comprehensive knowledge in nuclear engineering is necessary especially for the remaining operating terms but also for the decommissioning of nuclear facilities and waste management. For this reason, it is of some concern to discern that the lack in public funding of research on innovative nuclear engineering and safety-related concepts has jeopardized the training of scientific recruits at the universities and at research institutions not affiliated to the universities. Additionally, the extraordinarily negative image of nuclear energy in the German public media when compared to other countries has contributed to this alarming development. The recent portrayal of the topic "Intentional airplane crash on nuclear power plants" once again displayed the negative attitude harbored by many media representatives.

The ILK fears that, given a continued reduction in the number of training opportunities at German universities and given a continuing low level of interest shown especially by the qualified young generation in obtaining degrees in nuclear engineering, the maintenance of nuclear know-how and a competent staff base could be endangered among licensees, the manufacturing and service industry, third party experts and the regulatory authorities. Furthermore, the ILK fears that the lack in public funding of research on innovative safety and reactor concepts, will lead to a cut-off of research on nuclear safety in Germany from international developments in the medium term. Clear indications of this trend are already in evidence.

Faced with these facts, the ILK has recently addressed the topic of maintaining a comprehensive nuclear competence in Germany a number of times. Expanding on the relevant international and national developments and activities surrounding competence maintenance [1], the ILK evaluates the current situation in Germany and gives recommendations on measures and initiatives for preserving and furthering domestic competence in nuclear engineering. In so doing, the ILK not only refers to nuclear energy and reactor technology but also expressly addresses the aspects of nuclear safety research, radiation protection and waste management.

2 The German Situation

2.1 The Situation at Universities

Many German universities have reacted to the internationally discernible trend of student number reductions in nuclear engineering and to the aggravating national conditions in a logical way by reassigning or devaluing university chairs following retirement of the professors. The result has been a considerable shrinking of the offer of nuclear engineering courses at German universities. According to Knebel [2], in 1995 there were still 22 universities and 13 technical colleges offering an education in nuclear engineering. In 2002, only 11 universities and 6 technical colleges remain. It should be added that a truly comprehensive training in nuclear engineering is only really possible at the universities of Aachen, Munich, Stuttgart, Karlsruhe and Dresden and also at the technical college in Zittau/Görlitz. Even at these locations the course offerings are not guaranteed in the coming years. Especially Aachen's chair of nuclear engineering faces an uncertain future.
The existence of the university chairs is endangered not only by the current dearth of students, but also significantly by the refusal of the federal government to provide funding for research on innovative safety and reactor concepts. In this way, a downward spiral consisting of seemingly dire career prospects for nuclear engineering graduates coupled with a deficiency of innovation potential in nuclear engineering has been set in motion.
This development jeopardizes the ability to maintain the achieved high safety level of nuclear power plants operated in Germany during the negotiated remaining operating terms at the internationally progressing level of science and technology. Currently, both industry, i.e. manufacturers and licensees, as well as third party experts and regulatory authorities have shifted their recruitment drive towards the pool of scientists at universities and research institutions. However, without initiating sufficient measures for rearing qualified recruits, also through a substantial participation by the "clients" of universities and research institutions, the problem of preserving competence cannot be solved.

In view of the phase-out agreement and the slump in subsidies, the federal ministry of economics (Bundeswirtschaftsministerium, now BMWA[1]) attempted to achieve long term preservation of preventive research in the field of nuclear safety and waste management research already in 1998/99. The BMWA kicked off a nationwide evaluation of the nuclear safety and waste management research at the hands of a commission with a well-balanced composition of members, which included, amongst others, representatives of the federal environmental and the federal research ministries. As a result of the evaluation, the **national Alliance for Competence in Nuclear Technology** was established in 2000. Affiliates include the research centers Jülich, Karlsruhe and Rossendorf as well as the GRS (Society for Plant and Reactor Safety, Gesellschaft für Anlagen- und Reaktorsicherheit) and the BGR (Federal Institute for Geosciences and Resources, Bundesanstalt für Geowissenschaften und Rohstoffe). The universities and technical colleges in the geographical vicinity of the research institutions in question are also affiliated with the Alliance for Competence. To date, industry merely holds an observer status in the Alliance for Competence.
The primary task of the Alliance for Competence is to efficiently deploy the funds made available for nuclear safety and waste management research through coordination and division of labor regarding the subject matter and tasks. Although the Alliance for Competence does not have its own means of funding, it is also responsible for competence maintenance within its means. For instance, at the suggestion of the Alliance for Competence, the BMWA promotes young scientists at the universities within the framework of project-related reactor safety research.

Next to the issues outlined above, a comparison of the competence maintenance initiatives in Germany compared to international efforts which are described in detail in the **annex** can be characterized as follows:

- *Build-up of Competence Centers*
  In Germany, there are various approaches at different stages of development for competence centers with a local orientation that are established under the auspices of the national Alliance for Competence and where universities and non-university research institutions get together. These include the "virtual institutes" as they have been initiated by the HGF[1], especially for the Southwestern part of Germany, as well as the Competence Center East for Nuclear Technology which involves a close cooperation between the Technical University of Dresden, the technical college Zittau/Görlitz and the research center Rossendorf.

- *Creation of University Networks*
  A comprehensive cooperation in teaching that is typical for networks has not yet taken place between German universities. Efforts in this direction have been undertaken between the universities of Stuttgart and Karlsruhe. Discussions on further-reaching cooperation of the major German universities still involved in nuclear engineering (Aachen, Stuttgart, Karlsruhe, Munich, Dresden) both amongst each other and between German universities and international edu-

[1] Bundesministerium für Wirtschaft und Arbeit: Federal Ministry for Economics and Labour

[1] Hermann von Helmholtz-Gemeinschaft Deutsche Forschungszentren: Hermann von Helmholtz-Society German Research Centers

cational institutions take place within the framework of the planned participation in the European Nuclear Education Network (ENEN) which was founded in the Fifth EURATOM Framework program. Of special significance is the joint Master's Degree in nuclear technology offered by the cooperation of the TU Munich with the French Institut National des Sciences et Techniques Nucléaires (INSTN), which can be completed by students practically without any additional time burden.

- *Research Support Programs for Universities*
  Apart from the above-mentioned initiatives of the BMWA focusing on the promotion of young scientists, there are no state-funded or industry-supported research programs that specifically target universities. While universities may apply for funds of project-funded reactor safety research of the BMWA, the budget cut for this area of subsidy means that universities are subject to a very tough competition with other research institutions.

- *Support of University Infrastructure*
  In Germany, the infrastructure required for a university education in nuclear engineering is frequently located at research institutions to a considerable extent due to the common practice of dual appointments of university professors at both universities and research institutions. Thus only very few research reactors remain at the universities that are used primarily for educational purposes. The new research reactor at the Technical University of Munich will only be used for directly educational purposes to a very limited extent. However, the entire reactor environment will present many opportunities for "learning by doing". In contrast to international conditions, there is no state-funded program for maintaining these training reactors and for reinforcing other infrastructural elements for a training in nuclear engineering.

- *External Financing of University Chairs*
  Compared to countries such as the UK, Sweden and now also Switzerland, the degree of private sector engagement for medium and long term financing of nuclear technology related university professorships can be judged to be insufficient.

- *Sponsorship of Students, Ph.D. Candidates and Young Scientists*
  State- and privately-funded sponsorship programs for Ph.D. students and young scientists have been awarded in the past. However, they have not been very successful. Newer approaches seem more promising due to the improved financing for young scientists and also because of the increasing demand. Next to the 10 positions for budding scientists at the universities sponsored by the BMWA, both Framatome ANP and the German utilities are financing a total of 14 Ph.D. students. Also from an international perspective, the external engagement for promoting Ph.D. students and young scientists in Germany can be viewed as quite impressive. Other promotion mechanisms aimed at students at Masters degree level are, in contrast, relatively undeveloped in Germany.

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- *Content Diversification of Nuclear Engineering Degrees*
  Enriching the scope of nuclear engineering courses, for example with topics from the fields of radiation protection/radiation biology and systems analysis is successfully implemented abroad in order to enhance the attractiveness and the practical application of the education also with regard to new areas of employment. Similar approaches exist both at the Technical University of Munich in the wake of the restructuring of its nuclear engineering courses and also at the Technical University of Dresden that introduced a new orientation towards radiation oncology. Other universities also have the potential for taking similar measures; however, thus far they have not made any concrete modifications to the existing "classic" concepts oriented towards generating electricity from nuclear power.

- *Participation of Private Research Institutions and Companies in Vocational Training*
  In Germany, the participation of research institutions not affiliated to universities in tuition is normally regulated through the already mentioned dual appointments of university professorships. Beyond this arrangement, there are only very few teaching appointments and honorary professorships for lecturers from the private sector and from non-university research institutions. A systematic involvement such as in France does not exist in Germany.

2.2 The Demand for Recruits in Germany

The evaluation of the overall situation and the recommendations to be derived from it naturally depend largely on the demand for staff recruits in nuclear engineering. The Alliance for Competence in Nuclear Technology conducted a first survey on the need for university and technical college graduates with an education in nuclear engineering [3] in 2000. Starting with the current state among licensees, manufacturers, service industry, regulatory and third party expert bodies as well in research, the demand for qualified recruits up until 2010 was investigated, bearing in mind that 6 or 7 NPPs will be decommissioned by 2010.
According to the survey results, the total number of employees in nuclear will fall by about 10%, with the greatest reduction being among licensees and third party experts with approx. 20%. This development is countered by a slight growth in demand for waste management. Despite the overall drop in staff capacity, the age-related staff deficits need to be compensated. For this purpose, the survey states that about 170 graduates with a university or technical college background will be required per year. The licensees stated a quota of 30% for the proportion of graduates with **in-depth** nuclear knowledge; this figure rises to 40% for the manufacturing and service industry. However, the licensees believe that there will be essentially no new appointment of university and technical college graduates in their field until 2010 since the remaining staff demand in a phase-out scenario could be satisfied by redeploying existing staff among the plants.
If a quota of 30% is also hypothesized for research, third party experts and the authorities, an annual total demand of about 60 graduates with in-depth nuclear training results. Even if a lump quota of 25% is assumed for the entire nuclear engineering field, a need for 40 nuclear engineering graduates per year still remains. These figures of between 40 and 60 graduates with an in-depth education in nuclear engineering lead to a breakdown of between 1.9 – 2.8 nuclear engineering graduates per year and GWe. Compared to international figures, this represents a median recruitment rate (France: 1.3; Sweden: 5.3).
If these international data are taken into account, one must assume that the secured demand in Germany, even under phase-out conditions, will amount to at least 40-60 graduates with in-depth nuclear engineering training per year.

3 Evaluation and Recommendations

Enrolment in nuclear engineering has clearly diminished at German universities in recent years. Correspondingly, the respective course offers have narrowed. The structure currently in existence was not built up with the aim of covering current demands. Instead, it consists of the remaining elements of an earlier educational system that was conceived to satisfy a greater demand of the nuclear power industry.
The ILK deems it necessary to adapt the system to current requirements in a targeted manner. In this way, the effectiveness of the means applied should be optimized and the financing should be secured.

In the ILK's opinion, one of these current requirements, next to an in-depth education in nuclear engineering, is the ability to offer fundamental nuclear engineering knowledge within the framework of a general course of studies or core interdisciplinary knowledge, e.g. for physicists, mechanical engineers or electrical engineers, at as many universities as possible. This interdisciplinary approach represents a decisive contribution towards a better understanding of nuclear engineering and thus towards its acceptance as well as for improving opportunities to enlist qualified recruits from related degree courses.

The ILK furthermore emphatically believes that an education in nuclear engineering must not be restricted to „classic“ nuclear reactor technology and reactor physics, but should instead increasingly include aspects of radiation protection, radiation biology, waste management, systems analysis, risk management and also of atomic law.

For this reason, the ILK makes the following recommendations:

- *Build-up of Competence Centers*
  The existing approaches for building up regional and also supraregional competence centers should be undertaken under the auspices of the national Alliance for Competence. These competence centers should provide a meeting ground for universities/technical colleges, research institutions and if possible also for the private sector as well as for technical expert bodies. These competence centers should attempt, amongst others, to make the course offerings of the involved universities more attractive through a greater orientation of the course contents to practical requirements, the early involvement of students in research activities, and the joint supervision of students at Masters or Ph.D. levels. Within the framework of these competence centers, the nuclear engi-

neering industry can make a targeted and cost-effective contribution towards the promotion of education and research.

- *Creation of University Networks*
  Educational cooperation could be of particular interest to those universities that are no longer able to offer the full scope of nuclear engineering courses. A training course that has been agreed upon among the universities can definitely increase the attractiveness of a nuclear engineering degree, especially if universities from other countries can be included. The engagement in the European Nuclear Education Network (ENEN) offers good prerequisites for such a venture. A network of this kind is based on the mobility of both students and also of the teachers.

- *Research Support Programs for Universities*
  Aside from the BMWA and licensee programs aimed at promoting Ph.D. scholarships and young scientists, in the field of nuclear energy in Germany there are no state-funded or privately financed research programs that directly target universities. This represents a major drawback in the effort to maintain university departments for nuclear engineering. One justification for the preservation of university departments, next to the student numbers, stems from the reputation in the international research environment. In this context, especially private industry initiatives are called upon to finance innovative and internationally prevailing topics that do not receive support from public funding due to the phase-out agreement. Moreover, an increased cooperation between universities and nuclear research centers in the field of research programs may enhance the attractiveness of research at the universities.

- *Promotion of University Infrastructure for an Education in Nuclear Engineering*
  As in the USA, a mostly publicly financed promotion program should focus on maintaining the remaining training and research reactors at German universities. Additionally, and in accordance with the educational focus of each individual university, different types of research equipment such as neutron sources or radiochemical laboratories should be included in the program.

- *External Financing of University Chairs*
  A long term private sector engagement can help universities maintain their course offerings in nuclear engineering. By giving the benefactor a say in the dedication of the university chair, he is simultaneously given an influence over the practical orientation of the curricular and research profile.

- *Sponsorship of Students, Ph.D. Candidates and Young Scientists*
  While the main concern in the promotion of Ph.D. candidates and young scientists should be to stabilize the currently initiated and privately and publicly funded programs, the promotion and supervision of students in Masters degree courses should be systematically built up. It would make sense if such a promotion were to include a conditional employment offer by the sponsoring company.

- *Content Diversification of Nuclear Engineering Degrees*
  To round off and update the nuclear engineering course contents not only requires a cooperation between universities but also requires an improved cooperation within the university under consideration. In this way, the classic nuclear engineering degree can be enriched with training modules from the fields of radiation protection/radiation biology, radioecology, waste management, risk management or atomic law and thus be made more attractive to students and be adapted to better suit practical needs.

- *Participation of Private Research Institutions and Companies in Tuition*
  With the exception of the so-called joint appointments, there is little tradition of the participation of private research institutions and staff from industry in teaching when compared to other countries. In future, industry and research institutions should, on the one hand, offer a greater array of training opportunities (internships, lectures, exercises); the universities, on the other hand, should make greater use of these.

Overall, the ILK asserts that the individual recommendations can only take effect if one succeeds in convincingly conveying to the next generation that a career in nuclear engineering offers a viable and fascinating perspective. This will only be possible when German universities and research institutions can once again participate to a greater extent in international research on innovative systems and safety concepts in nuclear engineering aided by private and state financing.

4 Literature

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[3] P. Fritz, K.D. Closs, B. Kuczera, P. Erlenwein, G. Langetepe, F.P. Weiß, K. Wolfert, Vorauseilender Ausstieg aus der Kernenergie an den deutschen Hochschulen und Forschungszentren? Arbeitsplätze und Studienangebote im kerntechnischen Bereich, ATW, Heft 2, Seite 88 - 94, Februar 2001

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Annex

I Activities in Other Countries

The typical measures taken for maintaining competence in France, United Kingdom, Canada and the USA will be briefly presented in the following. These are viewed as being representative of foreign activities on the whole.

I.1 France

Since the 1950's, the Institut des Sciences et Techniques Nucléaires (INSTN) represents a central element of university level training in nuclear engineering in France. To this day, it remains the only French university that has state-approved nuclear engineering courses at the Masters level. The course at INSTN is mostly taught by assistant lecturers from industry (especially AREVA/FRAMATOME and EdF) and also from research institutions (IRSN and CEA). The INSTN offers a one-year course in nuclear engineering that concludes the fifth year of university degree courses attended at other engineering schools (Grandes Écoles) and also at universities. INSTN graduates complete their studies as engineers for nuclear engineering (Génie Atomique). It is also possible to do a doctoral thesis at the INSTN (as a collaboration between the CEA and the universities).
INSTN graduates practically always find employment in small nuclear engineering companies. EdF, however, usually satisfies its recruitment demand for the most part from the pool of graduates of non-nuclear study courses or takes on employees from these smaller companies.

I.2 United Kingdom

UK national spending on nuclear fission R&D has been in decline since the mid-1970s. This decline was accelerated during the late 1980s and early 1990s as a result of the UK Government decision to withdraw from fast reactor R&D, and as a result of the privatisation of the electricity supply industry. By the late 1990s, UK Government spending on nuclear fission R&D had reduced to almost nothing. Reflecting this situation, UK universities reduced their teaching and research activities in nuclear technology, so that by the late 1990s, all undergraduate degree courses in nuclear science and engineering had been discontinued. In response to this situation, British Nuclear Fuels PLC (BNFL) established a new approach to maximise its existing good links with the university community. In cooperation with key university partners, BNFL has currently established four University Research Alliances. Each Alliance addresses a core area of technology, the selection of which is based on BNFL's current and future business needs. The resulting Centres of Excellence have attracted a skill base of over 140 researchers, working on topics which range from basic science to applied development. Each Alliance receives kick-off financing from BNFL of around 3 mil. € for 5 years. It is anticipated that this will enable the Alliances to attract funding from UK research councils and other sponsors amounting to around four times this value.

I.3 Canada

In 2002, the University Network of Excellence in Nuclear Engineering (UNENE) was founded in Canada. Currently, 8 universities are involved. Next to issues of education and training, the network also addresses research. Each of the participating universities is responsible for a specific field of study.
The UNENE is financed by the Natural Sciences and Engineering Research Council (NSERC) with support by industry including licensees. NSERC and industry have pledged financial assistance amounting to a total of 5.4 mil. € over 5 years. These funds will also be used to finance university chairs.
Furthermore, it is also the intention of the sponsors to achieve the creation of an independent and publicly credible expert group with UNENE that is able to advise the public, the regulatory authorities CNSC, the government, the manufacturers and the licensees on nuclear issues.

I.4 USA

As in Germany, the number of students enrolled in nuclear engineering courses in the USA has declined considerably (by 60% for Bachelors degree courses and by about 30% for Masters and Ph.D. courses). At the end of the 90s, the number of students remained constant at a low level (approx. 350 students enrolled in the Masters degree courses and about 180 graduates per year). Additionally, ever since the 1960s, the number of universities that offer an education in nuclear engineering has dropped from 60 to 25 [A1]. Some of the remaining institutions include those with outstanding reputations such as the Massachusetts Institute of Technology and the University of California at Berkeley. The universities have increased the attractiveness of their course offering by, for example, including topics such as radiology and radiation protection in their teaching curricula.
Internal university activities such as these are flanked by several programs initiated by the Department of Energy (DoE). Special mention should especially be given to R&D programs on challenging and innovative topics in nuclear engineering which are also tailored towards the promotion of young scientists and universities. Examples include the Nuclear Research Initiative for Improving US Lightwater Reactor Technology and the Generation IV program for developing new reactor

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concepts and nuclear systems respectively. The programs sponsored by the DoE also concern the fields of radiation physics/biomedicine, risk analysis and transmutation. The DoE spent about 126 mil. USD on these R&D programs in the year 2002. Furthermore, the DoE also directly supports university research via the so-called University Reactor Fuel Assistance and Support Program. This program supports the university infrastructure and specifically the maintenance of research and training reactors [A2]. Scholarships for students and Ph.D. candidates can be financed with these funds. A total of 17.5 mil. USD was earmarked for this purpose in 2002. Additionally, the DoE offers programs for creating and supporting university cooperation and networks. For instance, the Innovations in Nuclear Infrastructure and Education Program promotes the joint use of research reactors by several universities while also fostering strategic partnerships between universities, national laboratories and industry. Within this framework, four university consortia were supported with over 5 mil. USD in 2002 [A3]. Each of the consortia has focused on a specific technical topic. The consortia are each coordinated by a lead university.

II International Activities

Next to such national initiatives as outlined above, the EU-Commission, the World Nuclear Association (WNA) and the NEA[1], amongst others, have also addressed the issue of preserving nuclear engineering competence.

II.1 Competence Maintenance in the Research Framework Programs of the EU

The central initiative for maintaining competence in the Fifth Framework Program is the so-called ENEN-project. ENEN is the abbreviation for the European Nuclear Education Network. Its essential goals include the definition of requirements placed on nuclear engineering degree courses at European universities, the preparation of a Europe-wide coordinated approach for strengthening university education in nuclear engineering and the testing of selected models of networked degree courses. ENEN involves 23 universities and 3 research centers from European member states (including Germany), candidate countries and Switzerland. The EU ENEN project expired at the end of 2003. The most important result has been the foundation of an ENEN-Association with headquarters in Paris that is grafted onto the infrastructure of INSTN. Next to the logistical support for the jointly offered postgraduate course that is offered Europe-wide, the Association’s tasks include awarding a European Masters in Nuclear Technology as a supplementary degree, the development and promotion of connections between universities on the one hand and between manufacturers, licensees, research institutions and authorities on the other.

[1] Nuclear Energy Agency of the OECD

The logical continuation of ENEN occurs under the guise of the NEPTUNO-project in the Sixth EURATOM Framework program. This Nuclear Platform of Training and University Organisations (NEPTUNO) aims for the fusion of the ENEN university network with the training sector that is frequently organized by the private sector. In this way, both licensees and training organizations are hooked up with ENEN. NEPTUNO is scheduled to begin in 2004.

II.2 World Nuclear University

The World Nuclear Association (WNA), the international association of companies active in nuclear engineering that is sited in London, established the World Nuclear University (WNU) with support by WANO[1], IAEA and the NEA. Thus far, universities and research institutions from 32 countries have expressed an interest in cooperating with the WNU [A4]. This includes many institutions that are already active in the ENEN Association. The aims of the WNU closely resemble those of the European ENEN network. The WNU furthermore also pursues the aim, in the style of the Canadian university network, of establishing a body of experts that is able to advise politicians and the general public in a credible and competent manner.

Essentially, the WNU is to be financed by companies participating in the WNA.

II.3 Analysis of the NEA

The OECD's Nuclear Energy Agency prepared a detailed analysis of the international state of university education and training in nuclear engineering over the past years and published the results in the report „Nuclear Education and Training: Cause for Concern?" [A5]. The report is based on a survey of 200 organizations from 16 OECD countries. In this report, the NEA makes some of the following recommendations for improving competence maintenance:

- Governments and industry including licensees should jointly engage in a coordinated effort to preserve competence in nuclear engineering.
- Universities should broaden the spectrum of topics covered in nuclear engineering education in order to attract more students also from other disciplines; the students should be introduced to research at an earlier stage.
- Industry, research institutions and universities should better coordinate their educational activities and should aim for enlarged international cooperation.

[1] World Association of Nuclear Operators

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III Literature

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11. **Prof. Dr.-Ing. habil. Eberhard Roos, Germany**
   Holder of the Chair for Material Testing, Material Science and Material Properties at the University Stuttgart
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12. **Prof. Dr. Frank-Peter Weiß, Germany**
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(Members are listed in alphabetical order)

ILK Publications:

ILK-01 ILK Statement on the Transportation of Spent Fuel Elements and Vitrified High Level Waste (July 2000)

ILK-02 ILK Statement on the Final Storage of Radioactive Waste (July 2000)

ILK-03 ILK Statement on the Safety of Nuclear Energy Utilisation in Germany (July 2000)

ILK-04 ILK Recommendations on the Use of Probabilistic Safety Assessments in Nuclear Licensing and Supervision Processes (May 2001)

ILK-05 ILK Recommendation on the Promotion of International Technical and Scientific Contacts of the Nuclear Safety Authorities of the German States (October 2001)

ILK-06 ILK Statement on the Draft Amendment dating from July 5, 2001 to the Atomic Energy Act (October 2001)

ILK-07 ILK Statement on Reprocessing of Spent Fuel Elements (November 2001)

ILK-08 ILK Statement on the Potential Suitability of the Gorleben Site as a Deep Repository for Radioactive Waste (January 2002)

ILK-09 ILK Statement on the General Conclusions Drawn from the KKP 2 Incidents associated with the Refueling Outage of 2001 (May 2002)

ILK Publications

ILK-10 ILK Statement on the Handling of the GRS Catalog of Questions on the "Practice of Safety Management in German Nuclear Power Plants" (July 2002)

ILK-11 ILK Recommendation on Performing International Reviews in the Field of Nuclear Safety in Germany (September 2002)

ILK-12 Internal ILK-Report on the Intentional Crash of Commercial Airliners on Nuclear Power Plants (March 2003)

ILK-13 ILK Statement on the Proposals for EU Council Directives on Nuclear Safety and on Radioactive Waste Management (May 2003)

ILK-14 ILK Statement on the Recommendations of the Committee on a Selection Procedure for Repository Sites (AkEnd) (September 2003)

ILK-15 ILK Recommendation on the Avoidance of Dependent Failures of Digital I&C Protection Systems (September 2003)

ILK-16 ILK Statement on Sustainability Evaluation of Nuclear Energy and other Electricity Supply Technologies (January 2004)

ILK-17 ILK Statement on Maintaining Competence in the Field of Nuclear Engineering in Germany (March 2004)

- CD with presentations held at the ILK Symposium "Opportunities and Risks of Nuclear Power" in April 2001
- Proceedings of presentations held at the 2nd ILK symposium "Harmonisation of Nuclear Safety Approaches – A Chance for Achieving more Transparency and Effectiveness?" in October 2003