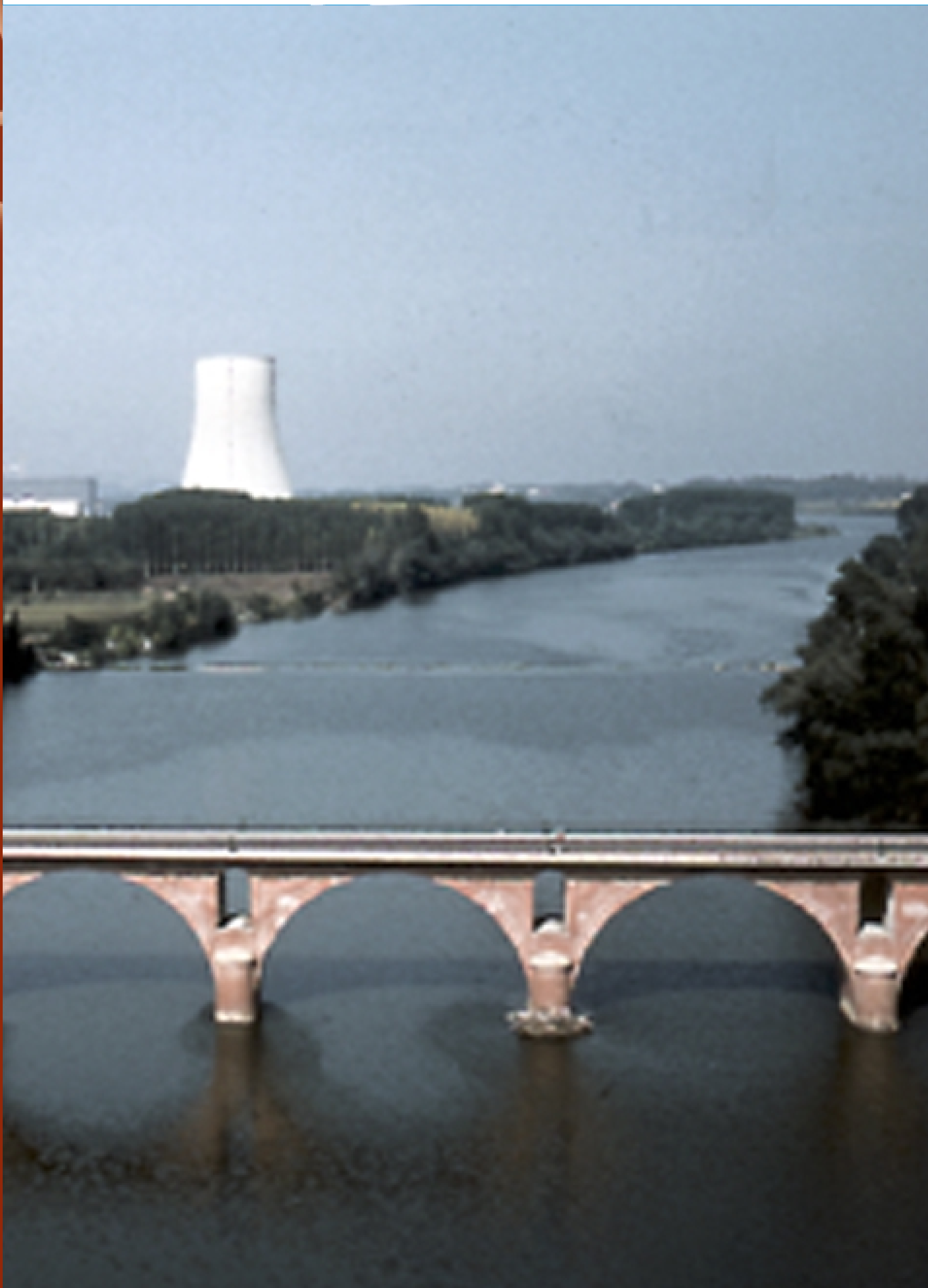
Newsletter

NUCLEAR • ENERGY • AGENCY



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NEA Newsletter

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1999
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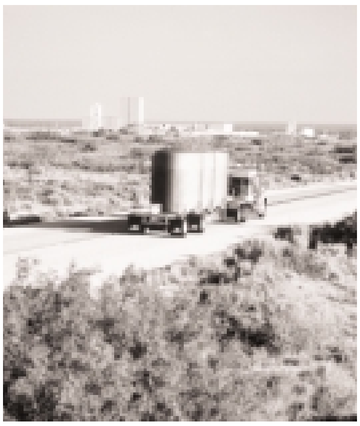
The OECD Nuclear Energy Agency (NEA) was established in 1958 as the OEEC European Nuclear Energy Agency and took its present designation in 1972 when its membership was extended to non-European countries. Its purpose is to further international co-operation related to the safety, environmental, economic, legal and scientific aspects of nuclear energy. It currently consists of 27 Member countries: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States. The European Commission takes part in the NEA's work and a co-operation agreement is in force with the International Atomic Energy Agency.

For more information about the NEA, see:

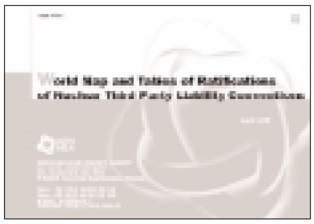
http://www.nea.fr

Facts and opinions

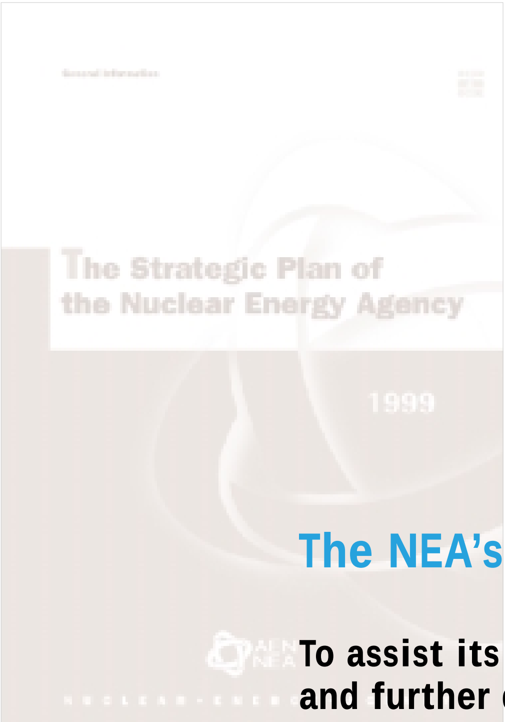
NEA update



NEA in brief

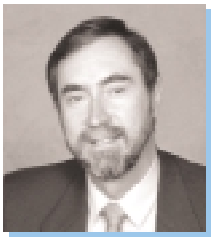


Cover page: General view of the Golfech nuclear power plant in France, courtesy of EDF, France.



The NEA's Mission Statement:

To assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.



The NEA Strategic Plan

Among the challenges facing the OECD in this day and age of aspiring economic globalisation and sustainable development, is the prospective role that nuclear energy could play in meeting future broad energy and environment objectives of its Members. As part of this process, a high-level advisory group on nuclear energy has delivered recommendations to the OECD Secretary-General regarding the future role of the Organisation in this area. One of the results has been to develop a Strategic Plan for the NEA.

The NEA's first Strategic Plan will serve as a fundamental tool for guiding the work of the Agency in the coming years including goals, priorities, methods of work and products. This Plan also addresses the adjustment of the structure of NEA bodies toward efficiency objectives.*

On the basis of its new Strategic Plan, the NEA will aim at fulfilling three major objectives, namely:

- *to provide Member countries and other parts of the OECD with nuclear policy analyses based on its technical work;*
- *to offer a forum for information and experience among Member countries and for promoting international co-operation;*
- *to create a centre of nuclear competence which helps Member countries pool and maintain their technical expertise and support their nuclear policies.*

Another new and important feature of the Strategic Plan is how the NEA could improve its interface with industry. In addition to responding to the needs of Member country governments, the NEA also recognises the important role of industry as a major stakeholder in nuclear energy matters, and the need to benefit from industrial expertise and experience. Furthermore, exchanges of technical contributions, excluding that of regulation, between key industry players and the NEA can be mutually beneficial.

The NEA Strategic Plan is aimed at helping to meet the evolving needs of its Members. Governments have traditionally played a major role with respect to research and development in the energy sector in general and specifically in the nuclear field. Many nuclear issues, such as safety, liability, waste and public information, have an international dimension. In addressing these issues, governments can benefit greatly from authoritative international assessments, and increased international co-operation to maintain nuclear expertise, and a sound scientific and technical infrastructure.

* *A free copy of* The Strategic Plan of the Nuclear Energy Agency *is available from the Secretariat.*

E. Bertel, I. Vera*

Three alternative nuclear paths to 2050

The circumstances surrounding nuclear power globally and the potential impacts of various issues affecting its future suggest several different paths to follow over the next 50 years. The NEA, as part of its programme on long-term prospects for nuclear power and its implications on climate change, has conducted a review of three potential developments of nuclear energy, identifying leading conditions, related challenges and consequences.

Economic deregulation, lack of competitiveness in some countries, public concerns about issues such as waste management and nuclear proliferation suggest that nuclear power might decrease progressively with a potential phase-out of the technology in the long term. Conversely, rapid growth in electricity demand world-wide and increasing concern over environmental degradation coupled with timely solutions to problems affecting nuclear technology today may allow a continuing penetration of nuclear power into the electricity market. A third alternative may be a progressive reduction in nuclear generation throughout a mid-term followed by a dramatic revival once nuclear advantages are recognised.

It is important to note that these nuclear paths illustrate possible but not predictive futures, depending on specific conditions and factors affecting nuclear development. The analysis of the implications resulting from these possible developments illustrates the potential contribution of nuclear power in alleviating the risk of global climate change.

* *Dr. Evelyne Bertel and Dr. Ivan Vera are members of the NEA Nuclear Development Division.*

Nuclear power and greenhouse gas emissions

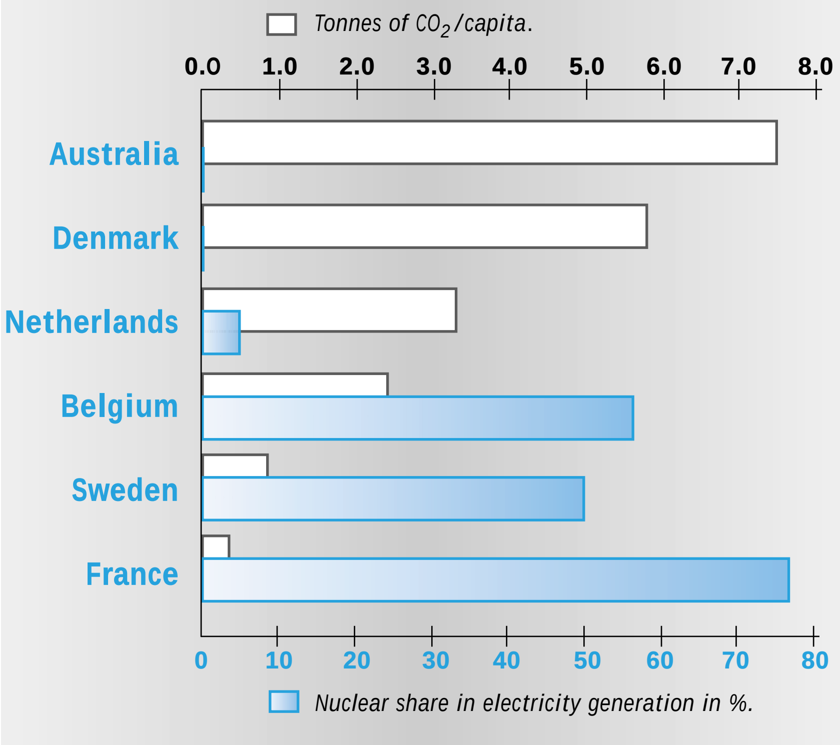
At the end of 1998, there were 437 nuclear reactors being operated in 32 countries globally, with a total capacity of 352 GWe (Gigawatt-electrical), some 86% of the world's nuclear power capacity is located in 16 countries of the OECD. In 1998, nuclear power plants generated 2 276 TWh (Terawatt-hours), which accounted for 17% of the electricity produced world-wide and 24% in OECD countries. The shares of nuclear power in total electricity supply exceeded 25% in 17 countries.

Nuclear power already contributes to lower the carbon intensity in the energy sector. A comprehensive analysis of greenhouse gas (GHG) emissions from different electricity generation chains shows nuclear power is among the least carbon intensive generating technologies, emitting only about 25 g of carbon dioxide equivalent per kWh (gCO_2 equiv./kWh) as compared with some 450 to 1 250 gCO_2 equiv./kWh for fossil fuel chains.[1] Assuming that the nuclear units in operation have substituted for modern fossil-fuelled power plants, the reduction of carbon dioxide emissions from the electricity sector amounts to about 17%.

A comparison of the CO_2 intensity, based on emissions from electricity and combined heat generated in 1995 in selected countries, illustrates the nuclear contribution. In countries with no nuclear power, such as Australia and Denmark, the CO_2 emissions per person are several times greater in magnitude than the corresponding CO_2 emissions in countries with large nuclear shares, such as France, Sweden and Belgium (Figure 1).

Other benefits with regard to the environment are related to the fact that the nuclear electricity generation chain does not release gases or particles that cause acid rain, urban smog or depletion of the ozone layer.

Fig. 1: CO_2 emissions per capita from electricity, combined heat, power generation and nuclear share in 1995



OECD/IEA, CO_2 emissions from fuel combustion, 1997 Edition

Alternative nuclear power developments

The three different potential nuclear power developments which have been considered by the NEA are illustrated in the table below and in Figure 2. They are not intended to reflect the extremes of all possibilities:

- *Path I, "phase-out"*, assumes that nuclear power would be phased out completely by 2045.
- *Path II, "continued nuclear growth"*, assumes that nuclear power capacity would grow steadily, reaching 1 120 GWe in 2050.
- *Path III, "progressive reduction followed by revival"*, assumes early retirements of nuclear units in the short term (to 2015) followed by a revival of the nuclear option by 2020 leading to the same nuclear capacity in 2050 as in Path II.

The global energy demand scenario adopted as a basic context for establishing the three nuclear paths is Case C of the 1995 International Institute for Applied Systems Analysis/World Energy Council (IIASA/WEC) study "Global Energy Perspectives to 2050 and Beyond".[2] In this "ecologically driven" scenario world primary energy demand would reach some 586 exajoule (EJ) per year (14 000 Megatonnes of oil equivalent, Mtoe) in 2050, and electricity consumption would reach some 23 000 TWh.

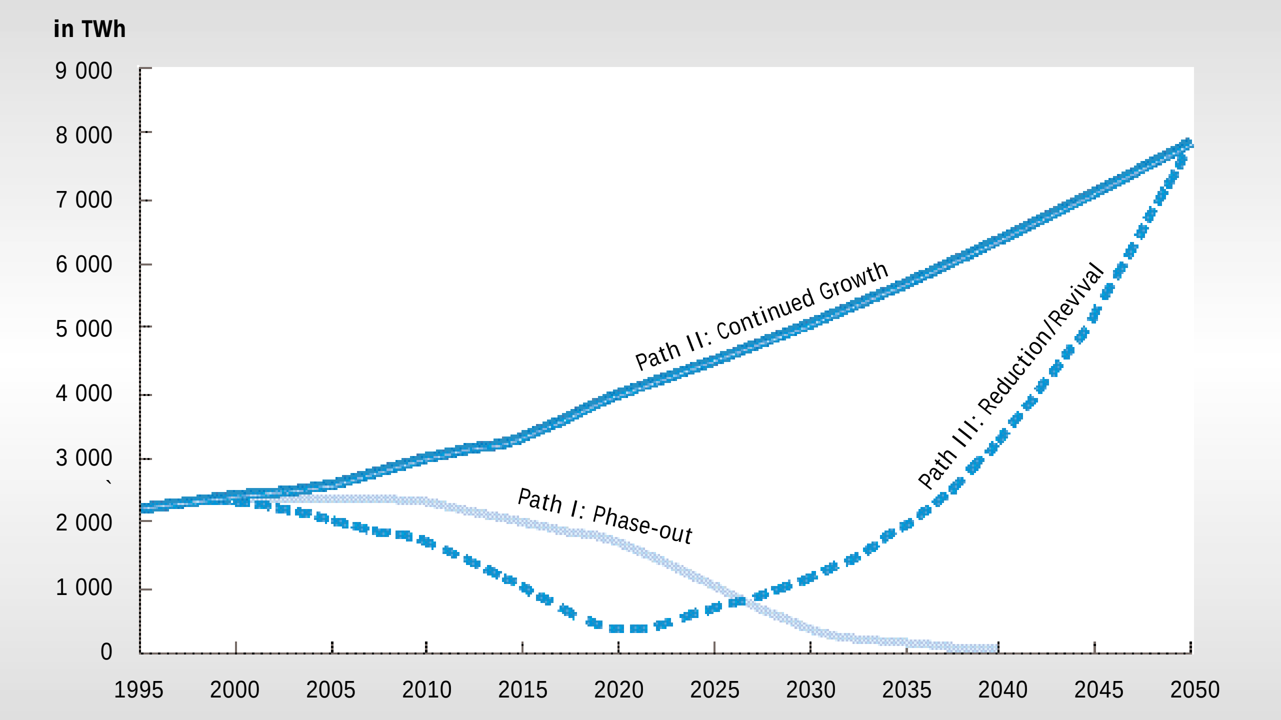
Three paths of world nuclear power capacity (GWe) up to 2050

Nuclear Path	2000	2010	2020	2030	2040	2050
I. Phase-Out	360	354	257	54	2	0
II. Continued nuclear	367	453	569	720	905	1 120
III. Reduction followed by revival	355	259	54	163	466	1 120

Path I: Nuclear phase-out

This path assumes that no new orders would be placed for nuclear power plants. Only the units already under construction would be completed. All units would be decommissioned after 40 years of operation (or less for the units for which an earlier shutdown has been announced already). Under these assumptions, all nuclear units would be retired by 2045. In Path I, nuclear

Fig. 2: World nuclear electricity generation



electricity generation in the world would increase slightly to 2 370 TWh in 2005, as plants that are under construction are completed, and decrease steadily thereafter to zero in 2045. Path I is not the lowest extreme of nuclear power evolution that could have been considered. For example, existing nuclear units might be retired earlier than assumed in this path.

This represents the path that some countries seem to be following given the very high rate of expected retirements and the absence of plans for new orders in the next 10 to 15 years. In fact, in OECD countries only Japan and Korea have firm plans for adding new nuclear capacity through 2015, although Finland and Turkey are also considering reactor orders. Countries with important nuclear programmes such as the United States, the United Kingdom, and Sweden are already planning for many of their nuclear plants to retire by 2015. The cumulative number of nuclear plants retiring by 2015 in OECD countries has been reported as 102 out of 358 currently operating.[3] Retiring capacity is about 58 GW out of 301 (19%) (Figure 3).

Circumstances negatively affecting the future of nuclear power include: lack of economic competitiveness in many countries, and concerns about radioactive waste, safety and nuclear proliferation. If these circumstances persist, the chances are high for a continued progressive decline in nuclear capacity toward a complete phase out by 2050. Nevertheless, it is difficult to imagine a complete phase out in several countries (e.g. France, Japan) which are highly dependent on nuclear power and which lack domestic fossil fuel and renewable energy resources.

Increasing the use of fossil fuels for electricity generation will make it more difficult to meet the United Nation Framework Convention on Climate Change (UNFCCC) objectives to reduce GHG emissions. In Path I, the avoided GHG emissions per year resulting from nuclear electricity generation would remain at around 1.8 Gigatonne per year (Gt/y) until 2010 and decrease to some 0.8 Gt/y in 2025 and to zero in 2045. The trend toward reductions in GHG, No_x and SO_x emissions observed in many countries with nuclear programmes would most likely be reversed. Consequently, higher levels of emissions per person and per MWh generated would be expected, depending on the mix of fossil-fuelled technologies used to substitute for nuclear.

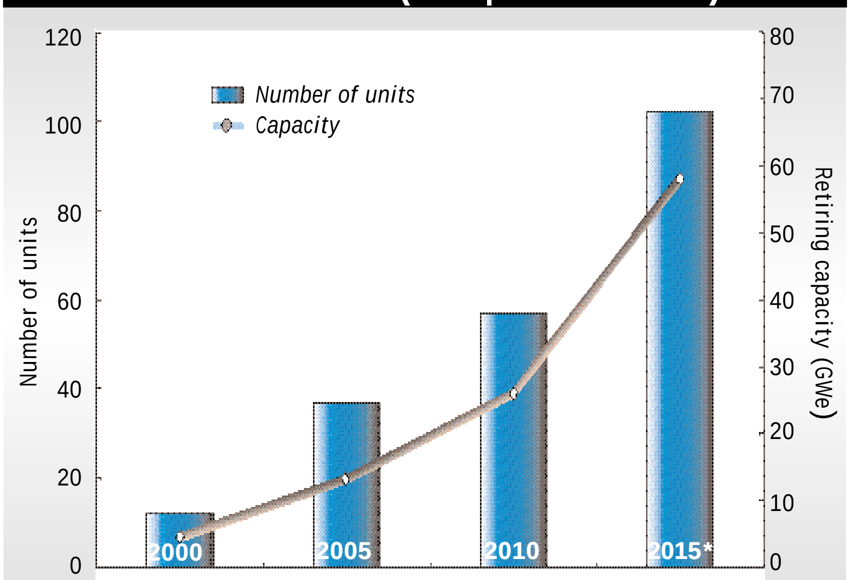
The consequences of a complete phase-out nuclear path would be increasingly translated into difficulties in meeting policy goals relating to supply security, fuel diversity and environmental protection.

Nuclear energy would have to be replaced mainly by fossil fuels since the contribution from renewables would be limited, at least in the medium term. In the short term, the most likely substitute fuel for nuclear power would be natural gas. Countries with low domestic fossil fuel resources would be forced to import even higher levels of fuel. Increasing demand for fossil fuels would put pressure on international markets. Large increases in gas demand would not only raise concerns about gas price escalation but also about security of energy supply as gas reserves are not evenly distributed in the world. In fact, over 70% of the 1996 world natural gas reserves are in countries of only two regions – the Former Soviet Union and the Middle East (15% in Iran). Any signs of instability in these regions could translate into disruption of supplies. Already, there are over 40 countries that are net importers of natural gas; some of them, including Japan, France, Italy and Germany, depend on imports for over 65% of their consumption.

Renewable energy sources are unlikely to contribute substantially to the total electricity supply at least out to 2025. The 1995 share of renewable energy (excluding hydroelectric power) in world-wide electricity production was only 0.4%.[4] The International Energy Agency (IEA) is expecting this share to increase only to about 0.9% by 2020. The OECD region where most of the nuclear reactors will be retired is already fairly saturated with respect to hydroelectric power. In fact, the share of hydroelectric power with respect to total electricity generation in the world is expected to decrease from 19% in 1995 to 15% in 2020.

The conflicting trends of diminishing emissions and phasing out nuclear may imply that some countries will have monofuel electricity sectors. If coal and oil continue following reducing trends, many countries will have to depend almost entirely on natural gas. Nevertheless, in the long term (after 2025), substitutes for nuclear power could include, in addition to gas-fired plants, coal-fired power plants based on advanced "clean coal" technologies and economically competitive renewable energy sources.

Fig. 3: Cumulative nuclear capacity retirements in OECD countries (as expected in 1997)



** Not all OECD countries have reported their retiring capacity for the year 2015.*

Path II: Continued nuclear growth

The continued nuclear growth path assumes that nuclear power programmes would expand in countries where nuclear units are in operation already and would be launched in countries (1 OECD and 15 non-OECD) which currently are planning to construct nuclear units by 2010-2015. Nuclear units reaching retirement would be replaced by new nuclear units. As a result, nuclear power capacity would grow steadily, but not at a very high rate because total energy and electricity demand growth rates are moderate within the energy demand scenario adopted. Nuclear electricity generation in the world would reach 7 850 TWh in 2050 as compared with 2 312 TWh in 1996. In 2050, nuclear would supply some 12% of total primary energy demand and some 35% of total electricity consumption, as compared with some 7% and 17% worldwide in 1996.

Circumstances affecting nuclear power negatively would need to be changed for this growth path to continue into the future and the changes would have to occur in the near-term. The industries and governments in countries with nuclear programmes or with plans to develop nuclear programmes would be challenged to maintain, or to create the conditions that would permit the progressive penetration of nuclear power in their electricity markets. In particular, it would be necessary to ensure that nuclear power improves its economic competitive position relative to alternative energy sources. In addition, issues related to the safe operation of nuclear reactors and the final disposition of nuclear waste would have to be addressed at a level that would satisfy the public in general.

Rapid growth in electricity demand world-wide coupled with increased environmental concerns, particularly with respect to climate change, could enhance the chances for nuclear growth. Recently, there have been some signs of a renewed recognition of the benefits that can be derived from nuclear power in the areas of environment and security and diversity of supplies. For example, the US Department of Energy released in the spring 1998 a Comprehensive National Energy Strategy that stresses the importance of continued reliance on nuclear power as the largest source of emission-free electricity.[5] In the UK a 1998 report released by a government committee on energy policy indicated that nuclear energy should not be ruled out in this country's energy future.[6] There is interest in Finland to build a fifth nuclear power unit in order to secure economic growth while complying with international agreements on cutting greenhouse gas emissions. A gradual change in Finnish public opinion has accompanied the ever-increasing electricity demand and a growing awareness of the environmental draw-backs of fossil fuel. A decision is scheduled to be reached sometimes in 1999.

The consequences with respect to security and diversity of supply are evident. Assuming a 35% nuclear share in total electricity by 2050, many countries would enjoy more diversified electricity sectors with respect to supply, and less dependency on fossil-fuels.

GHG emissions (expressed as CO_2 equivalent) avoided annually as a result of Path II would reach some 6.3 Gigatonnes (Gt) by 2050. GHG emissions avoided cumulatively to 2050 would be near 200 Gt. The factor of four reduction in GHG emissions from Path II (continued nuclear growth), relative to Path I (nuclear phase-out), highlights the significant role that an expanded use of nuclear energy could play in helping to reduce CO_2 emissions.

A reduction should also be expected in other types of emissions such as SO_x, NO_x and particulate in countries with increasing nuclear shares, and, as a result, less severe measures would be needed in non-nuclear sectors in order to achieve policy goals. The situation would be similar to the experiences of countries which have developed large nuclear programmes in the last 20 years. For example, in France, sulphur dioxide and particulate emissions from the power sector were reduced by factors of nine and ten, respectively, between 1980 and the mid 1990s, while electricity generation roughly doubled during the same period.

The projected levels of nuclear power development in Path II imply high consumption of nuclear fuel. At present, nuclear reactors are fuelled mainly with uranium and, in some cases, with recycled plutonium. Through the medium term, fuel from surplus defence inventories will be able to complement existing sources of civil fissile material. In the long term, thorium could become an additional natural resource for fuelling nuclear reactors, although thorium burning reactors would have to be developed and breeders could make nuclear power an essentially renewable energy source, through the replacement of fissile material consumed. In general, natural resource levels, civil and surplus defence inventories, technological means and industrial capabilities are expected to be adequate to meet required resources arising from this path up to 2050.

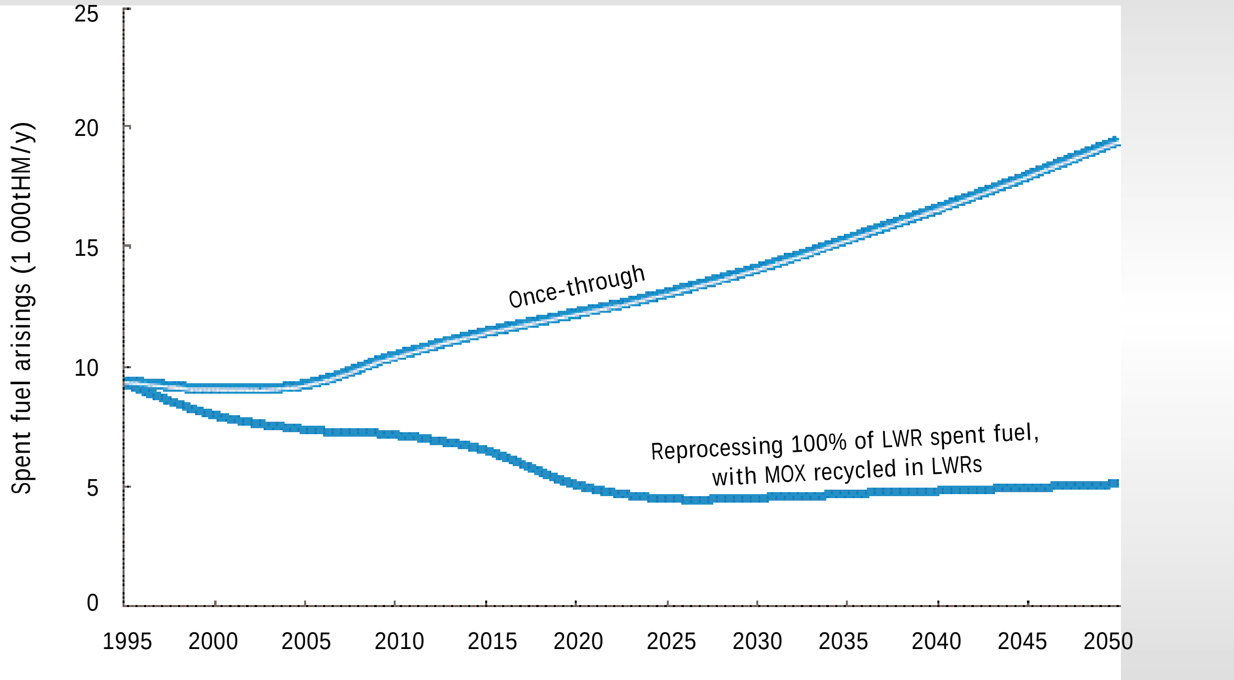
Natural uranium requirements arising from Path II would depend on the fuel cycle strategy adopted. Assuming that reactors would be operated on the once-through cycle, and that enrichment plant tails were to remain at present levels, annual natural uranium requirements would grow from less than 60 000 tonnes of uranium per year (tU/y) around the year 2000 to 175 000 tU/y in 2050. Those requirements exceed both the present level of production of fresh uranium (around 36 000 tU/y in 1996) and the production capability expected by 2010 (about 66 000 tU/y). However, demand growth would likely stimulate an expansion of production capacity, as was the case in the late seventies. Also, at present, uranium supply is met partly by drawing from excess civil and surplus defence inventories, and this is expected to continue in the coming five to fifteen years. In particular, dismantling of nuclear weapons would provide an additional supply of fissile materials for power reactors.

Cumulative uranium requirements in Path II would reach 5.6 million tonnes of uranium in 2050 if all reactors were operated following current fuel cycle strategies throughout the period. With these requirements, presently known uranium resources (4.5 million tonnes U) would not be sufficient. However, the cumulative uranium requirements would be far below the current estimation of total conventional resources recoverable at less than US$ 130/kgU (16.3 million tonnes U)[7] and it could be expected that additional exploration effort would considerably increase conventional resources.

On the demand side, uranium consumption per kWh can be reduced by:[8] increasing fuel burn-up, lowering enrichment plant tails assays and recycling plutonium and uranium recovered from reprocessed spent fuel. The combined effect of lowering tails assays and recycling could reduce cumulative uranium requirements by more than 30%.

If all reactors were operated on the once-through fuel cycle, spent fuel arisings would increase steadily reaching nearly

Fig. 4: Non-reprocessed spent fuel arisings in path II



19 500 tonnes of heavy metal per year (tHM/year) by 2050, i.e. more than twice the 1995 annual spent fuel arisings (around 9 300 tHM). Assuming, however, that all spent fuel from light water reactors (LWR) were reprocessed and recycled in LWRs accepting up to 30% mixed oxide fuel (MOX) in core, annual non-reprocessed spent fuel arisings in 2050 could be reduced to around 5 000 tHM/y (Figure 4). The introduction of fast reactors could reduce even further the accumulation of non-reprocessed spent fuel and of plutonium in excess of hold-up inventories at reactors and fuel cycle facilities.

Possible constraints that may be faced in Path II include: the rate of construction of new nuclear plants, the level of required investments and siting limitations.

In Path II, nuclear power capacity would more than treble between 1995 and 2050, reaching 1 120 GWe in 2050. Taking into account the replacement of nuclear power plants at the end of their lifetime, the nuclear plant capacity to be constructed yearly in this Path would be up to 35 GWe in the period 2010-2050. This rate of construction would far exceed that which has been experienced recently. However, past experience has shown that this construction rate is achievable. At the country level, with 47 countries assumed to have nuclear units in operation by 2040-2050, the global construction rate (35 GWe per year) would correspond to less than 1 000 MWe per year in each country.

The investment requirements for the construction of the expected nuclear capacity and associated fuel cycle facilities in this continued nuclear growth path are considerable. Potential constraints in raising the required funds include the perceived financial risks to investors and the need for adequate rates of return on energy investments. In the case of developing countries, the implementation of the nuclear power programmes would require international co-operation. Such co-operation agreements have been successfully implemented already in some countries, including China and Romania.

Siting of nuclear power plants and fuel cycle facilities may be a constraint since some countries might have difficulties in finding adequate sites meeting the seismicity characteristics and cooling capacities required for nuclear units. Nevertheless, most countries that are operating or planning to construct nuclear power plants have enough sites, or capacity on existing sites, to allow them to increase significantly their installed nuclear capacity. New reactor designs, especially small and medium-sized reactors with passive safety features and very low risk of off-site impact in case of accident, would increase the number of sites suitable for constructing and operating nuclear units.

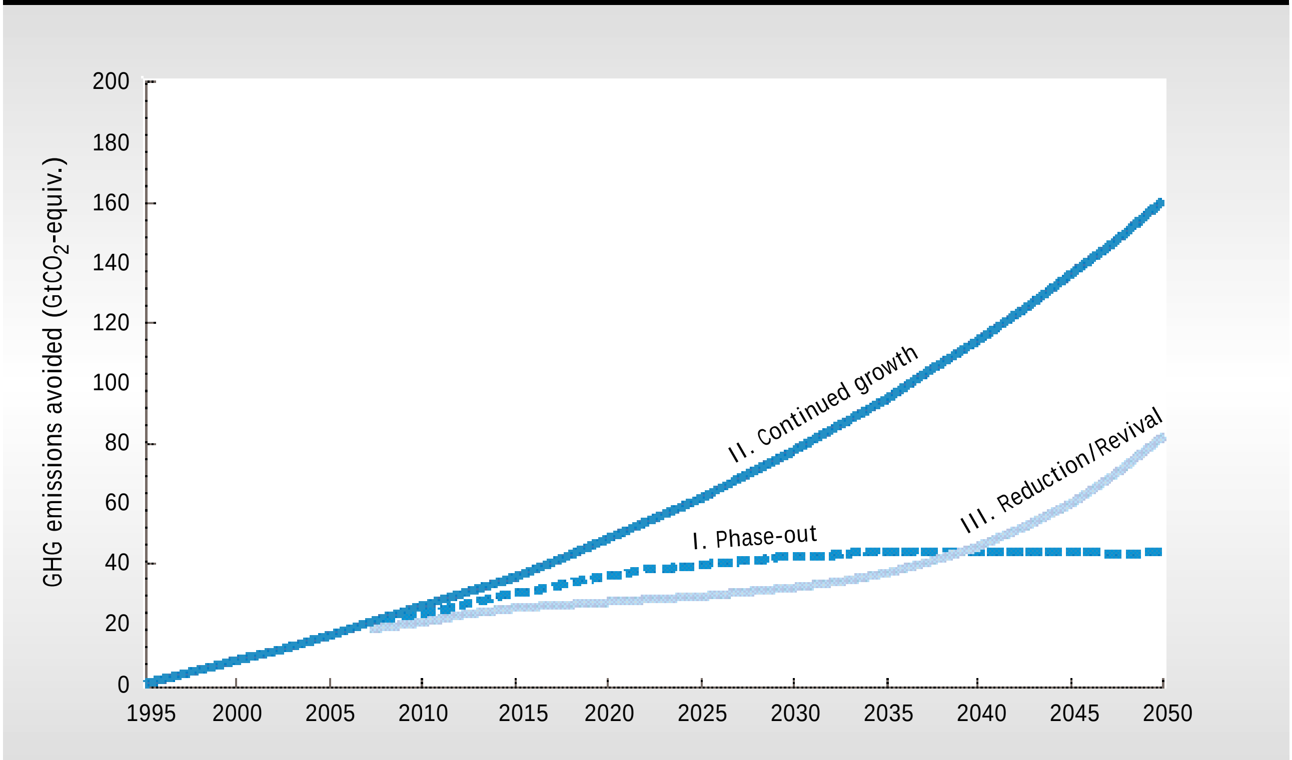
Path III: Progressive reduction in nuclear generation followed by revival

In Path III it is implied that a combination of energy price structures and a lack of public confidence in nuclear energy would render difficult the continuance of commercial nuclear programmes. Also, it is assumed that problems affecting nuclear power today would not disappear in the next few years, forcing the early retirement of a considerable part of the world capacity and further delaying orders for the construction of new nuclear units. The increasing demand expected for electricity world-wide, in the absence of a mature technology able to replace the retiring nuclear capacity, would eventually cause a return to nuclear power characterised by an accelerated deployment of new nuclear reactors. In addition, increasing concerns about the environment and security and diversity of supplies would contribute to the rebirth of nuclear.

Specifically, Path III assumes that no new nuclear power plants would be ordered until 2015-2020 and that existing units would be retired after 30 years of operation, with no replacement due primarily to waste and safety concerns, along with a lack of economic attractiveness and public acceptance. By 2020, nuclear electricity generation would have decreased to 360 TWh, i.e. less than 16% of the level of nuclear generation in 1997. After 2025, nuclear electricity generation would grow steadily to reach the same level in 2050 as in Path II (around 7 850 TWh) and the same share of total energy and electricity supply. The interest of this Path is in providing a framework for analysing potential stresses on the nuclear industries, and issues that might merit attention by governments in the context of a "progressive reduction followed by revival" scenario.

A revival of nuclear power by 2015 is assumed to be based upon a satisfactory performance record in nuclear power plant operation, satisfactory implementation of radioactive waste repositories, recognition that nuclear energy could alleviate a number of environmental concerns and a restructuring of energy costs through the widespread internalisation of externalities, together with improved nuclear technologies (reactor designs and fuel cycle strategies).

Fig. 5: Cumulated greenhouse gas (GHG) emissions avoided



In Path III, the level of annual GHG emissions avoided by 2050 would be the same as in Path II (6.3 Gt), but the contribution of nuclear power to GHG emission reduction would be marginal in the period 2015-2030. GHG emissions avoided cumulatively to 2050 would correspond to about 100 Gt. These avoided emissions represent only about half of those avoided in Path II (200 Gt), even though both paths reach the same level of nuclear electricity generation in 2050 (Figure 5).

A major concern related to this path is whether the supporting infrastructure would still exist by the time the revival would start to take place. Technical know how, industrial capabilities, availability of regulatory and legal frameworks are all factors that would be necessary to ensure a rapid deployment of nuclear reactors around the world.

The nuclear power plant construction rate in the later part of the period (2045-2050) would be much higher in Path III (55 to 75 GWe per year) than in Path II (25 to 35 GWe per year). The nuclear industry would likely face challenges to meet this rate, following a rather long period of low activity. In particular, it might be difficult to maintain adequate research and development efforts necessary inter alia to support advanced reactor designs in a sector affected negatively during nearly two decades. Furthermore, the education and training of qualified manpower for operating and, in the revival phase, constructing nuclear units could become a serious constraint.

Kansai Electric Power Co. Inc., Japan

Aerial view of the Mihama nuclear power plant, in Japan.

Conclusions

The future of nuclear power will be driven by a series of factors and circumstances that affect its development and by the importance given to the debate on climate change and sustainable development. Three possible nuclear developments illustrate the circumstances, implications and issues that could characterise the future of nuclear power. A complete phase-out path may have a significant negative impact on the environment and on the ability of many countries to provide security and diversity of fuel supplies for electricity. A sustained growth in nuclear power towards a 35% nuclear share in electricity by 2050 illustrates the dramatic contribution that nuclear power could provide to alleviate the risk associated with global climate change and in reducing dependency on fossil-fuel utilisation. A progressive reduction in nuclear generation followed by a revival highlights the challenge of maintaining the necessary infrastructure, achieving accelerated construction rates and ensuring a minimum level of R&D. In general, there are no physical limitations that could preclude nuclear power from following any of the three paths oulined; however, there are institutional policy implications that would need to be addressed in a timely manner to ensure the proper implementation of future strategies to satisfy world electricity demand.

Governments, industry, international organisations and policy makers, in general, have important roles to play in defining energy technologies that should be considered to ensure the satisfaction of future electricity demand given the goals of sustainable development. Nuclear power is one of the proven technologies that could be used to achieve this objective. ■

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C. Pescatore*

Long-term management of radioactive waste

Ethics and the environment

The protection of the environment and the ethical issues that it raises are important topics in the debate on the long-term management of radioactive waste. This article presents an overview of the general ethical principles developed in the wider context of the debate on the environment, and then addresses the specific case of the management of long-lived radioactive waste.

As a starting point, it may be useful to observe that although the respect for our neighbour is a basic tenet of all major religions, it is understood that these are referring to our contemporaries, i.e., to generations of people with whom we have direct contact. It is therefore a new challenge in our history to project ourselves far into the future and ask ourselves the question of our responsibility vis-à-vis future generations. The novelty and importance of this challenge justify that not only scientists provide their reflections, but also theologians, sociologists and other experts in human sciences. The reflection is on-going, and great humility is needed when addressing this topic.

General ethical principles related to the protection of the environment

At an international level, two major documents address the general questions of ethics and the environment:

- **The UNESCO Declaration on the Responsibilities of the Present Generations Towards Future Generations.** This Declaration refers to human rights and the need to protect the human genome, and specifically addresses bioethical issues.
- **The Declaration of the United Nations Conference on Environment and Development** (the so-called "Rio Declaration"). This includes more practical principles, notably in the field of environmental protection and the use of natural resources with the aim to achieve sustainable development. This is a milestone document which has inspired a great deal of work. The Rio Declaration recommends the systematic use of environmental impact studies for projects whose impacts might be significant; it recommends that the public take part in the decision-making process; it introduces the *polluter-pays principle* as well as the *precautionary principle*. The latter is a principle for action – and not inaction – which may be invoked in difficult situations. Namely, it suggests that: "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for post-

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poning cost-effective measures to prevent environmental degradation."

- **The principles of the Rio Declaration and the UNESCO Declaration** are the result of diplomatic and political co-operation among States. The reflection on ethics and care of future generations also takes place at the national level, as indicated earlier, and a relevant and very interesting document has been produced recently by the American National Academy of Public Administration (NAPA). The latter was requested by the United States Government and, in particular the Department of Energy, to study how the public administration could take account of the rights and interests of future generations when making decisions. After working on the topic for several years, the Academy proposes an approach based on four fundamental principles. It is recognised that each of these principles has its limits and that what is helpful, for decision-making, is achieving a balance between the application of the four principles.

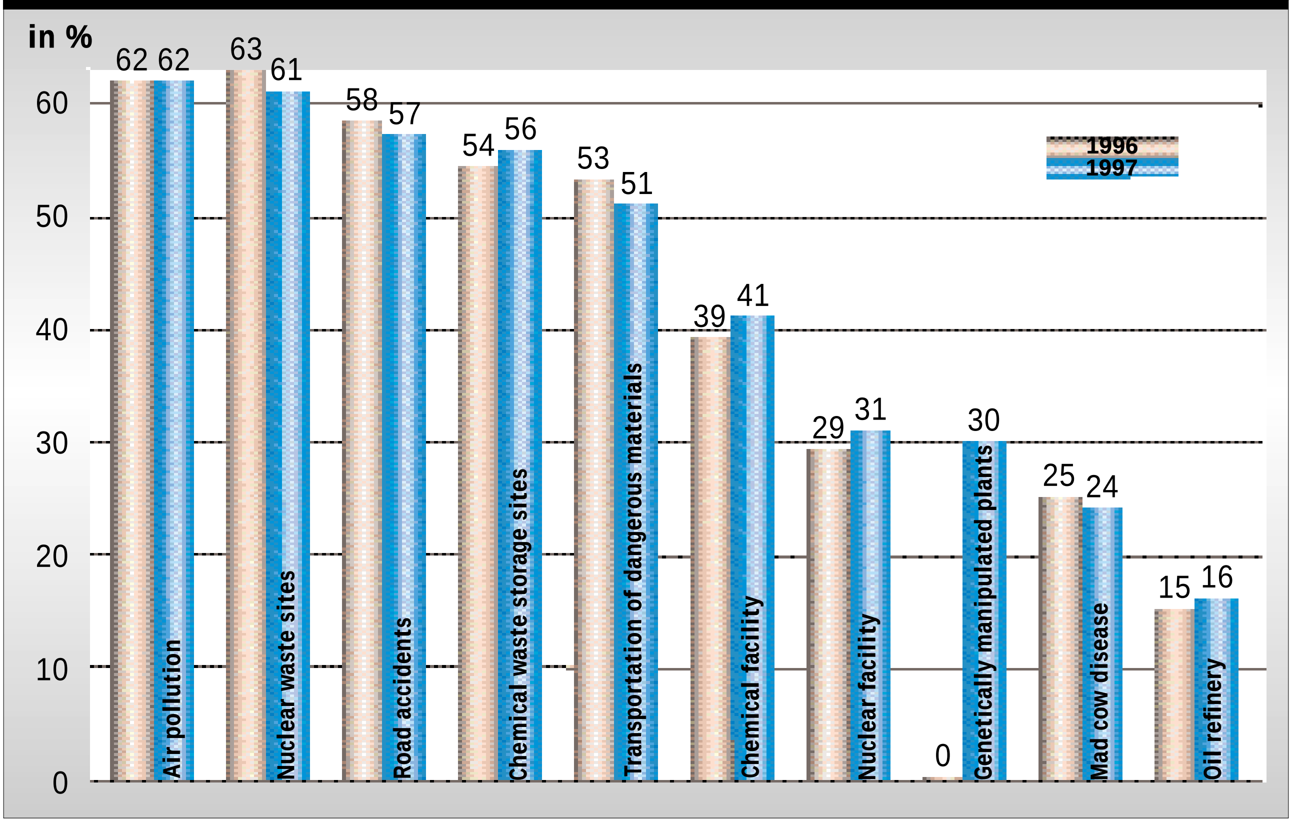
The first, *the Trustee Principle*, says that "Every generation has obligations as trustee to protect the interests of future generations".

It refers essentially to the responsibility of politicians and public administrators, who should first select and then use the best information possible, be trustworthy, and involve at least part of the public in the decision-making process.

The second, *the Sustainability Principle*, states that "No generation should deprive future generations of the opportunity for a quality of life comparable to its own" and is couched in slightly different terms from that of Rio. The new aspect of this principle is the reference to the quality of life. Rio was more concerned with the exhaustion of natural resources; here, it is considered that if our generation uses resources which could also be useful to future generations, efforts must be made to compensate them by undertaking, for example, to develop new technologies. It is noted that resources providing for a better quality of life can also be created, for example, by establishing an education system which will provide future generations with the intellectual resources needed for their development.

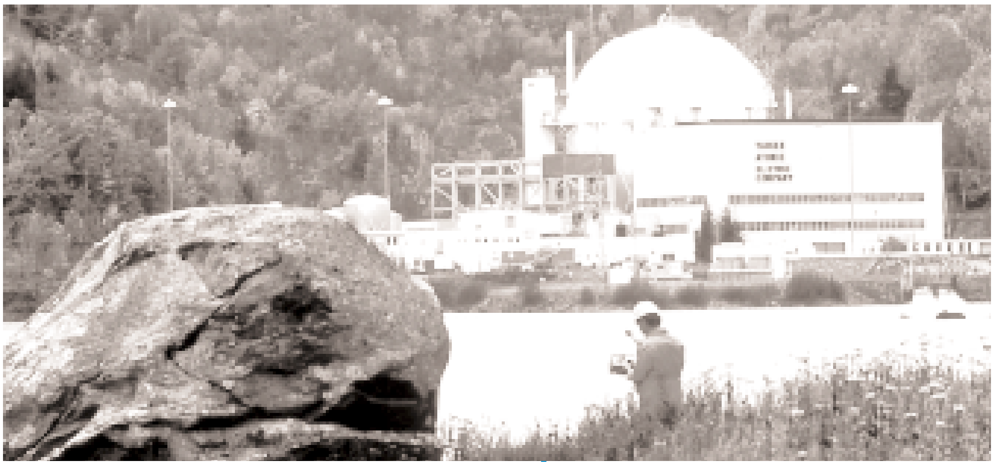
The third principle, *the Chain of Obligation Principle*, refers to our daily experience: "Each generation's primary obligation is to provide for the needs of the living and succeeding generations". Emphasis is placed on the living generations with whom we are in contact. Namely: "Near-

Ten top risks perceived by French people



BVA, France

term concrete hazards have priority over long-term hypothetical hazards". This principle recognises that the existence of future generations is dependent upon the existence of the current one and that the present generation has the highest degree of responsibility towards itself and those which follow immediately. It is a principle which can be assimilated to the chain of parental obligations that exist within families. This principle can give rise to problems of conscience which are delicate and which KASAM, the Swedish advisory body to the Ministry of the Environment that follows progress in the field of radioactive waste and deals also with ethical issues, summarises as follows: "We cannot assume full responsibility for a future which is beyond our imagination, knowledge and technical capacities. This dilutes the responsibility which we can assume in time. The full consequence of this remains still to be developed". On the one hand, there is a positive, even optimistic, aspect in this principle which proposes a vision of the future as a "rolling present", according to which the present generation provides the following one with the capacity to succeed, and the resources and opportunities to deal with whatever problems may be bequeathed by the present generation. It also means that decisions can be taken in incremental stages, thus allowing future generations to re-evaluate and change part of previous decisions. On the other hand, NAPA cautions that we must not limit ourselves to following only one of the four principles. For instance, if taken in isolation, the "rolling present" approach tends to ignore "time bombs", i.e. hazards which are more dangerous to later generations than to the present.



Eastern Utilities Association, United States

The nuclear industry has, over the years, demonstrated a major concern for environmental safety.

The Precautionary Principle was formulated by NAPA as a protection against "time bombs". Namely: "Actions that pose a realistic threat of irreversible harm or catastrophic consequences should not be pursued unless there is some countervailing need to benefit either current or future generations". The Rio Conference version of the precautionary principle is somewhat stronger than NAPA's because it is more active. No definition is given in either versions of "threat of irreversible harm".

These different principles are based on background considerations, and even ethical choices, that may go unnoticed and which merit being mentioned. In the first place, it is accepted that one cannot use the method of discounting, as it is done in economics, to assess future harm. In the second place, although emphasis is placed on "generations", "individuals" are also concerned and there is no enquiry as to whether the progress that benefits "generations" may be obtained at the cost of specific individuals. Lastly, there is a certain optimism in the relevant documents as to the behaviour of future societies:

- they will appreciate the flexibility of the options we leave for them;
- they will make the best possible use of these options;
- they will continue as democratic societies and hopefully will be more, or equally, responsible as our own generation.

As it will be seen, a more cautious approach is taken within the waste management community.

Regarding the first point, it should be noted that, in the long term, flexibility may turn out to become a burden if it requires continuous updating of the technical expertise to allow for specific interventions. For example, Italy has a very much reduced nuclear programmetoday; power plants remain to be dismantled, and the issue exists on how to maintain the technical competencies necessary for that task. As for the other two points which envisage the best possible use of options, it may be worthwhile to remember that during the war in Chechnya a Russian extremist threatened to disperse radioactive waste over the rebel state. Can we exclude that, in Paris, one day, somebody may not try to explode toxic wastes – chemical or radioactive – on top of the Eiffel tower? Hasn't there been already an attempt to use poison gas in the Tokyo metro?

Ethical principles formulated in the context of the long-term management of radioactive waste

Ethical issues in connection with the management of radioactive waste in the long-term were evoked even before the industrial development of nuclear energy. Two recent publications deal with these principles: the *Safety Fundamentals – the Principles of Radioactive Waste Management* published by the International Atomic Energy Agency (IAEA, 1995), and the Collective Expert Opinion of the Nuclear Energy Agency (NEA) on the *Environmental and Ethical Basis of Geological Disposal of Radioactive Waste* (1995).

Waste disposal strategies in the nuclear field can be divided into two groups which may be summarised as "dilute and disperse", and "concentrate and contain". Both strategies are being used today. "Concentrate and contain" is the preferred strategy but it is only feasible in cases in which the volume of waste is limited and is produced in centralised conditions or in controlled circumstances, which enables the waste to be collected and inventoried. This applies to long-lived radioactive waste, especially high-level waste.

Geological disposal is the technical solution that is most widely advocated. It takes into account the ethical principles already mentioned, and even goes further in certain cases. The relevant principles can be summarised as follows:

- The generation producing the waste is responsible for its safe management and the associated costs.
- There is an obligation to protect individuals and the environment both now and in the future.
- No moral basis exists for dicounting future health and risks of environmental damage.
- In particular, our descendants should not knowingly be exposed to risks which we would not accept today. Individuals should be protected at least as well as they are today.
- The safety and security of repositories should not be based on the presumption of a stable social structure for the indefinite future or on a presumption of technological progress.
- Waste should be processed in such a way as not to be a burden for future generations. However, we should not unnecessarily limit the capacity of future generations to take over management control, including the ability to recover the waste.
- We are responsible for passing on to future generations our knowledge concerning the risks related to waste.
- There should be enough flexibility in the disposal procedure to allow alternative choices. In particular, information should be given to the public to enable it to take part in the decision-making process which, in this case, will proceed in stages.

Geological disposal is considered as the final stage in waste management, ensuring security and safety in such a way as not to require surveillance, maintenance or institutional control. Although such measures are not necessary to ensure safety and security, they are not, however, excluded. Society will still be able to choose to use them as management tools.

Conclusion

Three points are worth remembering:

- Ethical principles concerning equity between generations have been formulated at international level. Discussion is continuing at the national level.
- The geological disposal of long-lived radioactive waste is being developed. The latter satisfies the ethical imperatives of today's society.
- Consensus exists among experts that geological disposal of long-lived radioactive waste is a solution which, once implemented, is intrinsically passive and safe both in the short- and long-term.

Note

This article is based upon a presentation given at the colloquium "Nucléaire et Santé" held at the Palais des Congrès in Paris, 29 January 1999. This article is a translation of the original French version.

J. Royen*

Russian Minatom nuclear safety research strategic plan

An international review

An NEA study on safety research needs of Russian-designed reactors, carried out in 1996, strongly recommended that a strategic plan for safety research be developed with respect to Russian nuclear power plants. Such a plan was developed at the Russian International Nuclear Safety Centre (RINSC) of the Russian Ministry of Atomic Energy (Minatom), by a working group of fifteen senior Russian experts representing twelve Russian organisations. These experts were assisted by a Project Team of other technical experts from key organisations throughout the Russian Federation, and by the US International Nuclear Safety Centre (USINSC) in Moscow, whose role was principally that of facilitator and reviewer. The Russian Minister of Atomic Energy was strongly supportive of this work.

The NEA was asked by the Director of RINSC and the Director of USINSC to organise an international review of the draft, in part because of its initial study that had recommended such a Plan. In response to the request, the NEA set up an international review group composed of senior experts from Canada, Finland, France, Germany, Italy, Japan and the United States, as well as from the RINSC and the USINSC. The report of the NEA international review group was officially transmitted to Minatom at the end of February 1999.*

The objective and contents of the Plan

The Strategic Plan is designed to address high-priority safety-research needs, through a combination of domestic research, the application of appropriate foreign knowledge, and collaboration. It represents major progress toward developing a comprehensive and coherent safety-research programme for Russian nuclear power plants (NPPs).

The Plan consists of 12 chapters, each addressing a specific technical area and containing a number of proposed research programmes and projects to advance the state-of-knowledge in that area. Some 175 specific research programmes are identified in the Strategic Plan, 83 of which deserve some degree of higher priority. The areas of research covered by the Plan are the following: integrity of piping and equipment; integrity of building structures; reactor dynamics and safety; severe accident and mitigation; radiation thermal mechanics of core components; simulators, operator training and support systems; operational safety and human factors; electrical equipment; fire safety; severe accident management; probabilistic safety analysis; improvement of the concept of safety assurance of nuclear power plants; and the development of the system of safety regulations and standards.

The NEA review of the Russian Minatom Plan

The NEA undertook its review of the Strategic Plan with the objective of providing independent verification on the scope, priority, and content of the research described in the Plan based upon the experience of the international group of experts. Another objective was to identify areas where similar work is being done in other countries, possibly forming the basis for co-operative research and beneficial exchanges of information, and specifically to identify possible NEA activities from which Russia could benefit.

The NEA review group recognised the large amount of effort that had gone into this Plan. It also believed that various elements of this Plan, when completed in light of the international review and further consideration by the Russian experts, would clearly reflect an improvement in understanding of safety, which would, in turn, lead to an improvement in the safety levels of the reactors themselves.

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However, both the review group and the Russian experts themselves recognised that the draft Plan is only a first step toward the development of an overall up-to-date Russian programme for NPP safety research. It will need to be improved in order that it can optimise the use of available resources, address all of the principal safety issues in a balanced way, and thereby improve NPP safety most effectively. The goal of the NEA review was to provide input to the Russian experts as they undertook the needed revisions to the first draft of the Plan.

available resources with the requirements of the groups that will act on the R&D results – regulatory authorities, design organisations for upgrades and for new plants, and utilities that operate the existing plants. The resulting programme should be well-rounded, while focused on providing the information required by the groups that will act on the R&D results. For example, a utility may require information for specifying a piece of hardware, whereas a regulatory authority may need information and analysis tools to develop a regulation or an inspection procedure.

designs; and experiments to support computer program development and validation.

Review details of the Russian Minatom Plan

The Russian Strategic Plan, as reviewed, provides for a programme containing most of the necessary elements, but does not appear to include a clear strategy for setting overall direction and priorities, nor does it show how the proposed R&D would be implemented to meet specific safety-research needs. This lack of clear strategy and implementation details

EDF, France

View of the Balakovo nuclear power station in Russia, equipped with VVER reactors.

Requirements for a safety-research strategic plan

A strategic plan for reactor safety research should identify the safety-research needs, provide a strategic approach for setting priorities for research, and define a programme that addresses the research needs and is consistent with that strategy. The safety-research needs arise from consideration of safety issues for operating plants and potential improvements for future plants. The strategy must balance the

A well-rounded safety research programme needs to address the following elements: database and data gathering activities to ensure that plant and material property information is available to support analyses; computer program development and validation to provide qualified tools to analyse plant performance; improved surveillance methodology; improvements to plant operation through operator training and support, and accident management procedures; improved components that can be retrofitted to existing plants and

is reflected in the following set of ten principal conclusions of the NEA review group, which summarise the group's general comments, particularly concerning the Plan's shortcomings:

- The Plan is not yet strategic: it needs an explicit overall strategy identifying objectives and priorities to which the individual research elements are tied.
- The Plan's scope should be expanded to include some important NPP safety research areas that are omitted or are given only minor weight.

- The Plan contains priority assignments (higher vs. lower priority) within each research area, but in general the method used is not clear and the priorities that are assigned do not provide enough discrimination. Also, the overall priorities that are assigned across the entire Plan, based on the proposed manpower numbers, seem to the NEA review group not to reflect a comprehensive strategy for improving NPP safety. In many technical areas these priorities do not provide enough detail to guide the appropriate allocation of actual resources, or to support effective planning and implementation.
- The Plan does not explicitly deal with how it will be executed, in terms of management strategies, funding principles, identification of institutional users, collaborations between lead Russian organisations and other supporting organisations, and manpower/time scale aspects.
- The Plan is not explicit in identifying which activities are mainly directed toward improving the safety of the existing NPPs, and which are primarily motivated by developing new designs and evaluating their safety.
- The Plan contains many important methodology-development activities to provide tools for understanding and improving NPP safety, but in many cases these development activities are not well linked to actual applications that will directly improve NPP safety.
- The Plan is not well balanced between analysis and experiments: the current emphasis should be either clearly linked to strategic objectives or modified.
- The Plan does not give as much emphasis to RBMK safety issues compared to issues affecting VVER-type reactors.
- The Plan does not identify adequately the large number of opportunities to advance its aims by applying or adapting knowledge and tools already available in other countries. It also only identifies a few of the large number of potential opportunities for international collaborations in NPP safety research.
- As to particular priorities, the NEA review group believes that the most important objective of this Plan ought to be to achieve as many short-term improvements in the safety of the operating power reactors as feasible. For many of these areas, the issue is not simply doing the needed research, but effective and rapid implementation of the new knowledge at the operating plants. Specific areas where the NEA review group recommends greater emphasis are discussed in the report.

More detail to support the review group's conclusions on each of these ten major resolutions is given in the report, published recently by the NEA.

In spite of the Strategic Plan's shortcomings, the NEA review group emphasises that it is an excellent starting point which can, with the needed enhancements, provide what Russian NPP safety truly requires: a comprehensive, strategic, effective safety research plan that can take full advantage of the strong and broad technical capabilities available in Russia. This review could increase the international support for and further the awareness of nuclear safety research in Russia, on both political and technical levels.

Note

* Russian Minatom Nuclear Safety Research Strategic Plan: An International Review, *available free on request from the OECD Nuclear Energy Agency.*

T. Lazo*

Strategies for emergency monitoring and key data management

Since the accidents at Three Mile Island in 1979, and more specifically Chernobyl in 1986, many countries have intensified their efforts in nuclear accident emergency planning, preparedness and management. As a result of this interest from its Member countries, the Nuclear Energy Agency (NEA) has been actively involved in this area. Experience from the NEA's programme in the area of nuclear emergency management, notably that from the two sets of International Nuclear Emergency Exercises (INEX 1 and INEX 2) and their related workshops, has shown that there is a need to further improve the international system of nuclear emergency data communication and management.

The NEA has been developing a strategy for the general management of nuclear emergency communications and data from the viewpoint of the decision maker's evolving information needs over the course of an accident situation. This strategy allows for the identification of important, or key data, at any particular moment during an accident. This includes how environmental monitoring can support the decision-making process. Also addressed is the best technical means of exchanging these key data to maximise the efficiency of their transfer and handling.

A report which is expected to be issued by the NEA before the end of 1999 will be the culmination of many years of experience in the area of emergency matters, and the result of a year and a half of effort by the Expert Group on Nuclear Emergency Matters, and three of its working groups: the Working Group on Emergency Communication and Information Exchange, the Working Group on Key Emergency Data, and the Working Group on Emergency Monitoring Strategy.

The detailed objective of the strategy proposed in this report is to facilitate the decision-making process by delivering the information, in the most appropriate format and when necessary, to decision makers, while at the same time minimising the resources required to send, receive and analyse data. In addition, such a strategy should allow the fulfilment of all existing international and multilateral conventions and agreements in a much more useful and efficient manner, and facilitate upgrading such conventions and agreements to better serve the needs of decision on makers.

While this work focuses on the application of a coherent strategy for the international aspects of data identification, communication and management, many of the ideas expressed in the report would be equally applicable at the national level. The focus thus far has been on nuclear power plants; however, this strategy is seen as also applicable to transportation accidents and to satellite re-entry incidents. Areas specifically not addressed by this report are emergency response and communications from the accident site owner or operator, and accidents involving nuclear devices, or terrorist incidents.

This strategy is based on a coherent subdivision of the accident into temporal and geographic phases, an understanding of the nature of the information sender and receiver, and of the data being transmitted. These subdivisions are categorised below.

Division of an accident situation into various decision-making time phases and geographic zones which are affected by the accident:

- Temporal time phases: notification; pre-release; immediate post release; intermediate; recovery.
- Geographic zones: urgent protective action planning zone; food and agricultural restriction area; area farther from the release site.

Identification of senders and receivers:

- Bilateral local exchanges.
- Government to government exchanges.
- Government to international organisation exchanges.

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Identification of the nature of data exchanged:

- Notification data.
- Dynamic, accident-related data.
- Static, background data.
- Public and media instructions and information.

Based on these characterisations, a strategy for better addressing the decision maker's needs can be defined:

Improving the selection of the data which is being transmitted

This will improve the data's usefulness, and will help to optimise the resources necessary to collect, receive and analyse them. These data can be referred to as key.

The existing Convention Information System (CIS), to facilitate the multilingual transmission of standardised accident description information as defined by the IAEA and the EC, provides a very extensive, numerically keyed listing of important emergency data, but provides no guidance as to which of these data are the most important at any given time during an accident. Using the CIS as a basis, data which is key during the previously defined accident time phases can be identified as a function of the above-defined sender and receiver classifications. A simple matrix has been developed to identify those data which are key for each matrix point.

Increasing the transmission reception of data and information using modern communication methods

The use of world-wide-web technology to develop a dedicated, secure network among nuclear response organisations will help to optimise the volume of data which is transmitted, as well as the data's quality.

By actively "pushing" notification and important dynamic accident-related information, and by making other dynamic, accident-related information and static background information available for "pulling", "consulting", or "downloading", national emergency response organisations will have the needed information available, and will be able to avoid the time-consuming and resource intensive automatic receiving of data and information which they do not need for their decision-making purposes. Such an electronic system will also greatly improve the quality of graphical transmissions (and retransmissions) and will help to minimise the volume of redundant messages which circulate, as well as the resources necessary to interpret them.

Refining the definition of emergency monitoring needs to assist decision making

The use of resources can be optimised by focusing on why emergency monitoring is performed (i.e. to address which needs), and in this context identifying what measurements are made (i.e. physical quantities), when measurements are made (i.e. with respect to the previously-defined accident time phases), and where measurements are made (i.e. with respect to the previously-defined geographic zones).

Such a system, using flexible, commonly-used and independently updated software, must be developed and tested based on international consensus. It is planned that the implementation details and procedures necessary for such an approach will be developed, and that an international emergency exercise, INEX 2000, will be carried out during the last half of 2000, to test the various aspects of this strategic approach.

KEPCO, Korea

Environmental radiation monitor at the Kori nuclear power plant site, Korea.

F. Wagstaff*

Nuclear law in Central and Eastern Europe

Activities of the Nuclear Energy Agency involving non-member countries, like those of the OECD, expanded considerably in the early 1990s with the major changes in Eastern Europe and finally the break-up of the former Soviet union. Nuclear law has been one of the areas of major co-operation with non-member countries during the ensuing period.

Since the inception of the NEA, the Member countries have entrusted the Agency with the task of promoting the development and harmonisation of national legislation governing the use of nuclear energy, in particular in the field of nuclear third party liability and compensation. The Agency is also actively involved in managing documentary resources on nuclear law, and disseminates information to both Member and non-member countries alike, in particular through the distribution of its *Nuclear Law Bulletin*, published bi-annually, and its *Analytical Study on the Regulatory and Institutional Framework for Nuclear Activities in OECD countries*, revised annually. An overview of nuclear legislation in Central and Eastern Europe (CEEC) and the New Independent States (NIS) was also published by the NEA in 1997, providing an analysis of the institutional and legal frameworks which have been established in those countries.

A co-operation and assistance programme with the CEEC and NIS aims[1] at improving nuclear legislation in these countries and at promoting their accession to international conventions in this field. In sum, this programme which has been described in a previous article in the *NEA Newsletter*,[2] combines three complementary forms of activities:

- The provision of information on, and training in, national and international nuclear law.
- The provision of legal opinions and assistance on the preparation of draft nuclear legislation and regulations.
- The resolution of third party liability issues involved in nuclear safety assistance programmes.

Before referring to the changes which have come about in the CEEC and NIS and which may to a certain extent have been catalysed by the work of the NEA in this field, a brief indication of the forms which these activities have taken over recent years provides a useful insight into the content of this programme.

Information and training

From 1992 to 1998 the NEA organised advanced training seminars on nuclear law in the CEEC and NIS on an annual basis, covering various aspects of nuclear law including third party liability, nuclear safety, radioactive waste and spent fuel management, the decommissioning of power plants, the convergence of national legislation with that of the European Union and international law, and exchanges of nuclear materials, equipment and technology, including issues of non-proliferation and transport. These seminars, organised by the NEA and co-sponsored by the International Atomic Energy Agency (IAEA) and the European Commission (EC), provided a forum for discussion between specialists from CEEC and NIS and their counterparts in Western countries and international organisations, creating a dialogue which proved particularly fruitful over the years.

One of the most notable features of these seminars over the years was the increased interaction between the experts present: the nature changed quite distinctly from one of assistance in the early years to one of co-operation later during the programme. Although this particular cycle of seminars has now drawn to a close, the NEA will continue to pursue actively training activities with the CEEC and NIS, organising events on a regional and more specialised basis, along the lines of the regional seminars which were held in Kazakhstan and Latvia in 1997 and in Lithuania in 1998. Such

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smaller-scale events allow the participants to focus on specific issues which are of direct interest to the countries concerned.

In 1999 the approach has somewhat changed, in that participants from CEEC and NIS have been offered assistance from the NEA and the European Commission to enable them to attend an International Symposium on the Reform of Civil Nuclear Liability. This event, organised by the NEA in co-operation with the IAEA and the European Commission, took place in Budapest, Hungary from 31 May to 3 June 1999.[3] The programme of this Symposium had been established, taking into account the specific interests of the CEEC and NIS, in order to use this event as a forum to examine the particular difficulties faced by these countries in joining an international system which both establishes liability for nuclear damage and provides for its compensation.

The importance of the continued participation of observers from CEEC and NIS in working meetings of the NEA, in particular the Group of Governmental Experts on Nuclear Third Party Liability, merits emphasis. The benefits of such participation are twofold: the observers from CEEC and NIS remain informed about recent developments in the nuclear field at an international level and the Member countries of the NEA benefit from the presence of high-level experts from these countries who are in a position to provide information on the latest developments in respect of their nuclear legislation, which for many CEEC and NIS, has been in a state of flux since transition. By way of illustration, the observers from four non-member countries (CEECs and NIS) who attended the last meeting of the Group of Governmental Experts in October 1998, participated in discussions on recent developments in the adoption and amendment of nuclear liability legislation.

Legal opinions and advice

The advice and assistance on drafting of national legislation in the nuclear field is based on two essential principles. First, advice is only provided upon the express request of the country in question, and second, the goal is a tailor-made solution which is best suited to the situation in a particular country, rather than reliance on predefined models which may not meet its specific needs. Assistance has been provided to several CEEC and NIS, either on their draft framework legislation or on their draft laws regulating specific areas, such as radioactive waste management, radiation protection or third party liability and insurance.

One of the most recent examples of such legal advice took place within the framework of the NEA Joint Task Force on Nuclear Legislation in Ukraine. Representatives from several Western countries, the NEA, the European Commission (EC), the International Atomic Energy Agency (IAEA) and the European Bank for Reconstruction and Development (EBRD), examined together with their Ukrainian counterparts the Ukrainian draft Law on Civil Liability for Nuclear Damage and its Financial Security. The experts present provided an exhaustive analysis of the provisions of this instrument, offering numerous suggestions for restructuring and improving the text. Many of these suggestions have since been incorporated into the text, and appear in the recently revised draft.

Third party liability issues

The issue of nuclear third party liability is extremely important and has been part of the core of the work of NEA Legal Affairs since the Agency was established. In order to explain the approach taken by the NEA with respect to the resolution of third party liability issues involved in nuclear safety assistance programmes, it is necessary to examine briefly the notion of third party liability itself.

The Chernobyl accident in 1986 highlighted the inadequacies of the international nuclear liability regime, the most notable problem being the limited geographical application of the Vienna and Paris Conventions which govern third party liability for nuclear damage.[4] In the case of the Vienna Convention, this limited geographical scope is not due to the nature of the convention itself, which is potentially global in character, but rather is caused by the reluctance of states to sign and eventually ratify such an instrument. In the case of Chernobyl, the USSR was not Party to any international third party liability instrument and did not have specific domestic legislation governing civil liability for nuclear damage. Through the NEA co-operation and assistance programme, wider accession to the relevant international conventions in the nuclear liability field has been promoted and achieved, and preparation of suitable domestic legislation on this subject has been stimulated. The progress made concerning accession to the relevant international legal instruments is examined below.

With the increase of co-operation and assistance projects organised by Western countries and international organisations to improve the safety of nuclear power plants in these countries, there was a concomitant increase in the risk of claims against these suppliers or financial backers in the event of nuclear damage. The precarious position in which these contractors found themselves was due to the fact that they were carrying out very important safety assistance work in countries where the nuclear liability regime did not provide for the strict and limited liability of the operator of a nuclear installation. Furthermore, these regimes did not ensure the channelling of all such liability exclusively to the operator. This created the risk of claims for compensation being brought against a contractor who intervened in any capacity whatsoever in the operation of a nuclear installation. The ideal way to resolve this problem, logically, is to ensure that the country in question adheres to the international instruments of the nuclear liability regime[5], and incorporates these principles into its domestic implementing legislation. In certain cases, however, and in particular in the NIS, countries have not been in a position to accede to the Vienna Convention and the Joint Protocol[6] within a short time-frame. Hence solutions have been identified in order to allow nuclear safety assistance projects to continue without the existence of an unacceptable liability risk for the contractor involved.

A conference organised by the NEA in July 1994 to address these issues resulted in the setting up of a contact group on liability questions raised by nuclear safety assistance programmes for Eastern Europe. This group, consisting of specialists from western countries, acts as a forum for exchange of information and informal consultations between NEA Member countries, international organisations, and western nuclear industry, providing legal assistance on a case by case basis to certain CEEC and NIS, in particular, the Russian Federation and the Ukraine on liability issues.

In this context, an international seminar on nuclear liability and insurance issues was held in Moscow in April 1997 in order to assess the potential benefits that the Russian Federation would derive by joining the system of international nuclear liability conventions, adapting its relevant legislation, and setting up appropriate nuclear insurance structures. Organised under the joint sponsorship of the NEA and the *Gosatomnadzor* (the Russian nuclear regulatory agency), the seminar focused on the international principles of nuclear liability law and their incorporation into Russian legislation, the systems and methods by which Russian insurance companies may provide coverage against the risk of damage arising from a nuclear incident, and the financial aspects of assessing nuclear risk and providing such insurance coverage.

View of the Kozloduy nuclear power plant in Bulgaria.

Kozloduy, Bulgaria

Progress made by the CEEC and NIS

Legislation

The CEEC and the NIS have been faced, over the last decade, with a large number of challenges in their transition to democracy, new legal systems and a market economy. The nuclear energy sector has certainly not been an exception, and nuclear law in particular has been the object of a radical overhaul in order to bring national legislation in this field into accordance with international standards. Before the transition, most of the CEEC and NIS were not endowed with framework legislation establishing the basic principles and institutional framework for the safe conduct of nuclear activities. Moreover, transparency in national nuclear policy was not prevalent and the public in each country was ill-informed about nuclear activities taking place.

The main objectives behind the adoption of national framework legislation governing nuclear activities are to set forth in one instrument the basic rights and obligations of competent government authorities, legal entities and private individuals with respect to the use of nuclear power, and establish the consequences of failing to comply with legislative requirements. In the particular case of CEEC and NIS, it was necessary to take into account the changes in the political and economic environment, and to acknowledge new legal developments in the nuclear field, both national and international. The latter development encompassed the implementation of international recommendations and principles pertaining to the use of nuclear energy and international agreements regulating the relationship between States in the nuclear field. In the case of those CEEC and NIS with nuclear power programmes, it was desirable to establish competent rule-making and decision-making bodies within the executive authority in order to ensure that the criteria for carrying out nuclear programmes were in place and that proper safety rules and standards were adopted.

Institutional structure

In a number of CEEC and NIS, the 1990's have witnessed widespread reorganisation of political and institutional structures. The vast majority of these countries have established an independent nuclear regulatory body, responsible for all nuclear activities. It was necessary to equip such bodies with the necessary technical and financial means, and the independence essential for the efficient exercise of their functions. The responsibilities of such bodies are extensive, and vary from country to country, but can be summarised as follows:

- Carrying out research.
- Regulating nuclear safety and radiation protection.
- Licensing of the production, treatment, storage, transport, use and trade of nuclear materials, radioactive sources and waste.
- Licensing of siting, construction, commissioning, operation and decommissioning of nuclear installations, and licensing of radioactive waste repositories.
- Supervising the management of radioactive waste (sometimes entrusted to a separate body).
- Accounting, control and physical protection of nuclear materals.
- Disseminating information to the public on nuclear activities.
- Co-operating with other countries in this area.

It is also noteworthy that Croatia, the Czech Republic, Hungary, Romania, Russia, Slovakia, Slovnia and Ukraine have established nuclear insurance pools in order to facilitate the provision of financial security for nuclear activities. These pools essentially consist of a mechanism whereby a number of insurers agree to merge their operations for a particular risk or class of business, in this case, the nuclear industry. This mechanism is commonly employed where the risks in question are few in number or require a capacity which is clearly beyond the individual means of the members themselves. Thus, the insurers can respond to the increasing demand for cover for the emerging nuclear industry without calling into question the very solvency of the insurance market.

Participation in international conventions

The progress which has come about over the past decade related to the participation of CEEC and NIS in international conventions in the nuclear field is noteworthy. In fact, the CEEC and NIS have been considerably more willing to sign and ratify the Joint Protocol relating to the application of the Vienna Convention and Paris Convention than their Paris Convention counterparts. Details on signatures and ratifications of, and accessions to, the major international conventions in the field of nuclear law are illustrated in the table on page 25.

Conclusions

There have been remarkable developments in the legal frameworks governing nuclear activities in the CEEC and NIS over the past decade. When one considers that legislation tends to evolve slowly in most countries, the progress which has already been made is remarkable. Although certain aspects of each nuclear legislative framework require fine-tuning, and some liability issues remain to be solved, the NEA co-operation and assistance programme in the field of nuclear law, coupled with the efforts made by the CEEC and NIS themselves to enact new nuclear legislation or to modernise their existing legislation, has already been fruitful.

Notes

1. *The recipient countries are: Armenia, Belarus, Bulgaria, Croatia, Estonia, Kazakhstan, Latvia, Lithuania, Poland, Romania, Russian Federation, Slovenia, Slovakia and Ukraine.*
2. *See in particular,* Nuclear Law in Central and Eastern Europe, *by A. de Kageneck,* NEA Newsletter Fall 1996 – *Volume 14, no. 2.*
3. *See also the News Briefs in this issue of the* NEA Newsletter, *p. 32.*
4. *The Paris Convention on Third Party Liability in the field of Nuclear Energy was adopted on 29 July 1960 under the auspices of the OECD. It has been amended twice, in 1964 and 1982, and has been complemented by the Brussels Convention Supplementary to the Paris Convention, adopted on 31 January 1963 and also amended in 1964 and 1982. The Vienna Convention on Civil Liability for Nuclear Damage was adopted on 21 May 1963, under the auspices of the IAEA. A Protocol to Amend the Vienna Convention was adopted in September 1997; however this instrument has not yet entered into force.*
5. *These principles include the exclusive and strict liability of the operator, limitation of liability in time and amount, and compulsory financial security to cover this liability.*
6. *There exists a Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention, which provides for reciprocal benefits for Parties to either of these instruments, i.e. victims in a country which is party to either convention are entitled to benefit from the provisions of the other convention.*

Signature and ratification of the major international conventions by the CEEC/NIS*

Country	Vienna Convention 1963	Joint Protocol 1998	Vienna Protocol 1997	Convention on Supplementary Compensation 1997	Nuclear safety Convention 1994	Convention on Radwaste & Spent Fuel Management 1997
Armenia	Yes	Signed	No	No	Yes	No
Belarus	Yes	No	Signed	No	Yes	No
Bulgaria	Yes	Yes	No	No	Yes	Signed
Czech. Rep.	Yes	Yes	Signed	Signed	Yes	Signed
Croatia	Yes	Yes	No	No	Yes	Signed
Estonia	Yes	Yes	No	No	No	No
Hungary	Yes	Yes	Signed	No	Yes	Yes
Kazakstan	No	No	No	No	Signed	Signed
Latvia	Yes	Yes	No	No	Yes	No
Lithuania	Yes	Yes	Signed	Signed	Yes	Signed
Poland	Yes	Yes	Signed	No	Yes	Signed
Romania	Yes	Yes	Yes	Yes	Yes	Signed
Russian Fed.	Signed	No	No	No	Yes	Signed
Slovakia	Yes	Yes	No	No	Yes	Yes
Slovenia	Yes	Yes	No	No	Yes	Yes
Ukraine	Yes	No	Signed	Signed	No	Signed

* "**Yes**" indicates that the country in question has either ratified, acceded to or succeeded to the instrument listed in the top column.
"**Signed**" indicates that the country has signed the instrument but has not yet ratified it, and therefore the instrument is not legally binding on that state.

L. Van Den Durpel, S. Sakurai, M. Domae*

NEA activities on partitioning and transmutation

The disposal of long-lived radioactive waste resulting from the operation of nuclear power reactors has been a sensitive issue for decades. Several proposals have been suggested: geological disposal in deep layers of the earth's crust, launching waste into outer space, or burning it in dedicated nuclear facilities.

There is a general consensus within the OECD Member countries that geological disposal, in one or another form, is a practical solution to protect humans and their environment for the foreseeable future. However, difficulties encountered in siting, constructing and licensing of repositories, not to mention public opposition to nuclear waste and its disposal, have caused extensive delays in the development of these facilities.

Nevertheless, nuclear power now meets 17% of the world's electricity demand and the issue of dealing with long-lived nuclear waste cannot be avoided.

The generation of spent fuel and highly active waste material amounts to quantities which are far in excess of the capabilities of any outer space disposal programme. In addition, such a practice would create contamination risks for the atmosphere and biosphere, because the possibility of an accident would always exist.

Partitioning and transmutation of radioactive and long-lived components from the highly radioactive waste streams is a complementary approach which could mitigate but not eliminate the disposal problem. Due to the Japanese government "Options Making Extra Gains from Actinides" Programme (OMEGA), an initiative taken in 1988, the Partitioning and Transmutation (P&T) option received an impetus which led to the creation of an international incentive for co-operation among OECD Member countries. The objective of the NEA Information Exchange Programme on Actinide and Fission Product Partitioning and Transmutation, established in 1989, is to enhance the value of basic research in P&T by facilitating the exchange of information and promoting discussions on programmes, experimental procedures and results. This Programme is conducted under the auspices of the NEA Committee for Technical and Economic Studies on Nuclear Energy Development and the Fuel Cycle. Complementary activities related to nuclear data, benchmark exercises and more basic science studies in relation to this Programme are conducted by the NEA Nuclear Science Committee and Data Bank.

Status and assessment report

Nuclear power plants produce spent fuel which contains, apart from short-lived fission products, actinides and fission products with high toxicity and very long half-lives. These nuclides constitute the long-term radiotoxic waste which remains hazardous for thousands of years.

When spent fuel is , most of the major actinides (reprocessed uranium and plutonium) are recycled and the minor actinides – mainly neptunium (Np), americium (Am), and curium (Cm) – remain with the fission products which are vitrified before being buried in deep repositories. Partitioning or separation of the minor actinides and some selected fission products could reduce the long-term radiotoxicity of the vitrified waste for disposal. The recovered minor actinide nuclides would be recycled into reactors where they would be transmuted to short-lived nuclides. P&T is, in principle, capable of reducing the radiotoxicity period, although a number of practical difficulties still exist.

A systems analysis working group, representing twelve countries and two international organisations, was established in 1996. It was commissioned to prepare a comprehensive P&T systems analysis report with the aim of providing decision makers with an authoritative and transparent document describing the potential impact of P&T on fuel cycle and waste management policies.

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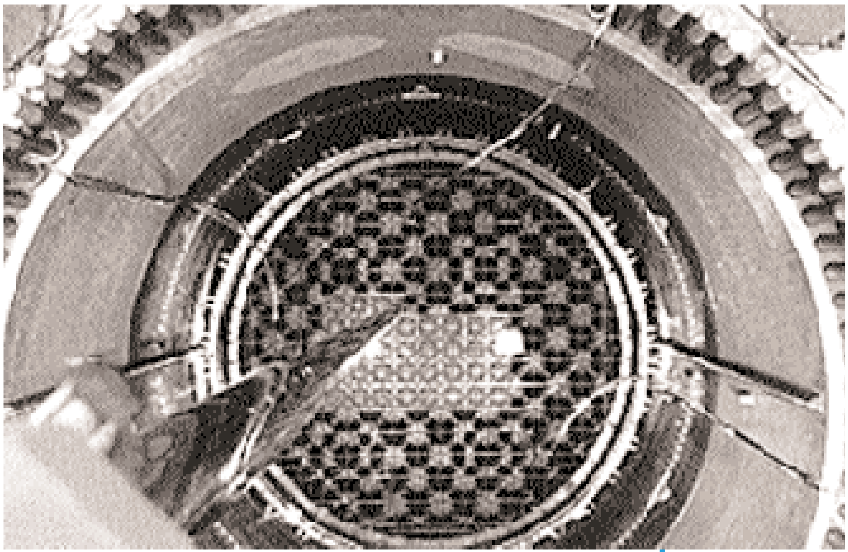


Federation of electric power companies, Japan

New fuel loading to LWR. After irradiation, the minor actinide and fission product in fuel will be a source of radiotoxic inventory.

The recently published NEA report, *Actinide and Fission Product Partitioning and Transmutation – Status and Assessment Report**, is a standard reference on the subject. It addresses the options available to decrease the final radiotoxicity of wastes for disposal and provides a limited systems analysis of the main options in order to clarify them. The systems analysis starts from the present technical state-of-the-art in the fuel cycle and considers some possible developments in P&T technologies which would result in an advanced fuel cycle with an overall reduction of the radiotoxic inventory of wastes.

The main general conclusions of this report are as follows:

- Implementation of P&T requires long lead-times and large investments in dedicated fast neutron spectrum devices, extension of reprocessing plants, and construction of remotely manipulated fuel and target fabrication plants.
- P&T will not replace the need for appropriate geological disposal of high level waste.
- Partitioning methods for long-lived radiotoxic elements have been successfully developed on a laboratory scale.
- Multiple recycling of plutonium and minor actinides is a long-term venture which may take decades to reach equilibrium of inventories, but recycling could stabilise the inventory of these nuclides in a nuclear power park.
- A possible option, either for geological disposal or for future transmutation, is the conditioning of separated long-lived nuclides in appropriate matrices being less soluble than glass in geological media.

Fifth information exchange meeting

"Information Exchange Meetings" form an integral part of the programme, providing a bi-annual review of the state-of-the-art of P&T. They have been co-organised by the NEA Nuclear Development Committee and major laboratories in Member countries.

The fifth information exchange meeting, hosted by the Belgian Nuclear Research Centre (SCK•CEN) and co-organised by the European Commission, was held on 25-27 November 1998 at Mol in Belgium with more than 130 participants from 15 countries and 3 international organisations. The proceedings are now available.

This meeting was characterised by two main developments: first, a more integrated view of P&T was taken in which a consensus on the possible ways to conduct P&T was achieved, subject to establishing its added-value in the nuclear fuel cycle. Second, the partitioning of minor actinides on a laboratory scale at pre-set performances was reported, representing a major achievement.

The need for a comparative assessment of the relative merits of transmutation in fast reactors and accelerator-driven systems, addressing the impact on the reprocessing needed, was identified. The assessment of the requirements, feasibility and reliability of these accelerator-driven systems are also included. The NEA is conducting a new study to address these questions. The new project, "Comparative Study of Accelerator-Driven Systems (ADS) and Fast-Reactors (FR) in Advanced Nuclear Fuel Cycles", started in May 1999 and is planned to take two years.

Conclusion

Since its inception, the information exchange programme has striven to establish a pro-active approach to P&T issues by conducting systems studies and supporting the information exchange among the various participants in this domain. By publishing a new Expert Group report and embarking on a second, the NEA is currently strengthening its activities in this field to establish an even more constructive approach for the future.

Note

* *An overview of activities on partitioning and transmutation and relevant publications are available on http://www.nea.fr/html/pt.*

E. Östhols*

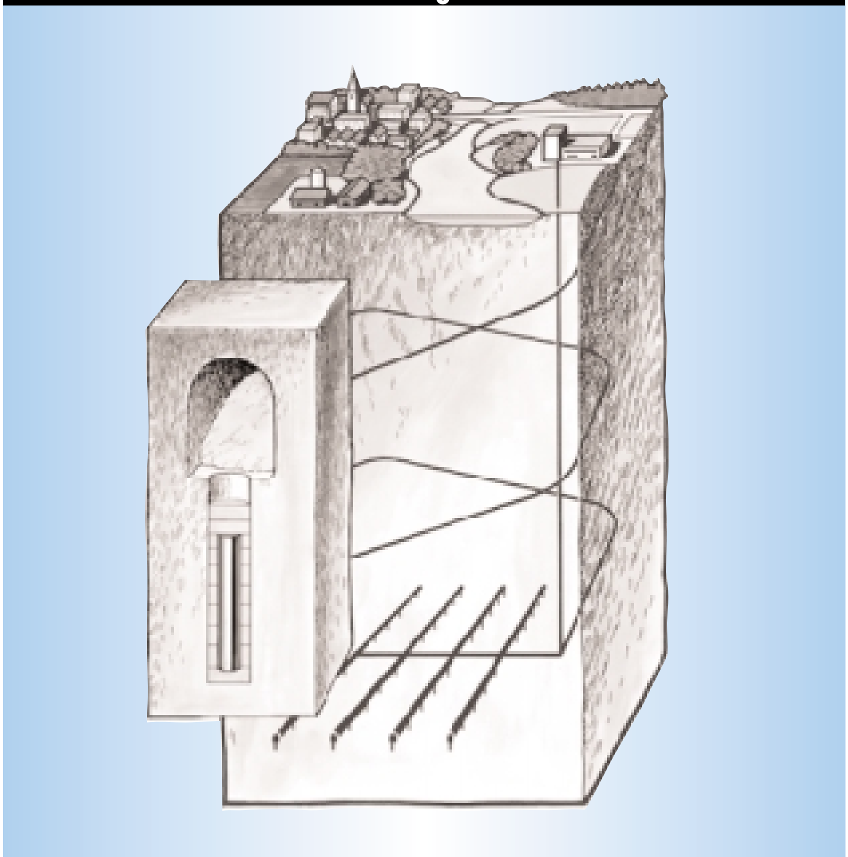
Confidence building in safety assessment

The role of the NEA TDB project

Engineered disposal systems are necessary to isolate radioactive waste from humans and the environment. Such systems have generally been constructed at or near the surface for wastes with low-level radioactivity and wastes with short-lived radioactivity. They are being built or are planned to be built deep underground in geological formations for high-level and long-lived wastes. A schematic picture of such a repository is shown above below. The photo on page 30 shows a section of a tunnel of the type envisaged for connecting the underground repository with the surface. These repositories are designed with the goal of ensuring that the risks of harmful release of waste to the environment are so low that they are acceptable to the regulatory authorities and the public. Several different barriers for keeping the waste from migrating into the surrounding ground water are usually planned, such as vitrifying of the waste, enclosing it in canisters and surrounding it by e. g. clay material or cement. If, for some reason, radioactive material finds its way through the primary barriers, and enters the surrounding geological formations, it will migrate through the surrounding ground-water and rock or clay minerals. A safety assessment of this type of nuclear waste repository requires the ability to build credible models for radionuclide migration. In order to build such models, it is essential to have access to basic thermochemical data relevant to varying geological environments for the radioactive elements involved.

These data are essential to permit predictive modelling. The data is very important, given the very long time scales necessary for storage of nuclear waste. The OECD/NEA Thermochemical Data Base project (TDB) aims to make widely available basic thermochemical data of the type needed for safety assessment of nuclear storage facilities. Special care is taken to make sure

Schematic picture of a design for an underground repository of spent nuclear fuel, with detail showing canister enclosing fuel elements



Swedish Nuclear Fuel and Waste Management Co. (SKB), Sweden

* *Mr. Eric Östhols is a member of the NEA Data Bank.*

that the data made available by the TDB project are internally consistent and have been evaluated in a transparent way.

The origins of the OECD/NEA TDB Project

The first phase (Phase I) of the TDB project was initiated in 1984. At the time, it was clear that, although a number of thermodynamic data compilations and reviews had already been published, none of them could be used reliably as a complete source data table to study the behaviour of radioelements in the environment. Some of the compilations do not give a comprehensive review of many elements of interest in the nuclear field and do not present the sources of data, or the rationale behind the selections. Some have been intended for a limited and different application, such as certain compilations which present data of interest primarily in geology. Still others deal only with non aqueous environments, or with a limited number of compounds and species. None of these publications adequately treats all the solid phases and aqueous species of an element of special interest to those studying the behaviour of radioactive elements in the environment. Consequently, most modelling groups supporting the performance assessment of radioactive waste disposal have developed their own data bases from the scientific literature. However, the geochemical modellers in different countries usually do not have the time and manpower required to thoroughly review the different experimental data sources appearing in the literature and to properly evaluate data. For this reason, these national data bases may lack consistency, and they sometimes differ considerably from each other. These data differences have important consequences for the safety assessment calculations, since it can lead to, and has led to, calculation results for similar conditions which differ by several orders of magnitude when calculated by different groups. It has been recognised that these discrepancies are due to shortcomings in different data bases, rather than in the computer codes used.

The NEA TDB project was started in response to the recognition among the member countries of the NEA of these shortcomings in existing, national data bases. In this first phase, a comprehensive, internally consistent and internationally recognised thermodynamic database has been developed for the inorganic chemistry of five elements: uranium, americium, technetium, neptunium and plutonium. Recommended data for uranium and americium have been published and similar publications for technetium, neptunium and plutonium are being finalised and will be sent to print in 1999. The data are also available on-line for access from the NEA Member countries.

Member country organisations participating in the TDB Project

ANSTO	Australia
NIRAS/ONDRAF	Belgium
RAWRA	Czech Republic
POSIVA	Finland
ANDRA	France
PSN	France
FZK	Germany
JNC/PNC	Japan
ENRESA	Spain
SKB	Sweden
SKI	Sweden
HSK	Switzerland
NAGRA	Switzerland
PSI	Switzerland
BNFL	United Kingdom
NIREX	United Kingdom
DOE	USA

Phase II of the TDB project

As the five initial reviews of the TDB Projects concluded, negotiations on an independently funded continuation of the TDB project were completed in late 1997.

This project is referred to as the TDB phase II project, or simply TDB II. The following new reviews will be performed within this project:

- An update of the existing U/Am/Tc/Np/Pu reviews (one review team for all elements).
- The inorganic chemistry of nickel (Ni).
- The inorganic chemistry of selenium (Se).
- The complexation of selected simple organic ligands (ISA, EDTA, citrate and oxalate) with uranium (U), americium (Am), technetium (Tc), neptunium (Np), plutonium (Pu), Ni, Se, zirconium (Zr) and some selected competing cations.
- The inorganic chemistry of zirconium (Zr).

These review areas have been decided on in consultation with representatives of the member countries, taking into account the toxicity, mobility, radioactivity and half-lives of the commonly occurring nuclides in radioactive waste.

Organisation of the TDB II project

The second phase of the TDB Project is organised as a semi-autonomous project under the guidance of a management board, representing the participating organisations or countries. The NEA acts as the project co-ordinator, and gets assistance and advice in technical matters from an executive group within the management board. As in Phase I, review teams evaluate existing data and prepare interim and final reports. The management board is ultimately responsible for the project and defines and approves the annual programme of work and budget of the TDB Project. The executive group, which consists of four persons with strong technical backgrounds, acts as a technical adviser to the management board. It also gives advice and assists the project co-ordinator. The main part of this work is performed by the NEA Data Bank and covers the co-ordinating of the review teams, editing of review report manuscripts, and the updating and maintaining of the TDB database. The review teams normally consist of three to five experts. Team experts must be highly qualified in the scientific area covered by the review, and have a wide range of direct experimental experience. This experience is crucial for the experts to be able to judge the quality and completeness of the scientific publications under review. The reviewers critically evaluate the chemical thermodynamic data available for the element or ligand in question. The review is carried out according to specified procedures, to ensure consistency and quality control. Based on this review, they recommend a set of data, and present these data along with their associated uncertainties. They also provide a detailed justification for the selection, including references to the primary data sources, in the resulting report.

As in TDB Phase I, the reports are then reviewed by an independent set of experts before final publication. The purpose of this additional "peer review" is to obtain an independent view of the judgements and assessments made by the primary reviewers, to verify assumptions, results and conclusions, and to check whether the relevant literature has been exhaustively considered. This is a very important part of the quality assurance for the published reviews. The published TDB Project reviews have earned widespread recognition due to their high quality, and have also found many users in the general research community, in addition to the intended audience of specialists in safety assessment studies. As the project now enters a new phase, it will aim to continue producing high-quality, relevant review reports useful to scientists and safety assessment modellers alike. ■

Section of a tunnel in Sweden which is the type envisaged for transport into a spent nuclear fuel repository.

SKB, Sweden

Nuclear power in NEA countries

Situation as of 31 December 1998

At the end of 1998, the total capacity provided by the 345 reactors now installed was 292.4 gigawatts (GWe). Another 11 reactors totalling 10.09 GWe were under construction and three reactors totalling 3.5 GWe were firmly committed. The total capacity of nuclear power plants in NEA countries in the year 2000 and 2010 is projected to be about 294.3 and 311.6 GWe, respectively. The 7.4 GWe of capacity that is expected to be retired by the year 2000 is already deducted from these projections.

Nuclear electricity capacity in NEA countries

	1998 (Actual)		2000		2005		2010	
NEA Country	Net GWe	%	Net GWe	%	Net GWe	%	Net GWe	%
Belgium	5.7*	36.5	5.7	35.8	5.7	34.1	5.7	32.0
Canada	10.3	9.4	10.3	9.6	13.1	11.8	14.7	12.9
Czech Republic	1.6	10.4	2.5	16.4	3.4	19.9	3.4	19.7
Finland	2.6	16.5	2.7	16.2	2.7	15.5	2.6	15.1
France	61.7*	57.4	63.1	57.6	62.9	56.6	62.9	55.8
Germany	21.1*	20.5	21.1	20.5	21.0	20.0	21.0**	19.8
Hungary	1.7	23.4	1.7	21.6	1.7	20.3	2.5	27.0
Japan***	43.5	20.3	43.5	19.8	45.4**	19.3	62.9	55.8
Korea	12.0	27.6	13.7	27.5	17.7	28.1	23.4	31.4
Mexico	1.3	3.7	1.4	3.6	1.4	2.8	1.4	1.8
Netherlands	0.5	2.3	0.5	2.4	0.0	0.0	0.0	0.0
Poland	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.7
Spain	7.3*	14.8	7.3	14.7	7.3	14.2	7.2	13.6
Sweden	10.1	32.3	9.5	28.6	8.9	26.6	8.9	25.9
Switzerland	3.1	19.8	3.3	19.1	3.3	18.3	3.3	17.8
Turkey	0.0	0.0	0.0	0.0	1.3	3.1	2.6	4.3
United Kingdom	12.9*	18.1	12.1**	14.9	9.3**	10.9	7.0**	8.2
United States	97.0*	12.0	96.0	11.6	87.0	9.8	80.0	8.7
NEA Total	292.4	15.3	294.3	14.8	292.1	13.7	311.6	13.8

Status of nuclear power plants

	Connected to the grid		Under construction		Firmly committed		Planned	
NEA Country	Units	Net GWe	Units	Net GWe	Units	Net GWe	Units	Net GWe
Belgium	7	5.7	0	0.0	0	0.0	0	0.0
Canada	14	10.3	0	0.0	0	0.0	0	0.0
Czech Republic	4	1.6	2	1.8	0	0.0	0	0.0
Finland	4	2.6	0	0.0	0	0.0	0	0.0
France	58	61.7	1	1.4	0	0.0	0	0.0
Germany	19	21.1	0	0.0	0	0.0	0	0.0
Hungary	4	1.7	0	0.0	0	0.0	1	0.6
Japan***	53	43.5	2	1.9	3	3.5	14	15.4
Korea	14	12.0	6	5.7	0	0.0	10	11.2
Mexico	2	1.3	0	0.0	0	0.0	0	0.0
Netherlands	1	0.5	0	0.0	0	0.0	0	0.0
Poland	0	0.0	0	0.0	0	0.0	2	2.0
Spain	9	7.3	0	0.0	0	0.0	0	0.0
Sweden	12	10.1	0	0.0	0	0.0	0	0.0
Switzerland	5	3.1	0	0.0	0	0.0	0	0.0
Turkey	0	0.0	0	0.0	0	0.0	4	2.6
United Kingdom	35	12.9	0	0.0	0	0.0	0	0.0
United States	104	97.0	0	0.0	0	0.0	0	0.0
NEA Total	345	292.4	11	10.9	3	3.5	31	31.8

* Provisional data.
** Estimate established by the NEA Secretariat.
*** Gross capacity data converted to net by the NEA Secretariat.

News briefs

International peer review of UK Nirex safety assessment methodologies

NIREX, United Kingdom

The area of investigation characterising a proposed radioactive disposal site: Longland Farm (Sellafield), United Kingdom.

Long-term safety of deep geologic repositories is of paramount importance in radioactive waste management. Methodologies for conducting safety assessments include at a very basic level the identification of features, events, and processes (FEPs) relevant to the system at hand, their convolution in scenarios for analysis, and the formulation of conceptual models to be further evaluated through numerical methods. These methodologies constituted the main subject of an international peer review conducted by the OECD Nuclear Energy Agency (NEA) on behalf of Nirex. Nirex is a British company which has national responsibilities for radioactive waste management. Nirex's objectives are to maintain technical credibility on deep disposal, to gain public acceptance for a deep geologic repository, and to provide relevant advice to customers on the safety implications of their waste packaging proposals.

In September 1998 the UK Department of Trade and Industry requested the NEA to undertake and manage an international peer review, on behalf of Nirex. The review primary objective was to judge whether the Nirex methodology provides an adequate framework to support the building of a future licensing safety case. Another aim was to judge whether the methodology could help establish a better understanding and, ideally, help to enhance acceptance of a repository among stakeholders: the scientific community, the community of public and industrial policy makers, and the public.

The main conclusion of the International Review Team (IRT) was that Nirex has developed a potentially sound methodology. Better documentation is needed, however, to allow the future reader, or reviewer of the methodology, or potential user or stakeholder, to judge the technical relevance of the methodology and to identify where, in the overall decision process, the reader may be expected to be consulted or may expect to obtain specific information. A challenge to Nirex will be to describe in easier-to-understand terms some of the more technical concepts. To aid interactions with its stakeholders, the IRT recommends that Nirex more comprehensively and transparently document their methodology.

The IRT also recommended that Nirex make available some of its computerised databases to stakeholders and other interested parties. If properly managed, e.g., through a "user group", a review of these tools by external users to Nirex could lead to important insights and improvements. Ultimately, the broader familiarity with these tools could favour the acceptance of the Nirex methodology by the larger community of radioactive waste management organisations and stakeholders. ■

The WIPP: a world premiere

In March 1999, the Waste Isolation Pilot Plant (WIPP), in south-eastern New Mexico, became the first operational deep geologic repository in the world for long-lived waste. The waste to be disposed of at the WIPP comes from the United States defence programmes as a by-product of nuclear weapons production and dismantling. It is commonly referred to as transuranic waste and consists of clothes, rags, tools, debris, residues and other non-liquid disposable items contaminated with trace amounts of radioactive nuclides, mainly plutonium.

The waste is being placed in caverns excavated at a depth of 650 meters below ground in a bedded salt formation. This formation was chosen primarily for its geological stability and for the lack of significant sources of potable water in the area affected by the repository. In particular, the WIPP site was selected and constructed to meet the safety criteria established by the responsible US regulatory authority, the Environmental Protection Agency (EPA). The regulatory approval process included public hearings and an assessment of the long-term safety of the repository after its closure, as documented in the Compliance Certification Application and was submitted from the U.S. Department of Energy (DOE) to the EPA. Legal actions were taken by some groups opposed to the WIPP project, but were dismissed in court.

The underground repository will comprise 55 storage chambers with a capacity to store 6 million cubic feet (180 000 cubic meters) of waste. This capacity is expected to meet half of the US military's projected contaminated waste needs over the next 35 years. It will require thousands of waste shipments from several locations in the US. The identification of routes required extensive consultation with affected transit States and Indian Tribes. In April 1999, shipments have already been received from waste producers in New Mexico and Idaho.

World-wide radioactive waste exists now and will continue to be produced. The waste comes mainly from the civil nuclear power, but also from medical and research uses of radioactivity and, in some countries, from military nuclear programmes. Experience with geologic disposal of waste comes from underground research laboratories and, in several countries, underground facilities for disposal of radioactive waste, including waste containing longer-lived radioactive components. The opening of the WIPP paves the way for future repositories for waste containing higher concentrations of long-lived radioactivity, such as high-level waste and spent fuel. The operations of such repositories can go a long way toward convincing the public that nuclear waste can be dealt with safely and effectively.

The NEA and other international organisations play an important role, through the provision of peer reviews. Through the peer review process, it is possible to benefit from experience of the world's leading experts in nuclear waste disposal and radiological safety assessments and to take into account the approaches followed by other advanced countries towards the safe disposal of long-lived radioactive waste.

In 1996, the NEA organised jointly with the IAEA a peer review to examine whether the post-closure assessment in the Compliance Certification Application of the WIPP was appropriate, technically sound and in conformity with international standards and practices. The expert group carrying out the review included representatives from nuclear regulatory bodies, radioactive waste management agencies, universities and research institutions. A report containing the international expert group's findings was transmitted to DOE. The NEA has organised a number of similar peer reviews in other Member countries at their request. ■

A tractor-trailer, called a TRUPACT-II transportation system, travels to the WIPP.

WIPP, United States

Combined waste repository and storage facility starts operation in Norway

In Norway the Himdalen repository for low and intermediate level waste has started operation in March 1999 after a period of operational testing and quality insurance. The first shipments are of waste containers (mainly drums) presently stored at the Norwegian Institute for Energy Technology (IFE).

The Himdalen facility consists of four waste caverns under a 50 m cover in a hard rock formation. The entrance is from the hillside through a tunnel that declines slightly towards the entrance. With a total capacity of 10 000 drums, the facility is planned to receive all low and intermediate level waste generated in Norway until year 2030. This quantity includes decommissioning waste, 45 containers of radioactive materials (NORM waste) from petroleum extraction, and about 10 000 drums which in 1970 were buried in a shallow ground repository at the IFE's premises in Kjeller.

It was decided by the Parliament, for public acceptance reasons, that some plutonium containing waste (200-300 drums, about 35 g of Pu) should be stored in the facility in a retrievable way. This will give the next generation the option of choosing another solution for this waste before closure of the facility. Therefore one of the four caverns has been defined as storage area, while the drums emplaced in the other three caverns, the repository area, will be irretrievably surrounded by concrete. The waste is emplaced in concrete structures with waterproof cover, and a self-drainage system has been constructed in order to keep the waste and the caverns in a dry state (i.e., not immersed in water).

The Himdalen facility is located about 40 km east of Oslo. The Institute for Energy Technology (IFE) is the facility operator. The licence was granted by the Government in April 1998.

Formal operation and maintenance agreements have been concluded between the Ministry of Trade and Industry and IFE about financing, and between Statsbygg (the governmental Directorate of Public Construction and Property) and IFE about maintenance responsibility. ■

Note

For more information on NORM waste, see Dealing with naturally occurring radioactive materials, *in the* NEA Newsletter, *Vol. 16, No.2, 1998, pp. 18-22.*

House of Lords report on the management of radioactive waste

On 24 March 1999 an important report has been released in the United Kingdom regarding waste management policy. Prepared by a subcommittee of the house of Lords Science and Technology Committee, the report states that geological disposal is presently the most suitable solution for indefinite disposal of long-lived radioactive waste. Phased disposal, including a long period of monitored, retrievable storage – at depth – should be considered before closing the repository.

Parliament should examine periodically the repository development process, and it has been indicated that phased disposal will allow decisions to be taken in a considered way.

The report includes recommendations to set up a new Nuclear Waste Management Commission which would seek to develop a broad national consensus on choice between options for waste management in the United Kingdom and, later, a Waste Management Company to deal with detailed investigation and implementation of technical solutions. The report can be consulted, and ordered via the internet at htpp://www.parliament.uk. ■

International symposium on the reform of civil nuclear liability

Public concern over the risks arising from the production and utilisation of nuclear energy is an obstacle to the future development of nuclear power as a safe and reliable energy source. This concern normally focuses upon safety issues associated with the operation of nuclear installations, the shipment of nuclear materials and the management of radioactive waste and spent nuclear fuel. However, much importance has also been placed upon the need to ensure the equitable compensation to victims in the event that a nuclear accident actually does occur.

One means of satisfying this need is the establishment, on both national and international levels, of legal regimes which guarantee the payment of such compensation to all nuclear accident victims. Such regimes have the effect of alleviating public apprehension while at the same time reflecting the fundamental duty of states to protect their citizens from hazards arising from potentially dangerous activities or the use of potentially dangerous substances.

While national regimes may vary considerably from state to state, historically there have been only two international regimes in place covering liability and compensation for nuclear damage suffered by third parties. The first regime was established by the Convention on Third Party Liability in the Field of Nuclear Energy of 29 July 1960 (the “Paris Convention”). This Convention was adopted under the auspices of the NEA and covers most Western European countries. The Paris Convention is complemented by the Supplementary Convention on Third Party Liability in the Field of Nuclear Energy of 31 January 1963 (the “Brussels Supplementary Convention”). The second regime was established by the 1963 Vienna Convention on Civil Liability for Nuclear Damage (the “Vienna Convention”) which was adopted under the auspices of the International Atomic Energy Agency and is world-wide in character. The two Conventions are linked by a Joint Protocol which came into force in 1992.

In recent years, major efforts have been undertaken by the international community to improve these two regimes, and in September 1997, such efforts culminated in the adoption of two new instruments: first, the Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage; and secondly, the new Convention on Supplementary Compensation for Nuclear Damage which establishes a global regime for dealing with liability and compensation for nuclear damage. Subsequently, the Contracting Parties to the Paris Convention began negotiations to revise their own Convention, and it is likely that any resulting amendment of that Convention will necessitate a corresponding revision of the Brussels Supplementary Convention.

In the context of this recent and ongoing reform, the NEA organised an International Symposium on the Reform of Civil Nuclear Liability in Budapest, Hungary from 31 May – 3 June 1999. The symposium benefited from the co-operation of both the IAEA and the European Commission and was hosted by the Hungarian Atomic Energy Authority and the Institute for Legal Studies of the Hungarian Academy of Sciences. This Symposium provided an opportunity for government experts, representatives from the nuclear industry and from nuclear risk insurers, academics and international organisations to focus on topical issues arising from the practical implementation of these new reforms and the many challenges that lie ahead.

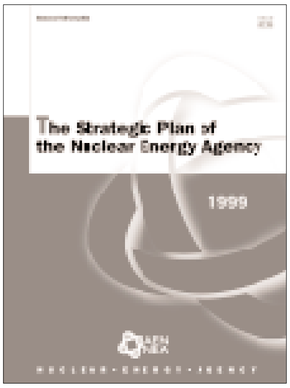
Speakers were invited from a wide variety of countries and sectors, whether or not they use nuclear power, and practically every discipline interested in the peaceful utilisation of nuclear energy was represented. Approximately 225 participants from all over the world attended the Symposium. The NEA will publish the proceedings of the Symposium later this year. ■

Inaugural session of the Budapest International Symposium on the Reform of Civil Nuclear Liability.

New publications

The Strategic Plan of the Nuclear Energy Agency

To assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.



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Also available on Internet: http://www.nea.fr

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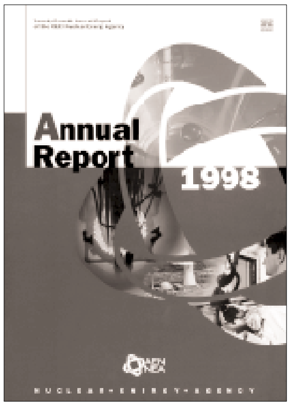

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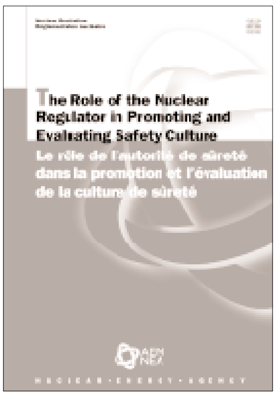
The Role of the Nuclear Regulator in Promoting and Evaluating Safety Culture



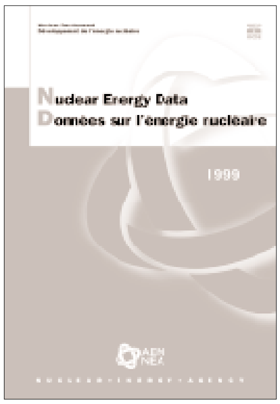
Bilingual. Free on request.

Nuclear Energy Data – 1999

Bilingual.

ISBN 92-64-05856-7

Price: FF 120 US$ 21 DM 36 £ 13 ¥ 2 400



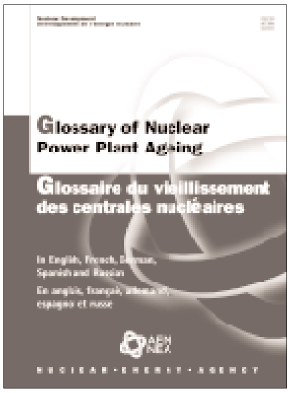
Nuclear Energy Data is the OECD Nuclear Energy Agency's annual compilation of basic statistics on electricity generation and nuclear power in OECD countries. The reader will have quick and easy reference to the status of and projected trends in total electricity generating capacity, nuclear generating capacity, and actual electricity production, as well as to supply and demand for nuclear fuel cycles services.

Glossary of Nuclear Power Plant Ageing

In English, French, German, Spanish and Russian

ISBN 92-64-05842-7

Price: FF 300 US$ 52 DM 89 £ 32 ¥ 6 050



Plant life management is becoming an increasingly important topic both in nuclear power plant operations and in international discussions on the role of nuclear energy. As in many other aspects of nuclear power plant operations, there is much to be learned by international comparisons of pratices. This five-language glossary of terminology is intended to assist utility operators and regulators in OECD countries, and more generally to help readers benefit as much as possible from international experience.

Actinide and Fission Product Partitioning and Transmutation

Status and Assessment Report

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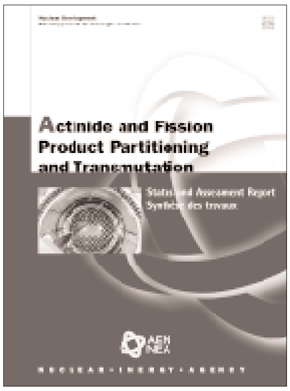

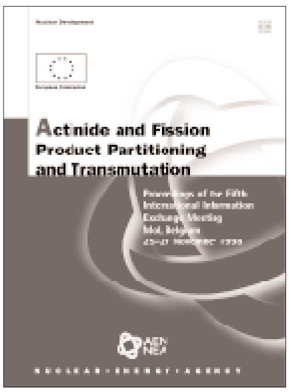

Proceedings of the Fifth International Information Exchange Meeting, Mol, Belgium, 25-27 November 1998

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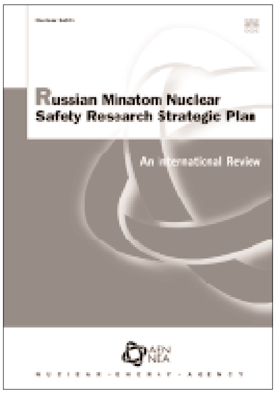
Russian Minatom Nuclear Safety Research Strategic Plan

An International Review



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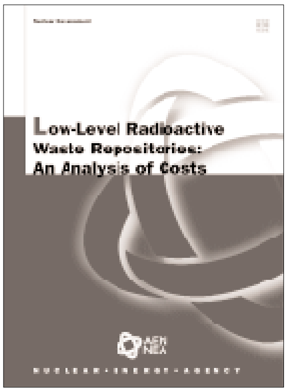
Low-Level Radioactive Waste Repositories: An Analysis of Costs

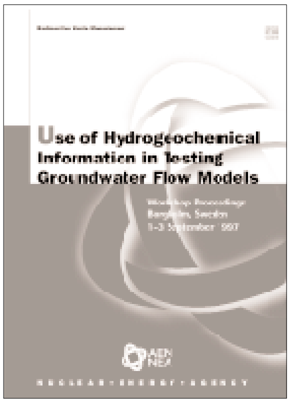
ISBN 92-64-16154-6

Price: FF 300 US$ 50 DM 89 £ 31 ¥ 7 000



Low-level radioactive waste (LLW) arises in the normal operation of nuclear power plants and fuel cycle facilities, as well as from the use of radioactive isotopes in medicine, industry and agriculture. This report sets out the costs of operating disposal sites for LLW in OECD countries, as well as the factors that may affect the costs of sites being developed. This publication will be of special interest to experts in the field of radioactive waste management and economics of the nuclear fuel cycle.

Use of Hydrogeochemical Information in Testing Groundwater Flow Models



Workshop Proceedings,
Borgholm, Sweden,
1-3 September 1997

ISBN 92-64-16153-8

Price: FF 550 US$ 91 DM 164 £ 56 ¥ 12 500

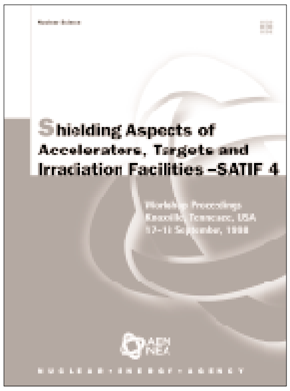
Site characterisation and evaluation are important elements for determining the site suitability and long-term safety of a geological repository for high-level and/or long-lived radioactive waste disposal. In that respect, matching the results of the various geoscientific methods used in site characterisation is important for building confidence in the data, concepts and models used for describing and understanding geological barriers of deep repository systems and assessing their performances. As groundwater chemistry may provide a method to test site-specific, time-dependent groundwater flow models, a workshop on the "Use of Hydrogeochemical Information in Testing Groundwater Flow Models" was hosted by the Swedish Nuclear Fuel and Waste Management Company (SKB) in Borgholm, Sweden, on 1-3 September 1997, to assess the progress to date in this multidisciplinary aspect of site characterisation and evaluation. These proceedings include the papers presented at the workshop, as well as a technical summary of the topics addressed and the conclusions reached.

Shielding Aspects of Accelerators, Targets and Irradiation Facilities – SATIF 4

Workshop Proceedings
Knoxville, Tennessee, USA,
17-18 September 1998

ISBN 92-64-17044-8

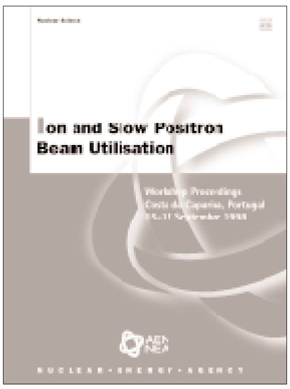
Price: FF 500 US$ 88 DM 149 £ 53 ¥ 10 300



Over the last 50 years particle accelerators have evolved from simple devices to powerful machines, and will continue to have an important impact on research, technology and lifestyle. Today, they cover a wide range of applications, from television and computer displays in households to investigating the origin and structure of matter. It has become common practice to use particle accelerators for material science and medical applications. In recent years, requirements from new technological and research applications have emerged, giving rise to new radiation shielding aspects and problems. These workshop proceedings review recent progress in radiation shielding of accelerator facilities, evaluating advancements and discussing further developments needed with respect to international co-operation in this field.

Ion and Slow Positron Beam Utilisation

Workshop Proceedings
Costa da Caparica, Portugal
15-17 September 1998



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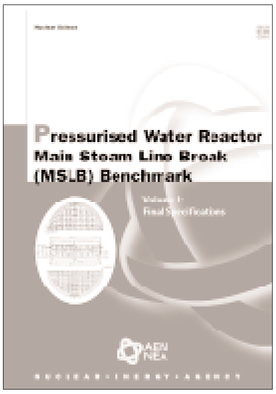
Price: FF 400 US$ 72 DM 119 £ 43 ¥ 8 500

The use of ion beams in nuclear research is well established, with many facilities and networks of experts active in the field. Applications for ion beams are expanding, in particular in the development of new materials, biotechnology and the creation of new isotopes. Positron beams are likewise a very powerful tool for observing and influencing microscopic material structures, as well as for medical diagnosis. The combined utilisation of ion and positron beams is expected to open up new horizons in the areas of material science and biotechnology. These proceedings provide an overview of the latest developments in this field, and highlight areas for future international co-operation.

Pressurised Water Reactor Main Steam Line Break (MSLB) Benchmark



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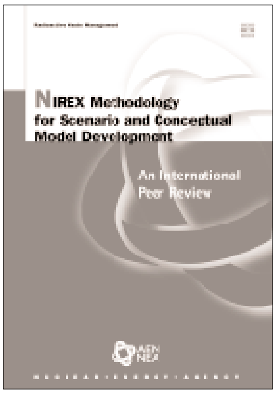
An International Peer Review



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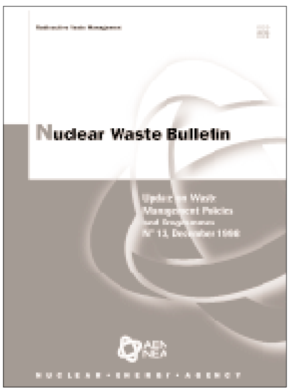
Nuclear Waste Bulletin

Update on Waste Management Policies and Programmes
No. 13, 1998



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Also available on Internet: http://www.nea.fr

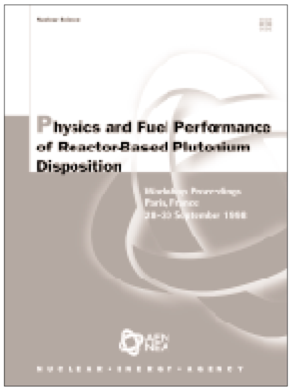
Physics and Fuel Performance of Reactor-Based Plutonium Disposition

Workshop Proceedings
Paris, France,
28-30 September 1998

ISBN 92-64-17050-2

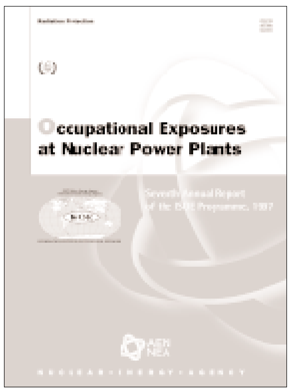
Price: FF 400 US$ 70 DM 119 £ 43 ¥ 8 200

Following recent disarmament agreements, the Russian Federation and the USA have declared part of their stockpiles of weapons-grade plutonium as a surplus to their national defence needs. This material needs to be disposed of, and one of the suggested means of doing so is burning it in existing reactors and transforming the material into spent fuel. The experience in these two countries with mixed oxide fuel (MOX) is either dated or scarce. Several European countries and Japan, however, have acquired much experience in using MOX fuel in reactors which was shared at this important workshop. This publication presents the workshop results which reviewed existing technical information from the civil nuclear power programmes that are beneficial to weapons-grade plutonium disposition. It also proposes concrete actions that could help expedite this process in the near future.



Occupational Exposures at Nuclear Power Plants

Seventh Annual Report of the ISOE Programme 1997



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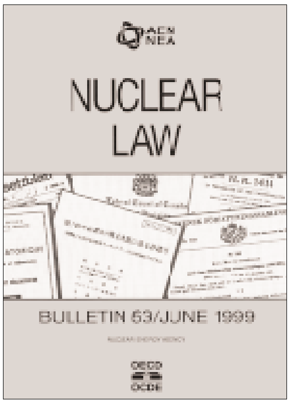

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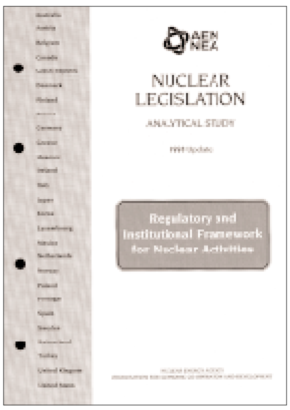
Regulatory and Institutional Framework for Nuclear Activities – 1998 Update



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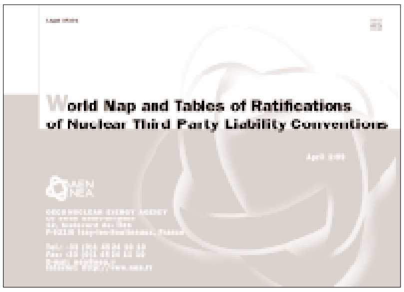


World Map and Tables of Ratifications of Nuclear Third Party Liability Conventions

April 1999

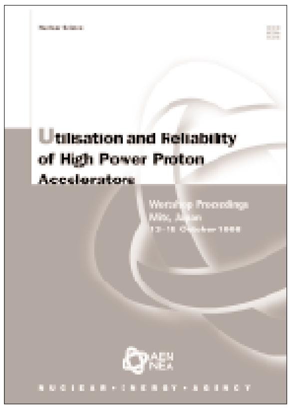
Free on request.

Utilisation and Reliability of High Power Proton Accelerators

Workshop Proceedings,
Mito, Japan, 13-15 October 1998

ISBN 92-64-17068-5

Price: FF 650 US$ 113 DM 194 £ 69 ¥ 13 100



The use of high power particle accelerators in various areas of applied nuclear science is presented with special emphasis on accelerator driven reactor systems (ADS) for transmutation of nuclear waste. National programmes for the development of spallation neutron sources are presented and the performance and reliability of existing or planned accelerators for use in ADS are discussed. Effects, such as thermal shocks and material resistance on the reactor part of an ADS from loss of accelerator beam, are discussed more in greater detail.

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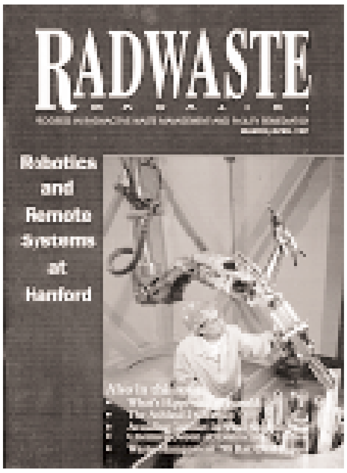

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