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## Editorial

It is hardly surprising that the possibility of a 'nuclear energy renaissance' is fanning the embers of old hopes and old arguments back into life, especially when it is against the backdrop of current preoccupations with global security. The year is less than three months old and we have already seen heated debate over fuel enrichment in Iran and the launch of a major international fuel cycle initiative by the USA. The prospects of increased worldwide nuclear power development in the frame of international fresh and spent fuel trading has brought out the two extremes of the pro- and anti-nuclear lobbies – optimistic schemes based on advanced reactors and scare stories about global environmental contamination.

In these developments, the spotlight is always on the front-end of the fuel cycle. But none of the international schemes will work unless the back-end is taken care of too – a point recognised by the proponents, but currently rather lost in the enrichment and fuel supply debate. Our work at Arius is thus becoming ever more central to the viability of these, largely security-driven, developments and it is our job to make sure that the whole picture is presented clearly. Readers will find that these concerns dominate this issue of our Newsletter.

Neil Chapman  
Baden

## Arius Internal News

### 2006 Assembly

The annual Assembly of Members was held in Dättwil, Switzerland on 10th February 2006 and was well-attended, with both organisational Members and individual Members present. The Annual Report for 2005 was presented and approved and a wide-ranging discussion took place on plans for 2006. The highlights of the 2005 report were the successful

completion of the SAPIERR project, the development of contacts with Russian and Central American national and regional projects and the preparation of 12 Arius papers and publications – illustrating the extent to which the Association has been involved in international meetings and also contributed articles to journals and nuclear industry magazines. The financial status of the Association stabilised during 2005 as a result of tight budgeting during our formative years.

The main strands of the 2006 programme were agreed to comprise the continued development of the two main multinational storage/disposal scenarios:

- **shared regional solutions scenario:** principally via the SAPIERR-2 project (see later item in this Newsletter) but also maintaining contacts in central-south America and Asia;
- **international fuel cycle facilities scenario:** principally via our contacts with Rosatom and the IAEA.

The Assembly acknowledged that work on the SAPIERR-2 project would have a major impact on the overall programme of work that Arius would be able to undertake with its present infrastructure. Given current international developments, the prospects in both areas look promising for this year.

### SAPIERR-2 progresses through EC

In our previous Newsletter we reported on the completion of the SAPIERR project and on submission (and content) of the SAPIERR-2 proposal to the 6th Framework Programme of the European Commission. The next article contains some reflections on the outcome of SAPIERR, by Vladan Stefula, the project co-ordinator.

The project results were presented to an international workshop in Brussels on November 9<sup>th</sup> and received very favourable feedback from the participants. The meeting was extensively reported in *Fuel Cycle Week* (v.4, No. 160), which featured interviews with a number of the participants. Apart from the SAPIERR results themselves, the workshop also heard from Igor Rybalchenko of VNIPIET, St Petersburg, on current Russian considerations of spent fuel import (as a resource) and the possibility of a Russian multinational repository (see Newsletter 11). The workshop also proved a valuable opportunity to receive comments on the scope of the proposed follow-on SAPIERR-2 project. The discussions suggested some modifications to the content, which were subsequently incorporated into a revision of the project proposal.

In December, Arius heard that the proposal had received high scores from the EC's independent evaluation panel and, in early 2006, we were invited to enter negotiations with the Commission, with a view to entering into a contract for the project. The amended project was submitted to the EC in draft form near the end of March and first negotiations on the details took place on March 28<sup>th</sup>.

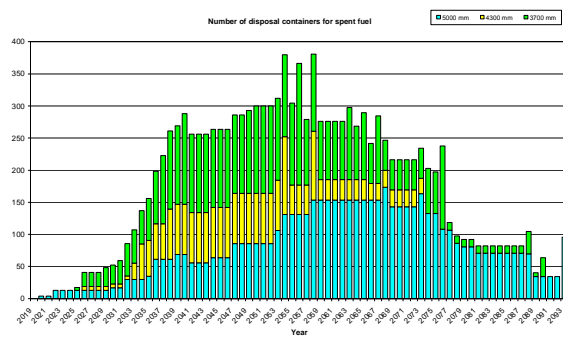
The negotiations with the EC should be completed in a few weeks and it is hoped that a contract will be signed in the summer, allowing this 2-year project to begin in the autumn of 2006. If all this proceeds smoothly, we will be able to report the final, accepted structure and content of SAPIERR-2 in the next Newsletter.

### Some personal reflections on SAPIERR by Vladan Stefula (Project Co-ordinator)

For two years, SAPIERR - the pilot initiative on European Regional Repository - has been a focus of ARIUS activities. It was successfully completed with the submission of the Final Report and the mandatory management reports to the EC in January – and also to the Swiss government, which partly financed the project. SAPIERR was a purely technical analysis of various aspects of a European Regional Repository but, in this article, I would like to venture a little into an area that we technicians usually avoid and leave to political analysts.

During the project, we came to some surprising conclusions. Perhaps the most surprising was the one about the optimum timing of the potential European Regional Repository. To remind you, we investigated a notional shared inventory of spent nuclear fuel from all 10 SAPIERR project participant countries that possess spent fuel from nuclear power plants that is destined for disposal (i.e. 10 out of the total 14 countries involved in the SAPIERR project). We made a working hypothesis two years ago that no more nuclear power plants would be constructed in the 'SAPIERR countries', in order to simplify our analysis. Even at the time, such a conservative assumption was not quite credible and, since then, the odds of constructing new European nuclear power plants (including 'SAPIERR countries') have increased significantly. New reactors have been announced in Bulgaria, Slovakia and Lithuania (see later item in this Newsletter). The renaissance of nuclear power does not change the SAPIERR conclusions about the most suitable timing of the potential European Regional Repository, but it adds more credibility that the relevant countries are determined to resolve early the issue of the final fate of their spent fuel. No government would countenance further support for nuclear power without parallel support for the fuel cycle back end.

Returning to the notional shared inventory, in order to obtain a "ready-for-disposal" inventory of spent fuel we assumed a uniform 50-year cooling period for all types of spent fuel and, based on purely geometrical properties, we assigned all fuel types to three types of disposal overpack. The number of containers "ready-for-disposal" is presented graphically in Figure 1.



**Figure 1:** Containers of spent fuel 'ready for disposal' in SAPIERR participant countries from 2019 to 2093, assuming no new nuclear power programmes and no further lifetime extensions. The three colours denote different container types for different types and sizes of spent fuel assembly.

From the sharp increase of disposal containers that can be seen to occur in the mid 2030's, we concluded that it is desirable that the European Regional Repository be in operation in the mid 2030's and the siting programme should thus be underway by 2010 - 2015.

The European Regional Repository siting programme will have to have an owner – an international organisation that will be established on the basis of inter-governmental agreements. I realize that it is naïve to presume that a sufficient number of the 14 governments of the countries involved in SAPIERR would find the common grounds to agree to the development of a shared repository by 2010 – or even 2015. It is, however, clear that such an agreement will not be within the competence of waste management organisations and private companies. Very broad political support will be necessary, with governmental or parliamentary endorsement. And, let's face it, disposal of spent nuclear fuel has never yet been an idea you can benefit from politically. It does not matter whether the radioactive waste repository is national or international, people do not want it in their backyards – and politicians do not risk their careers by willingly backing unpopular undertakings.

But this is exactly the key point: **it does not matter** whether the radioactive waste is from the nuclear power plant you live next to all your life, whether it is from another part of your country or whether it is from an altogether different country – the radionuclides in the waste do not have any national feelings! Plutonium will behave the same, no matter which country it originates from. At the end of the day, acceptability *anywhere* is all about safety, which rests on the question of whether the waste will remain isolated from the environment for a sufficiently long period of time not to cause any harm. We technicians are convinced that we are able to make the repository safe and, most importantly, to prove that it is safe. But, only when we are also able to show ordinary people and politicians that the waste will be disposed of safely, can we start presenting the economic case for international facility.

We laid some solid grounds for the economic case for the European Regional Repository in SAPIERR. Even though the input data for economic assessments were very coarse, the savings associated with sharing the disposal facilities are indisputable and are of the order of billions of Euros (see previous Newsletter). Specifically, we showed that the cost saving between having 10 individual national repositories and a single European Regional Repository for 10 SAPIERR countries might be 8 billion EUR. Such an amount is more than mere 'money' – it is politics.

At this economic scale, all projects become political issues. But, unlike the issue of radioactive waste disposal itself, savings of this magnitude are something from which one *can* benefit politically. This realisation makes me optimistic. Although it is often claimed that the idea of an international repository is politically and socially unacceptable, my personal opinion is that it is the idea of radioactive waste disposal itself that is dreaded, not the 'international' aspect. And, when the time comes that we overcome this social fear, people and politicians will be able to listen to the economic arguments for regional repositories. Then, attention may also turn to the potential safety, security and environmental benefits.

So, what exactly has SAPIERR given us? We demonstrated clearly that the idea of European Regional Repository is technically feasible and economically attractive, and that it should be discussed now, not after twenty years. But we avoided, so far, any analysis of how this idea might become reality.

I already indicated that I am sceptical about any large-scale international treaty of the countries that were involved in SAPIERR. Personally, I see more prospects in the gradual growth of such an agreement. There are some countries within SAPIERR where I see some chance of establishing bilateral or multilateral agreements on shared disposal facilities:

- Slovenia and Croatia (which already co-own a nuclear power plant)
- Lithuania, Latvia and Estonia (which have recently agreed to build a shared nuclear power plant – see page 6)
- Czech Republic and Slovakia

Let me, as a Czech, analyse further the case of the Czech Republic/Slovakia, where I have some insight. These countries have a history of close co-operation, even 70 years of co-existence. Czechs and Slovaks do not see each other as strangers and the political issues discussed in one country ultimately become topics for discussion in the other. Economic links are also very strong and the nuclear industry is especially intertwined. For many years, only one deep geological repository was foreseen for Czechoslovakia as a whole and, only after separation, did the repository development programmes also become separate.

Current political representations in both countries support further development of the nuclear industry and both countries have shortages of money in their

respective funds for the back end of the nuclear fuel cycle. It seems very likely that a decision will be made to fuse the two programmes for development of deep geological repositories back together again. It is the responsibility of we technicians to face the politicians and ordinary people and explain that we have to build the repository and, if we do it together, we will not cut corners and we will make it very safe. We must not succumb to pressure and we must be able to advocate what may be unpopular but, nevertheless, correct decisions.

If two countries prove that an agreement on development of a shared deep geological repository is feasible, there will then be the possibility of the gradual growth of such a treaty – maybe even to the size of SAPIERR. This is certainly food for thought for SAPIERR-2.

## International News

### *International Fuel Cycle plans leap forward*

In the last few months, a number of important initiatives have substantially increased the profile of the concept of international fuel cycle facilities and services. This article explores some of the main news items connected to these developments.

On December 10<sup>th</sup> 2005, Mohamed ElBaradei gave his Nobel prize-winner's speech in Oslo. One of the points he made was to promote his concept of internationalisation of the fuel cycle, to further the aims of nuclear security:

*"My plan is to begin by setting up a reserve fuel bank, under IAEA control, so that every country will be assured that it will get the fuel needed for its bona fide peaceful nuclear activities. This assurance of supply will remove the incentive - and the justification - for each country to develop its own fuel cycle. We should then be able to agree on a moratorium on new national facilities, and to begin work on multinational arrangements for enrichment, fuel production, waste disposal and reprocessing."*

This reiterated a point that the IAEA Director General has made in several fora in the last six months, most recently prior to his Oslo lecture, at the Carnegie International Non-Proliferation Conference in Washington, on November 7<sup>th</sup>. At the same meeting, Dr. Pierre Goldschmidt, a visiting scholar with the Carnegie Endowment of International Peace (and, until last year Head of the IAEA Department of Safeguards) explained in detail how he believed nations could be provided with guarantees of fuel supply within an international scheme.

A Supplier State and a Recipient State would negotiate bilateral terms for a fuel supply contract. Fresh fuel would be leased to a nuclear power plant in the Recipient State, with the supplier in the Supplier State remaining the owner of both the fresh and spent

fuel at any point in time. The number of fresh fuel assemblies stored at the power plant would never exceed two annual reloads. The spent fuel would have to be returned to the Supplier State after a minimum cooling time and, if not, the delivery of any further fresh fuel would be suspended. The power plant would pay a specified monthly amount into a dedicated account to cover transportation costs of the spent fuel to the Supplier State and all management, storage, conditioning and final disposal costs after its return. The account would be managed by an international organization such as the EBRD, the IMF or possibly the IAEA. The supplier might include provisions whereby the Recipient State would have to take back HLW in a quantity (and toxicity) equivalent to the fission products contained in the spent fuel. The contract would be most attractive to the Recipient State if it resolved completely its spent fuel and HLW management problems.

A Recipient State might need fuel supply assurances beyond usual contractual arrangements (e.g. a guarantee that export licences would not be refused for political reasons). As noted above, provided the Recipient State met a number of safeguards and security related requirements, the IAEA itself could act as a fuel bank. If, as a result, the IAEA ever became the owner of spent fuel, it would need to have the guarantee that at least one state would take over ownership of the spent fuel for storage, processing and final disposal. Dr Goldsmith made the point that, without such assurance, it would be unlikely that the IAEA Board of Governors would agree to provide fuel supply guarantees.

At the time of the Washington meeting, only Russia was considering offering the kind of fuel take-over scheme that might give the IAEA confidence to operate a fuel bank. However, the USA entered the arena on February 11<sup>th</sup>, when President Bush announced the launch of the Global Nuclear Energy Partnership (GNEP) with a start-up budget of 250 M USD for the US Department of Energy in 2007. GNEP is described as *“a comprehensive strategy to increase U.S. and global energy security, encourage clean development around the world, reduce the risk of nuclear proliferation, and improve the environment.”* It will develop and demonstrate new proliferation resistant technologies to recycle nuclear fuel and reduce waste, with the USA working with other advanced nuclear nations to develop a fuel services programme that would provide nuclear fuel and recycling services to nations in return for their commitment to refrain from developing enrichment and recycling technologies.

Quoting from the GNEP information package:

*“Under GNEP, a consortium of nations with advanced nuclear technologies would ensure that countries who agree to forgo their own investments in enrichment and reprocessing technologies will have reliable access to nuclear fuel. By participating in GNEP, even developing nations can enjoy the benefits of clean, safe nuclear power while not only minimizing proliferation concerns, but also eliminating the need for expensive infrastructure investments. Moreover, once the advanced recycling*

*technologies are demonstrated, the spent fuel would be returned to fuel supplier countries for recycling and possibly ultimate disposition. This builds on the moratorium on the sale of enrichment and reprocessing technologies that has been in place over the past two years among G-8 nations.”*

As sceptics have pointed out, this is an ambitious scheme, with, at its heart, the capability to recycle spent fuel using relatively untested technologies and re-use it in a new generation of ‘advanced burner reactors’ (variants of fast reactor technology) that have yet to be developed for commercial use. This overall concept parallels the one that has been promoted extensively in Russia over recent years, with significant advances already made in a number of new technologies (see Newsletter 11). GNEP also includes proposals to design and deploy small scale, cost effective nuclear reactors in developing nations – again, an area of current technology development.

One component of GNEP concerns the future of the Yucca Mountain project. The proposed recycling of spent fuel through fast reactors will, according to USDOE, change the characteristics and significantly reduce the volume of spent fuel to be disposed of in Yucca Mountain, *“making disposal less complex and minimizing the need for additional geologic repositories for generations to come”*. This, together with the internationalised fuel cycle component of GNEP, has raised questions in some quarters as to whether, if the USA is to provide fuel supply services to some countries, it would also take back the fuel, recycle it, reuse it in the USA and then dispose of it at Yucca Mountain – essentially the same model that Russia is promoting, with a repository at Krasnoyarsk in mind.

Naturally, this prospect, whether realistic or not, has been seized on by Yucca Mountain opponents, with the Nevada Commission on Nuclear Projects (which advises the Governor and Legislature) saying, with rather wearying predictability for those of us involved in promoting multi-national solutions, *“...what the government would like to do is turn Yucca Mountain and Southern Nevada into a dumping ground for the entire world”*. So far as we can see, the USDOE seems to have been rather careful in its written material on GNEP *not* to mention any prospect of ‘foreign’ HLW (from recycling spent fuel from non-US NPPs) going to Yucca Mountain. Of course, a similar question must attend interim storage of foreign spent fuel, even if it is to be recycled for re-use in a new generation of US reactors. Since there now seems to be no certainty about how or where even US spent fuel is likely to be stored, this GNEP-generated problem adds an extra dimension of uncertainty to the current vagaries of the US waste management programme.

It might be observed that both Russia and the United States now seem to be contemplating offering similar spent fuel import (and, perhaps, HLW storage and/or disposal) services. Russia clearly hopes to be able to use such spent fuel as a resource, whereas the prime driver in the US is, rather, that of global nuclear

safeguards. If both these schemes come to fruition as part of an IAEA-brokered and monitored system, the element of choice, with the economic benefits that will apply, can only be seen as attractive for 'small user' countries. For a while, in February, it seemed as though a fuel leasing and take back scheme might be brokered between Russia and Iran, to resolve the difficulties that have developed between the IAEA, Iran, the USA and the EU – but this seems to have fallen by the wayside.

There is considerable ambition to be seen in the emerging international fuel cycle schemes – especially in GNEP. From an Arius perspective, we would hope that the GNEP linking of the relatively simple concept of international fuel cycle services, as promoted by the IAEA, to the development of new fuel cycle technologies, which will take decades to bring to widespread commercial implementation, will not detract from the good intentions or capability to deliver secure solutions of the former.

#### **....meanwhile, Greenpeace looks increasingly marginalised and obstructive**

In the midst of all these positive developments, Greenpeace continues doggedly to fail to see the security, economic and societal advantages of multinational solutions to global nuclear energy issues. This is a rather studied myopia, as the organisation seems more concerned to cling hopefully to its 1980s 'flagship' political platform opposing nuclear energy, than to think afresh and constructively about lasting global security and well-being.

In a September 2005 polemic (*The Real Face of the IAEA's Multilateral Nuclear Approaches*), Greenpeace criticises the Agency's MNA report (see Newsletter 11) with the scare-story that the measures proposed will increase nuclear proliferation and "...lead to massive contamination of the environment". The document says that "the MNA is aiming to ease the pain of the 'Western' nuclear industry by allowing it to dump its nuclear waste spent fuel in regional sites", justifying its opposition with the incorrect and now rather tired claim that "as there is no current solution for spent nuclear fuel final storage, countries operating nuclear power reactors should move as early as possible to a phase out of nuclear power".

Being implacably opposed to nuclear power, Greenpeace equates the provision of multilateral solutions with facilitating the expansion of nuclear energy usage worldwide – which may be inevitable in any case. They overlook entirely that, if a nuclear renaissance is going to occur, then it could have global benefits to all nations and having the kind of safeguards that the IAEA proposes in place must be vital to any expansion.

Observers can be forgiven for thinking that an organisation originally established in good faith, with the health and well-being of the planet in mind, has allowed an ideological core of anti-nuclear activists to divert it from its real mission.

#### **Increasing profile for international fuel cycle in Australia**

Last Newsletter, we reported on the September 2005 statement by the former Prime Minister, Bob Hawke, that Australia should consider accepting radioactive wastes for disposal from other countries. Since then, the Australian Nuclear Forum (ANF) has issued a policy paper (8<sup>th</sup> December 2005) developing the concept into highly relevant elements of an international nuclear fuel cycle scheme (the second type of scenario being promoted by Arius: see '2006 Assembly' article above). In its paper, the ANF states:

*"Australia has been very active in the head-end of the nuclear fuel cycle by supplying uranium to the world market but has not been comparably involved in the tail-end of the cycle – spent fuel management. Understandably there is some political sensitivity to this from both non-proliferation and waste disposal aspects, however the prospects of improvements in spent fuel reprocessing and the development of waste-burning reactors should change the perspective. Also, the acceptance of foreign fission product wastes in this country would facilitate the use of nuclear power in countries that might be more vulnerable to diversions of nuclear materials and have less ability to store wastes. Such facilities should bring significant economic benefits to Australia.*

*It is proposed that a reprocessing plant that would accept spent fuel from overseas reactors should be built when feasible. This plant would separate the actinides (U, Np, Pu, Am Cm) from the waste stream and re-export these to be destroyed by irradiation in reactors. The remaining fission product waste would then be immobilised in a medium such as SYNROC and placed in the proposed repository. Since this repository would be primarily for fission product wastes it would need to have a design lifetime of no more than about a 1000 years at which time the radiotoxicity of the waste should be on the order of geologic deposits of naturally occurring radioactive materials. Such a repository could also accept the same type of immobilised wastes from overseas."*

In describing the proposed repository, the ANF policy paper goes on to say:

*".....the ANF proposal for Australia needs to have a design lifetime of only 1000 years because it will be used to retain just separated fission products. By design after 1000 years, the radiotoxicity of the fission products in the repository volume would be comparable with that of a similarly sized uranium ore body (e.g. a uranium assay of ~1%) and of similarly minor radiological concern. The repository should be located in a remote area of stable geology, low seismicity, little volcanicity and limited groundwater. Such areas are common in this*

country as was found by the studies previously carried out by Pangea International. A repository such as this could also serve as a site for disposal of Australia's existing intermediate level wastes plus that which will eventually be returned to this country from overseas processing of its research reactor fuel.

Incentives for this scheme include both the economic and strategic. Australia is a technically advanced and politically stable country that is geographically isolated from all others and has strong ties with countries that would actively support its defence. It also has a long history of active involvement with the IAEA and the pursuit of its nuclear non-proliferation program. As such, Australia offers advantages for the location and operation of sensitive facilities such as a reprocessing plant and a fission product waste repository plus the necessary temporary storages for irradiated fuel, separated irradiated uranium, reactor grade plutonium, minor actinides and immobilised fission products. Many countries that have nuclear power plants or are considering them would welcome access to such facilities. Furthermore, the operation of these facilities would provide this country with considerable long-term economic benefits."

Shortly after Bob Hawke's September statement, the Australian Broadcasting Corporation held an informal interview with Geoff Hudson, a Melbourne-based nuclear physicist, in its Sunday morning Ockham's Razor radio science programme (October 9th). Talking about the implications of an international repository in Australia, Dr Hudson said:

*".....there is a very good reason why we should exploit our unique capabilities in this activity: our own self interest. By putting our hand up, not only do we make the world a safer place, and protect our country from the major threat which nuclear waste poses to us, but we earn large sums of foreign exchange. Let me deal with the money first. The United States has a fund to solve the nuclear waste disposal problem, and all nuclear power plants in the US invest \$24 for each megawatt day of electricity they produce, into this fund. In 2004, these plants produced 32-million megawatt days, so contributions to the fund last year totalled more than \$US750-million. That's nearly \$AU50 for every man, woman and child in Australia. Of course you and I wouldn't get that. But as a country we have a terrible balance of trade, even when the prices for our exports are the best we've had for years. So when they fall, as they will, our debt to the rest of the world will grow at an even faster rate. Our currency will devalue, and imports will become more expensive. That could easily cost us \$1 a week.*

*I should point out here that we sell uranium to the US for about \$60 a kilogram but the money put aside by the US nuclear power companies amounts to \$300 per kilogram of used fuel rod, so you are a mug to be in the uranium mining*

*business if you could be in the waste storage business.*

*So much for the money. I also said that it would make the world a safer place. I really believe that. Nuclear waste stored below a desert in Australia is much less likely to become a dirty bomb, than waste stored alongside a nuclear reactor in France or America. Taking the used fuel rods would greatly reduce the chance of a dirty bomb exploding in a large city, and that is the major risk that waste poses to us. The natural causes of release of waste into the environment are easy to manage in Australia, so we run a lower risk of radioactivity reaching our shores from a desert location inland from the Indian Ocean than from temporary storage facilities in California or Japan.*

*I say, for our own good, we should offer a little patch of Australia to store the stuff. It doesn't have to be that big. The 200,000 tonnes would occupy a space 100 metres by 100 metres by 10 metres high, with lots of rock fill in between. If you took a 1 square kilometre site, this spot would be 1% of the area. There are cattle stations in Australia which have areas exceeding 600 square kilometres. But none that yield revenues approaching \$US750-million per annum.*

*For those who feel we should keep our present policy of avoiding everything nuclear, I would ask a question: Where would you have the waste stored? Don't say somewhere else. Pick a spot and consider the consequences."*

At Arius, we applaud this healthy debate and its focus on international responsibility and security. We hope it is taken seriously by Australian politicians – not swept under the carpet. Indeed, we may have the opportunity to contribute to the debate, via an invitation received to contribute a presentation to the 15<sup>th</sup> Pacific Basin Nuclear Conference in Sydney, this October.

### **Shared nuclear power plant in the Baltic**

In February, Latvia, Lithuania and Estonia agreed on the joint construction of a nuclear power plant by 2015 to solve an expected energy crisis in 2009, when the Ignalina nuclear power plant (Lithuania) closes.

The arrangements for managing the wastes from this shared facility are not currently known. We note that, in a somewhat analogous situation in Slovenia and Croatia, the wastes from the common Krsko NPP are owned equally by both countries and common disposal facilities seem likely.

### **New EC Directive on shipments of radioactive waste recognises needs of small producers**

At the end of December, the European Commission proposed a new council directive on the supervision and control of shipments of radioactive waste and nuclear spent fuel. This is in the frame of the revision

process of Directive 92/3/Euratom (February 1992) on the supervision and control of shipments of radioactive waste between Member States.

The directive is an important step forward to ensuring that small producers of radioactive waste and spent fuel can transfer them to other countries for storage and disposal without hindrance or obstruction. While the directive recognises the right of EU Member States to prohibit the import of radioactive wastes it points out that:

*Providing for a solution for small producers of radioactive waste is the necessary corollary of recognising the right to prohibit the import of radioactive waste for final disposal.*

*.....a specific duty of co-operation needs to be enounced in order to avoid situations where the authorisation/consent procedure might be misused for dilatory purposes and constitute an unjustified obstacle e.g. to the free movement of spent fuel within the Community. The appropriate Community control mechanisms apply, including, as the case might be, the opening of infringement procedures under Article 141 Euratom.*

Article 16 of the directive states:

*1. Member States shall promote agreements in order to facilitate the safe management, including the final disposal, of radioactive waste from countries that produce it in small quantities and where the establishment of appropriate facilities would not be justified from the radiological point of view.*

*2. Each Member State shall ensure that its competent authorities cooperate and communicate with the competent authorities of other relevant Member States or third countries so that to avoid undue delays in the procedures laid down by this Directive.*

Also, in line with the Joint Convention, the directive is now explicit on the need for consent from countries outside the EU that might be recipients of radioactive wastes or spent fuel. It notes that, in the case of radioactive waste and spent fuel leaving the Community, the third country of destination should not only be informed of the shipment, but should also give its consent.

## International Meetings

The annual Tucson 'Waste Management' meeting (Waste Management '06) took place from 26<sup>th</sup> February to March 2<sup>nd</sup> and was attended by Arius President Hans Codée. Once again, the meeting led to an animated discussion on multilateral initiatives. The Nirex speaker, John Mathiesson, repeated the 'Nirex view' expressed in 2004 that disposal of waste in another country was unethical. Apart from being a convoluted and lopsided interpretation of ethics, as we have discussed before in this Newsletter, this position is not tenable on the basis of what are now

widely accepted national and international practices. Nationally, in the USA for example, trans-boundary waste movement takes place within a federal system. Internationally, there are numerous examples of consenting countries transferring wastes. An earlier item in this Newsletter showed that, within the European Union, encouragement is now being given to small waste producers to allow the movement of waste and spent fuel to other countries.

The forthcoming CATT project (aimed at making expertise available to smaller waste management programmes) within the EU FP 6, has been described as 'an antidote to SAPIERR'. On the contrary, the EU will soon have two projects that could act in a complementary fashion to assist smaller waste producing countries: SAPIERR to establish a feasible route to shared regional solutions and CATT to provide the expertise of the established national programmes to help smaller countries implement shared facilities in a cost-effective manner.

## Topical Article

### Do it together..... or wait\*

**Hans Codée**

Most human activities generate waste. Some say that one of the characteristics that make us human is that we produce 'waste'. In the early days of our existence most waste was degradable, only a few traces are left of the human activities. Some waste, however, was, and still is, long-lived – such as the stone chisels or arrow points of people living in the Stone Age. This long-lived waste can now be found in museums. It tells us today about the life of the past. Many of the treasures you will find in museums are actually wastes: materials and products intended to be forgotten, at the end of their practical use. Centuries-old dumpsites provide archaeologists and historians with new treasure troves. Waste production is not new, but we have improved our means of producing it. Since the beginning of the Industrial Age much more (hazardous and long-lived) waste has been produced than in the past. Unfortunately, our waste management methods did not advance at the same speed.

In general, not much attention was given to waste management until the 'discovery of the Environment' in the seventies. The city of New York landfill, Fresh Kills, is the largest man made structure in the world and results from only six decades of the New York way of life. The possible adverse effects of CO<sub>2</sub> have only been widely discussed for a decade! The nuclear industry and the widespread use of radioactive materials started in 1953 with the Atoms for Peace programme. In the beginning, neither the environment nor radioactive waste got much attention. In the early fifties some radioactive waste was tipped overboard from passenger cruise ships crossing the Atlantic Ocean. At that time of course, it was just a few drums, produced each year.

When quantities increased, multinational sea disposal started in the late sixties, which called for international surveillance. This practice ended in 1982. The philosophy behind disposal at sea was the dilution principle, which was abandoned at the end of the seventies. Waste prevention, reuse and isolation of hazardous materials from the biosphere were the guidelines of the eighties, followed by sustainability, in the nineties. As a result, the current EU Landfill directive prescribes maintenance, monitoring and control (after-care) for as long as required by the authorities, taking into account the time during which a landfill could present hazards. This may be up to a thousand years. The price charged by the operator must include the costs for an after-care period of at least 30 years. The fixed, but very long life times of radioactive substances such as the transuranic elements, imply even longer periods of time that these materials have to be looked after. Radioactive waste management is therefore in the forefront of long-term environmental management.

At national level, most countries in Europe created dedicated waste management organisations. On the time scale of radioactive waste disposal, however, state boundaries and therefore national solutions are meaningless. It can easily be seen that, rather than the present purely national approaches, regional approaches are absolutely necessary, together with a multinational, or even supranational, surveillance system. This paper will argue that, although environmental and safety concerns are the dominant drivers, common sense and economic factors also point to shared or regional solutions.

### **Practice in the Netherlands**

One nuclear power plant, two nuclear research centres, a uranium enrichment plant and a medical isotope production facility are in operation in the Netherlands. In addition, there is widespread use of radioactive materials in other areas. The small nuclear power programme is foreseen to remain stable over the next tens of years. The Borsele nuclear power plant (a 450 MWe PWR) has been in operation since 1973 and is scheduled to remain operational until 2033.

The quantity of radioactive waste produced annually in the Netherlands is small and heterogeneous. A solution to manage this waste, tailor-made to the country's needs, has been set up since the early eighties and is now in full operation. All radioactive waste in the Netherlands is managed by COVRA, the Central Organisation for Radioactive Waste. Its task is to execute the policy of the government, which has not changed since it was approved by Parliament in 1984. All radioactive waste will be stored above ground in engineered structures allowing retrieval at all times for a period of at least 100 years. After this period of long-term storage, final disposal is foreseen. The policy is based on a step-wise decision process in which all decisions are taken to ensure safe disposal in a repository, but without excluding unforeseen alternative solutions in the future. Buildings for the treatment and storage of all

categories of waste have been commissioned and are now in full operation.

### **Economy of Scale**

In general, the volume of radioactive waste is small in comparison with municipal waste or chemical waste. This is an advantage, because it can easily be controlled and contained. But there are also negative effects of economy of scale. "Small is beautiful" is a nice slogan, but it has its drawbacks. In the Netherlands, it was obvious that a period of long-term storage was needed before a deep repository could be constructed. Both the small volume of waste and the limited financial means are determining factors. A direct disposal route is not feasible because of the economy of scale. Moreover, the small volume of waste can easily be kept under control in above ground structures. This 'interim' storage provides time to let the volume of waste accumulate and to let the money, needed for disposal, grow in a capital growth fund. With only 450 MWe installed nuclear capacity, some 100 TWh of electricity will be produced over a period of 30 years. The estimated costs for a national repository are 1.3 billion EUR. A levy on the nuclear electricity of 1.3 EUR cents/kWh is calculated to be needed for the repository. Considering that the cost price of nuclear electricity is around 2 to 5 EUR cents/kWh, this would mean an increase of 65% to 26%. From this simple logic, a national direct disposal route for a country with a small nuclear programme is economically impossible!

The economic threshold for a direct disposal route is an installed nuclear capacity of some thousands of MWe. It is clear that not all European countries can afford this option. For western economies, financial advantage can be found in net value calculations. Practically, disposal will take place after some thirty years of operational lifetime of the nuclear installation. Net value calculations with thirty years delay will result in a reduction of a factor of two to three in actual money value. The general result is that realisation of disposal is only financially feasible after some thirty years of operation of at least 2500 MWe.

The small volume of radioactive waste from nuclear activities is a further reason to wait or to co-operate. For the Netherlands, the volume of all categories of radioactive waste generated by the 450 MWe Borsele nuclear power station over 30 years is only a few thousand cubic metres. Such small volume make the disposal cost per cubic metre unacceptable. Other waste generators certainly cannot afford these prices. The total volume after 30 years is still too small to urge direct disposal. For these reasons, a repository is never available at the very beginning of waste generation, and interim storage is always needed.

The costs of interim storage cannot be avoided. Structures for interim storage that will last for 100 years, compared to just some tens of years, do not differ fundamentally in costs. The challenge in engineering buildings to last for a hundred years or more is ensuring compliance with present and future environmental legislation and acceptability to the public at all times. It is thus uncertainty that costs

money: policy changes every few years, lack of a clear policy or lack of political decisions, create sub-optimal solutions. Constructing a facility for storage just for a short period of time and then refurbishing it several times because the storage period is not as short as expected, is a waste of money and has a negative effect on the image of radioactive waste management.

The reality today is that radioactive waste has already been generated for over half a century. Apart from the waste disposed of in the WIPP facility, no other long-lived waste has yet been disposed of in a deep repository. A small volume of waste can easily be kept under control in above-ground structures. Under these conditions, it is not feasible to realise a national disposal facility within, or directly after, a 30 years operating lifetime for just one nuclear plant. Even a lifetime extension to 60 years does not change that conclusion. Time is needed to let the volume of waste grow and to let the money grow in a capital growth fund. Over long periods of time, such as 100 years, an order of magnitude growth can be obtained with a real interest rate of 2.5%. Of course, higher real interest rates, such as could easily be obtained in the seventies and eighties, create better results.

### Changing Borders

There is a widespread preference for national disposal solutions, as this would enable closer control of possible environmental and safety impacts. However, long-term national control appears an oxymoron. A deep repository is likely to be operational for many tens of years. A period of active control and monitoring of some hundreds of years could follow and, ultimately, the repository could be left for some hundreds of thousand of years with minimal, or perhaps even no surveillance. For a period of hundreds of years, national boundaries as well as national structures are uncertain. The history of Europe shows this clearly. Any control of the environmental and safety impacts of the chosen disposal solution, that needs to last for times exceeding the lifespan of national structures, has to be as independent as possible of national structures. Hence, regional solutions must be preferred to national solutions.

### Surveillance

The materials placed in a deep repository are still hazardous and, within the context of today's society, should be kept under surveillance. First, surveillance is needed to confirm that the material does not pose adverse affects to people or the environment. Second, surveillance is needed to prevent abuse of the materials. Since 2001, awareness has increased on this last point. As security is a global concern, surveillance limited to one national institute or structure is not sufficient. A multinational structure, at least, must be present to confirm that the materials remain in place. Considering the long time frame within which national, and therefore multinational, structures are unstable, a system of supranational surveillance is preferable. Control by an institution such as the IAEA seems logical. A recent

'Eurobarometer' survey in the EU indicated a very broad consensus (89% of those interviewed) on the need for European monitoring and harmonization of national programmes.

### Do it Together....

Many countries have a nuclear power programme smaller than 2500 MWe, meaning that direct disposal is not economically feasible. Either a waiting period is needed, to let the money accumulate in a growth fund, or a repository has to be shared with others. In the EU, all 25 Member States generate radioactive waste. Of course, there are large differences in type and quantity between the member states. But even a country whose only long-lived waste is lightning rods containing radium, does need a long-term solution. The 1600 year half-life of radium does not fit into a solution with a span of control of just a few hundred years.

If each of the 25 European countries creates a repository adequate to its needs, this will be a tremendous waste of resources – one repository can cope with the volume of all the radioactive waste in the European Union. However, because of present public attitudes, as well as legislative obstacles, this will be very difficult to achieve. A more realistic scenario is the creation of a few regional repositories. Until now, there has not been much consideration of multilateral approaches in the Netherlands. All effort has been put into setting up the infrastructure of COVRA and to the construction and commissioning of the facilities needed for long-term storage. Now that these are operational, the time has come to start working on the subsequent step: final disposal. This was already foreseen in the policy paper on radioactive waste that was accepted by Parliament in 1984 and which forms the base of COVRA's activities:

*"Therefore a site must be found in the Netherlands where storage of all categories of radioactive waste can take place. During the storage period further considerations can be given to final disposal, international developments can be followed and even an international facility could be used".*

Considering the many advantages of a shared repository, it is logical to include it as an option. This has to be done with a very open mind, which means that sharing does not exclude being the host. All possibilities should be kept open, and the pros and cons of a shared facility will have to be studied first.

SAPIERR was the first study of this kind and an important step towards an outline of a European facility. Another important initiative was the creation of ARIUS, which will continue to initiate discussions with those interested in creating solutions for waste management – in full knowledge of the sensitivity of this subject. It might be expected that the first reaction of society on this subject will be that shared solutions are, of course, to be preferred – but that NIMBY will follow on immediately. Waste, including household waste, was kept on private premises in the past. One logic that makes a complex society work is the

sharing of activities in order to obtain better solutions. Better, nowadays, not only means better in an economic sense, but also in an environmental and safety sense.

In practice, only one solution exists for the final disposal of long-lived radioactive waste: a deep geological repository. Political and societal constraints have hampered the realisation of such facilities up to now. For countries with small nuclear power programmes, economy of scale will force them either to wait and opt for long-term storage, or to share a repository with others. Historical development, uncertainty of national borders, the need for supranational surveillance and simple logic will also drive towards shared solutions. Repositories should become common!

**\*A longer, illustrated version of this article first appeared in the Proceedings of the WM'06 Conference, 2006, Tucson, USA.**

## Upcoming Conferences

This section of the newsletter highlights upcoming conferences that are specifically relevant to Arius activities and objectives. Those at which Arius is attending or presenting papers are indicated.

March	
13 <sup>th</sup> – 17 <sup>th</sup>	World Nuclear Fuel Cycle 2006, Hong Kong
April - May	
28 <sup>th</sup> - 29 <sup>th</sup>	Geological Challenges in Radioactive Waste Isolation, 4 <sup>th</sup> Worldwide Review, San Francisco, USA <b>Arius Presentation</b>
30 <sup>th</sup> Apr to May 4 <sup>th</sup>	ILHRWM meeting, Las Vegas, USA <b>Arius Presentations</b>
June	
12 <sup>th</sup> – 13 <sup>th</sup>	Radioactive Waste Management: The Next Step IBC Conference, London, UK <b>Arius Invited Presentation</b>
19 <sup>th</sup> – 23 <sup>rd</sup>	International Conference on Management of Spent Fuel from NPPs, Vienna <b>Arius Presentation</b>
September	
6 <sup>th</sup> – 8 <sup>th</sup>	World Nuclear Association Symposium, London
October	
15 <sup>th</sup> – 20 <sup>th</sup>	15 <sup>th</sup> Pacific Basin Nuclear Conference, Sydney, Australia