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**GLOBAL DEVELOPMENTS IN MULTINATIONAL INITIATIVES
AT THE BACK END OF THE NUCLEAR FUEL CYCLE**

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ABSTRACT

Interest in expanding nuclear power globally continues to grow and various studies are underway to examine all issues associated with much expanded nuclear programmes. The most open questions today are related to the security and non-proliferation implications and to the disposal of radioactive wastes. The security and proliferation concerns have been almost entirely focussed on enrichment technology at the front-end of the nuclear fuel cycle and on reprocessing. Although these are the highest risk areas, it is also important that the potential security problems associated with waste management (in particular with the storage and disposal of spent fuel and radioactive wastes) are not neglected. Furthermore, the costs of national geological repositories imply that, for new or small nuclear programmes, such facilities can be implemented only in the far future, if at all. The international community should continue to strengthen its efforts to highlight the risks and to facilitate solutions that reduce the threats of nuclear materials being distributed widely across the globe.

In practice, this challenge has been taken up by a number of organisations that are developing initiatives that can alleviate the potential global security and proliferation problems by promoting multinational approaches to the fuel cycle. This paper addresses those initiatives that are concerned with the storage and final disposal of radioactive wastes and spent nuclear fuel.

THE NEED FOR MULTINATIONAL SOLUTIONS

Because of the urgent needs to expand energy production in many countries, and despite the economic problems that could restrict large investments, interest in expanding nuclear power globally continues to grow. Various studies are underway to examine all issues associated with much expanded nuclear programmes. The most open questions today are related to the security and non-proliferation implications and to the disposal of radioactive wastes. The security and proliferation concerns have been almost entirely focussed on enrichment technology at the front-end of the nuclear fuel cycle and on reprocessing. Although these are the highest risk areas, it is also important that the potential security problems associated with waste management (in particular with the storage and disposal of spent fuel and radioactive wastes) are not neglected.

All countries with nuclear materials and especially those with nuclear power programmes must take measures to ensure continuing safety and security. A serious incident involving misuse of nuclear materials anywhere in the world will impact strongly on nuclear programmes all over the globe. Safe and secure storage is a first priority, but ultimately long-lived, hazardous nuclear materials for which there are no further uses must be disposed of in a proper manner – and today that implies that a deep geological repository must be available for such wastes. However, the costs of national geological repositories imply that, for new or small nuclear programmes, such

facilities can be implemented only in the far future, if at all. The international community should continue to strengthen its efforts to highlight the risks and to facilitate solutions that reduce the threats of nuclear materials being distributed widely across the globe.

THE MULTINATIONAL STORY SO FAR

At the ICEM 2007 Meeting in Bruges, the authors of the present paper documented the long history of attempts to initiate multinational efforts to enhance safety and security at the back-end of the fuel cycle (McCombie et al 2009). These go back to the early days of nuclear power when it was widely acknowledged that there were obvious advantages to an international fuel cycle system that limited the spread of sensitive nuclear technologies while still making nuclear power available to all. In the last decades of the 1900s, however, interest in nuclear power declined and no concrete multinational project emerged. When this situation began to change due to the growing need for energy and the growing pressure for CO₂ free electricity production, attention again focussed on how to enable nuclear power expansion without significantly increasing proliferation and nuclear security problems.

The IAEA took an active role, e.g. through the high level MNA advisory group formed at the instigation of the Director General (IAEA 2005). High profile initiatives were launched by the Presidents of Russia and the USA. These largely overlapping proposals, entitled respectively the Global Nuclear Infrastructure Project (GNPI) and the Global Nuclear Energy partnership (GNEP) concentrated on expanding nuclear power and promoting advanced recycling, while restricting the spread of enrichment and reprocessing facilities (Ruchkin and Loginov 2006, USDOE 2007). They both, however, recognised that incentives had to be provided to countries that would voluntarily agree to desist from those activities, neither of which is forbidden for NPT signatories. Much effort was put into devising front end incentives related to ensuring the supply of fresh fuel for reactors in countries that would undertake to be only "users" of nuclear power.

From the viewpoint of most countries, however, this supply issue was not a major stumbling block. An important exception to this is, of course, Iran, which insists that historical refusal to supply enrichment services justifies building a national enrichment programme despite its limited number of reactors. For small countries, the "carrot" that might most effectively convince them to forego national fuel cycle facilities may well be the guarantee of a back-end solution – i.e. the "take-back" of spent fuel supplied by the large fuel cycle facility nations.

In practice, both Russia and the USA recognised this and indeed proposed a scheme in which spent fuel would be repatriated for reprocessing, with no return of HLE that requires geological disposal. Public and political opposition in both countries, however, has prevented implementation of take back options, with the exception of Russia's willingness to repatriate fuel that they themselves have supplied to some countries. Both countries, and also other nuclear supplier nations such as France, would be prepared to accept fuel for reprocessing if the HLW could be reshipped to the user country. This is not a very sensible solution, however. Reprocessing is expensive, the returned HLW is still a safety and security hazard and the user country would still require an expensive geological repository. Today, little is heard from GNPI and the GNEP initiative has had its funding in the USA cut off (REF). In the USA, recent events concerning low-level waste import from Italy have demonstrated that import of radioactive wastes is legally possible – but that political and public opposition can be strong (Ling 2009).

NEW STUDIES SINCE 2007

Despite the lack of progress with the above high profile concepts for enhancing back end safety and security, interest in developing workable solutions continues unabated and there have been significant developments since the ICEM 2007 review paper was published. Most of the recent thinking has been in the scope of specific studies or of multinational discussions that cover both front and back end of the nuclear fuel cycle. These theoretical considerations are summarised in the present section of this paper. Specific project-related work has been restricted effectively to achievements within the EC supported SAPIERR project and its follow on activities, which are described in the subsequent section.

International and national organisations continue to support the concepts of multinational cooperation at the back end of the fuel cycle. Following on its 2004 report (IAEA 2004), the IAEA initiated work on a new report entitled "Viability of sharing facilities for the disposition of spent fuel and nuclear wastes" (IAEA 2009). In 2008, in a high level report to the DG by the Director General for the Commission of Eminent Persons, Feb 2008), it is confirmed that (IAEA 2008)

"For countries with limited waste or without access to geologically suitable disposal sites, multinational disposal at sites with good geology might be an option. Several studies have identified the potential benefits, in terms of possible economic, nonproliferation, safety and security advantages, of multinational disposal as well as the institutional and political issues standing in the way. The

IAEA could help States arrive at a solution that fits their needs".

The EC has supported at all levels up to the responsible Commissioner himself the efforts described below to encourage small European countries to pool their efforts. The topic was also included in a paper (Verhoef et al 2008) and a panel discussion at the major 2008 EURADWASTE Conference (EC 2008). The most active support of the EC, however, has been in financing the SAPIERR projects and in encouraging further efforts to promote European collaboration, described below.

The OECD/NEA has been rather silent on the issue of multinational repositories, presumably because many of its key member countries are those with advanced disposal programmes and thus those that most fear a negative backlash of progress with multinational approaches to disposal. As the advanced programmes become definitive, however, tensions ease and, ultimately, the relevant nations could become technology providers for the multinational repositories discussed in this report.

A bi-national study between the National Academies of the USA and Russia (NAS 2008) included the following conclusion of relevance here:

"Arrangements that would provide assured return of spent nuclear fuel could provide a much more powerful incentive for countries to rely on international nuclear fuel supply than would assured supply of fresh fuel, because assured take-back could mean that countries would not need to incur the cost and uncertainty of trying to establish their own repositories for spent nuclear fuel or nuclear waste. Further, it would reduce the number of countries where plutonium-bearing material is stored around the world."

Various individual organisations have also organised specific nuclear power or fuel cycle studies that have included in their scope discussion on the need for a credible back-end strategy and the potential for multinational initiatives to help make this feasible even for small or new nuclear countries. In the USA, the AAAS has initiated a Global Nuclear Future Initiative under which workshops have been organized to discuss the nuclear fuel cycle. In May 2009, a diverse group of participants met to reconsideration the entire nuclear fuel cycle, but with primary focus on the back end. Topics covered were the potential for growth and spread of sensitive nuclear facilities, the resulting impacts of spent fuel and HLW management, security implications, interim storage and ultimate disposal. The Nuclear Threat Initiative also organized an initial Workshop on Nuclear Energy in a World Free of Nuclear Weapons aimed at developing

principles, criteria, and objectives against which future technologies and governance models may be evaluated as durable barriers between nuclear energy and nuclear weapons. Both of these generalised nuclear initiatives include in their scope the issue of managing and disposing of hazardous, long-lived radioactive materials, with multinational approaches being one focus. More specifically multinational was the technical meeting organized in Como, Italy by the Landau Network Cento Volta on Expanding Nuclear Power to New States (LNCV 2008). The conclusions of this meeting which had participants from numerous new nuclear nations included the following text:

"Geological repositories are essential and a global network of international repositories would assure that all countries would cope with their waste in a responsible manner. Noting that some of the participants expressed a willingness to consider hosting geological repositories, steps should be taken to explore how such an approach might be pursued, noting the very long time intervals involved and the need for a formal legal basis protecting the interests of the host country(ies) and the countries making use of such installations. International cooperation in geological repositories should be pursued as a means to provide alternatives to national repositories."

In summary, it is clear that there is sustained interest in the impacts of the global nuclear expansion on back-end plans and vice-versa. It is to be hoped that some of the many discussion for a addressing this issue will ultimately move to propose concrete steps that can be taken to minimise the environmental, safety and security risks associated the spread of nuclear power.

PROGRESS WITH SPECIFIC PROJECT WORK

Over the past two years, somewhat more specific progress has been achieved by initiatives aimed at regional groupings combining to introduce nuclear energy. In several cases, countries are linking up to consider multinational ownership of nuclear plants. Examples are the Baltic States (possibly together with Poland) and the United Arab Emirates. In Europe, cross border co-ownership of plants is becoming ever more common. These developments must lead to consideration of shared responsibilities for waste management and should hopefully lower the barriers to shared disposal facilities.

The most specific regional disposal initiative, however, is currently the SAPIERR (Strategic Action Plan for Implementation of European Regional Repositories) project that is described in detail in a companion paper to this conference (Verhoef et al 2009). In January 2009, the EC

sponsored project held its final symposium in Brussels. The results of studies on the viability of shared, regional European geological repositories were presented to 50 participants from 21 countries. The aspects considered included organisational and legal issues, economic impacts, safety and security considerations, and public and political attitudes to multinational repositories.

The proposal that resulted from SAPIERR was a staged, adaptive implementation strategy for a European Repository Development Organisation (ERDO). The first step in the strategy is the establishment of a Working Group of interested countries to carry out pre-cursor work to enable a consensus model to be agreed for a ERDO, using the SAPIERR findings as a starting point. This model will then be presented to potentially interested countries in about two years' time, so that they can decide whether and when to set up the ERDO and whether they wish to be part of it. The pilot meeting of potential participants in this Working Group involved 32 Representatives from 14 European countries were present, all of whom had been nominated through their national governments, as well as observers from the IAEA, the EC and American foundations. The countries represented were: Austria, Bulgaria, Czech Republic, Denmark, Estonia, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Romania, Slovakia, and Slovenia. Strong support for further activities was shown, dates and venues for further meetings were decided and all representatives undertook to formalise at their national levels the necessary agreements to enable the activities of the Working Group for the next 1-2 years. The secretariat will be provided by Arius, Switzerland and the administration by the Netherlands waste agency, COVRA.

Currently, the structure, Terms of Reference and work programme for the ERDO Working Group are being worked out. The principal hurdles to finalising these steps concern the financing issues. Although relatively modest financing is required, the present economic crisis make it difficult in some particularly badly hit, small European countries to propose any new projects, however small, that require new funding.

THE CHALLENGE OF SITING

The most common obstacle brought up in discussion on multinational repositories concerns the question of siting. Is it conceivable that one country will agree to disposal of radioactive wastes from another? In the case of acceptance of foreign wastes by a large nuclear country, some past experience has been positive. Early French and UK reprocessing contracts had no waste return clauses; the Soviet Union repatriated spent fuel from its neighbouring countries; still today specific wastes are shipped across

national boundaries for disposal if a better environmental solution results. An example of the latter point has been the acceptance of foreign low level waste by the USA – but the Italian case cited above shows that this can also be problematic. In fact, there are probably more negative than positive examples of proposed import of radioactive wastes. The French and UK reprocessors stopped the practice, although the UK allows waste substitution. There has been opposition in weapons States such as the USA and Russia and proposals that Australia host an international repository have also led to controversy and political opposition. These attitudes could conceivably change if the offering of a disposal service by a country meeting the appropriate technical, political and social requirements came to be regarded as a praiseworthy contribution to global safety and security, as well as a sound financial investment for the host.

At present, however, the more probable route towards multinational repositories may be through a partnering initiative of small and new nuclear countries. This issue has been addressed directly in a recent publication (Chapman and McCombie 2008), the essentials of which are summarised here. In this paper it is acknowledged that initiatives aimed at developing regional, multinational waste disposal facilities have been criticised as not being credible until such time as a country agrees to host one. It is also pointed out that, in practice, multinational siting strategies can be modelled directly on successful, modern, national siting approaches since both approaches face very similar challenges. National and multinational disposal projects both have to go through exactly the same technical and stakeholder involvements steps; they may take many years to achieve siting successfully (and, indeed, should avoid the premature selection of potential sites). The essence of any successful siting programme is that it is consensual and inclusive from the outset and all aspects of the repository project are transparent. The process must allow for active inclusion of the local communities at all stages.

In common with the most recent national repository development projects, multinational projects would best employ a gradual multi-step process (frequently referred to as 'staging') to achieve a disposal solution. The principles of such an approach have been described in overview documents such as the report "One Step at a Time" produced by the National Research Council of the US National Academies (NAS 2003).

For a multinational project, the suggested approach is one that can run for some considerable time in parallel with national siting efforts without prejudicing their outcome. A key aspect of the process proposed here is that it allows a

progressive approach to identifying both host countries and host sites. The approach specifically avoids requiring partners in a shared multinational project to commit at the outset to being a potential host country for a repository, or even to agree on a common optimised development timescale. For technical, programmatic, financial or political reasons, several stages of agreement will be required before a host emerges.

The approach suggested is to place the initiative firmly in the hands of local communities, once certain boundary conditions have been established. The sequence of developments envisaged is as follows:

A group of countries comes together to explore the possibility of sharing a geological repository. Having established the way in which they will work together they give wide publicity to the project, explaining all aspects including initial aims with respect to national and community benefits, and they announce that a volunteer process will be launched in the near future. They then establish a common set of technically based exclusion criteria to remove from consideration clearly unsuitable land areas within all their countries. Communities in non-excluded areas in all the countries are invited to express interest (on a non-committing basis) in the possibility of being a host for the repository, thus starting the siting process. National governments would agree not to stand in the way of this process – indeed, they may actively encourage it. Participating national governments would be free to solicit specific volunteer communities that they considered might have a particular interest in the project or have particularly favourable characteristics for hosting a repository. Finally – and very importantly - up to a pre-defined 'point of commitment' (probably after several years of site investigations), both interested communities and national governments would be free to withdraw from the process.

CONCLUSIONS

Despite the expected impacts of the current global financial crisis, the number of countries seeking to introduce or expand nuclear power programmes will remain significant. For environmental ethical reasons and public acceptance reasons, it is crucial that these countries have a credible strategy that will lead, at the appropriate time to geological disposal in state-of-the-art repositories. This is the only acknowledged safe route for permanently isolating long-lived radioactive wastes from the human environment. The economic burden of implementing a national repository may well be too large for small and new nuclear programmes. It must be an objective of the global community to help make such facilities available to all.

A further major objective of the global nuclear community today is to restrict the spread not just of weapons technology but also of the facilities, techniques and the materials that could lead there. The concepts being proposed are that the large powers could supply smaller countries with the reactors needed to produce nuclear energy. They would also guarantee a supply of nuclear fuel to these countries. In exchange, the small user countries are expected to forego national implementation of sensitive technologies like reprocessing and enrichment.

However, there is no current shortage of supply of front end services; in fact, there is strong competition to supply reactors and fuel. A much greater incentive could be the provision of a spent fuel or waste disposal service. This would alleviate the considerable economic, technical and political challenges faced by a small country attempting to build up a geological disposal programme.

However, there is a marked reluctance of any large supplier country to step up and offer a disposal service. Because of this, it would be prudent for small and new nuclear countries to join forces and look for possibilities for a shared repository approach in which the willing host country or countries would be properly rewarded for providing a valuable service. Indeed, even if a large supplier country does eventually come forward with a "take back" proposal, it would be prudent for the small potential customer countries to have an alternative option such as the shared regional repository since this could greatly improve their bargaining position.

As has always been the case, there are few or none urgent technical drivers for implementing geological repositories. The credibility of nuclear power as a positive contributor to solving the global energy and environmental challenges we are facing depends, however, on having credible disposal strategies that are recognised as such by the public and the politicians as well as the technical community. Multinational disposal initiatives, whether by partnering or by take-back are a valuable element in establishing and maintaining this credibility.

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