Is Now the Time for Regional Repositories?

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Introduction

Over the last three years, the twin demands for security of energy supply in a turbulent world and reduction of carbon emissions have brought nuclear power out from languishing in the doldrums and put it firmly back on front-stage. The actual strength of the nuclear renaissance is much debated and certainly varies from nation to nation and region to region. However, it is abundantly clear that, in many countries, embarking on a programme of new or extended nuclear power will be severely hampered by the lack of facilities to dispose of the fuel wastes that will be produced. Indeed, no country has comprehensive, operating disposal facilities for all the fuel-related wastes produced since the inception of its nuclear power programme.

The reasons for the problems and delays between the early 1980s and early 2000s are well rehearsed and have great similarities in all countries: lack of urgency at a time when progress may have been easier, public fears of all things ‘waste’ and ‘radiation’, and absence of political interest or will all being at the forefront. Latterly, efforts to make progress have focussed on obtaining societal buy-in by means of elaborate consultation processes and the promise of slowly staged disposal programmes that, correctly, postpone some key management decisions to many decades into the future. This approach is possibly resulting in renewed progress in those countries that have experienced the most difficulties. However, we believe strongly that real progress in any country will still be impossibly slow without the impetus of political will. This resolve has only just emerged in the last three or four years, in response to the energy security and carbon reduction drivers mentioned above, strengthened by political concerns about the physical security of radioactive wastes sitting in surface stores.

For some countries that have been making slow but steady progress over many years this situation has not been especially relevant. They have adhered to a broadly debated and widely accepted plan and taken things slowly but surely, at least thus far. But the number of such countries is small; Finland, Sweden and possibly Hungary in more recent years are the best examples. The push to move ahead and recover lost ground now comes mainly from the larger nuclear nations with the full range of fuel cycle facilities and, consequently, a wide diversity of wastes, to consider. France, the UK, Russia and the USA are all trying to isolate and tackle with more fortitude what had previously been intractable programmatic obstacles, so that a credible and achievable time schedule for disposal can be established.

In this global scenario, the smaller nuclear nations are generally overlooked. They have all the same problems of publics that are suspicious of nuclear matters and nuclear organisations, uninterested politicians and lack of will, but compounded by an overarching problem: developing their own national repositories for small waste inventories is either prohibitively expensive if it is to be paid for from the proceeds of

a small nuclear power programme or, even if affordable, is clearly a huge waste of national resources if an alternative, equally good but less expensive solution can be found. For the European Union, now blessed with 27 member States, 13 of them nuclear power producers (and the rest, consumers), this last point has become an EU-scale consideration – how best to use Europe's resources as a whole.

For many years, Arius has put forward the logic and rationale for sharing regional and international waste facilities (e.g. McCombie et al 2001, McCombie and Chapman, 2004). There are many compelling reasons, above and beyond straightforward economics. Ensuring that timely disposal solutions are available for the whole of Europe seems a critical aspect of the overall, global security concern, especially in a fast-moving world with its kaleidoscope of international security problems, behind which the achievement of disposal, even in the faster programmes, is taking decades. Having only part of the European inventory disposed of 'beyond conventional reach' in secure deep repositories in the next ten years still leaves a persisting problem of a huge amount of other materials that have more potential to go astray.

If we accept that a swifter solution is better than there being no solution in prospect, the question is, would regional shared solutions help to move things forward more quickly for the smaller programmes? The answer seems to be positive. The alternative that has been advocated by the leading programmes in the past is to wait until they have achieved their own solutions and then use this success as a flag-waver to boost confidence in geological disposal elsewhere. Today, this looks like a lame response to the need to enhance nuclear security – now – and the need to extend nuclear power – now.

It has often been pointed out that, if one were to look ahead 30 years, it is inconceivable that all 27 EU Member States would have a geological repository for its radioactive wastes – and every country has at least some waste that ought to go for geological disposal, even if the have no nuclear power plants. Some have swept the eventual requirement for disposal of these wastes under the carpet for the time being. What are Ireland, Denmark, Austria, Portugal, to name but a few countries, to do with their wastes? Whilst some still resist the concept of one country hosting a regional repository on behalf of itself and its neighbours as being somehow distasteful or unethical, there is some studied avoidance of the issue of transferring small amounts of waste to a willing recipient country with the facilities to manage it. Some countries that have opposed shared disposal solutions have not been at all reticent to accept offers to 'repatriate' their research reactor fuel to its source, as though it were somehow an ethically different substance to waste from commercial power generation. Nations have quietly got on with transferring small but inconvenient amounts of waste out of their own country whilst opposing the concept of an open, shared regional facility in Europe for commercial nuclear fuel wastes.

What are we to understand from this? Certainly, at a national level, the politics of managing waste on a multinational scale contains much posturing, issue-avoidance and a marked degree of disingenuousness. It is clear that, from the viewpoint of a small European country with limited nuclear power, there is going to be little tangible help from the big EU players for many years to come. There is talk of technology transfer – generally of technology that is anyway openly available and neither particularly complex nor problem-specific – but this fails in any case to address the real issue. What is actually needed is assistance with the infrastructure needed to implement a complex management (not technical) system, assistance with the

financing and with the process itself. Assistance is also needed with the political problems; it will be necessary to develop a communal resolve within Europe to solve the community's waste disposal problems, sooner rather than (maybe) later.

There are currently two lights in the distance. One is a properly European initiative – the other comes from over the horizon, to the east and the west, from Russia and from the USA. We look at them separately below. As we shall see, the first is addressing the real needs of smaller countries, whilst the second has so far only addressed the needs of its originators and has some of the characteristics of a cargo cult.

SAPIERR: a European Initiative

SAPIERR-1 (2003-5) was a small project designed to help the European Commission clarify basic questions affecting the issue of shared waste solutions and to identify the research and technical developments needed to implement regional solutions for European radioactive waste storage and disposal. Twenty-one organisations from fourteen countries took part in the project, which addressed legal aspects, inventory questions and possible options and scenarios for regional storage and disposal facilities. The project investigated a notional shared inventory of spent fuel from the ten SAPIERR project participant countries that have spent fuel from nuclear power plants that is destined for disposal.

The top-level conclusions from SAPIERR-1 (see Stefula, 2006) were:

- The potential benefits of multinational, regional facilities are recognized widely throughout the EU.
- The most obvious benefits are in the economic area, where shared repositories would lead to substantial reductions in EU expenditure (a figure of around 8 billion EUR was estimated for the scenarios considered).
- Many or most of the problems faced by regional repository initiatives are common to those being tackled by national disposal programmes, in particular concerning the task of siting the facility.
- If shared regional stores or repositories are to be implemented, even some decades ahead, efforts are already required now.
- Before greatly enlarging the scale of the work on regional stores or repositories, a structured framework should be established.

The project made a very conservative assumption that no more nuclear power plants would be constructed in the 'SAPIERR countries', in order to simplify the analysis, and assumed a 50-year cooling period for all types of spent fuel. Based on purely geometrical properties, all fuel types were assigned to three types of disposal overpack. The number of containers "ready-for-disposal" is shown in Figure 1.

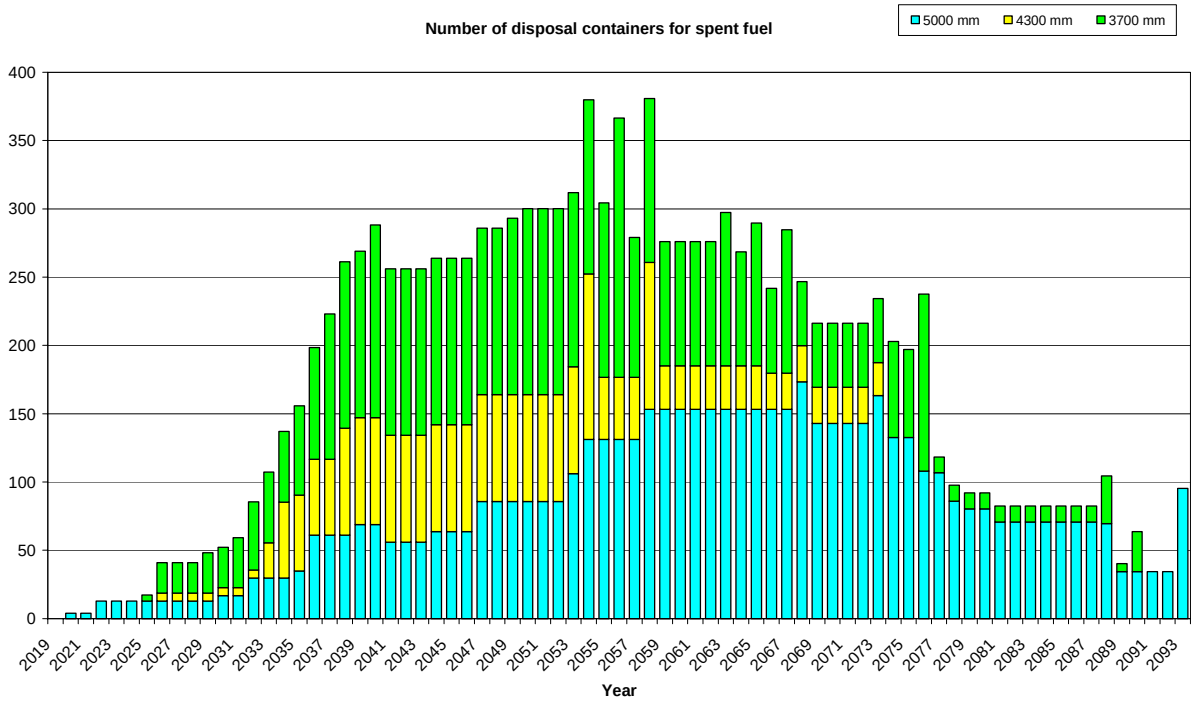

Figure 1: Numbers and times of arising of containers of spent fuel 'ready for disposal' in the ten SAPIERR-1 participant countries from 2019 to 2093, assuming no new nuclear power programmes and no further lifetime extensions. The three colours denote different container types for different types and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

There is an evident sharp increase of disposal containers in the mid 2030's, which suggested that the optimum time for a European Regional Repository (ERR) to be in operation would be around 2035 if more or continued storage was to be avoided. In this scenario, the ERR siting programme would need to be underway by 2010 - 2015.

As pointed out by Stefula (2006) the ERR programme will require an 'owner' – a multinational organisation established on the basis of intergovernmental agreements. Such agreement will not be within the competence of waste management organisations and private companies alone. Broad political support and governmental endorsement will be necessary.

SAPIERR-1 developed some scenarios, looked at technical issues with respect to a shared ERR and made some suggestions on programme timing that now look even more relevant than they did only two years ago. However, it left many open question about the way in which an international organisation might be set up and operated to develop an ERR.

SAPIERR-2

The objective of SAPIERR-2, which is also a two year project and which began in late 2006, is to develop the feasibility studies of SAPIERR-1 in order to propose a practical implementation strategy and organisational structures that will enable a group of countries to create a formalised, structured organisation that could be established from 2008 for working on shared EU radioactive waste storage and disposal activities. The SAPIERR-2 objectives are:

- The development of an organisational framework and a project plan to facilitate debate on the establishment of a modestly sized, self-sufficient, European

Development Organisation (EDO) that can work in parallel with national waste agencies.

- To make further studies of key issues related to economics, design, public and political attitudes and the safety and security of shared storage and disposal facilities.
- To achieve and document the consensus on a preferred way forward that could take place after 2008.

There are six main technical work packages within the project:

1. Preparation of a management study on the legal and business options for establishing an EDO.
2. Study of the legal liability issues of international waste transfer within Europe.
3. Study of the potential economic implications of European regional stores and repositories (building on the preliminary findings of SAPIERR-1).
4. First considerations of the safety and security impacts of implementing regional repositories.
5. Survey of public and political attitudes towards regional stores and repositories and of approaches to involving communities in decision making.
6. Development of a strategy and a project plan for the work of the EDO.

The immediate tasks of an EDO would be to agree a progressive, slowly-staged strategy that would lead to the definition of potential host countries and eventually, to potential storage or repository sites, and, in addition, to define a parallel science and technology programme that could be addressed by the EDO after its initiation.

SAPIERR-2 will report in late 2008. It would be unreasonable and overly-optimistic to suggest that the EU countries who would be interested in shared solutions would move quickly to establish an EDO. However, a developed strategy will be available and, if we are really concerned with nuclear and energy supply security, it will only require a champion and an EU-level resolve to start the ball rolling. Let us now look further over the horizon.

Russian SF Storage Initiatives

The seminal IAEA report on multinational approaches to fuel cycle (IAEA, 2004) identified two routes to achieving international waste solutions – regional repositories, shared by cooperating partners (e.g. the SAPIERR initiative described above), and international disposal facilities, provided as a service by a large nuclear country.

The only option of the second type that has been seriously discussed in the intervening three years is the possibility of spent fuel storage in the Russian Federation. The current status of this storage proposal is unclear – in its original form, it would involve using surplus capacity at the state-owned Mining and Chemical Processing Plant, an underground facility for spent nuclear fuel storage, disposal, reprocessing and transportation, near Krasnoyarsk in eastern Siberia.

Chapman and McCombie (2005) noted that the concept of a Russian storage and/or disposal facility is regarded by many with suspicion that would have to be alleviated and they proposed nine key requirements that they believed would have to be met to

make a ‘Russian Option’ an attractive and achievable solution. Although the impacts of the recent re-organisation of the whole Russian nuclear sector will clearly have major and currently unknown impacts on international fuel cycle policy, under existing national legislation, Russia could only import spent fuel for:

- long-term storage, with eventual return to the sender;
- storage, with recycling of light water reactor fuel for re-use in new generation reactors, perhaps in Russia (thus possibly entailing no return requirement to the sender);
- storage, with reprocessing and return of some of the ensuing wastes to the sender.

Each option is economically attractive for Russia since they all provide either income from provision of services or fuel for the future, or both. However, at present, the law does not allow import for eventual disposal. Nevertheless, the existence of an option that would be attractive to potential users and which would satisfy international requirements for safety and security would be wholly beneficial, given the two drivers discussed at the beginning of this paper. Success will require a range of important international stakeholders to be highly comfortable with what is offered and with the conditions attached. In addition to the technical aspects, complex political, societal and security issues are at stake.

The nine key requirements identified by Chapman and McCombie, which would need to be met for a Russian solution to have a realistic chance of success and international acceptance, were as follows:

1. Import of spent fuel for disposal, as well as storage, should be permissible. A new law will be required in the Russian Federation to allow disposal of fuel that is not to be, or cannot be, recycled (reprocessed or regenerated). Potential users of a Russian service are unlikely to wish to receive fuel back after interim storage. A major attraction of an international facility is that provisions for long-term storage and disposal do not have to be made in one’s own country, thus avoiding the high costs of a national repository and also reducing many of the political and societal problems entailed in siting such facilities. In addition, this would allow accommodation with the United States over the fate of US-flagged fuel. A 2005 paper from the US State Department noted that a permanent repository need not be available at the time of the export, and long-term interim storage could be part of any scheme. But the scheme should also involve specific plans for, and the commitment of sufficient resources to, development of a geologic repository (Burkart, 2005).
2. A geological disposal option (not only for spent fuel, but also for vitrified high-level wastes and other long-lived wastes) should be part of the package. As noted above, any country that does not want to build a repository for spent fuel will not want to have to build one for returned reprocessing wastes or for its other long-lived wastes. Russia needs to be prepared to retain HLW from reprocessing of foreign spent fuel, to accept high-level wastes that customer countries may already have received from other reprocessing countries and to accept other long-lived wastes from customer countries. The service should thus be complete, so that countries can use it for all their wastes that will require deep disposal.

3. International acceptability is essential, in particular to the European Union and the United States. Disposal outside the EU is not current EU policy and the USA has strict requirements for US-flagged materials. Any country (or group of countries) would have to present the scheme's credentials to their own public and institutions with great commitment. Acceptability will depend upon the scheme being openly executed to the highest technical standards being developed internationally, using appropriate best available technology and being subject to international monitoring. At present, politicians and the public tend to prefer national options, arguing that this enables closer control of possible environmental and safety impacts. It will only be possible to gain support for export if Russia can demonstrate clearly that there will be no relaxation of standards.
4. Economic advantages for user and supplier. Any scheme must benefit both implementer and user economically. If the previous requirements are met, Russia stands to benefit substantially by charging appropriate rates for a service not currently available anywhere else. The approach to compensating host communities willing to accept an international responsibility needs to be set out clearly, so that users are convinced of the equity of the scheme. Offering a service that enhances global security and helps small countries to meet their waste management responsibilities can also bring significant political advantages. Users should be prepared to pay for avoiding the problems and unpredictable costs of running their own national disposal programmes, which can take decades and might never even reach a successful conclusion. Disposal prices will thus be significant but, owing to the huge economies of scale in repository implementation (e.g. as estimated in the SAPIERR-1 project), they may still be less than small nuclear countries would have to pay for a national repository.
5. Long-term availability of facilities should be guaranteed for user countries. The facilities offered by Russia may be unique. If so, they need to be available over the period that wastes will be generated by user countries, so that all wastes for geological disposal can be exported – otherwise their national problems are not solved. This point is very important for some Central and Eastern European countries that began a nuclear power programme under the assumption that spent fuel would be returned to the USSR – an option that was later withdrawn.
6. International support and recognition. If the scheme proves internationally acceptable (point 3, above) then the major nuclear nations and international agencies and associations (IAEA, OECD-NEA, WNA) should throw their weight behind it, acknowledging that Russia would be providing a service that will enhance global security and safety. These organisations can promote groups to help establish and guard the rights of the various parties to any waste transfer agreements.
7. Transparent project management. Information on the way that the scheme is managed, along with all its significant technical, societal and economic aspects, should be available to interested parties. Public and political communication should have high priority in Russia and internationally. The acceptability of the project to national and local stakeholders in Russia needs to be clear. An analogue for major international services being provided by one or a few countries is reprocessing, where customers countries have

formally joined together to require extensive access to information from the reprocessors. A similar arrangement may be appropriate for disposal and Arius could be a pre-cursor for such a group.

8. Use of best knowledge and expertise. Transparency and international standards will be achieved by ensuring direct participation of the best international technical expertise. The Russian scheme should be a truly international project, generating wide enthusiasm in the global scientific and technical community. Russia could take the initiative by establishing credible advisory groups at the outset, including internationally recognized experts in the disposal area.
9. Active involvement of the IAEA in establishing the project and, later, in an oversight monitoring role, will underwrite its overall credibility. The IAEA has already expressed its interest in the monitoring function.

Satisfying each of these nine requirements presents its own challenges, especially since some of the main players have very different views on them. But each of the key players needs to be confident and convinced, which requires their involvement in setting up such a scheme. Purely unilateral initiatives (in Russia or elsewhere) will probably not succeed – a proper multinational approach is absolutely essential.

The Global Nuclear Energy Partnership

In early 2006, President Bush announced the Global Nuclear Energy partnership (GNEP), under which America intends to work with nations that have advanced civilian nuclear energy programmes, such as France, Japan, and Russia.

The prime domestic aim is to develop and deploy innovative, advanced reactors and new methods to recycle spent nuclear fuel. GNEP is, however, also meant to provide a reliable fuel services programme, under which a consortium of nations with advanced nuclear technologies would provide fuel and reactors to other countries that agree to refrain from fuel cycle activities. The hope is to develop an international regime that will allow for fuel leasing, so that fuel can be leased to a country interested in building a reactor and taking fuel, but then the fuel can be taken back to the fuel cycle country. This fuel leasing approach would provide an incentive for nations to forgo enrichment and reprocessing technology. The recipient countries should benefit from "*the certainty that fresh fuel would be available when needed and that used fuel would be taken back under agreed and reasonable terms*".

In May 2007, Russia and Kazakhstan announced an intergovernmental agreement to establish a joint fuel enrichment facility that would form one component of such an International Nuclear Fuel Cycle Centre (INFCC). This follows the announcement by Russia in January 2006 of the concept of a Global Nuclear Power Infrastructure (GNPI) – a direct parallel to GNEP – capable of providing access to the benefits of nuclear energy to all interested countries while remaining in compliance with non-proliferation requirements.

The GNEP plan concentrates strongly on technological issues associated with enhancing the US capabilities for undertaking key fuel cycle activities. This is obviously important because of the US expertise that has been lost over the past decades. It also highlights the view that GNEP can postpone for a long time the need for a second repository in the USA, provided that the facilities for advanced fuel cycle operations are brought on line. The strategy, however, needs to be strengthened in

one key point – how to win the support of other nations and thus achieve success in the area of enhancing global security.

GNEP can work on the hoped for global scale only if the “P” for partnership includes the smaller or the newer nuclear programmes (called ‘Tier 2’ countries) around the globe that are to be prevented from having fuel cycle facilities (enrichment and reprocessing, which are their right under the current NPT that they have signed up to).

Currently, the only real incentive being offered to these Tier 2 countries is *“reliable access at reasonable cost to fuel for civil nuclear power reactors”.* However, they need to have guarantees that costs will be indeed reasonable and – perhaps more important – guarantees of security of supply of fuel cycle services. Why should small countries welcome a regime that creates, even more firmly, a two-tier status in the nuclear world? Unless GNEP can offer a more complete service than at present, there is little or no incentive for these countries to buy-in to the initiative. The most tangible additional service offer is the take-back of spent fuel. Removing the disposal problem from small nuclear programmes could outweigh the possible disadvantages that GNEP might bring them.

However, there is no clarity about spent fuel take-back and GNEP is also currently silent about whether the HLW resulting from recycling will be retained by the recycling service provider. These wastes were previously retained in the case of the UK, France and Russia – but all of these subsequently altered this policy due to public and political pressure. The obvious question is whether the USA and other Tier 1 GNEP countries will be able to accept foreign HLW for final disposal.

There is another problem. Small countries with existing modest inventories of spent fuel, HLW or other long-lived radioactive residues from activities in power production, research and industry will have little incentive to send future spent fuel arisings to a foreign recycler if they have to implement a national deep repository anyway. As was pointed out above, when discussing the Russian case, a comprehensive geological disposal service will have much greater chances of acceptance by users.

Currently, the back-end issues associated with GNEP are open and discussions must be held that include not only the Tier 1 service suppliers but also the potential Tier 2 service users.

Another light?

Other multinational disposal options could change the global picture. Another model exists. Fuel supplied to smaller nuclear programmes could be shipped back, not to the supplier, but to an accepted third party country that has the required capabilities and is trusted to operate safe and secure disposal facilities. Australia has been mentioned often in the past as a nation that has many geological, technical and political attributes that would make it an extremely suitable host for such a repository. In fact, in the current debate in Australia on the use of its huge uranium reserves and on the possibility of its introducing nuclear power, options for introducing all facets of the nuclear fuel cycle have also been addressed.

Conclusions

There are heightening concerns about both nuclear security and the security of energy supply. There is also a growing awareness that carbon reduction goals are more reachable with increased use of nuclear power. The existence of operational, globally available, disposal solutions for the intractable higher-level, higher-activity and fissile-material wastes from nuclear power generation is required if these concerns are to dissolve.

Waiting on purely national disposal programmes will not solve these security problems on any realistic timescale. Shared and multinational approaches are essential to ensure availability of solutions for every country and all relevant wastes. Whilst there are several initiatives at hand, each has its difficulties. The difficulties can only be overcome if there is a general acknowledgement that combined international action is needed now, and if there is a resolve to work together to begin this action. Specifically:

- For the European Union, when SAPIERR-2 reports in late 2008, the community must be prepared and ready to consider how to move forward. Getting ready for the discussions and decisions that will be required is something that should begin now.
- Both GNEP and the GNPI need to move towards dealing comprehensively with the fuel cycle if they are to be accepted by the target community of developing nations and if they are to have a serious impact on international security. Potential GNEP "Tier 2" countries receiving nuclear services must be included in discussions on feasible arrangements and the incentives offered should include back-end services that cover disposal of spent fuel and other long-lived wastes.

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