RADIOACTIVE WASTE MANAGEMENT IN THE EUROPEAN UNION APPLICANT COUNTRIES

Simon Webster

Directorate General XI - Environment, Nuclear Safety and Civil Protection

European Commission, Rue de la Loi 200, B-1049 Brussels

ABSTRACT

The major task facing the European Commission during the coming years concerns the enlargement of the European Union to include the applicant countries from Central and Eastern Europe. Nuclear safety concerns, including those in the field of radioactive waste management, are a key issue in the enlargement process. For some time, the Commission service responsible has been amassing information on the radioactive waste situation in these countries, in order to identify and categorise the problems and target areas for remedial action. This information will be issued shortly in the form of a Commission EUR report (ref. EUR19154). The present paper reproduces the Executive Overview from this report, and thus represents a summary of the current situation regarding radioactive waste management in these countries and a critical appraisal from the perspective of the European Commission. The reader is referred to the above report for more complete information, including all raw data.

1 Introduction

Over the coming few years, ten countries in Central and Eastern Europe are likely to join the European Union (EU). However, the current level of safety in the nuclear sector in the majority of these applicant countries is not considered to be as high as that in the present EU Member States, and nuclear safety in general has therefore become one of the priority issues in the enlargement process. This point is clearly mentioned in Agenda 2000[1], the Commission's detailed strategy for strengthening and widening the Union in the early years of the 21st century. During the period of Soviet influence in these countries there was little evolution in nuclear safety culture, and the practices in evidence in the 1960s were still being applied three decades later. In comparison, the nuclear sector in the West underwent radical changes during this period, which have led to overriding importance being placed on issues of nuclear safety and protection of man and the environment.

Over the last eight years, the EU has allocated large sums of money to finance studies and safety improvements in the field of nuclear safety in these applicant countries. Much of this money has been devoted to safety improvements on nuclear power reactors of older Russian design. As a result, important improvements have been made in the area of reactor operational safety. However, those reactors that cannot be upgraded to an acceptable level of safety at a reasonable cost will be faced with early closure. Other studies and assistance projects have helped evaluate the current situation in the field of radioactive waste management. These have produced a clearer picture of what needs to be done in this field to attain an acceptable level of safety and environmental protection, both now and in the future.

The radioactive waste problems in the applicant countries were again emphasised in the 1998 report[2] of a panel of high-level advisers on nuclear safety. The panel, chaired by Mr. J.-P. Contzen, was appointed by the Commission to review the PHARE and TACIS nuclear safety programmes in the light of criticism from some quarters of these programmes. In their conclusions, the panel recommended a shift in focus from pure reactor safety improvements to other aspects of nuclear safety such as radioactive waste management and safe closure of research reactors. They also mentioned specifically the need for continued assistance concerning remediation of uranium mining sites in several applicant countries.

The Commission service in DGXI responsible for nuclear safety has compiled a report on the current radioactive waste situation in the applicant countries of Central and Eastern Europe (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia). The information was provided principally by nominated representatives from the countries themselves. The report will be issued shortly in the EUR series, reference EUR19154. The following sections summarise and interpret the information in this report, with emphasis on those areas where present practices in these countries are not considered to reach currently accepted Western standards. Though these problems vary considerably in type and severity from country to country, they can be categorised as follows:

- the management of spent nuclear fuel, including that from research reactors;
- insufficient or inadequate treatment and conditioning facilities;
- storage and disposal facilities of unacceptable design and construction, with unknown contents or with insufficient capacity;
- lack of identified disposal sites;
- lack of plans or financial provisions for decommissioning of ageing and unsafe facilities and management of the resulting waste;
- the management of spent sealed radioactive sources;
- the legacy from uranium mining and milling activities;
- institutional, legislative, regulatory and financial issues.

2 The management of spent nuclear fuel

Power reactors

The management of spent fuel from nuclear power plants (NPPs) became a crucial issue in many applicant countries following the collapse of 'take-back' agreements with Russia. Such agreements not only allowed for the return of the spent fuel, but also meant that reprocessing wastes would remain permanently in Russia. It is far from certain that future contracts can be arranged under the same conditions. One special case concerns the remaining spent fuel at the Bohunice A1 reactor (Slovakia), currently being decommissioned, which will be returned to Russia during 1999. Bulgaria has recently concluded a contract with Russia for the reprocessing of VVER-440 spent fuel, though the high-level waste (HLW) will be returned to Bulgaria.

As a consequence of the need to store spent fuel on-site, a number of reactor cooling ponds are reaching saturation, resulting in difficulties during reactor operations. However, steps have been or are being taken in all countries with NPPs to increase the interim storage capacity for spent fuel by constructing additional AFR ('away from reactor') wet or dry storage facilities, or increasing the capacity of existing AR ('at reactor') or AFR storage. These measures may need to be supplemented with additional storage capacity in the years to come, depending on the lifetime of the reactors concerned. All operating VVER and RBMK reactors are affected by these problems of spent fuel storage. The new dry interim storage facility at Ignalina NPP (Lithuania) was only commissioned in May 1999, just a few months before the AR ponds would have reached capacity. At Kozloduy NPP (Bulgaria), the AFR wet store is currently experiencing licensing problems, and a replacement AFR dry store is under consideration.

Most if not all countries operating NPPs have still to decide on their long-term strategy regarding spent fuel, i.e. open versus closed fuel cycle (direct disposal versus reprocessing of spent fuel). Only Bulgaria does not currently consider the possibility of direct disposal of spent fuel.

Research reactors

In the case of Russian designed research reactors, some, but not all, countries made regular returns of spent fuel to the Russian supplier, but these arrangements all broke down in the late 1980s. Consequently, there are accumulations of spent fuel at all sites (Bulgaria, Czech Rep., Hungary, Latvia, Poland, Romania), and where no fuel has ever been returned these accumulations can be

considerable (e.g. > 5000 assemblies at Swierk in Poland). There is a possibility that a fuel return programme could be implemented in the future, though this is far from certain and as yet no financial arrangements have been made. In comparison, the TRIGA research reactors in Romania and Slovenia still benefit from agreements with the USA allowing return of spent fuel until May 2006.

Where the research reactors are likely to remain in operation for several more years (e.g. Czech Rep. and Hungary), routine maintenance and monitoring of the spent fuel storage should continue at a satisfactory level. At other sites, the run-down in site activities could affect the continuing safe storage in the long term, and it is therefore much more urgent to deal with the problems of spent fuel storage as soon as possible. The facilities at these sites were not designed for long-term storage of spent fuel. Nonetheless, some of this fuel has been in wet storage for almost 40 years, and there is evidence of cladding degradation that manifests itself as small releases of fission products into the pond water. As no country has any immediate plans for the reprocessing or disposal of this fuel, continued interim storage will be necessary.

International assistance projects have studied the problems at most of the sites and recommendations have been made concerning options for the management of spent fuel and decommissioning in general. For instance, at Swierk the favoured approach is to convert the old research reactor biological shield into a dry store for all spent fuel currently in wet storage. In Romania, one possibility could be to transfer the spent fuel to a planned dry storage facility for NPP spent fuel at Cernavoda. The situation at the reactors in Latvia and Bulgaria is the subject of a current PHARE regional project.

3 Radioactive waste management facilities

Treatment and conditioning

Before 1990, in line with the approach in the former Soviet Union, normal waste management practices at NPPs meant that operational waste was simply stored on-site with very little treatment, and all decisions relating to volume reduction, conditioning, long-term storage and disposal were postponed until the time of NPP decommissioning. Even now, waste treatment capabilities at some NPPs are still very rudimentary, relying at best on sorting and packaging of solid waste and ion exchange or evaporation of liquid waste. However, new treatment facilities are being commissioned or planned, which show a trend towards improved volume reduction and conditioning techniques such as compaction or supercompaction and incineration. These include a new waste treatment centre at Bohunice in Slovakia, treatment facilities under construction at Kozloduy NPP in Bulgaria, and additional facilities planned at Cernavoda NPP in Romania.

The other waste treatment facilities in the region are situated in nuclear research institutes, usually in close proximity to research reactors. These facilities employ a variety of basic techniques on a small scale, such as compaction, cementation, ion exchange etc. Though their main role is to treat the site's own waste arisings, they often also treat institutional (i.e. non-fuel cycle) radioactive waste coming from the country as a whole. However, owing to ageing of the plant and lack of investment, the efficiency of some of these facilities is questionable. As more modern facilities become available at some NPPs, institutional waste may increasingly be sent there for treatment and conditioning prior to disposal. This, for instance, will be the situation at the new Bohunice waste treatment centre.

Storage and disposal sites

Only the Czech Republic has a licensed and operating disposal facility for NPP operational waste, though a new facility in Slovakia is currently in the licensing phase. In all other countries with operating NPPs, operational waste is being stored on-site at the power plant. Concerning institutional waste, there are operating repositories in several, but not all, of the applicant countries. Some of these sites have accepted NPP operational waste in the past.

Most of these existing disposal sites were constructed in the 1960s or 70s without a recognised site-selection procedure and have been operated in the past without applying strict waste acceptance

criteria or using accepted waste conditioning techniques. In some instances (e.g. "Radon" type facilities in the Baltic States), sites were also used for disposal of military waste. As a result, many of these repositories are now considered to be of unsuitable construction and contain inappropriate waste packages with unknown radionuclide inventories. However, it should be stressed that these sites were constructed and operated in accordance with the national regulations in existence at the time.

Some of these disposal sites have now been closed with the intention of retrieving and repackaging the waste (e.g. Tammiku in Estonia, Maišiagala in Lithuania), while others have been closed pending upgrading (e.g. Novi Han in Bulgaria). Some repositories are still operating as storage sites, at least for certain waste types, pending further safety assessments or the availability of alternative disposal sites (e.g. Baldone in Latvia, Rozan in Poland). There is a similar situation at Ignalina NPP, where changes in regulations have meant that what was originally intended as a disposal facility can only be used as an interim store for operational and institutional waste. Other disposal facilities are operational but very close to full capacity (e.g. Püspökszilágy in Hungary) and alternative sites need to be found soon. Finally, some sites are in operation but upgrading is acknowledged to be necessary (e.g. Baita Bihor in Romania).

Siting programmes for low and intermediate level waste (LILW) disposal are on-going in countries currently lacking adequate facilities for NPP or institutional waste (Bulgaria, Estonia, Hungary, Poland, Romania, Slovenia), though often these programmes are not far advanced, and in any case suffer from the same problems of public acceptance experienced in the West. In Lithuania, efforts are concentrating on the upgrading of the storage facilities at Ignalina NPP; with the construction of additional barriers, the current store for bituminised waste could be converted to a disposal facility.

Geological disposal

The only currently acceptable long-term management solution for high-level waste (HLW) or long-lived LILW is deep geological disposal. In the applicant countries, depending on the management option chosen for spent fuel, such repositories would serve either for disposal of HLW from reprocessing operations or spent fuel conditioned for direct disposal. No matter which fuel management option is adopted, the associated costs will be very high and adequate long-term financial planning is essential. Only the Czech Republic, Hungary and Slovakia have begun siting investigations for a deep repository, though these are at a very preliminary stage.

Small but significant quantities of HLW also arise from decommissioning activities at nuclear facilities and research reactors, including in countries with no operating power reactors (Estonia, Latvia and Poland). In these cases, it is inconceivable that national disposal sites would be constructed for such small amounts of waste, and some form of regional solution, possibly involving exchanges of waste in other categories, would appear to be the only viable long-term solution.

International assistance

There has been international assistance in the field of site selection (e.g. Hungary, Slovenia) and in topics such as safety assessments of existing repositories (Rozan in Poland, Novi Han in Bulgaria, Maišiagala in Lithuania, others planned in Czech Rep., Hungary and Latvia). Past or on-going regional PHARE projects have also provided assistance in such aspects as derivation of waste package acceptance criteria, QA and QC procedures and LILW storage methodologies. Training of local staff in various waste management techniques will also be provided by a planned PHARE regional project.

4 Decommissioning of facilities

In several countries there are ageing power reactors that will enter the decommissioning phase during the next decade. Detailed decommissioning plans often do not exist, and the countries concerned have, until recently, made little or no financial provisions for the decommissioning or to cover the costs of managing the resulting radioactive waste. Perhaps the first reactors to be affected will be at Kozloduy (Bulgaria) and Ignalina (Lithuania). In both these countries, decommissioning funds have recently

been created, though the ability of these funds to pay will depend to a large extent on the length of time the reactors are allowed to continue in operation. Current and planned PHARE projects are concerned with decommissioning studies at Ignalina NPP, and DGXI regional studies have assessed the situation at nuclear sites in other nuclear countries[3].

Concerning decommissioning projects currently in progress, international assistance programmes have addressed some of the problems at sites such as the Bohunice A1 reactor in Slovakia and the Paldiski nuclear naval training centre in Estonia.

In the case of the Bohunice A1 reactor, decommissioning waste is likely to be disposed of at the new Mochovce repository, though there will be quantities of high-level waste requiring long-term storage pending the availability of a deep disposal facility. In Estonia the waste must be stored until a national repository is available. In other countries, decommissioning waste may be accommodated by extensions to existing disposal sites, e.g. Baldone (Latvia) and Baita Bihor (Romania) for waste from decommissioning of research reactors at Salaspils and Magurele respectively.

5 Management of spent sealed radioactive sources

There can be little doubt that spent sealed radioactive sources pose a potentially serious threat to public health. During the Soviet era, a large number of such sources, containing a range of different nuclides including radium, were in use in the applicant countries. In many of the Soviet style repositories of the region, spent sources were disposed of in borehole facilities, often without any conditioning. More recently, use of radioactive sources in these countries has declined, presumably for economic reasons, and it is becoming more routine to return spent sources to the foreign suppliers.

However, the management of spent sources remains a serious problem in these countries, and for this reason two DGXI regional study contracts are being organised to assess the situation[4]. Of particular concern are the sources that have become "lost" and are no longer under any regulatory control and those containing radium or other long-lived radionuclides.

6 Uranium mining and milling operations

Such operations have been widespread in many of the applicant countries, though now most have ended for economic reasons. The only countries not affected are Latvia and Lithuania. The legacy is one of open pits, tailing ponds and low-grade ore or waste heaps - all constituting a health or environmental hazard, either through radon emanation or contamination of water supplies. The worst affected countries are perhaps Bulgaria, the Czech Republic, Estonia and Romania. There are current PHARE projects studying most aspects of the required remediation, in which all countries are co-beneficiaries.

However, the scale of the problem is such that full remediation will undoubtedly be very costly, possibly running to several tens of millions of euro for one major site alone. It is important, therefore, that international funding should also be available to assist in the actual remediation work at the worst affected sites. This will probably take the form of co-funding arrangements with other international financing institutions and the host country. Two such mechanisms co-ordinated by the Commission are the Large-Scale Infrastructure Facility (LSIF)[5] within the PHARE programme, and the Instrument for Structural Policies for Pre-Accession[6] (ISPA) managed by DGXVI. In the meantime, most countries concerned are taking at least some active remediation measures paid for out of public funds. In Bulgaria, where there is a lack of finance available from inside the country, 100% PHARE funding has been arranged to cover the work at two critical tailing pond sites. On a smaller scale, DGXI is organising financing for necessary remediation work at the one remaining tailing pond site in Poland.

7 Institutional, legislative, regulatory and financial issues

Reform of national institutions and regulatory structure

In the centrally planned economies of the region during the period of Soviet domination, all aspects of nuclear power were the responsibility of the state, with no clear separation between regulating and implementing functions. The general principles were dealt with in nuclear energy acts, but these concentrated on the period of NPP operation and did not deal with waste or decommissioning. These laws and regulatory systems were found to be inadequate with the emergence of the new socio-political systems. All countries have therefore entered a period of reform; in this process the goal of earlier accession to the EU has proved a powerful incentive to harmonise legal and institutional systems.

Most countries have now passed new or revised basic legislation in the form of atomic laws or similar. Under this new legislation it is normal for the regulatory authority to have responsibility for licensing of nuclear activities, including those involving radioactive waste management and spent fuel. However, to be effective, this new basic legislation must be strengthened by the drafting of robust secondary legislation, e.g. revised and updated radioactive waste regulations, and the formulation of management policies and programmes. This strengthening of the legal framework will take more time and has yet to be achieved in many countries.

The institutional reforms involve a trend away from the old style of regulatory and institutional system, with no clear separation of responsibilities, to the western - style "classical triangle" of independent waste producer, regulator and waste management organisation (WMO). Those countries demonstrating the most progress include the Czech Republic, Hungary and Slovenia, in which WMO have been created and are expected to assume most if not all responsibilities for the activities in the field of radioactive waste management in the next few years. In addition, a significant production of radioactive waste generated in these countries is from electricity production, and electricity sales provide a continuous source of revenue that should be adequate to cover the costs of waste management activities.

In comparison, Bulgaria and Lithuania, who also rely heavily on nuclear power and thus have significant waste arisings, are still in the process of reforming their legal and institutional framework. Legislation either enacted or being prepared anticipates creating independent WMO, but concrete steps in this respect have not yet been taken. The progress in the Slovak Republic is more encouraging. Here a waste management company has been created as a subsidiary of the electricity generator, rather than a WMO in the "classical" sense.

In Romania, the large-scale production of radioactive waste has only just started with the recent commissioning of the first reactor at the Cernavoda NPP. A WMO has not yet been established, but there is less urgency owing to the present small volume of operational waste. However, a dedicated WMO will eventually be desirable.

There are no NPPs in Estonia, Latvia and Poland, and consequently the waste arisings are much less in these countries. Waste needing management and disposal is mostly legacy waste, and there are large accumulations of waste at Paldiski in Estonia and of spent research reactor fuel at Swierk in Poland. In these cases, it is obvious that without an active nuclear power producing sector, the majority of the financing of these waste management activities will have to be covered by the State. Estonia has already created a state-owned company responsible for the management of radioactive waste and acting independently from the waste producers and regulator. In Latvia, the former RADON organisation created under Soviet rule is still in charge of waste management but in an updated regulatory context. In Poland, there is no dedicated waste management company, with the Institute of Atomic Energy (IAE) instead being responsible, as the single largest producer, for most waste management operations.

Financial aspects

As a complement to the modernisation of waste treatment and conditioning facilities, efforts are also needed to reduce waste arisings at source through improved NPP operational practices. This is one of the basic principles upon which modern waste management practices are founded.

In Western Europe, the incentive for making such reductions in waste arisings has largely been driven by the high cost per unit volume of waste management and the general application of the "polluter pays" principle. Adequate funding for the long-term management of radioactive waste is guaranteed through a variety of financing schemes[7].

In the applicant countries with operating NPPs, such schemes are just being introduced and are usually based on Government controlled segregated funds[8]. Though these countries are in general adopting the principle that the "polluter pays", there is a question mark over the adequacy and availability of the new funds. As with the funds for decommissioning, the adequacy of the funding that can be supplied by these funds will be determined, to a large extent, by the length of time the NPPs remain in operation.

However, waste arisings at some sites will remain higher than the average simply as a result of the NPP type. For example, the RBMK design produces roughly four times more waste per unit of electricity than pressurised water reactors, though this is also true of Western designed gas-graphite reactors. Modern light-water reactors in the EU produce approximately 100 m^3/GWe of LILW, and waste arisings are still being reduced. Currently available data show that light-water reactors (VVER) in the applicant countries produce approximately 2.5 times as much LILW per GWe. Clearly, with more modern treatment facilities, improved operating practices and the right financial incentives, substantial reductions in arisings are possible.

Adoption of EU legislation

The applicant countries are currently amending national legislation in line with the formal legislative "acquis" from the EU. In the field of radioactive waste, the relevant EU legislation covers basic safety standards for the protection of workers and the public against ionising radiation, transport of waste and environmental impact assessment (EIA) for radioactive waste storage and disposal sites. The present degree of harmonising with this legislation varies and is continuously monitored by the relevant Commission services.

The EIA Directive in particular was the subject of a recent DGXI study[9], which demonstrated that there is already good compliance with this legislation in most applicant countries, even though international best practice is not yet widespread.

International aspects

The applicant countries should be encouraged to become contracting parties to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management[10], and in general to implement the technical recommendations of the IAEA and ICRP. The ensemble of these international instruments represents a framework for safe nuclear practice, and their adoption by all applicant countries constitutes an essential prerequisite to accepted safe and environmentally sound management of radioactive waste.

The Joint Convention was opened for signature in September 1997. At the beginning of May 1999, eight of the ten applicant countries had become signatories of the Joint Convention, the exceptions being Estonia and Latvia. In addition, four countries, Czech Republic, Hungary, Slovakia and Slovenia had ratified the Convention.

8 Conclusions

In the applicant countries the radioactive waste problems are wide-ranging and pose potentially significant threats to man and the environment, especially in the long-term. The changes that are necessary require not only allocation of financial resources, but also fundamental changes in the institutions themselves, in the system of regulation and control and in the underlying safety culture. Though these changes have begun in many countries, it could be several years before the new political and economic systems of the region have matured sufficiently to allow this process of change to be completed.

The scale of the problem has been established by numerous regional and country-specific studies with the help of Western funding and expertise, and the next phase is actual remedial action. However, assistance programmes will not continue indefinitely, and can only make a small contribution to the total cost. Co-operation and partnership with the West will remain a crucial element of the West's strategy during the enlargement process, though eventually there must be a return to self-help.
Through these numerous assistance and co-operative projects, these countries have now been exposed to current internationally acceptable waste management techniques and philosophy, and this culture is gradually being adopted as part of an increased awareness of environmental issues in general. However, there is still a lack of local expertise in certain aspects of these new techniques, such as long-term safety assessments. Until all aspects of this new culture are in place, these countries will still be dependent on Western help.

One key element of the new safety culture is a strong and independent nuclear regulator. Until this is achieved, assistance to regulatory and technical safety organisations will continue to form an important part of the help provided by the West.

Internationally accepted principles assuring the protection of man and the environment, both now and in the future, form a basis for the modern system of waste management. These fundamental principles are largely being respected in EU Member Sates despite delays in advancing to geological disposal of high-level and long-lived waste. In the applicant countries, more progress is still required before the region as a whole can make the same claim. However, with the right co-operation, advice and cross-fertilisation from the West, there is every chance that this progress can be achieved by the time of their planned accession to the EU.

The full report of the radioactive waste management situation in the applicant countries will be published shortly as Commission Report EUR19154. This report is an update of a previous Commission report published in September 1997[11].
In the light of the future enlargement of the EU, this report represents an important first step in assessing the radioactive waste problems in the applicant countries of Central and Eastern Europe. The report will help formulate future Commission strategy in this field during the enlargement process, and provides a necessary benchmark by which to judge subsequent developments in these countries. These developments will be the subject of periodic report updates.
The report complements the information on EU Member States contained in the Communication and Fourth Report from the Commission on the Present Situation and Prospects for Radioactive Waste Management in the European Union[12].

9 References

[1] http://www.europa.eu.int/comm/agenda2000/index_en.htm

[2] http://www.europa.eu.int/comm/dg1a/nss/

[3] EC DGXI studies: General overview of existing and future requirements for decommissioning nuclear facilities in five countries of the region (two studies - see Table 2 of Introduction to main report)

[4] EC DGXI study contract: Management of Spent Sealed Radioactive Sources in the Central and Eastern Europe (Czech Republic, Estonia, Poland, Hungary, Slovenia) - to start 1999
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[5] http://www.europa.eu.int/comm/dg1a/phare/programme_types/lsif.htm

[6] http://www.europa.eu.int/comm/dg16/dwnld/pdf/draft/ispaen.pdf

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[9] EC DGXI: Environmental Impact Assessments and geological repositories for radioactive waste; 1999; EUR19152 (Vol. 3: Central and East European Countries)

[10] http://www.iaea.org/worldatom/

[11] Hämäläinen L.: An Overview of Radioactive Waste Management in Central and Eastern European Countries; Trainee Final Report; Document No. XI/475/97; DGXI European Commission; September 1997

[12] published as COM(98)799 final, 11/1/99 (the Council conclusions to this Communication are in Council Doc. 8857/99 ATO 74 ENV 189)