Radioactivity Management and Nuclear Safety

RADIOACTIVITY MANAGEMENT

Many countries described their national programmes for the management of radioactive wastes and releases. These programmes are the result of the need to develop an optimal radioactivity management scheme for a growing number of nuclear power plants and for the industrialization of the nuclear fuel cycle. A number of countries are investigating the possibilities of vitrifying the highly radioactive liquid waste resulting from reprocessing irradiated nuclear fuel, and of disposing of the solidified waste product in a deep geological formation (geological disposal).

These presentations generally indicated that technology now is available for the safe treatment, conditioning, and storage of essentially all of the hazardous radioactive wastes from the nuclear fuel cycle. While improvements in the currently applied techniques are possible, it also seems unlikely that revolutionary new methods will appear in the near future.

It was apparent that development efforts for radioactive waste management should now concentrate in the area of waste disposal. On the other hand, guidance from many national regulatory bodies is lacking for waste product specifications and disposal requirements. This appears to stem mainly from the lack of demonstration of disposal concepts. Nevertheless, national authorities in all cases are to have the responsibility for the actual disposal of radioactive wastes and the operation of the disposal facilities.

In a panel discussion on radioactive waste disposal options and their availability, the panel members agreed that, at least from the viewpoint of technological availability, burial of wastes in a high-integrity form deep underground in stable geological formations was the preferred disposal option. The panel also felt that those benefitting from the use of electricity generated by nuclear power should bear the disposal costs for the nuclear wastes.

With the exception of radioiodine, the gaseous radionuclides seemed to be of limited importance to population exposures at this time. But in view of the expected expansion of nuclear power plants and fuel reprocessing facilities, several papers called attention to the eventual possibility of hazardous concentrations on a global scale of carbon-14, krypton-85 and tritium, if they are allowed to escape unchecked. It also was indicated that technology and appropriate flow-schemes have been developed to prevent these gaseous radionuclides from entering the atmosphere, but they have not been tested operationally. While it appeared that early demonstration of applicable techniques for the retention and storage of gaseous radionuclides would be of considerable value, it was not clear when such demonstrations could be expected.

Some papers noted that more attention should be given to the eventual decommissioning of nuclear facilities. They agreed that tentative decommissioning plans and procedures should be taken into account during the design and licensing stage and be approved by the licensing authorities. In this respect, it was consistantly pointed out at the conference that it is time for national authorities to formulate the financial arrangements and responsibilities to cover the future costs of waste disposal and decommissioning.

The papers on criteria and standards for radioactivity management placed emphasis on applying to the public the general recommendations of the International Commission on Radiological Protection (ICRP) that all exposure to radiation should be justified and that it should be kept as far below the permissible individual dose limit as is reasonably achievable.

The assessments showed that the application of such principles can ensure that the exposure of workers and of the general public arising from the nuclear fuel cycle facilities can be kept to acceptable levels now and in the foreseeable future. However, there eventually is reached a trade-off for minimizing the exposure to population groups vis-à-vis minimizing the exposure to the workers in radioactivity management.

Several speakers pointed out that more work needs to be done on an international basis on the assessment of occupational and public exposure and in the setting of limits for radioactive releases to the atmosphere, aquatic systems and marine environments.

Several papers reviewed national and international experience regarding the transport of radioactive materials, including the transport of many hundreds of tons of irradiated nuclear fuel elements, for which an impeccable safety record has been maintained. The IAEA's Transport Regulations, which form the basis of national and international regulations under which radioactive materials are shipped, generally appeared to be adequate. However, it was pointed out that there would be considerable merit in standardizing casks and cask handling facilities, and additional work needs to be done on risk assessment, quality assurance and public acceptance. The future trend lies in the development of heavy larger-capacity packages and casks to be used in rail or sea transport of radioactive materials, and especially for irradiated nuclear fuels.

NUCLEAR SAFETY

Among the sessions dealing with nuclear safety, several were devoted to safety-related operating experiences of commercial nuclear power stations and to regulatory aspects. The excellent safety record based on many reactor years of operation was stressed. For example, pressurized-water reactors have had over 300 reactor-years of commercial operation in the USA and more than 150 reactor-years in other countries. The total for all light-water reactors is about 1000 reactor-years — all this without an accident leading to a nuclear radiation-related disability. The technical points in the design and construction which have resulted in this achievement were described, such as the extreme high quality of fabrication of components, the high degree of quality control, the philosophy of defense-in-depth for both normal and postulated conditions.

However, a number of unanticipated incidents which are safety-related have also been reported, such as defects of steam generator tubes, cracks in parts of the primary system, fuel element deficiencies, fire damage to electrical and control cables. These events,

while in no case leading to an adverse radiological impact to the public, sometimes caused power plants to be shut down for inspection, maintenance and repair, thus entailing reduced plant availability for power production.

National practices and experiences in the regulation of nuclear installations in many countries show that the establishment of a strong independent and visible regulatory function, as represented by regulatory bodies in the USA, UK, Canada and France, may contribute considerably to public understanding and to ensuring safety during all stages of implementing a nuclear power programme.

An IAEA paper described the development of a set of internationally agreed safety codes and guides for nuclear power plants, which will be recommended for use to its Member States.

The adoption of these safety codes and guides is expected to assist in the harmonization of safety standards for nuclear power plants in developed and developing countries.

In a round table discussion on the use of generalized safety reviews, the trend in the standardization of nuclear facilities in a number of countries including the Federal Republic of Germany, France, UK, USA and USSR was discussed. There seemed to be common factors in that the administrative procedures were becoming relatively standard, that safety reports were reaching a relatively standard format, and that the methods of evaluation of nuclear plants were emphasizing barrier protection, defense in depth and probabilistic methods.

A session was orientated towards the research and development, both theoretical and experimental, which is being done in many countries to enhance the understanding of major safety problems in the field of thermal power reactors. The major topics of nuclear safety as described in the papers of this session were:

- the integrity of the pressure boundaries, especially of the reactor pressure vessel,
- the initiation, course and consequences of hypothetical accidents, especially the loss-of-coolant accident and its connected safety aspects, that is emergency core cooling, fuel element behaviour, and containment integrity,
- the reliability of safety-related equipment,
- the development of inspection methods and equipment,
- the consequences of external impacts (natural as well as man-made).

Selected papers:

1. F.R. Marcus and F. Seynaeve, "Industrial aspects of radioactive waste management in Western Europe". IAEA-CN-36/8.
2. V.I. Spitsyn et al., "Scientific prerequisites and practice for using deep water-bearing horizons for disposal of liquid radioactive wastes". IAEA-CN-36/345.
3. N.T. Mitchell et al., "Options for the disposal of high-level radioactive wastes". IAEA-CN-36/67.
4. L. Cecille et al., "Nuclear transmutation of actinides other than fuel as a radioactive waste management scheme". IAEA-CN-36/366.
5. J.M. Costello, "Management of wastes containing radioactivity from mining and milling of uranium ores in Northern Australia". IAEA-CN-36/418.

6. L.M. Mergan et al., "Evaluation of solidification matrices proposed for nuclear power plant radwaste". IAEA-CN-36/186.
7. B. Ya Galkin et al., "The discharge into the atmosphere of volatile fission products from nuclear power stations and fuel reprocessing plants and the outlook for their retention". IAEA-CN-36/317.
8. E. Detilleux and W.L. Lennemann, "Criteria, standards and policies regarding decommissioning of nuclear facilities". IAEA-CN-36/490.
9. J.P. Olivier, "Present trends in radioactive waste management policies in OECD countries and related international co-operative efforts". IAEA-CN-36/491.
10. R.P. Randl, "Waste management in the Federal Republic of Germany – a survey of policy and R and D". IAEA-CN-36/98.
11. M. Tomlinson et al., "Management of radioactive wastes from nuclear fuels and power plants in Canada". IAEA-CN-36/178.
12. T. Itakura et al., "Reduction of releases of radioactive effluents from light-water power reactors in Japan". IAEA-CN-36/166.
13. S.Aoki and Y. Ando, "Research and Development of spent fuel shipping casks and the criteria for seagoing ocean transport". IAEA-CN-36/155.
14. A.N. Kondratiev et al., "Spent fuel transportation problems". IAEA-CN-36/316.
15. H.W. Curtis, "Experience of European irradiated fuel transport – the first four hundred tonnes". IAEA-CN-36/69.
16. A.M. Platt et al., "United States experience in the transportation of radioactive materials". IAEA-CN-36/563.
17. V.A. Blinov et al., "On the necessity of the evaluation of limits of radioactive waste disposal into aquatic systems of international importance". IAEA-CN-36/346.
18. H.L. Gjoerup, "Differential cost-benefit considerations in connection with global collective dose commitments from the release of long-lived radionuclides". IAEA-CN-36/205.
19. F. Gera, "Radioactive waste disposal in geological formations". IAEA-CN-36/313.
20. R.E. Blanco et al., "A cost-benefit analysis of methods of controlling the release of radioactive materials in the nuclear fuel cycle". IAEA-CN-36/429.
21. Sir Edward E. Pochin, "Basis for establishing radiation exposure limits". IAEA-CN-36/488.
22. D. Beninson, "Collective dose commitments from nuclear power programmes". IAEA-CN-36/9.
23. B. Lindell, "New approaches to deriving limits of the release of radioactive material into the environment". IAEA-CN-36/280.
24. J.K. Donoghue et al., "Safety Aspects of a Fuel Reprocessing Plant". IAEA-CN-36/75.
25. N.I. Kozlow et al., "Aspects of Nuclear Safety at Nuclear Power Plants and Fuel Cycle Plants in USSR". IAEA-CN-36/323.
26. H. Akutsu et al., "Safety Aspects of Reprocessing and Plutonium Fuel Facilities in Power Reactor and Nuclear Fuel Development corporation". IAEA-CN-36/550.
27. P. Candes et al., "Safety and Radiological Protection Aspects of High-level Radioactive Waste Management". IAEA-CN-36/231.
28. V.A. Sidorenko et al., "Problems of WWER-LWR Reactor Safety". IAEA-CN-36/344.
29. W.H. Arnold, "Safety Considerations of PWR's". IAEA-CN-36/512.
30. S. Levine et al., "The Rasmussen Report: a Retrospective and Prospective Review". IAEA-CN-36/447.