Site investigation techniques and assessment methods for underground disposal of radioactive wastes

by J.U. Heinonen*

Studies of waste disposal systems and research relating to repository sites are important components of national nuclear power programmes. Several Member States are investing large resources in extended site investigations of potential repositories for high-level waste in particular. With respect to the shallow ground disposal of low-level wastes, it has been shown that the few problems which have occurred have largely been overcome by giving more attention to site selection and to improved operational practices.

To discuss the various aspects of site investigation and assessment in different countries, both developing and industrialized, the IAEA convened an international seminar on "Site investigation techniques and assessment reflects the present situation: extensive work with large resources is being done in several Member States in this subject field. A number of informative papers were presented, including reviews of new results obtained and of *in situ* investigations representative of various geological conditions and of different types of host rock, methods for underground disposal of radioactive wastes" in Sofia, Bulgaria, from 6 to 10 February 1984. The seminar dealt, in principle, with all the different phases and aspects of the investigation and assessment of the suitability of a site for a waste repository, starting from general and regional investigations, and proceeding via comprehensive site-specific detailed geoscientific investigations to site confirmation studies and final assessment. The various categories of waste, and underground disposal options (the disposal of low- and intermediate-level waste in shallow ground and rock cavities, and the disposal of high-level waste in deep geological formations) were also included in the programme.

The main part of the programme was oriented to detailed geoscientific investigations and hydrogeological studies for siting repositories for high-level waste. This such as granite, clay, salt and tuff. There were also descriptions of continuing programmes of investigation at different levels, modelling, laboratory and *in situ* experiments. Applications of technology and investigation methods, such as the development of modelling and the interpretation of results from experimental studies (and extrapolation to permit the evaluation and prediction of the transfer of waste from the repository within the environment) were also introduced. The presentations also included studies of the migration of specific radionuclides, and of important physico-chemical parameters. Interesting measurement and sampling techniques for the analysis of groundwater properties and flow were introduced, and the limitations of available technology were recognized: in formations of very low permeability, for instance, ensuring that water sampling is representative, and determining groundwater velocity and direction, are problematic.

Papers dealing with disposal of low- and intermediate-level waste demonstrated that site investigations in this field have become more sophisticated and comprehensive Studies related to the rock-cavity concept proved the increasing practical importance of this option, which has up to now been applied only relatively rarely. Such aspects have been recognized in the Agency's programme on underground disposal, and are reflected in its activities and publications.

One of the objectives of the seminar was to provide an overall picture of site investigations, through discussion of the integration of various studies in different disciplines with the aim of achieving a purposeful, goal-oriented, investigation to assure human and environmental safety. The entire seminar, and in particular papers presented in a session on "site assessment and confirmation studies", contributed to that aim. One paper referred to the lack of performance criteria for the sub-systems and components of disposal systems. The author of this paper also underlined that conclusions concerning the acceptability of a site at the confirmation stage cannot be based on, for example, geohydrological, geochemical or geotechnical knowledge alone unless a quantitative

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hydrological impact analysis is performed. Such statements support the Agency in its efforts to develop criteria for different underground disposal options and for certain system components, and in the preparation of guidelines for performance evaluation of the repository systems.

From the Agency's viewpoint, one very significant aspect was that the necessity for efficient collaboration at different levels (regional, national, and multi-national) was emphasized with regard, in particular, to detailed geoscientific investigations of a site and assessment of its suitability for the location of a repository for high-level waste. Many different disciplines interact in a complex process, and large-scale *in situ* experiments are needed. Thus, for example, the programme in one Member State involves more than 30 institutions, universities and companies from eight countries, as well as many leading scientists who are working in similar programmes in many countries.