



INTERNATIONAL ATOMIC ENERGY AGENCY

Information Sheet

Co-ordinated Research Project

1. Title of the Co-ordinated Research Project

"Behaviors of Cementitious Materials in Long Term Storage and Disposal"

2. Scientific and Technical Background

Operations in the nuclear power industry, application of radioactive materials in academic and industrial research, biomedical research and medical treatment produce a wide variety of radioactive wastes. Wastes are generated in all sectors that handle radioactive materials, and include almost any process material or equipment used in that sector. These wastes may include small amounts of process chemicals, spent solutions for specific analysis, spent ion exchange resins, scintillation cocktails, and discarded laboratory and process equipment. In addition, very large quantities and broad variety of waste are generated from the decommissioning/dismantling of nuclear power reactors and other nuclear industry facilities.

The predisposal waste management is to produce waste forms or waste packages suitable for storage, transportation and final disposal. Many countries use cementitious materials (concrete, mortar, etc.) as a containment matrix for immobilization, as well as for engineered structures of disposal facilities. Radionuclide release is dependent on the physical-chemical properties of the waste forms and waste packages and of the environmental conditions. In the use of cement, diffusion process and metallic corrosion can induce radionuclide release. The advantage of cementitious materials is to contribute also to stability and mechanical support at both storage and disposal. Long interim storage is becoming an important issue in countries where it is difficult to implement L&ILW disposal facilities and in others where cement is used in the packaging of waste not suitable for shallow land disposal.

Radioactive waste conditioning technology, based on cementation is a subject that has received considerable attention in the Member States in recognition of its importance for the protection of human health and the environment from adverse effects of radiation associated with radioactive waste. During the evolution of waste management practices, many cementation processes achieved a high degree of acceptance and many of them are now regarded as a technically mature discipline. A large body of information is currently available on these proven waste conditioning technologies. Most of the existing technologies have been developed for conditioning of large amounts of operational radioactive waste from such facilities as nuclear power plants and other nuclear fuel cycle facilities.

Selection of waste conditioning technologies based on cementation for specific waste streams should follow certain waste safety and waste acceptance criteria. Most safety criteria are well developed and are generally applicable to almost all wastes management systems. Other criteria, e.g. waste acceptance criteria could be site or country-specific. These requirements and criteria should be carefully considered in development and application of cementitious materials in multipurpose packaging for transportation, long term storage and disposal

Information collected during implementation of several previous CRPs (e.g. on "Combined methods for treatment of liquid radioactive waste", "Evaluation of radioactive waste forms and packages"), during TC missions to different facilities in Member States and information presented at International Conferences shows that prediction on behaviors of cementitious materials and understanding the processes that may result in degradation of their physical and chemical properties exist in many countries.

New emerging technologies are under different stage of development in different countries and institution to address the problem of long term behaviors of cementitious materials in multipurpose packaging for transportation, long term storage and disposal. Combining efforts and shearing the information and experience in this field would be of benefit to Member States. The Agency by its statute as International organization could play a key role in co-operation and co-ordination of this work in its Member States. Coordinated Research Project is well established instrument for such co-operation and co-ordination of common efforts in solution of specific waste management problems. The experience and knowledge gained by participating institutions during project implementation could serve as a basis for improving existing waste management practices in these institutions and in participating countries, for improving existing practices or in proper planning of future waste management activities.

3. Overall Objective

The CRP will investigate the behaviours and performance of cementitious materials used for an overall waste conditioning system based on use of cement, [including waste packaging (containers), waste immobilisation (waste form) and waste backfilling, as well as, interaction and interdependencies of these individual elements (containers-waste form-backfill)], during long term storage and disposal, and understand the processes that may result in the degradation of their physical and chemical properties.

The purposes of these elements in a waste management system are very different, and thus the requirements for long term performance and degradation methods/consequences are very different as well. However all these elements are important as well as interactions envisaged between them to ultimately ensure the overall safety of a storage/disposal system.

4. Specific Research Objectives

The specific research objectives of this CRP are to encourage and to coordinate R&D work on behaviours and performance of cementitious materials during long term storage and disposal, to facilitate exchange of information and technological experiences on new developments in the area, to identify innovative technologies to be applied for conformity with modern safety and economic requirements.

The following R&D topics will be primarily considered:

1. **Cementitious materials for radioactive waste packaging: including radioactive waste immobilisation into waste form, waste backfilling and containers.** Types and characteristics. Ordinary Portland Cement systems. Composite cements. Additives to cements. Use of additives for increase of water resistance, mechanical durability, waste loading, and flowability important while using cementitious materials to immobilise solid radioactive wastes such as ashes and spent sorbents.
2. **Emerging and alternative cementitious systems** (low pH cements, geopolymers, non-hydraulic cements such as MgO-phosphates).
3. **Physical-chemical processes occurring at production of cement compound (cement hydration) and their influence on the cement compound quality.** Hydration products, role of CSH, AFt and AFm phases, separation of liquid phase, heat generation during hydration, pH and pore water evolution, waste-cement interactions. Factors influencing hydration rates and determining the loss of fluidity. Effects of temperature on hydration.

4. **Methods of production of cementitious materials for: immobilization into wasteform, backfills and containers.** Specific of cementation process of various kinds of radioactive wastes: solid non-metallic radioactive wastes, metallic wastes, reactive metals, ashes, spent sorbents including both organic and inorganic ion exchangers, flocks (hydroxide pulps), evaporator bottoms, and other salt solutions, high organic content wastes, high-tritium waters, and under-water solidification of bottom deposits in storage ponds. Specific requirements to waste cementation processes, mixing device designs and packaging options (metal drums, concrete containers or boxes).
5. **Conditions envisaged for packages (physical and chemical conditions, temperature variations, groundwater, radiation fields.)**. Influence of external and internal factors on change of properties of cementitious materials during long term storage and disposal: effects of water, temperature, radiation. Waste-cement interactions in solidified waste, role of pore water, corrosion of metal in cements, gas generation, micro and macro cracking, degradation processes important for long-term behaviour of immobilised wastes, containers and backfills.
6. **Testing and non-destructive monitoring techniques for cementitious materials.** Microstructure and long term durability. Application of conventional techniques to radioactive waste packages. Practices and emerging techniques.
7. **Waste acceptance criteria for waste packages, waste forms and backfills. Transport, long term storage and disposal requirements** (Mechanical stability, Water (leach) resistance, Frost resistance, Radiating stability, Biological stability, etc.) Dependence of requirements to cement compound quality from the conditions of long-storage and disposal.
8. **Modelling or simulation of long term behaviours of cementations materials used for packaging, waste immobilisation and backfilling during long term storage and disposal.**

5. Expected Results

Exchange of information and research co-operation in resolving identical problems between different institutions in Member States will contribute towards improving waste management practices, its efficiency and general safety. The execution of the CRP will promote the exchange of advanced information on the ongoing research and development activities and facilitate access to the practical results of their application for conditioning or packaging of specific waste types. As a result of the project implementation a new knowledge and practical experience would be established and transferred to Member States to improve their radioactive waste management capacities, which is in line with the general rational of the Agency's Subprogramme L.4 "Technologies for disposable radioactive waste".

6. Action Plan

a) Activities

Activity 1: Formation of a network of institutions to realise the tasks identified in specific research objectives of the CRP.

The CRP will involve 12-20 institutions from developed and developing Member States. Some institutions participated in previous IAEA CRPs, in particular working on development of combined methods for treatment of specific waste types, may be included into the Project. Selection of institutions will be based on the relevance of individual

proposals according to scope and objective of the project, the qualifications of counterparts and availability of proper R&D facilities. The balance between representatives from developed and developing Member States should be maintained.

Activity 2: Organization of the 1st Research Co-ordination Meeting to identify objectives of individual projects and to justify R&D programme for the future work.

Objectives of the CRP and individual projects will be discussed together with the initial results of CRP implementation. Capabilities of individual institutions, availability of resources and facilities for all individual projects implementation will be evaluated. The working plan for CRP implementation will be discussed.

Activity 3: Organization of the 2nd Research Co-ordination Meeting to discuss the progress in the CRP implementation.

The 2nd Research Co-ordination Meeting will discuss the status of the CRP implementation, progress in implementation of individual R&D activities and results achieved, recommendations for further development and implementation of the CRP, establishment of bilateral and multilateral co-operation between participating institutions. The programme for preparation to the final Research Co-ordination Meeting and preparation of individual summary reports would be discussed.

Activity 4: Organization of the final Research Co-ordination Meeting.

Summary reports on individual projects implementation will be presented and discussed. The structure and the scope of the Final report of the CRP as a whole will be developed. The material to be included into the Final report of the CRP will be prepared and discussed. The main achievements and general summary of the CRP will be identified.

Activity 5: Publication of the CRP results.

The CRP results will be published as an IAEA-TECDOC as appropriate. The TECDOC would include the summary of the CRP implementation and individual reports of all participating institutions.

b) List of potential participating countries and institutions

1. Argentina	CNEA, Buenos Aires
2. Australia	ANSTO, Lucas Heights
3. Belarus	IREP, MINSK
4. Belgium	SCK/CEN, Mol
5. Brazil	CNEN/CDTN, Belo Horizonte
6. Canada	AECL, Chalk River Nuclear Laboratories
7. China	CIAE, Beijing University of Defense, Changsha

	Institute of Nuclear and New Emerging Technologies
8. Czech Republic	NRI Rez, Prague
9. Finland	VTT POSIVA
10. France	CAE, Saclay Centre
11. Germany	Research Centre Julich
12. Hungary	TS Enercon, Budapest ETV, Budapest
13. India	Bhabha Atomic Research Centre, Mumbai
14. Japan	Hitachi Organo, Tokyo
15. Korea (Republic of)	KAERI, Taejon KHNP, Seoul
16. Romania	IFIN HH, Bucharest NRI, Pitesti
17. Russian Federation	RADON, Moscow VNIINM (Institute Bochvar), Moscow
18. Serbia	Institute Vinca, Belgrade
19. Slovakia	Vuje, Trnava AllDeco, Jaslovske Bohunice
20. Spain	Enresa, Madrid
21. Sweeden	SKB IDNAR
22. Switzerland	Laboratory for Construction Materials, Nagra
23. United Kingdom	Immobilization Science laboratory, University of Sheffield Nexia Solutions University of Aberdeen Quintessa Limited
24. USA	BNL, New York East Carolina University

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7. Assumptions

Several Institutions from developing Member States, with recognized expertise in one (or more) of eight specific research topics will participate as the contract holders. The main part of the CRP will be the agreement holders, both from developed and developing countries. Technical supervision of the CRP implementation will be implemented by the IAEA Project Officer and Chief Scientific Investigator. The proposed Chief Scientific Investigator is Michael I. Ojovan, Reader, DSc., University of Sheffield, Engineering Materials Department, Immobilisation Science Laboratory, Sir Robert Hadfield Building, Mappin Street, Sheffield, S1 3JD, United Kingdom, Tel.: +44-114-2226033, Fax: +44-114-2225943, e-mail: M.Ojovan@sheffield.ac.uk. Every participating country will select Chief National Investigator, who will communicate with IAEA Project Officer and Chief Scientific Investigator. It is also assumed that the national support is provided to all participants during whole duration of CRP.

The CRP should commence in January 2007 and, therefore, the invited institutions will be urged to submit their applications by the mid November 2006.

8. Brief Summary for Inclusion in the Agency's Bulletin

The CRP will investigate the behaviours and performance of cementitious materials used for an overall waste conditioning system based on use of cement, [including waste packaging (containers), waste immobilisation (waste form) and waste backfilling, as well as, interaction and interdependencies of these individual elements (containers-waste form-backfill)], during long term storage and disposal, and understand the processes that may result in the degradation of their physical and chemical properties. Exchange of information and research co-operation in resolving identical problems between different institutions in Member States will contribute towards improving waste management practices, its efficiency and general safety. The execution of the CRP will promote the exchange of advanced information on the ongoing research and development activities and facilitate access to the practical results of their application for conditioning or packaging of specific waste types.