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CONDITIONING OF DISUSED SEALED SOURCES IN COUNTRIES WITHOUT DISPOSAL FACILITY: *short term gain–long term pain.*

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Abstract

Owing to the considerable development in managing disused sealed radioactive sources (DSRS), the limited availability of disposal practices for them, and the new recommendations for the use of borehole disposal concept, it was felt that a paper reviewing the existing recommendations could be a starting point of discussion on the retrievability of the sources. Even when no international consensus exists as to an acceptable solution for the challenge of disposal of disused sealed sources, the "Best Available Technology" for managing most of them, recommended for developing countries, included the cementation of the sources. The waste packages prepared in such a way do not allow any flexibility to accommodate possible future disposal requirements. Therefore, the "Wait and See" approach could be also recommended for managing not only the sources with long-live radionuclides and high activity, but probably for all kind of existing disused sealed sources. The general aim of the current paper is to identify and review the current recommendations for managing disused sealed sources and to meditate on the most convenient management schemes for disused sealed radioactive sources in Member States without disposal capacities (Latin America, Africa). The risk that cemented DSRS could be incompatible with future disposal requirements was taken into account.

1. Introduction

Sealed radiation sources are widely used in industry, medicine and research. Many developing Member States have used sealed sources for many decades. Although most Member States have laid down a regulatory framework to control sealed sources, there are still a number of uncertainties concerning management of them once they have became disused. Some Member States have disposal routes for a wide range of sources. For countries having operational disposal facilities and allowed disposing of conditioned disused sealed sources, the problem is completely solved. Some other Member States have low-level waste disposal routes authorized for receiving small numbers of low activity sources (e.g. short-lived isotopes). The great majority of developing Member States has no disposal routes. It is recognized that in most Latin American countries there is a lack of adequate storage facilities, lack of disposal solutions and lack of equipment to implement widely used disposal concepts for their DSRS.

For sources containing radionuclides with half-lives of 30 years or more, deep geological repositories offers the highest level of isolation available within disposal concepts currently considered [1]. However, such facilities are extremely expensive to develop. It is unlikely that such an option will become available in the foreseeable future for most countries, particularly for those that do not have nuclear industries. The safe long-term management of disused radiation sources thus remains, for our countries, an open question.

2. Conditioning of disused sealed sources. practical examples of the actual conflict

The IAEA is in an continuing process of exploring ways to improve its waste management programme. The publication of technical documents in the format of a technical manual provides a more practical approach and better guidance on the actual conduct of such work.

2.1. Cementation of DSRS

Originally the approach of conditioning of DSRS was developed to remove sources from the human environment and inaccessible to humans for the very long time scales. The recommended methods for conditioning of disused sealed sources are simple and quite adequate. A number of 200 liter drums are prepared with concrete filling having a hole in the center. The concrete filled drum is prepared by inserting a removable spacer into the center of the drum. Disused sources, with the radiation shielding, are successively placed in the hole until it is full or until a limit of activity has been reached. The recommendations in 1990 [2], 1991 [3] and 1994 [4] included the pouring of cement mortar over the sources. The disused Radium sources should also be embedded in concrete in a 200 liter drum, after enclosing the sources in stainless steel capsules or in ordinary tin cans [2,3].

In the year 2000 two new technical documents related with the management of DSRS were issued. The TECDOC-1145 provides detailed technical information about handling, conditioning and storage of spent sealed sources [5]. TECDOC-1183 is related with the management of radioactive wastes from the use of radionuclides in medicine [6] and provides recommendations for conditioning of DSRS. On-site immobilization of DSRS by cementation in 200 liter metal drums is described. Two options for immobilization were considered: DSRS in their original container or DSRS unloaded from their original containers. What to do with the drums already conditioned with this "old" recommended technology?. Do we face the same situation, in the near future, if we immobilize the current disused sealed sources?

2.2. Not cementation of ^{226}Ra sources – interim storage

In the middle of the nineties the IAEA recommendations for conditioning of disused sealed sources have shown small changes, regarding specifically the conditioning of disused Radium sources. General procedures for the rest of the sources have kept almost similar in the 1995 report TECDOC-806 on reference design for a centralized spent sealed sources facility [7]. Generic designs of facilities for processing and storage of DSRS have been developed in this document. It provides advice on how to establish such facilities at the national level. A separate technical document has been issued on conditioning and interim storage of spent Radium sources [8]. This document, for the first time develops the concept of "retrievability" of the sources. It is used as important factor in designing the waste package with the Radium sources. The chapter 7.3 of this document states that: *it must be expected that conditioned Radium sources will have to be stored for several decades until further management has been established. Therefore, the "wait and see" approach is clearly (and logically) recommended.*

2.3. Not cementation of disused sources with high activity – interim storage

Another document TECDOC-1145 has been issued in 2000. It provides detailed technical information on handling, conditioning and storage of spent sealed sources [5]. A new group of sources is them separated from the general scheme of managing of disused sealed sources: high activity disused sources (e.g. ^{60}Co and ^{137}Cs from irradiators and radiotherapy units). These high activity gamma sources, usually contained in heavy shielding devices, may not be suitable for conditioning by traditional methods. Therefore previous suggested procedures are

not applicable. For such sources the only management option, except returning the source to the manufacturer, is retain them in their shielding devices and long term interim storage (several decades) awaiting future managing options. A new technical document is planned to describe methods and procedures for managing and storing high-activity disused sealed sources [9].

2.4. Not cementation of disused sources with long-lived radionuclides – interim storage

The IAEA-TECDOC-1145 states that conditioning of Ra, Am, Am-Be, Ra-Be and other long lived DSRS for interim storage will include stages for their encapsulation in stainless steel capsules. The recommendation is then, not to immobilize the sources with cement mortar to facilitate their *retrieval* for final disposal. For conditioning of other long lived DSRS such as ^{226}Ra/Be, ^{241}Am/Be, that emit neutron radiation, hydrogenous material should be included in the shielding design. A new technical document in preparation is planned to describe methods and procedures for conditioning and storing of long-lived disused radioactive sources [10]. It is now clear that high activity and long lived DSRS require special conditioning, followed by interim storage.

3. Underling radioactive waste principles

The recommended conditioning process for DSRS included the immobilization of these sources, by cement grouting. Because of reduction of potential hazards during interim storage, such action provides short-term benefits. For example package strength and resistance is increased and the mobility of radionuclides is reduced. However the implications of such actions for the eventual end point should also be addressed. Retrieving the sources can be extremely difficult and risky. Any reason why the cementation of sources may not be suitable for future disposal must be carefully considered.

Internationally agreed principles for radioactive waste management have been set out by the IAEA [11]. Principle 8 of the "safety fundamentals" sets out the need to take into account interdependencies in the main waste management steps. In particular there is a need to be aware that decisions made at any one step may foreclose alternatives or otherwise affect subsequent steps, particularly disposal. This should be taken into account when any conditioning activity is being considered. Cementation of DSRS without a clear established end point violates this principle. Additionally undue burdens are imposing on future generations, therefore the fifth principle [1] could also be violated.

4. What to do?

The question is: what to do with the rest of the sources, different from high activity and long lived?. DSRS containing radionuclides with half life between 100 days and 30 years are considered in this group. It includes ^{137}Cs (30.1 y), ^{90}Sr (29 y), ^{3}H (12.3 y), ^{85}Kr (10.8 y), ^{60}Co (5.3 y), ^{147}Pm (2.62 y), ^{252}Cf (2.6 y), ^{106}Ru (1 y), ^{57}Co (271.7 d), ^{153}Gd (242 d), ^{210}Po (138 d), etc. Could the cementation of these sources be a good recommendation?

Management schemes for disused sealed sources need to address the available disposal practices. Immobilization methods such as direct and indirect cementation are appropriate where the final disposal route is known. In our case, there is no disposal route defined.

Leaking sealed sources should be managed and conditioned as not compactable solid waste. They should be embedded in concrete, providing greater confinement and not expecting retrievability. In this case the best available technology is well recommended.

Having neither disposal facility implemented nor deep geological repository, and additionally it is well recognize that these options are non-feasible from economical point of view, what to do with DSRS stored in the country?. In these circumstances, simple disposal solutions that can be operated locally on a small scale appear to offer the best solution. An obvious candidate for such facilities is borehole disposal [1].

4.1. The borehole concept

The Borehole Disposal of DSRS concept would be suitable for implementation in Latin American countries as the borehole has a large capacity for such sources and it is possible that all country's disused sources can be placed in a single borehole. The costs should be a lot lower than for any other disposal option. The BD-DSRS concept seems to be technically and economically feasible to implement in our countries. With this in mind the Atomic Energy Corporation of South Africa have initiated the development of the BOSS disposal concept (an acronym for "Borehole disposal Of Spent Sources") as part of the IAEA AFRA-I-14 Technical Co-operation project [12].

The management of DSRS involving disposal in boreholes is in an advanced stage of preparation. The IAEA is preparing a technical document aimed to provide general advice and guidance on safety considerations related to the disposal of DSRS and other limited quantities of radioactive wastes in borehole facilities [13]. The report will be of particular interest to countries with limited waste management facilities and resources.

The IAEA-TECDOC-1183 [6] states that some countries, where the number of DSRS is very large should adopt another option for conditioning of their sources. The DSRS are unloaded from their original containers and transferred into shallow boreholes specifically designed for long term storage. Taking into consideration the possibilities of implementing the Borehole disposal concept; it is recommended not to immobilize the DSRS by cementation. The retrievability is essential for this option.

4.2. Retrievability

Generally, where the final disposal route is unknown, retrievability is advised. If there is no disposal facility in operation and them the waste acceptance criteria for disposal do not exist at the time of the conditioning, the waste package produced shall be fully characterized and the conditioning procedure has to take in consideration retrieving of the sources. Due to the high cost of disposal, sources conditioned for interim storage should have the flexibility to accommodate future waste acceptance criteria. Furthermore conditioning by complete embedding in concrete may be counterproductive with regards to efficient utilization of repository space. Consequently any conditioning process for interim storage should be carried out with the possibility of the need to retrieve the source for further conditioning without imposing undue cost [5].

5. The way forward

There are currently some uncertainties on future recommendations for conditioning of DSRS. The conditioning process should take into consideration the possibility of retrievability of the sources in the future. Carefully selected conditioning and storage methods should be

employed in order not to compromise final disposal requirements and to avoid possible costly reconditioning. We have discussed the problems caused by current uncertainties in conditioning of DSRS in countries without disposal facilities, having regarded to ensure that end-point of DSRS is not jeopardized by actions taken in the short term. All the DSRS should be packaged in passive safe, monitorable and retrievable interim storage. It looks to be that we must leave options open for future solution.

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