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port2004@ijs.si
www.drustvo-js.si/port2004
+386 1 588 5247, fax +386 1 561 2276
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Waste Management in the Institute for Nuclear Sciences "Vinca" – Belgrade

Jagos Raicevic, Ivana Avramovic, Ilija Plecas, Miodrag Mandic
Institute for Nuclear Sciences "Vinca"
Radiation Protection Department
P.O. Box 522, Belgrade, Serbia and Montenegro
jagos@vin.bg.ac.yu, aivana@vin.bg.ac.yu, iplecas@vin.bg.ac.yu, mandic@vin.bg.ac.yu

Wolfgang Goldammer
Environmental Consulting
Koln, Germany
WGoldammer@epost.de

ABSTRACT

The Vinca Institute of Nuclear Sciences served for many years as the only Yugoslav (Serbia and Montenegro) nuclear institute. Therefore, it acted for many years as national storage facility for the radioactive waste from all institutional (medical, military, etc.) activities. The interim storage was situated within the Vinca Institute historically at several different places. The main fraction of the wastes is stored in two metallic hangars. In addition, underground stainless steel tanks in concrete shields have been constructed to accept all processed liquid waste from the research reactor RA.

The current situation of the interim storage facilities is not satisfactory. However, the principle limitation for improvements of the waste management at the Vinca Institute lies in the fact that long-term solutions cannot be addressed at the moment. Plans for a final repository for radioactive waste do not exist yet in the Serbia and Montenegro. Consequently, waste management can only address an interim solution. In order to conduct all waste management activities in a safe manner, an overall strategy and study for improvement/rearrangement of radioactive waste storage facilities was developed which addresses all wastes and their management.

The IAEA is providing assistance to these activities. This support includes a project which has been initiated by the IAEA to improve the waste management at the Vinca Institute. This paper describes the current status of the development of this overall strategy and study for improvement/rearrangement of radioactive waste storage facilities. The information available and the current status of the development of concepts for the processing and storage of the waste are summarised.

1 INTRODUCTION

The Vinca Institute was founded in the year 1948. Radioactive waste initially was stored at the present site of the Department of Material Sciences (Laboratory for **R**eactor **M**aterials - RM building); the methodology employed was shallow land burial of 200 l drums.

During the preparation of the site for the construction of the RM building, the old storage was dislocated to a new open repository in 1962 (Figure 1).

Later on, radioactive wastes were stored in two metallic hangars on the territory of the Vinca Institute. Hangar 1 (H1) was put into operation in 1968. Hangar 2 (H2) was put into operation in 1982. In 1984, the waste from the new open repository was, after compacting and repacking, stored in H2.

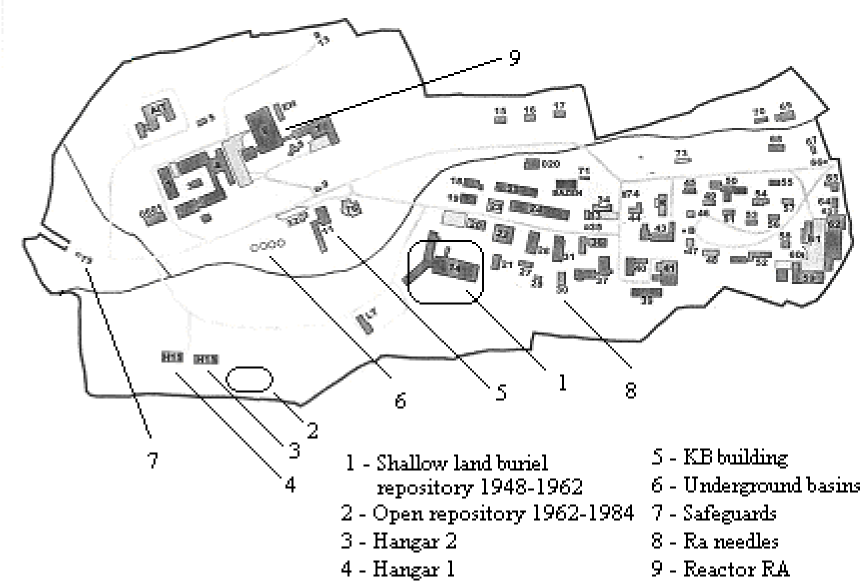

Figure 1: Map of Vinča Institute with important locations for waste management

Radioactive wastes from the entire operational period of the Vinca Institute as well as large amount of institutional radioactive waste (hospitals, institutes of oncology, institutes of biology, industrial application of radioactive sources, radiochemical laboratories) collected from former Yugoslavia is stored without segregation, treatment or conditioning in these hangars. This includes non-processed contaminated ventilation channels, cemented liquid and various kinds of solid waste packaged in carbon steel barrels, and contaminated floral material in damaged plastic bags.

The major part of the wastes is stored in the first hangar H1, called also the “old” hangar. This hangar is in an unsatisfactory technical condition. Some of drums are partly corroded, unlabelled and without written records about their content. Further on, the contamination was detected inside the hangar. In addition, the wastes are not properly protected against rainwater and potential ingress of wild animals, resulting in a high risk of a spread of activity out of the hangar. Finally, the waste registry is incomplete and details (especially for older waste) are missing. For these reasons, immediate action has to be planned to avoid any kind of environmental and health consequences.

The “new” hangar H2 contains also significant amounts of radioactive material. However, the radioactive waste is mostly properly stored (except for a small amount of waste which still has to be reprocessed).

With regard to the overall situation for waste management it is very important to note that there is a certain amount of radioactive material situated outside the waste storage area in different laboratories. For example, there are about 7 grams of radium-226, several tons of natural uranium, about 310 m^3 low-level radioactive effluent, intermediate level radioactive sludge from spent fuel pool etc.

Because of this situation, improvements of the waste management facilities at the Vinca Institute are urgently required.

The principle limitation for improvements of the waste management at the Vinca Institute lies in the fact that long-term solutions cannot be addressed at the moment. Plans for a final repository for radioactive waste do not exist yet in the Serbia and Montenegro. Consequently, waste management can only address an interim solution. Nevertheless, wastes should be stored in a form that allows for transferring them into final storage with minimal further handling and processing requirements.

The assessments described in the Feasibility study [1] intend to provide a basis for the selection of options for the interim storage of radioactive wastes at the Vinca Institute, based on feasible and reasonable options for the safe management of radioactive wastes.

In order to conduct all waste management activities in a safe manner, an overall strategy [2] has to be developed which addresses all wastes and their management. This strategy has also to consider interfaces to other projects giving rise to waste management requirement, in particular the spent fuel movement and the decommissioning of the research reactor.

The overall activities within the waste management are:

1. Construction of the new waste storage facility
2. Construction of the waste processing facility
3. Retrieval of wastes from Hangar 1;
4. Reprocessing of retrieved wastes;
5. Processing of other wastes to be incorporated (from Vinca site, part of the waste from Hangar 2, from outside, Hangar 1 decommissioning/decontaminating waste, etc.);

2 THE FATE OF HANGAR 1

Different options are considered with respect to the fate of Hangar 1 after retrieval of the wastes. One option is to decommission Hangar 1 and to store the wastes generated by this in the new waste storage area. The alternative would be to decontaminate and refurbish Hangar 1 and use it for waste storage afterwards. This would have the beneficial consequence of needing less space in the new waste storage facility (no need to store Hangar 1 decommissioning wastes and space for further wastes arising in refurbished Hangar 1).

However, this decision about Hangar 1 only can be made after the wastes have been retrieved from it and a detailed characterisation of the extent and nature of the contamination in Hangar 1 and of its building structures has been performed. At that time the new waste storage facility already has to be in operation to accept the wastes (after processing) currently stored in Hangar 1. Therefore, the current decision on the required space in the new waste storage facility has to be made without knowing whether a refurbishment of Hangar 1 will be feasible and economical.

This leads to the conclusion that the waste storage concept currently to be developed has to be based on the pessimistic case that a refurbishment of Hangar 1 is not feasible or not economical. The new waste storage therefore has to be designed to store all wastes that are in the scope of the current assessment including decommissioning wastes from Hangar 1. The decision about the new waste storage facility is therefore decoupled from the decision about the fate of Hangar 1.

The decision about Hangar 1 has to be made at a later stage (after all wastes have been retrieved). It can then be decided to refurbish or decommission Hangar 1. A refurbishment could represent a sensible option if additional storage volume is needed (e.g. for reactor RA decommissioning wastes). Sufficient data about Hangar 1 are not available at the moment and based on the above argument to design the new waste storage area to have full capacity for all waste considered within the scope of this assessment it is also not necessary to decide about the fate of Hangar 1 at the moment.

The general approach for the waste retrieval will be as follows:

- Wastes in cemented barrels will be sent directly to the waste characterisation.
- Non-conditioned wastes will be subject to characterisation and sorting.
- Wastes which are not in barrels may directly be characterised (sampling and or measurement) or will be temporarily packed in barrels and then sent to characterisation and sorting. This may require some cutting of wastes in order to fit them into barrels.
- During waste retrieval, non-fixed floor-contamination, if any, will be removed.

The actual procedures to be followed will have to be decided about in the detailed planning of these activities.

3 WASTE STORAGE OPTIONS

The total amount of radioactive waste (in standard 200 litres metallic drums) considered in the concept for interim storage is about 8000. The estimates are based on the wastes to be stored after processing. It may be possible to reduce the amount of low-level waste to be stored by clearance. This would lead to excess storage capacity in the options considered. All waste storage options are designed to receive all wastes that are within the scope. The assessment considers the following options for waste storage:

A. Construction of new Hangar 3
B. Waste storage in KB building[1] after refurbishment and extension
C. Waste storage in ISO containers on concrete plateau with movable cover
D. Waste storage in ISO containers on concrete plateau without cover
E. Waste storage as concrete blocks on concrete plateau with movable cover
F. Waste storage as concrete blocks on concrete plateau without cover

The option of using the KB building was ruled out because it has in all relevant parameters (safety and costs) clear disadvantages in comparison to Option A. The other options are analysed using a Multi-Attribute-Utility-Analysis. MAUA was designed to take all kinds of factors (quantitative and qualitative) into account. Weights between the different factors can be assigned and are consistently treated within the methodology. MAUA involves mathematical equations for the normalization of the results for the individual factors and for the incorporation of the weighting factors. For this, cost and risk factors are investigated within each option. This also includes, according to IAEA guidance [3], the possibility of unplanned events. After defining an appropriate weighting between the relevant factors an overall ranking of the options is achieved, the stability of which against parameter variations is tested in a sensitivity analysis.

3.1 Factors relevant for comparative analysis of options

The factors that have to be considered are:

1. Doses and risks within reference scenario (i.e. under the assumption that everything behaves as planned and no incidents or accidents occur)

[1] "KB" is abriviation for historical name of this building: Construction Bureau (**K**onstrukcioni **B**iro, serb.)

2. The impacts from unplanned events and failures, as described in ISAM TecDoc [3] to assess the inherent safety of options.

The following events and processes are to be addressed as relevant factors:

1. Fires;
2. Explosions
3. Mechanical impacts on waste containers
4. Effects of seismicity
5. Effect of acidic rain.

The following cost components are to be considered:

1. Direct costs of options;
2. Additional waste processing costs
3. Ongoing costs for surveillance and maintenance;
4. Costs for extra surveillance and possible substantial repairs of waste containers for options without building or cover;
5. Costs for decommissioning;
6. Stability of a solution in time (what happens if a final repository is not available within anticipated time frame);
7. The possibility to deal with unexpected wastes arising in terms of quantity and/or quality;
8. The concentration of the wastes at one location;
9. Time required for the implementation of options;
10. Appropriateness with respect to the final disposal.

3.2 Results

The results of the MAUA are given in Figure 2. They represent the overall utility function for the options on a scale between 0 and 1. The higher the value of the utility function is, the more favourable the option is.

There is a clear preference for Option A in the results. Based on the approach to treat uncertainties an analysis of the sensitivities of the results to changes in the most important input data and assumptions is presented. The different cases considered in the sensitivity analysis are:

1. Increase of relative weight of implementation, maintenance and decommissioning costs by a factor of 3
2. Decrease of relative weight of implementation, maintenance and decommissioning costs by a factor of 3
3. Increase of operational period to 50 years
4. Increase of real interest rate (discount factor) to 5 %
5. Decrease of real interest rate (discount factor) to 1 %

The resulting ranking of the option for these cases is presented in the Figures 2-6. The results of the sensitivity analysis show that the preference for Option A is stable. Also the relative ranking of the other options is not affected by the parameter variations considered. Since these variations cover the range which is reasonably to be expected, a clear recommendation for Option A results from this analyis.

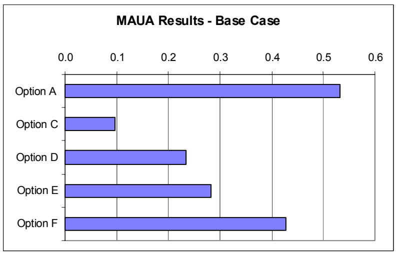

Figure 2: MAUA results for Base Case

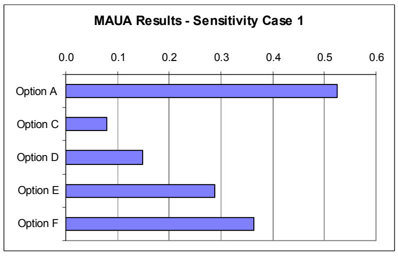

Figure 3: Sensitivity Case 1

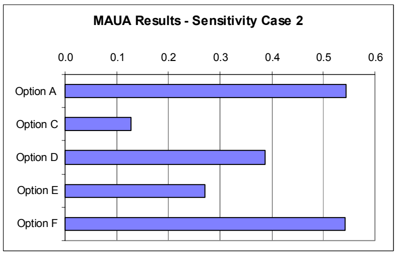

Figure 4: Sensitivity Case 2

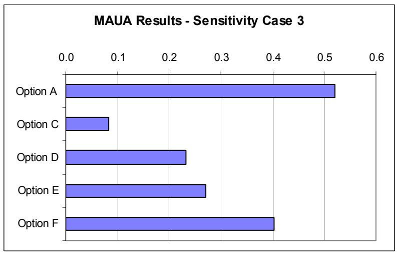

Figure 5: Sensitivity Case 3

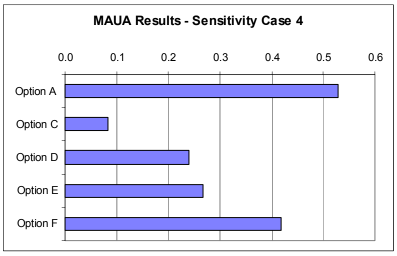

Figure 6: Sensitivity Case 4

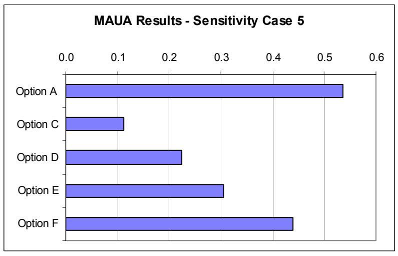

Figure 7: Sensitivity Case 5

From Figure 4, where the relative weight of the cost factors has been decreased, it can be seen that the preference for Option A is mainly due to advantages in anticipated costs for implementation, maintenance and decommissioning. In terms of risks and costs to remediate the consequences of incidents or accidents the options involving ISO or concrete containers have advantages. These are, however, not large enough to compensate for the substantially higher anticipated costs.

This analysis of the options shows a clear preference for Option A - the storage of wastes in a new Hangar H3. Since this preference has proven to be stable also in the sensitivity analysis performed, the recommendation results to base the design of the required new waste storage facility on this option.

3.3 Conclusion

In summary, the analysis has shown that the implementation of Option A - construction of Hangar H3 - can provide an important element for safe radioactive waste management at the Vinca Institute and that other options that should be preferred for safety and/or economical reasons do not exist.

In connection with strategy of waste handling and processing [2] it is worth to implement the following statements:

- 200 l drums are considered as the common container.
- 280 l drums are considered for over pack of damaged (corroded) drums as well as 200 l drums with compacted waste, if necessary.

- ISO containers are considered for interim storage of waste, which processing will be performed together with reactor RA decommissioning waste (reactor channels and glove boxes).
- Separate space should be designed for interim secure storage of disused sealed sources which are the subject of the special project.
- Separate space should be designed for special categories of waste (U and Up containing, under IAEA safeguards supervision).

4 WASTE PROCESSING

The overall amount of wastes requiring treatment is estimated at 4,400 m3 [2]. A substantial amount of wastes will be, according to available information, cleared. Only crude estimates are possible at the moment.

To achieve the goal of safe storage of the wastes a number of processing technologies will have to be used. Considered processing technologies in the Vinca Institute are:

- Characterisation;
- Sorting and repackaging;
- Clearance - A strategy for clearance, encompassing adequate clearance levels, conditions and controls, has to be defined together with the relevant Serbian Authorities. Applying clearance procedures will require measurement capabilities of low activities. Clearance of large amounts of wastes such as the existing 3500 drums with very low-level wastes in Hangar H1 will require appropriate equipment to check the contents of barrels. Since, according to available information, a substantial amount of waste will be below clearance levels, this process step will have an important role for the minimisation of waste volumes that have to be stored;
- Decontamination;
- Dismantling (smoke detectors);
- Cutting;
- Compaction;
- Treatment of liquid wastes;
- Immobilisation;
- Packaging and
- Final characterisation and record keeping.

Preliminary design considerations for the waste processing facility are based on the IAEA reference design [4]. In the detailed planning of the facility it will be required to adjust this to the actual processing steps to be employed.

5 SUMARRY

The radioactive waste in Vinca Institute of Nuclear Sciences is stored in interim storage, which needs an urgent improvement. The principle limitation for improvements of the waste management at the Vinca Institute lies in the fact that long-term solutions cannot be addressed at the moment, since plans for a final repository for radioactive waste do not exist yet in Serbia and Montenegro. Consequently, waste management at the moment can only address an interim solution. From this reason Feasibility study for improvement and/or rearrangement of radioactive waste storage facilities in Vinca was performed [1], in order to find the most feasible option. The final result indicated a clear preference for Option A - the storage of wastes in a new Hangar H3.

Since the most of the waste is stored without segregation, treatment or conditioning it is necessary to include the waste processing facility into overall strategy for improvement of waste management in Vinca Institute [2].

Clearance will be a very important aspect of the overall strategy since a substantial part of the wastes present has a very low activity. This can only be performed if a systematic clearance regime, including the clear definition of limits and conditions for the release of control exists [2]. For that purpose it is necessary to improve legislative and regulatory process in Serbia and Montenegro and establish the clearance and exemption limits which are still missing.

The Government of Serbia supports all of these waste management activities and the IAEA is providing assistance through Technical Cooperation Project SCG/4/031.

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