STRATEGY DEVELOPMENT FOR SOLID RADIOACTIVE WASTE MANAGEMENT IN ISLAMIC REPUBLIC OF IRAN

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Abstract. I.R. of Iran is planning for construction of more NPPs (up to 7000 MWe) in near future. Large volume of solid radioactive waste (non-solidified) is expected to be generated in all nuclear facilities in Iran. In this study a strategy for solid radioactive waste management was developed for the whole nuclear fuel cycle facilities starting from uranium conversion facilities to nuclear power plants and research reactors as well.

Two concepts for estimating the inventory of radioactive solid waste were adopted. The first estimation is based on the actual generation rate at the existing nuclear facilities (e.g. Bushehr Nuclear Power Plant –BNPP) and the second was based on the BNPP final safety assessment report (FSAR) as the maximum generation rate. Both of these assumptions were considered for further scenario development for near future and by the end of operation period of Iran near surface repository.

Financial and technical analysis were performed for four available management options such as compactor, super compactor, incinerator, plasma incinerator and a combination of them with a concrete package as the final waste package.

Identifying the criteria playing role in the strategy development, the AHP[1] method was applied as a decision-aid method to help making the best decision. The questionnaires were prepared in proper format of spreadsheets and judgment of selected experts was sought through delivering these forms. The comparison between different technical options of solid waste management was carried out based on the judgment of a smaller group of project members. All the results were analyzed and the most suitable strategy for the relevant assumptions and scenarios was developed.

Keywords: solid radioactive waste,compactor, super compactor, AHP method

1. Introduction

Bushehr nuclear power plant (BNPP) which is the first nuclear power plant of Iran has started its full power operation since 2013 and following the increase of energy consumption during the past decades, I.R. of Iran is planning for construction of more NPPs (up to 7000 MWe) in near future. The normal operation of such power plants will lead to generation of large volume of solid radioactive waste in all nuclear facilities in Iran. In this study a strategy for solid radioactive waste management was developed for the whole nuclear fuel cycle facilities starting from uranium conversion facilities to nuclear power plants and research reactors as well.

[1] - Analytical Hierarchy Process

2. Factors playing role in strategy development for solid RadWaste management

It is so important to identify criteria that influence on strategy development. By literature review and consulting with internal and international experts, 17 criteria were identified and sorted into two main groups of technical and non-technical ones [1, 2].

In AHP method the criteria are once compared together and scored by the selected group of experts and technical options are scored separately for each of criterion by the project team members. Finally these two scores are mixed together to find the ranking of technical options.

In practice it was revealed that it was so difficult for experts to compare this number of criteria and score them based on this method. As a result the most important criteria and sub-criteria were sorted out and finally 7 criteria were chosen for final decision making. FIG 1 shows the selected 7 criteria and order of their importance according to expert judgments.



FIG 1. 7 criteria in AHP method and their ranking based on judgment of group of experts.

3. Methodology for ranking criteria

As it is impossible to consider all factors at the same time, one needs to use a decision aid method to compare criteria together and make final decision based on the ranking of this comparison [3]. Among several methods and decision aid tools, the AHP method was chosen to fulfill this aim.

4. Inventory of solid RadWaste generation

Inventory of solid waste is one of the most important factors affecting the selection of technical option [1]. As it is difficult to estimate exact amount of solid waste generation during the next 70 years (operation time of Iran near surface disposal site) and majority (more than 90%, volumetric) of solid waste is the production of nuclear power plants, the generation was estimated based on two scenarios: 1- BNPP final safety assessment report, 2- real case (the present condition of solid waste generation in BNPP).

The operation time of disposal facility was considered based on two short (20 years) time and long (70 years) time, as well. There are also two orientations in design of trenches of Iran near surface disposal site: optimal and non-optimal.

5. Technical options

Among various technical methods and options for solid waste management, 4 main options were selected as to be compared together: compaction, super-compaction, incineration and plasma incineration.

It was also possible to consider a combination of two methods together to cover the wide range of inventory streams of compactable, combustible, non-compactable and non- combustible [1, 3].

6. Financial analysis

This important issue is divided into three main sub-criteria: investment, operation cost and maintenance cost [1]. A rough estimation of these three parts was done for all 4 main options. Also, the value of disposal area has been estimated based on two scenarios of optimal and non-optimal design of disposal trenches and added to the final cost estimation of different options related to the volume of disposal area occupied by each technical option. The summary of cost estimations are shown in FIG 2 and FIG. *3*.

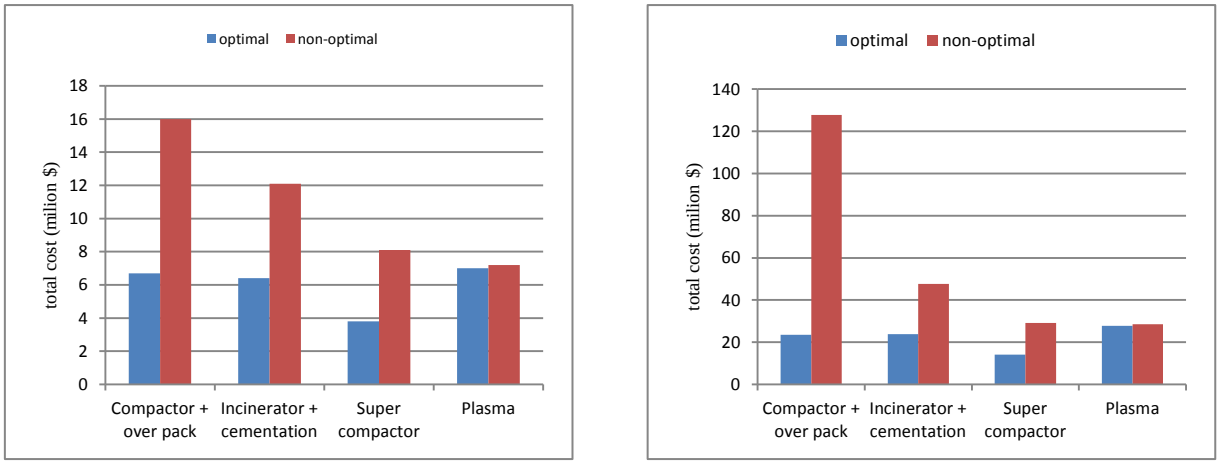


FIG 2. cost comparison of different technical options
based on FSAR solid waste generation during 20 (left) and 70 (right) years

7. Results and discussion

According to the results of AHP (FIG 4), cost analysis and international experience, together with taking into account the different waste generation conditions for short and long term and trenches design, it can be concluded that super-compaction can be the best technical option followed by compactor + overpack and plasma incineration.

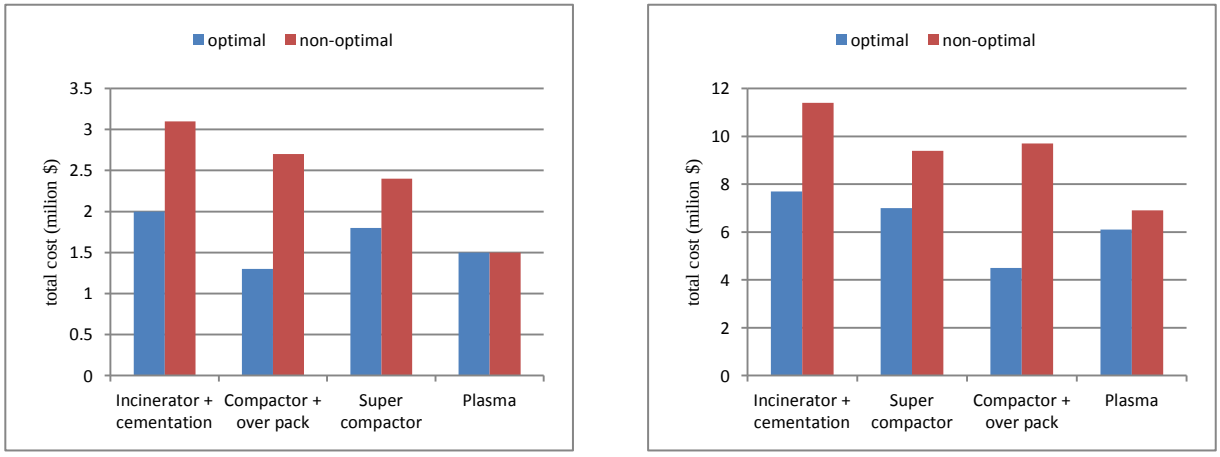


FIG. 3. cost comparison of different technical options based on real case solid waste generation during 20 (left) and 70 (right) years



FIG 4. ranking of technical option in AHP method

Although the cost of compactor + overpack is one of the lowest and it can be a suitable option for short time, but by passing the time and generation of more solid waste, the capacity of disposal site should be considered.

Plasma incineration has a lot of advantages like high volume reduction, wide waste stream input and easy to dispose of the produced waste. However, there is little experience in use of this technology in radioactive waste management [3]. It can be concluded thet despite of potential of manufacturing such torch in Iran, it doesn't look suitable for mentioned scenarios.

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