OPTIMIZATION OF THE PROCESS OF SOLID RADWASTE MANAGEMENT AT THE "SHELTER" OBJECT TRANSFORMATION TO THE ECOLOGICALLY SAFETY SYSTEM

V.G. Batiy*, A.I. Stojanov

Institute for Safety Problems of Nuclear Power Plants, 07270, Chernobyl, Ukraine

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Methodological approach of optimization of schemes of solid radwaste management of the "Shelter" object and ChNPP industrial site during transformation to the ecologically safe system was developed.

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The "Shelter" object (SO) was built at limited time and under high radiation influence on personnel. This Sarcophagus does not fully satisfy the requirements of safety standards. For example, probability of roof damage is about 0,1 per year [1]. The consequences could be catastrophic. Therefore, the necessity exists in implementation of measures that increase the "Shelter" object safety and transform it to the ecologically safety system.

Now works of the "Shelter" object transformation to the ecologically safety system are performed in the frameworks of the SIP international program. It is necessary to underline, that during preparatory works, that include creation of construction bases, infrastructures and other objects, considerable amount of different kinds and categories of radwaste will appear.

The feature of the present stage of activity concerned with consequences elimination of the accident in 1986 is substantial increase of work amount on solid radwaste characterizing and management on the ChNPP industrial site. Therefore, the necessity in optimization of technological process of radwaste management for expenses minimization and increase of safety of these works exists. Modelling and optimization of single technological operations of radwaste management is needed for implementation of such optimization. In this work the modeling of the process of choice of optimum schemes and technologies of management of solid radwaste, which will generate at transformation of the "Shelter" object to the ecologically safety system, will be briefly described.

The general scheme of the modelling process is presented on the Fig.1. Following input data for the fulfillment of the modelling process are needed:

1. The characteristics of solid radwaste, including specific activity, radionuclide composition, type of radiation, type of contamination (on surface or into volume), material (soil, concrete and etc), supposed volumes sizes and so on;
2. The characteristics of forthcoming works, including place, volume, duration, weather conditions, financial expenses and so on;
3. The normative documents relating to solid radwaste management;
4. The table (list) of technological operations of the solid radwaste management;
5. database of existing equipments and technologies of solid radwaste management.

From the aforecited categories of input data only categories "the characteristic of forthcoming works" and "the characteristic of solid radwaste" substantially change depending on the works type. The remaining input data categories do not depend from the works type and does not change during time. Therefore, in more detail we will consider two first input data categories.

In the near-term formation of solid radwaste is expected as an output of the number of works on the "Shelter" object and near him, such as:

-creation of new infrastructure (sanitary cordon, accesses roads, engineering networks and other);

-stabilization of the "Shelter" object building constructions;

-dismantling of the stack VT-2 (between the 3th and the destroyed 4th units of the Chornobyl NPP);

-building of the new safety confinement ("ARKA") over the existing object;

-dismantling of the unstable constructions of the "Shelter" object;

-other works.

*Corresponding author. E-mail address: batiy@mail.ru

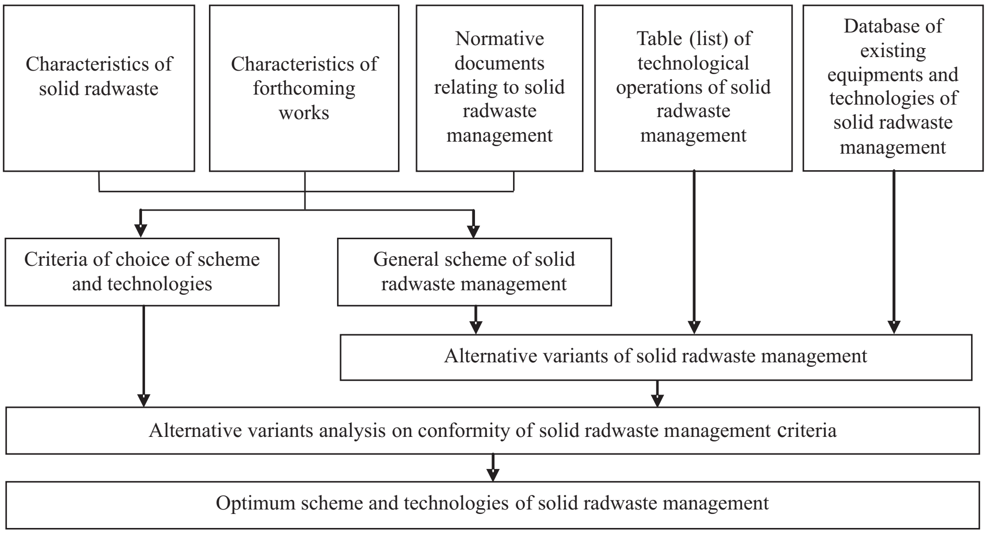

Fig.1. *Algorithm of choice of optimum scheme and technologies of solid radwaste management*

All these works will produce different kinds of solid radwaste represented on the Fig.2. It consists of fragments of reactor core and fragments of greatly contaminated concrete, which can be classified as high-level activity and long-live radwaste. The soil is the free-flowing short-live radwaste. Building debris and fragments of concrete are the small-size short-live radwaste. The main volume of the fragments of metal and reinforced-concrete constructions (with the exception of rooms building constructions, in which is located the fuel-containing materials) is the large-size short-live radwaste. Therefore, radwaste, produced during transformation of the "Shelter" object, is the characterized by large variety (see Fig.2).

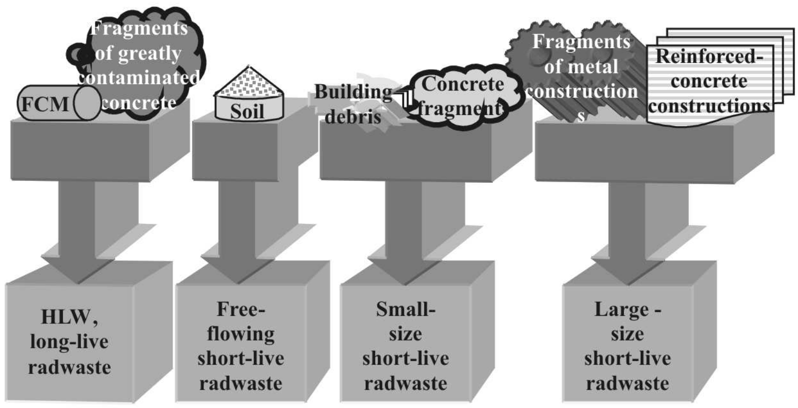

Fig.2. *Main radwaste types, generating at transformation of the "Shelter" object (HLW - high-level radioactive waste; FCM - fuel-containing materials)*

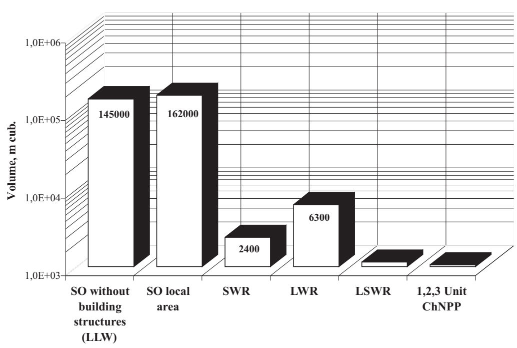

Fig.3. *Radwaste of the ChNPP industrial site (SWR – Solid Waste Repository; LWR – Liquid Waste Repository; LSWR – Liquid and Solid Waste Repository)*

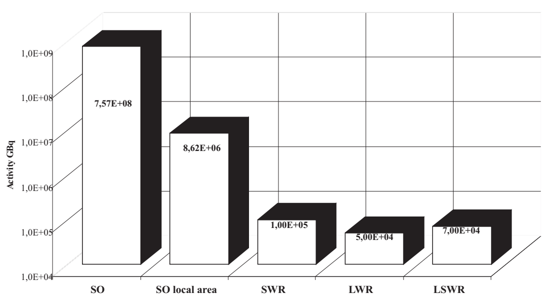

Fig.4. *Radwaste activity of ChNPP industrial site (SWR – Solid Waste Repository; LWR – Liquid Waste Repository; LSWR – Liquid and Solid Waste Repository)*

The main volume of the solid radwaste, located on the ChNPP industrial site, is, foremost, radioactive-containing buildings - a few million cubic meters, and also soils – up to 2 million cubic meters. The volumes of other radwaste types are represented on the Fig.3. The radwaste of the "Shelter" object are not include of reinforced-concrete building constructions, which are presented low-level radwaste, as full dismantling of the "Shelter" object constructions is improbable. The greater part of radwaste activity (without taking into account spent nuclear fuel) is concentrated directly in the "Shelter" object (up to $7,57 \cdot 10^8$ GBq) and its local area, that is represented on the Fig.4.

The characteristics of removal place of radwaste, such as illumination conditions, spatial limitation and other, have a substantial influence on the choice of optimum scheme of radwaste management. On this basis, one can select the zones of radwaste formation during transformation by three basic types:

- the zone with the limited access – those are places of works realization, where usage of loading-unloading mechanisms is possible to deliver the containers of only definite types, and also small equipment for radwaste management (sizes of a technological openings and areas of loads accept will be, as a rule, limited);

- the zone with free access – those are places of works realization, which are characterized with the possibility of usage of various equipment, including remotely handling, and also different containers for radwaste (foremost, this the places of works realization at building of foundations).

The aforecited examples of input data ("the characteristics of forthcoming works" and "the characteristics of solid radwaste") allow us to make conclusion about their substantial variety. Therefore, these input data are variable factors, changing in a large interval during the choice and optimization of scheme and technologies of solid radwaste management.

Solid radwaste management is necessary to carry out in accordance with national normative documents [2]-[4], and also with account for recommendations of IAEA [5]-[8]. On the basis of these normative documents (see Fig.1), "the characteristics of forthcoming works" and generated solid radwaste criteria of choice of scheme and technologies, and also general scheme (the strategy) of the solid radwaste management are developed (Fig.5).

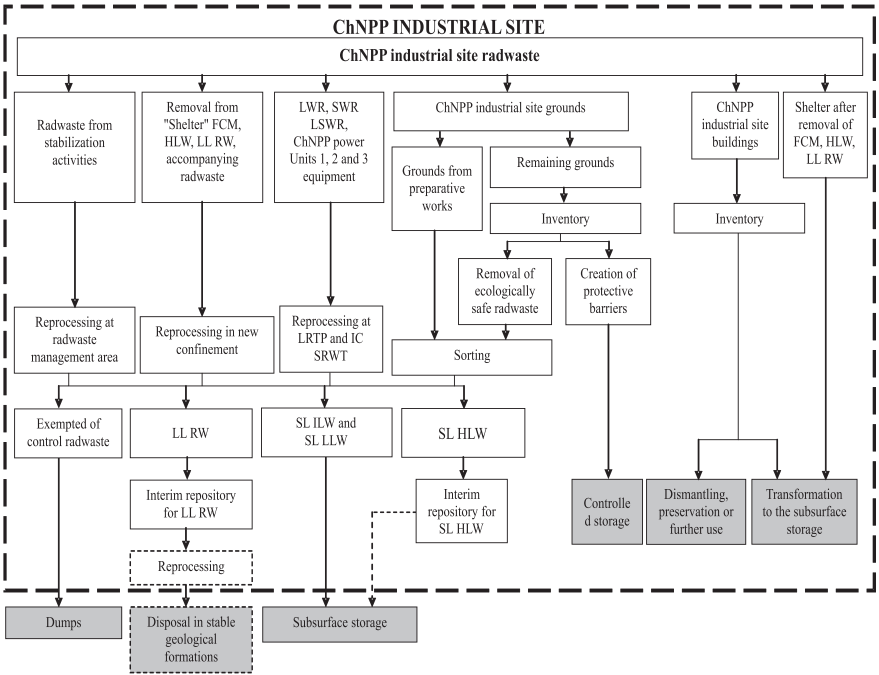

Fig.5. *General scheme of ChNPP site radwaste management (FCM - fuel-containing materials; HLW - high-level radioactive waste; LL RW – Long-Lived Radwaste; LWR – Liquid Waste Repository; SWR – Solid Waste Repository; LSWR – Liquid and Solid Waste Repository; LRTP – Liquid Radwaste Treatment Plant; IC SRWT – Industrial Complex for Solid Radwaste Management; SL ILW – Short-Lived Intermediate-Level Radwaste; SL LLW – Short-Lived Low-Level Radwaste; SL HLW – Short-Lived High-Level Radwaste)*

The process of radwaste sorting takes central place for radwaste management. As a rule, this is a sorting process that determines productivity of all radwaste management scheme, and also presence or absence in this scheme other technological operations of radwaste management. In accordance with principle of minimization sorting process must be "placed" as near as possible to the places of formation of radwaste. It is necessary to mention that this process must be executed in the conditions of the high gamma-background created by the "Shelter" object, and also by radioactive contamination of nearby territory and buildings situated in it.

The management of radioactive contaminated soil is one of numerous types of works where radwaste is formed. The formation of large volumes of the radioactive contaminated soil is forecasted during works on transformation of the "Shelter" object. Therefore, it is necessary to choose a sorting process so that productivity of all schemes as whole will increase and will to the lowest possible level minimize formation of radwaste.

In the work [9] the process of the sorting with usage of collimating dosimeter, which is placed on boom of power shovel, in the conditions of the high gamma-background was analyzed and modeled. In these conditions usage of existing sorting equipments, for example, the automatic conveyer of sorting of soil and building garbage developed in CANBERA, is inadvisable because of the high cost, heterogeneity of soil (near an active layer we have large probability of possibly location of high-activity fragments of radwaste [10]), high external gamma-background from the radwaste conglomerations in the "Shelter" object, and also the insufficient mobility (the similar equipments are intended for the system removing of radioactive contaminated soil, but are not for building works, creation of foundations, etc.). In addition, this automatic conveyer has the high rate of the dust formation.

On basis of the developed general scheme and, using "the table of technological operations" (see Fig.1), and also "the database of existing equipments and technologies of solid radwaste management", are developed of alternative variants of schemes and technologies of solid radwaste management. The choice of the optimum scheme and technologies, on the basis of developed criteria, can be carried out by different ways, for example, using the multicriterion analysis proved in the work [11].

The gist of method constitutes of the aggregated criterion uniting all other criteria. For each criteria desirability function $u_j(x)$ representing the region of change for each criteria of x in the interval from 0 to 1 is constructed. The generalized index of efficiency of U_i for variant i is defined as sum of the corresponding desirability functions:

$$U_i = \sum_{j=1}^{n} k_j u_j(x_{ji}), \tag{1}$$

with the weight coefficients of k_j, which are chosen as

$$\sum_{j=1}^{n} k_j = 1. \tag{2}$$

On this basis in the work [11] the scheme of choice of the optimum technical decision using multicriterion analysis was suggested.

CONCLUSIONS

Expected substantial increase of works amounts of solid radwaste characterizing and management on the ChNPP industrial site is the feature of the present stage of activity related to the beginning of works of the "Shelter" object transformation and the ChNPP decommissioning.

The main volume of the solid radwaste of the ChNPP industrial site is radioactive-containing buildings and soils. The greater part activity of radwaste (without taking into account spent nuclear fuel) is concentrated directly in the "Shelter" object and its local area.

Wide spectrum of solid radwaste types of the "Shelter" object and ChNPP industrial site allow to relate their characteristics to the variable factors, which have substantial influence on the choice of optimum scheme and technologies of solid radwaste management. The general scheme of radwaste management of the ChNPP industrial site is suggested.

The choice of optimum scheme and technologies can be carried out on the basis of multicriterion analysis. Practical realization of this methodological approach was used for building of sanitary cordon and is carried out presently in measures directed for the stabilization of the "Shelter" object constructions.

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ОПТИМИЗАЦИЯ ПРОЦЕССА ОБРАЩЕНИЯ С ТВЕРДЫМИ РАДИОАКТИВНЫМИ ОТХОДАМИ ПРИ ПРЕОБРАЗОВАНИИ ОБЪЕКТА "УКРЫТИЕ"В ЭКОЛОГИЧЕСКИ БЕЗОПАСНУЮ СИСТЕМУ

В.Г. Батий, А.И. Стоянов

Разработана методика оптимизации схем обращения и технологий обращения с твердыми радиоактивными отходами объекта "Укрытие"и промплощадки ЧАЭС в процессе их преобразования объекта "Укрытие"в экологически безопасную систему.

ОПТИМІЗАЦІЯ ПРОЦЕСУ ПОВОДЖЕННЯ З ТВЕРДИМИ РАДІОАКТИВНИМИ ВІДХОДАМИ ПРИ ПЕРЕТВОРЕННІ ОБ'ЄКТА "УКРИТТЯ"В ЕКОЛОГІЧНО БЕЗПЕЧНУ СИСТЕМУ

В.Г. Батій, О.І. Стоянов

Розроблена методика оптимізації схем звернення і технологій поводження з твердими радіоактивними відходами об'єкту "Укриття"і проммайданчика ЧАЕС в процесі їх перетворення об'єкту "Укриття"в екологічно безпечну систему.