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Research Article

Classification the Radioactive Waste in Russian Silo according to their Threat (D value)

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Abstract

Recognizing that human health and safety is of paramount importance, the categorization system is, therefore, based on the potential for radioactive sources to cause deterministic health effects. This potential is comprised partly by the physical properties of the source and partly by the way in which the source is used. The actual practice in which the source is used, the provision of any inherent shielding provided by the device containing the source, portability, level of supervision and other judgmental criteria are taken into consideration. Radioactivity is a natural phenomenon and natural sources of radiation are features of the environment. Radiation and radioactive substances have many beneficial applications, ranging from power generation to uses in medicine, industry and agriculture. The radiation risks to workers and the public and to the environment that may arise from these applications as radioactive waste has to be assessed and, if necessary, controlled. Various methods have been used for classifying radioactive waste according to the physical, chemical and radiological properties that are relevant to particular facilities or circumstances in which radioactive waste is generated and managed. The aim of this study is classification of radioactive waste according to the threat they may cause. Based on that the sources should be characterized according to the A/D quotient, where A is the activity of the radioactive source and D is a pre-defined normalization factor. The concentrations activity of radionuclides founding in the radioactive wastes was measured using germanium detector. The higher quotient causes higher potential threat meant by the radioactive source to human health.

Keywords*: D values, radioactive waste, dangers level.*

Introduction

The response to a radiation emergency is basically the same as the response to any emergency involving hazardous material. The major difference is that in many hazardous material emergencies, the hazard can be smelled, seen or felt. This is not the case with radiation emergencies. In addition, in most cases responders will have no experience with radiation emergencies, very small amounts of radioactive material and radiation can be immediately detected with simple, commonly available instruments, and the medical symptoms of radiation exposure (except in extreme cases) will not appear for days, weeks or even years. Finally, many misconceptions prevail concerning the risks from radiation exposure and radiation emergencies, which can lead to decision making and public actions that do more harm than good. Therefore, preplanning on the basis of established principles of radiation protection and safety is essential.
In during last year putting many categorizing of radioactive source or waste aimed at specifying security level (József Rónaky, 2011).

Waste categorization pre-dates waste classification, and in the 1960s and 1970s the terms were often used synonymously. It is critical to recognize that both categorization and classification are systems of communication for use among workers, organizations and nations. As such, they are dynamic, evolutionary processes, and their meanings have diverged as waste management technology has matured (IAEA, 2007).

Radioactive sources are used in a wide range of practices in industry, medicine, agriculture, research and education, and they are also used in military and defense applications. Within this variety of practices there is a range of radionuclides, forms and quantities of radioactive material that need to be considered in the categorization system. High activity sources, if not managed safely or securely, can cause severe deterministic effects to individuals in a short period of time (IAEA, 1988; IAEA, 1990; IAEA, 1998; IAEA, 2000; IAEA, 2002a; IAEA, 2002b), whereas low activity sources are unlikely to cause such effects. The categorization system, therefore, provides a relative ranking and grouping of sources and practices, on which decisions can be based.

Radioactive wastes are product from the generation of nuclear power and nuclear research for purpose using of material in medicine, industry, agriculture, research and education. The importance of classification is the safe management of radioactive waste for the protection of

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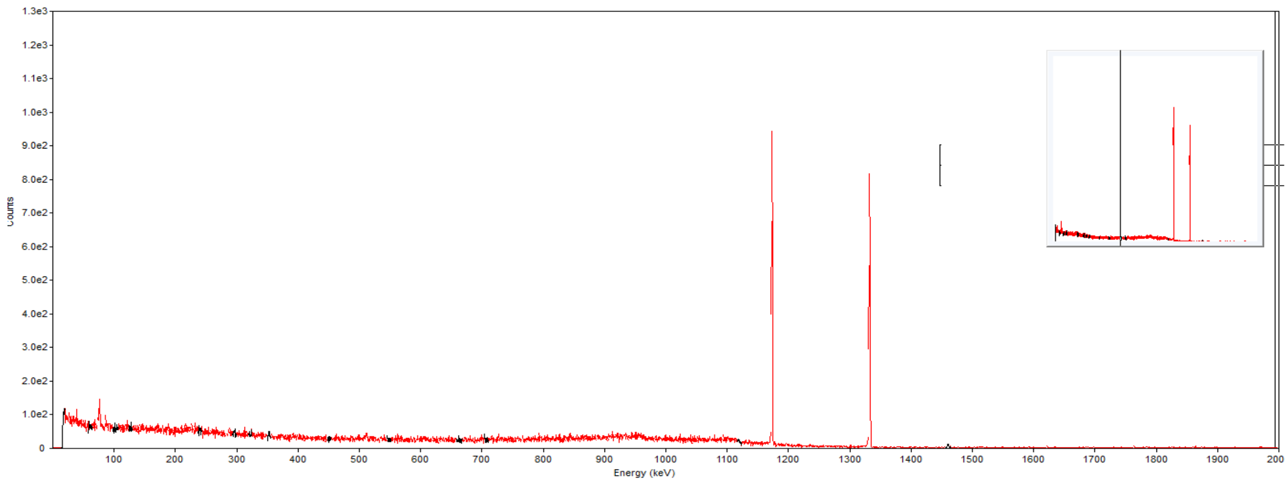

Fig. 1: Calibration spectrum for GeLi detector using Co-60

human health and the environment and protection of workmen in this field.

In order to implement a graded approach, various security levels are specified for determine the minimum required level the physical protection of hazard radioactive wastes under the possession of the obliging should be categorized.

Theory

Categorization of radioactive sources and radioactive waste should take place according to the threat they may cause, based on that the sources should be characterized according to A/D quotient (IAEA, 2003).

As usual exposure scenarios were developed for deriving the D value. These scenarios consider external exposure of the non-dispersed material or exposures that my results from the dispersion of the material. For each scenario several pathways were defined as well as the dose limit that may result in severe deterministic effects. the lower value of activity obtained was threshold activity, and two activity limits were derived, one for non-dispersible material D_L and other for dispersible material D_2, can be calculated as a function of the D_2 value as follows (S. A. McGuire, 1998).

$$10^{-4} * D_2\,[Bq] = 0.01g * C_L\,[Bq] \qquad (1)$$

where
10^{-4} D_2 is the activity intake that produces the reference dose
10 mg is the maximum intake mass of material.
C_L is the threshold activity concentration for considering a RW a dangerous source.

The categories are depending of D value as defined in the Annex of Ministerial decree 11 /2010. (III.4.) KHEM issued by the Minister of transport, telecommunication and energy on the rules of accountancy for and control of radioactive materials, and on the corresponding data provisions (hereinafter referred to as KHEM decree) and using Eq. (1) and according Table (1).

Table (1) consists of five categories are different about ratio of dangers of the radioactive material. The category 1 is extremely dangerous; this amount of radioactive material may cause permanent damage to life within a few minutes spent in the vicinity of the source. And the category 2 is very dangerous; this amount of radioactive material may cause permanent damage to life within a few hours spent in the vicinity of the source. The category 3 is dangerous, this amount of radioactive materials may cause permanent damage within a few days spent in the vicinity of the source. The category 4 is unlikely to be dangerous, this amount of unshielded radioactive material. The category 5 is not dangerous. This radioactive source cannot cause permanent injury.

Table 1: Categorization of standard radioactive sources (IAEA, 2003)

Radionuclide inventory (R)	Category
$R \geq 1000$	1
$10 \leq R < 1000$	2
$1 \leq R < 10$	3
$0.01 < R < 1$	4
$0.01 > R$	5

The categorization of wastes is similar to the categorization of radioactive sources that contain a mixture of radionuclides.

The amount of radioactive waste at a given site should be taken into account for the categorization. The total value of A/D summed over each radionuclide contained in the radioactive waste should determine the category: by using Eq. (2) (József Rónaky, 2011)

$$R = \sum \frac{A_i n}{D_n} \qquad (2)$$

where:
$A_{i,n}$ = activity of each individual source *i* of radionuclide *n*.
D_n = D value for radionuclide *n*

Four categories are defined for wastes: 1 - 4, where the most dangerous materials are in category 1 and category 4 means the least dangerous ones. If the radioactive material contains more than one radionuclide, then the sum of the quotients of the activity of each radionuclide and the respective D activity gives the activity of the given material in terms of D.

Experimental Work

To classify the radioactive waste stored 91 wells in Russian silo in Al-Tuwitha site, the portable high purity germanium proved with gamma vision (6.8) from ORTIC Company used to characterization radioactive waste. More these walls were filling with materials contaminated with radioactive waste since 1991 to 2003, the contamination come from different source. The measurement of concentration activity was done direct by putting the Ge detector over the well for measuring the concentration activity and types of radionuclides found in the well. The wells were numbered and a dose map for the top and the sides of the facility were drawn. The radiation dose rate for each well were measured each well were identified for the radionuclide that is contaminating the waste. The efficiency of GeLi detector is better than 42%. More than 95% of the concrete wells were a converted. The resolution of this detector is 1.32185 MeV for Co-60 energy. The energy calibration of Ge(Li) gamma-ray spectrometer is performed by Co-60 radioactive source as shown in Fig.1

The samples spectra are corrected for background radiation, the background values obtained by using eq (1)

$$\text{Background (Bq)} = \frac{Area}{IY\%\ EFF\ \%\ Tc}$$

where
Area: The neat area under the peak count
I_Y% : The branching ratio for photon energy
Eff: Efficiency of the Ge(Li) detector.
Tc : The total counting time interval in seconds
But the specific activity measurement for samples are done by

$$\text{Specific Activity (Bq)} = \frac{(Area-Bg)/Tc}{IY\%\ Eff\ \%\ m}$$

where: m=The mass of samples

All the radioactive waste in present work was solid waste types. Each well contains many radionuclides, activity of each radionuclide was measured and divided by its 'D' value (IAEA, 2003; S. A. McGuire, 1998), then the thread for radionuclides R calculated by summation the value of A/D over each radionuclide contained in the radioactive waste in the well as shown in Table (2).

Table 2: R ratio for square and circular wells of radioactivity waste for Russian silo

Well no	R = ∑ A / D
1	1.64922E-06
2	6.39992E-07
3	0.00030106
4	5.04792E-05
5	3.17692E-08
6	0.000105788
7	4.42674E-05
8	2.33914E-06
9	2.11777E-07
10	3.61098E-05
11	0.000247999
12	9.62011E-08
13	6.7618E-09
14	4.82217E-07
15	2.9197E-07
16	5.968E-05
17	3.33787E-07
18	1.19143E-07
19	3.86664E-07
20	3.42086E-07
21	0.00082591
22	7.31453E-07
23	1.452E-09
24	8.92106E-06
25	1.71434E-05
26	1.24521E-07
27	3.16476E-05
28	1.12501E-05
29	2.83951E-05
30	1.29E-09
31	1.00026E-05
32	1.21875E-07
33	2.0821E-08

Conclusions

The new categorization system provides basis for physical protection and deter of risk consideration. When compare the results in Table (2) with categorization of standard radioactive sources Table (1), we found that all waste under study have A / D ratio less than one, therefore, the radioactive waste in Russian silo are located in category 5 is unlikely to be dangerous, this radioactive source cannot cause permanent injury.

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