THE RADIOACTIVE WASTE MANAGEMENT IN THE AREAS OF CROATIA AFFECTED BY THE WAR

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ABSTRACT

There have been in use a lot of devices having ionizing radiation sources in the areas of Croatia affected by the war. They have been mainly applied in industry and medicine, but the most numerous radiation sources considered are radioactive lightning rods (arresters) and ionizing smoke detectors. In destruction caused by the war operations, a number of these devices was damaged or even destroyed, being turned into a special type of radioactive waste. Consequently, there have been developing circumstances leading to possible environmental pollution and imperilment of human health. Hence, the Croatian Radwaste Management Agency, as an authorized institution supported by some international organizations (IAEA, Conference of European Communities etc.) started the rescuing of radioactive waste deriving from damaged and/or destroyed radiation sources in the areas of Croatia affected by the war.

INTRODUCTION

Since July, 1991 almost a half of Croatian territory has been affected by major war operations. Under heavy artillery attacks and air raids a large portions of Croatian regions of Slavonia, Bania, Lika and Dalmatia have suffered serious damages. It became eventually clear that in all areas affected by war a special attention should be paid to damaged and/or destroyed ionizing radiation sources turned into radioactive waste. The sources have been installed mainly in medicine (used for diagnosis and therapy) and industry. But the most numerous sources are radioactive lightning rods (arresters) and ionizing smoke detectors. Consequently, damaged, destroyed or lost radiation sources are supposed to endanger the environment and human health not only in affected areas or even in entire Croatia itself but also - due to possible uncontrolled transboundary migration of these sources - in the other countries. Therefore, it has been given a high priority rate to the rescuing of radioactive waste that has been derived from damaged or destroyed radiation sources in the areas of Croatia affected by the war. The project implementation started in September 1992, after the allowance for approach to damaged or destroyed sources had been issued by the Ministry of the Interior. The project is planned to be carried out until September 1993. The Ministry of Health, Ministry of Civil Engineering and Environmental Protection, Ministry of the Interior and Ministry of Defence are co-operating in the project. An expert consultancy has been given by the IAEA. Radioactive waste considered is being stored in interim storages in Zagreb.

It should be emphasized that rescuing of radiation sources turned into radioactive waste, figures as prerequisite of the country renewal. The approach of inhabitants or workers participating in restoration activities to most of buildings or facilities containing damaged or destroyed radiation sources will not be allowed before considered sources will be removed.

RADIATION SOURCES INSTALLED IN THE AREAS AFFECTED BY THE WAR

According to register on radiation sources in Croatia, there have been installed in the areas affected by war 6,800 ionizing smoke detectors, 105 radioactive lightning rods and 90 other sources, installed mainly in industry. The largest medicine institution affected by war is the hospital in Osijek, having installed a cobalt bomb (activity 90 TBq) and 16 needles Cs-137 reaching 55 GBq. The most frequent isotopes considered are Co-60 and Eu-152, encapsulated in radioactive lightning rods and ionizing smoke detectors, as well as Cs-137, being applied in industry.

According to the above mentioned records the mean (per source) activity of installed ionizing smoke detectors is cca 100 kBq, of radioactive lightning rods cca 10 GBq and that of sources used in industry 370 MBq - 7.4 GBq. But it should be added that allowed activity of radioactive lightning rods in the OECD countries must not surpass 400 MBq if the source is Am-241, respectively, 40 MBq if the source is Ra-226. Without regard to these limitations, the use of radioactive lightning rods is not recommended in Italy, and is even forbidden in Sweden and Denmark (1).

The share of destroyed, damaged and lost sources in the considered areas i.e. the quantities and activities of radioactive waste derived from them is not yet precisely known.

According to present situation concerning come-back of refugees to their homes and restoration of Croatian economy, rescuing priorities in terms of objectives contained in the considered project, are given to the urban areas of Osijek and Vinkovci in Slavonia as well as to those of Zadar, Šibenik and Dubrovnik in Dalmatia.

APPLICATION OF RADIATION SOURCES

Since radioactive lightning rods and ionizing smoke detectors are the most numerous radiation source affected by the war, an information on operating types of both devices is given here.

Ionizing Smoke Detectors

As it is presented, ionizing smoke detector is composed by two chambers containing low-active ionizing radiation sources: Ra-226 has been almost completely replaced by Am-241 (Fig. 1). There are two Am-241 source types being applied: sources having lower activity (20-100 kBq) in households, and those with higher activities (up to 4 MBq) in industry.

After recommendations by the OECD/NEA, ionizing smoke detectors should be subjected to recovery and the

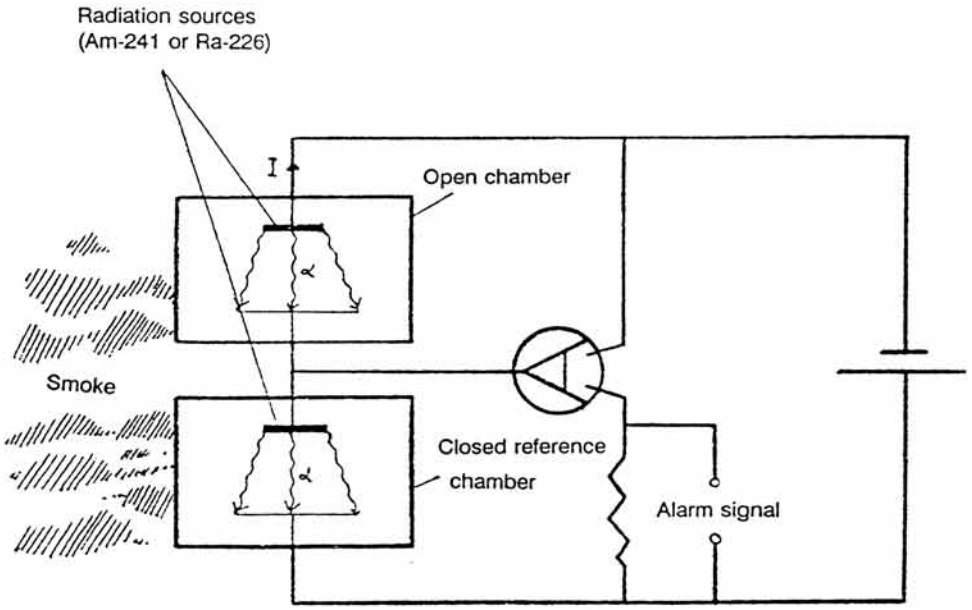

Fig. 1. Ionizing smoke detector.

normal radioactive waste disposal requirements at the end of their useful life (2). If subjected to fire only very small amounts, if any, would become airborne. Ionizing smoke detectors are fairly safe even in case of accidents. It should be mentioned that the most likely pathway leading to exposure to radiation from the misuse or mutilation of ionizing smoke detectors would be that involving transfer of contamination from damaged sources to fingers and subsequent ingestion of the activity (2). Circumstances leading to such accidents should be expected in the areas affected by war, above all concerning the children playing around the places with damaged ionizing smoke detectors.

Radioactive Lightning Rods (Arresters)

Radioactive lightning rods bearing two types of ionizing sources have been applied most frequently: Co-60 and Eu-152,154. These sources are gamma-emitters, being encapsulated in special holders (Fig. 2). Their standard (mean) activity is 10 GBq, varying in general between 7.4 - 14.8 GBq per source. Due to higher ionization capability Co-60 is more frequently applied, but it has shorter decay half-time than Eu-152,154. Based on air-ionization principle, maximal range of Co-60 gamma-emission is some 360 m and decay half-time 5,26 years. On the other hand, half-time of Eu-152,154 is 13 years, but due to its lower ionization capability, it should be installed a stronger source.

Due to estimate risk deriving from displaced damaged radioactive lightning rod, we have performed a rough calculation of dose rate for radioactive lightning rods with unshielded (open) dotted source characterized by isotropic radiation (Table I). In calculation we have induced presumptions that displaced lightning rod is placed in the factory area and the worker is exposed to radiation 4 hours per day.

DAMAGES IDENTIFIED ON RADIATION SOURCES

As it has been already mentioned, the precise number of damaged, destroyed and lost radiation sources is not known so far but there is a well-arranged register on radiation sources in Croatia. The contact with most of radiation source owners

TABLE I
Estimated Exposures to Ionizing Radiation of Radioactive Lightning Rod

Distance to Radiation Source (meters)	Dose Rate (mSv/h)	Time Needed for Annual Dose Absorbtion (1 mSv)
1	0.351	3 hours
5	0.014	18 days
10	0.0035	71 days
15	0.0016	156 days

in the areas affected by war has been re-established and identification of actual situation in the non-occupied areas of the country is going to be terminated soon. This introductory stage is being immediately followed by the field-inspection according to the above mentioned priorities.

According to available information, major damages and possible dangers concerning radiation contamination could be expected at facilities containing the industry applied sources like defectoscopes, gauge-meters etc., and both the ionizing smoke detectors and radioactive lightning rods which have been installed at numerous sites. The first rescuing action scheduled is to carry out an inspection of all affected sites by an expert team in order to assess radiation protection measures and, if needed, to remove the radiation source.

PROJECT PERFORMANCE SCENARIO

In order to ensure a complete and well-organized project implementation, based on realistic time-schedule and rational budgeting, the following operation stages should be considered:

1. preparatory actions (including purchase of equipment and financial means needed to run the project);

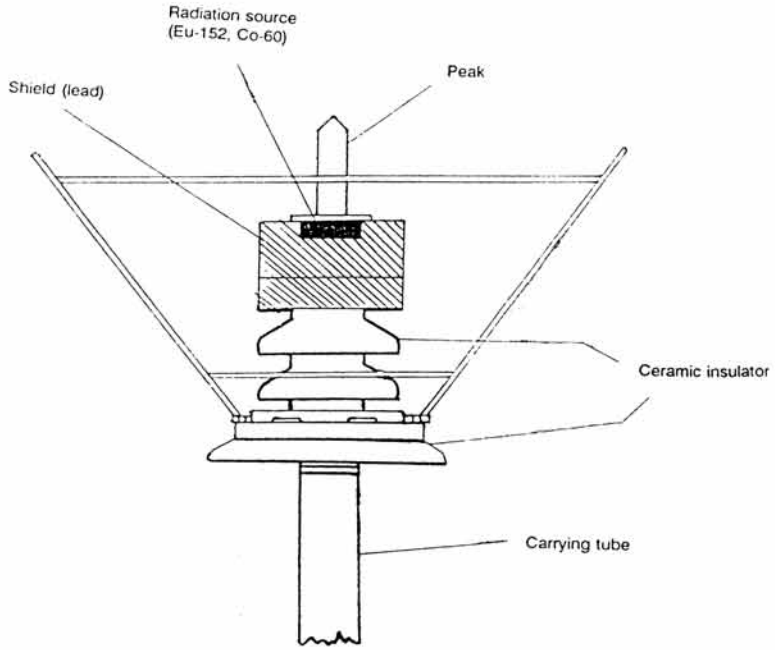

Fig. 2. Radioactive lightning rod (arrester).

2. get reliable data on damages identified on radiation sources in the affected areas, according to the register on radiation sources users;
3. provide for a strict access control for all damaged buildings and facilities containing radiation sources;
4. measure the radiation and contamination levels, and foresee local actions referring to the management of damaged and/or destroyed radiation sources;
5. organize rescuing of considered sources by the authorized expert team co-operating with representatives of source users;
6. transport damaged and destroyed radiation sources by special vehicles equipped in accordance with the Law of Transportation of Dangerous Materials 3., and provide an adequate control;
7. before storing, classify sources in order to separate those, foreseen to be re-used, apart of the unusable sources that will be considered as radioactive waste;
8. provide adequately arranged necessary storing capacities for unusable i.e. damaged and destroyed radiation sources (undamaged radiation sources could be temporary stored at their original sites if it could be expected them operating in reasonably short term).

It should be noted that the public will be continually, completely and correctly informed on the project performance (4).

According to the available information, it seems to be even much more damaged or destroyed radiation sources in the neighboring Republic of Bosnia & Herzegovina. It would be necessary to plan an integral and co-ordinated action of their saving as soon as the war in this country will be over.

INTERNATIONAL SUPPORT TO THE PROJECT

The stand-by arrangement in terms of consultancy and supervision of the project has been established with the IAEA. In accordance to this, an expert mission was carried out in August 1992 (5). The Croatian experience on management of radiation sources affected by war operations (and being consequently turned into radioactive waste) is supposed to be helpful to the IAEA; moreover, some of the IAEA actions in the field are being implemented for the first time just in the case of the war that has taken place in Croatia. According to this, the IAEA is going to develop procedures dealing with disasters, including war as well. The procedures are expected to be issued as the special IAEA guidelines.

The IAEA has already purchased a part of the equipment needed for the project implementation, donating it to the project leading company - Croatian Radwaste Management Agency. The equipment is just being delivered and, consequently, some of project tasks have been run.

In addition, the Westinghouse Energy Systems International made recently a financial donation to the project. The project started in September 1992. However, the activities could soon be stopped if no additional financial support will be given to the project. In order to enable a proper project implementation, the project has been also presented to the European Community. It has been completely accepted by the Community experts, having in this way an occasion to be partly financed from the EC sources. But due to some formal reasons, financing of the project by the EC has not yet been achieved.

Some additional institutions have also paid an attention to the project realization (e.g. Central European Initiative, the governments of Germany, Switzerland and Hungary, the Regional Environmental Center for Central and Eastern Europe, the ENEA from Italy etc.). There have been established contacts with some institutions from the USA and Canada as well as with corresponding offices of the United Nations Organization.

PRESENT STATE OF THE PROJECT IMPLEMENTATION

The operational stage leading to fulfillment of the project objectives, started in September, 1992. It is referring to inspection and immediate rescuing actions of damaged or destroyed radiation sources. The actions are being carried out by the

experts coming from the ECOTEC, the authorized institution for handling radioactive materials. Each rescuing mission is supposed to be registered on Rescuing Action Report Form containing basic data on the ionizing radiation source (name of owner, location, person in charge, radiation source and its activity and decay half-time, type of device bearing radiation source etc.), description of damages that have been caused by war, and performed radiation source rescuing measures. The report should mention a status considering possible environmental contamination and measured radiation doses on the site. It should be submitted by the operating expert team to the Ministry of Health holding the Register on Radiation Sources in Croatia and the Croatian Radwaste Management Agency as the project leading institution.

There were performed several rescuing actions concerning the rescuing of displaced radioactive lightning rods (radiation sources have remained in the lead holder undamaged) in Slavonski Brod and Vinkovci, and the removal of ionizing smoke detectors in Osijek (all locations are in Slavonia region) so far. At all sites no contamination has been identified and radiation dose was within the background values.

PROBLEMS THAT HAVE BEEN ARISING IN THE PROJECT IMPLEMENTATION

The main problem in carrying out the operational tasks is limited, aggravated or even impossible access to some areas where the objects containing radiation sources have been identified. There are mainly two groups of the access difficulties: physical and political. The first group of problems is relating above all to mine-removal around the objects or facilities of interest, and the second to the access to areas being not yet under control of Croatian Government, without regard for they are being controlled by the UN Protection Forces (UNPROFOR) or they have been neither liberated nor fully controlled by the UNPROFOR. Hence, the project has been planned to be carried out first in unoccupied areas where access to the buildings containing radiation sources is possible, and thereafter in the areas where the enemy is refusing to be replaced by the UNPROFOR. Although there is no access possible to these, still occupied zones, we have some information on situation concerning radiation sources safety in that regions: e.g. there is the hydrated alumina facility at Obrovac in northern Dalmatia containing 18 radiation sources Cs-137 and one source Co-60 (their mean activity is 3.7 GBq per source). The facility storing area, being still under control of the enemy, has been meanwhile turned into the ammunition dump and - according to some rumors - blew up a couple of months ago. If it is true, disintegration of the radiation sources into dust particles occurred followed by their further airborne dispersion. In these circumstances, a serious contamination having possible impact to human health could be supposed.

CONCLUSION

The urgent and complete implementation of the project concerning rescuing of radioactive waste materials derived from damaged or destroyed radiation sources in the areas of Croatia affected by war could prevent major radiation contamination in Croatia itself but also - through uncontrolled transboundary migration - in the other countries. The project is based on professional approach, safety regulations and rational budgeting. As a specific action it represents a new experience for international institutions in the field, anticipating the performance of a similar action in the neighboring country of Bosnia & Herzegovina after the war taking place there will be over.

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