

ZRÍNYI MIKLÓS NATIONAL DEFENSE UNIVERSITY
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BOOK OF THESES

GÁBOR PETOFI

Author's summary and official reviews of PhD dissertation titled

*Examination of harmful consequences of malevolent actions involving radioactive material,
preparation for responding to the consequences*

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1. SCIENTIFIC PROBLEM

The possibility for a malevolent action involving radioactive material, meaning a potential challenge for the emergency response system, has mainly come into the interest of experts since the 9/11 act committed in the US and the subsequent terror acts in Europe. The former assumptions on the possibility of implementation for such an action have been reemphasized, and several in-depth analyses have shown that the basic approach should be revised. Emergency response professionals point out that this event might jeopardize the public, the infrastructure and the economy at the same time, responding to which requires considerations different from the current emergency planning principles. Since the topic can be regarded as new even on international floor, it should not be judged as important fault to miss the evaluation of such threats and specify the required response steps in Hungary, because this state is usually subjected to moderate terror threat. However further delay is not justified. Recognizing this problem I have commenced the work focused on malevolent actions committed with radioactive materials, to evaluate its actual threat and to establish the response, to prevent the potential consequences on the public and the harmful environment effects.

Malevolent use of radioactive material might be an effective tool in the hands of terrorists to cause panic and then long term fear in the public, significant financial loss and, at least on local level, to break up the health and economy system. All these would draw tremendous attention from the side of international media, which is one of the most important goals of terrorists. It is questioned how real this threat could be. The experts do not agree. On the one hand they agree that based on the existence of the intention, capabilities and accessibility of necessary devices, certain potential exists to implement such an action and the question is not whether terrorist will or not execute it but when and where they will do. According to other opinions if the terrorist would think logically, they would choose other, less problematic tools, the application and accessibility of which is simpler, and the implementation via which might be more effective. Detailed research, to enroll more professional arguments may contribute to decide these questions. Beyond the professional debates, in agreement with the international conventions aimed at safeguarding nuclear materials and limiting terrorist acts, none of the countries may neglect, with due responsibility, the evaluation of this threat in order to protect its citizens and none of them may miss to determine the possible mitigatory and response actions to such events. Altogether I have concluded that the intention is available and the expertise and the tools are accessible for the terrorists to commit a malevolent action. Notwithstanding the terrorists have proven that they are able to act at any part of the world, thus nor Hungary is an exception. In summary it is justified and actual to research the issue both from scientific and safety point of view.

In Hungary there is detailed regulation and guidance on how to respond to a nuclear facility accident, but the threat meant by a malevolent action involving radioactive material has not been evaluated in details, and there is no response plans for such events. Activities scheduled in nuclear emergency preparedness and those applied in response to malevolent actions are rather different in the early phase, the resolution of which may be obtained by drawing up a strategic model plan for this scenario too. Accordingly the scientific problem is to find the

potential threat modes and the respective worst consequences to be used as design basis and finally to develop the plan itself.

2. RESEARCH OBJECTIVES

General objective of my research is to evaluate the threat in Hungary departing from the scrutiny of international literature of the topic, the features of national preparedness and from the international conventions, obligations related to nuclear terrorism, non-proliferation of nuclear and radiological weapons, and to quantify the probable consequences of such an event, and to develop the response model plan for malevolent actions involving radioactive materials. Within that I have identified the following objectives:

- A) Based on international experience and national threat I will set up a hypothesis for the scenarios to be considered in Hungary. A system of aspects will be worked out to evaluate applicable radioactive materials and devices to be used in malevolent acts.
- B) By justifying the hypothesis I will identify those credible threat modes, including the potentially usable devices, materials, actions and locations, for which the Hungarian response system should be designed. In order to design bounding scenarios will be adjusted to the selected events, which I will analyze and quantify in details by means of advanced simulation codes.
- C) Based on the quantitative analysis I will evaluate the real threat of the scenarios from the aspect of potential consequences and I will propose improvement actions on the preparedness system.
- D) Based on the comparison of the results obtained with the international recommendations, and by considering the national features I will create the strategic model plan for malevolent actions including radioactive materials.

3. RESEARCH METHODS

Basis for commencing the research is to scrutiny, critically evaluate and compare the accessible written and electronic, Hungarian and international literature of the topic. There are several Hungarian and international publications, laws, conventions, studies, manuals, project reports and professional conference materials available. The first, substantiating step of the research is to review these, and to give comparative critics to the national preparedness and response system. From the comparison, and based on own considerations I will set up a hypothesis on those event sequences, the occurrence of which may be realistic, credible in Hungary. I will draw up a method to justify the hypothesis, and I will justify it. The selected scenarios will be covered by bounding ones and analyzed by advanced computational methods and codes in order to establish and measure the real threat to Hungary in this regard. The other goal of this step is to substantiate the critical takeover of the international best practice into the strategic model plan. Finally I will develop the strategic response model plan, which will be appropriate to be considered for the national or the organizational emergency response plans, after due adaptation.

4. RESEARCH PERFORMED AND SUMMARY CONCLUSIONS

In the chapter I I have fully reviewed and evaluated the compliance with national responsibilities derived from international conventions related to nuclear and radiological non-proliferation and to malevolent use of nuclear and radioactive materials. Based on that and by examining the terrorist threat in Hungary from this aspect, and after overview of the protection of nuclear and radioactive materials and comparing that with the actual threat level I have concluded that it is indispensably necessary to develop a strategic response plan for malevolent acts involving radioactive materials. An appropriate basis for that could be a model plan.

In chapter II, based on the international and Hungarian threats I have evaluated the potential scenarios from the aspect of possible implementation. I have summed up the possible threat modes and listed the applicable devices. I have analyzed the potential forms and quality of radioactive materials. I have developed the system of viewpoints based on which I have performed the evaluation. I have compared the applicable materials with those available in Hungary and Europe and selected those, which should be included in the design basis. I have concluded the modes of implementation according to location, usable devices and materials and defined the 5 possible scenarios. These scenarios should be taken into account as design basis for the preparedness and response planning.

In chapter III I have performed the analysis of the 5 credible scenarios. The selected method has been the use of bounding events. I have performed the analyses by internationally recognized and validated codes to specify the radiological consequences. In the case of direct exposure, external explosion and external dispersion of radioactive material I have used codes developed for that purpose, while in the case of internal dispersion I have developed a new method to evaluate the process: I have performed joint 3D flow and radiological calculation. I have determined that deterministic effects could occur in none of the cases if a realistically assumed radiation source is used for the action. Strategic response can be planned taking account of that fact. Also I have concluded that the dose conditions make it possible to organize the response within 100 m environment of the act in case of external explosion and outside the building or construction in case of internal action.

In chapter IV, based on the comparison of my analysis results and the international recommendations, and on the Hungarian response capabilities and features I have developed the strategic response model plan for malevolent actions involving radioactive materials. I have formulated the objective of the plan and I have specified the radiation protection limits to be used during the response. Considering my calculations and the international recommendations I have specified those characteristic distances that should be observed during the planning of the response. After that I have determined the steps of strategic response (justification of emergency, development of protection zones, protection of responders, protection of public, environmental monitoring and source survey). I have described the activities to be executed in each step and the practical questions occurring during response activities. The model plan I have developed may serve as basis for the national preparation and for the implementation of the response in the development of the respective organizational plans.

5. NEW SCIENTIFIC RESULTS (THESES)

Based on the survey of international experience and the level of national threat I have set up a hypothesis for the potential scenarios of malevolent actions involving radioactive materials. For the justification of the hypotheses I have been the first to draw up the system of aspects to be applied for the evaluation of devices and materials to be applied in the implementation of such events.

I have stated those 5 scenarios which should be taken as design basis for the strategic planning. I have adjusted a bounding scenario for the selected event sequences and I have quantified them via computer codes. In case of a scenario I have worked out and applied a specific method for the evaluation: I have jointly used a 3-D flow code and a radiological code for the evaluation of internal dispersion.

I have specified based on my analysis that in case of the examined scenarios no deterministic health effects are expectable. The strategic response can be planned by observing this fact. Also I have concluded that the dose conditions make it possible to organize the response within 100 m environment of the act in case of external explosion and outside the building or construction in case of internal action.

Based on the comparison of conclusions of the above three theses and the international recommendations I have been the first to develop a strategic response model plan for malevolent actions involving radioactive materials to be used on the early phase of the emergency. The significance of the plan is that it may serve as basis for the national preparation and for the implementation of the response in the development of the respective organizational plans.

6. PRACTICAL APPLICATION OF RESEARCH RESULTS, SUGGESTIONS

The final product of my research is the strategic model response plan for malevolent actions involving radioactive materials. Based on the plan the National Emergency Response Plan can be extended to such event sequences, including the specific features. Also the plans of those organizations involved in the response can be prepared and supplemented based on my work. Response capabilities of the same organizations may be developed, and such programmes scheduling the required training and drills can be specified which may contribute essentially to the level of preparedness to improve the defense of the country. Finally, a growth of safety perception and confidence of the Hungarian citizens is not a negligible result.

I suggest the strategic model response plan to be considered by the organizations involved in the management of radiological emergencies, at first place by the disaster management organizations. At the same time I draw the attention that the here established elements of emergency response may also be effectively used for reacting to malevolent chemical or biological event sequences. I also suggest the codes and methods applied for analysis to the attention of the Hungarian Atomic Energy Authority to apply them in practice, because thereby the analysis potential may significantly be extended, which furthermore contribute to the development of emergency preparedness in Hungary.