PROTECTION OF THE POPULATION AND INSTALLATIONS OF THE ZONE OF THE INTERIOR FROM RADIOACTIVE CONTAMINATION

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Uninterrupted operation of industry and transportation and of power supply and communications systems, and dependable functioning of the administration of the country during a war make possible the vital activities of the state and are the most important factors in the achievement of success in armed conflict.

Maintenance of the vital activities of the state in a modern war depends primarily on the level of protection afforded the population and installations of the zone of the interior (tyl strany) against weapons of mass destruction, and on the effectiveness of the protective measures.

Problems of this protection are set forth in this article with reference to only one of the important destructive factors of a nuclear blast -- radioactive contamination, assuming that other factors (the shock wave, light radiation, and penetrating radiation) may be subjects for separate consideration.

It is known that in case of massed nuclear attack on targets of the zone of the interior, along with tremendous destruction there will be radioactive contamination of extensive areas.

All armies now consider radioactive contamination an important factor of destruction which may destroy the productive activity of important industrial centers and economic regions, kill and injure great masses of people, paralyze the operation of transportation, disorganize administration, and make difficult the rescue and restoration operations after the nuclear attacks.

The zones of radioactive contamination, of course, may encompass very sizeable areas of the country. Thus, according to data of the Scientific Committee on Radiation Information of the US, with a 10-megaton ground blast the zone of radioactive contamination, with an irradiation dose of 450 roentgens in 48 hours (for unprotected people), will be 240 km downwind and 40 km across the wind. It is easy to imagine what would be the extent of contamination in case of a massed nuclear attack.

The probability of contamination of large areas and the danger of destruction of the inhabitants makes necessary an extensive system of protective measures, directed at timely detection of radioactive contamination and maximum reduction of its destructive effect.

In various countries measures are being studied which enable the majority of inhabitants to survive the short initial period of nuclear war and its relatively prolonged succeeding stage. Thus, according to data from study of various forms of nuclear attacks, carried out by US scientists, the number of people remaining alive after a massed attack with a system of protection from radioactive fallout would be about twice that it would be without such a system.

Obviously, preparations for protection of inhabitants and targets of the zone of the interior is a problem of paramount importance. The main problem is seeing to it that the system of protection does not lag behind the capabilities of the weapons of the probable enemy, and this requires constant improvement of the means of protection and methods by which they are organized.

Under conditions when vast areas and practically the whole population of the country is involved in the sphere of combat operations of a nuclear war, the system of protective measures cannot be a local matter. Now it has been converted into a nationwide system of measures and is on a strategic scale. This system is based on the broad capabilities of the state to accomplish the necessary protective measures.

In our country the development and improvement of the system of defense in general, and of anti-radiation protection in particular, are facilitated by a number of favorable conditions which have a decisive effect in determining the nature and methods of accomplishing protective measures. Thus, the planned development of the national economy, including the planning of housing and industrial construction, makes it possible to provide ahead of time for the rational location of structures, building of shelters in the case of new construction, and reconstruction of existing buildings and installations.

The vast area of the country facilitates the most suitable dispersal of industrial, transportation, communications, and power-supply targets to decrease their vulnerability to weapons of mass destruction. And this has a very favorable effect on the solution of the problem of dispersal and evacuation of the inhabitants of the major cities to relatively safe areas.

The socialist economic system makes possible utilization of its necessary elements for the organization of stable administration, from top to bottom, in carrying out protective measures. The vast possibilities of using the materials and equipment base in the interests protecting the population creates the main prerequisites for successful solution of the problem we are discussing.

It must be noted that in these conditions morale is an important factor. The highly organized and disciplined nature of the Soviet people, their feeling of responsibility in the performance of their duty, combined with initiative and resourcefulness, gives to the system of protective measures a special patriotic character, which cannot fail to give exceptionally favorable results.

The special features of formation of zones of radioactive contamination and of the destructive effective of radiation, involving the absence of any visible signs of contamination, unevenness of distribution of the level of radiation in the zones, and gradual appearance of the signs of injury, determine the specific nature of anti-radiation protection.

The success of organization of this protection depends primarily on the state of the system for warning the inhabitants and the target installations of the movement of the radioactive cloud and the beginning of fallout of radioactive matter. Since the process of formation of zones of radioactive contamination proceeds gradually, there will always be a certain amount of time, without any hard and fast limits, for warning inhabitants of the radiation danger. Because of this, all the necessary protective measures can be taken in good time, before the beginning of radioactive contamination, especially in areas remote from the targets of nuclear attack.

We have in mind early warning of the danger, mainly on the basis of data for the prediction of radioactive contamination, with the warning time for delivering the necessary commands as to the danger depending on the rapidity of spread of the radioactive cloud and the distance from the target of nuclear attack of the areas located in the threatened direction. Some idea of the possible periods of time for taking preventive protective measures, from the moment of nuclear blast to the beginning of radioactive fallout, is provided by the following table.

Possible time (in hours) for delivery of warning of radiation danger.

Average wind velocity (km/hours	Distance of region from target of nuclear attack (km)					
	20	30	50	75	100	150
25	0.8	1.2	2.0	3.0	4.0	6.0
50	0.4	0.6	1.0	1.5	2.0	3.0
75	0.3	0.4	0.7	1.0	1.3	2.0
100	0.2	0.3	0.5	0.8	1.0	1.5

From the table it is apparent that with timely warning, the population will have enough time to take the necessary protective measures. Any delay in delivery of these warnings by the lines of communications will decrease the possibilities of protection from the effects of radioactive matter and may entail unjustified losses.

However, early warning does not solve all the problems of notifying the population. It only alerts the appropriate agencies as to the danger of contamination which will arrive within a certain time. There may be cases when the danger will pass by the warned region, since prediction of radioactivie contamination does not alway prove to be sufficiently accurate.

Here there arises the need of providing a local warning signal when there is immediate danger of contamination of a certain region. This can be accomplished by very simple sound means, with a network of points for instrumental checking for contamination. The primary task of such a network is determining the beginning of fallout in time.

Modern radiation reconnaissance instruments make it possible to detect the movement of the front of a radioactive cloud from five to ten minutes before its arrival at an instrumental observation point. Consequently the warning signal can be given in good time, before the beginning of fallout, which enables the population to take cover in time and put on protective clothing.

Thus constant readiness of an early warning system, and local warning of radiation danger, with a network of instrumental observation points, are the necessary prerequisites for effective protection from radioactive radiation.

Radiation shelters, capable primarily of weakening the effect of radioactive radiation, are of decisive importance in protecting the population from such radiation. Information is found in the foreign press which indicates the reduction of casualties depending on the nature and amount of protective measures taken in advance. Thus it has been calculated that in case of nuclear attacks on the 150 largest cities of the US, loss of life would be cut in half just by the use of radiation shelters and partial evacuation, and with shelters affording protection against the shock wave, losses would be cut to less than one-sixth.

Outside the zone of the effect of the shock wave, it may be assumed, use of radiation shelters might decrease casualties by tens of times. Hence the necessity of preparing and building such shelters. This problem should not be made too difficult or involve the expenditure of great amounts of money and labor; to a considerable extent it can be solved by discovering already existing shelter facilities.

In the US, for example, it is proposed to make maximum use of existing buildings for protection against radioactive fallout. It is believed that in this way about 50 million people can be saved. In the US and Great Britain, a program is under way of surveying existing buildings and installations and selecting ones for protection against radioactive fallout.

The possibilities of using buildings and installations for such protection are very great. In principle all buildings and installations (sooruzheniya) are suitable for this purpose, all the way from simple farm structures to large capital constructions. An ordinary wooden house weakens radiation by two or three times, a multi-story stone house, by tens of times, and basements and simple shelters like covered slit trenches, by 40 or 50 times or more. Therefore determination ahead of time of the protective qualities of structures and assignment of people to shelters (in case the danger signal is given) will promote the most effective use of already existing possibilities of protecting the population and also expedient planning of measure to increase the number of protective installations.

In selecting one type or another of protective structure it is necessary to give strict consideration to the radiation attenuation factor. Naturally, one should not turn toward the use of structures with a low such factor, since in such a case losses of life under conditions of strong contamination will be unavoidable.

It is known that the degree of injury to people is in accord with the following reference data: with irradiation doses of up to 25 r, no injury is perceptible; with doses of 25-100 r there is slight injury; with 100-200 r, medium injury; and 200-400 r, serious injury. Irradiation doses of 400-800 r cause extremely serious injury.

When people are in a danger zone of radioactive contamination, it must be taken into account that the radiation attenuation factor (K) is different for different kinds of shelters. Thus, on open terrain, where the total dose of irradiation is 1000-1200 r, personnel in shelters with the factor K-2 will receive an irradiation dose of 500-600 r, and, respectively, with K-5, 200-240 r; K-10, 100-120 r; K-20, 50-60 r; K-30, 33-40 r; K-50, 20-24 r; and K-100, 10-12 r.

From comparison of the above data, it follows that in case of heavy contamination, injury to the population can only be avoided if shelters are used which have a factor meeting acceptable standards. This does not mean, of course, that people cannot be put in shelters having a lower radiation attenuation factor.

Evacuation and dispersal of the inhabitants are effective means of protection. At the beginning of a nuclear war, preparation for and carrying out evacuation from large cities may be made difficult because of the formation of zones of radioactive contamination. Is it expedient to carry out evacuation in such cases?

Calculations of probable losses of people from a nuclear attack before evacuation and after it show that even with the existence of zones of radioactive contamination, evacuation can be a very effective measure of protection if it is carried out taking into account the special features arising from the conditions of the radiation situation. Chief among them are the following:

-- The directions and routes of evacuation are chosen with a view to using those least contaminated.

-- The time for beginning the evacuation is set in consideration of a decline in the level of radiation, in order to avoid over-irradiation of people at the points where they go aboard means of transportation and in the period of movement along the routes.

-- The points where they get off the means of transportation and the regions for relocation of the evacuated population are chosen as far as possible in consideration of the prevailing direction of the average wind and at such a distance from the probable targets of nuclear attack that, with a nuclear blast of the power assumed for a given target, they will not be in the danger zone of the path of the radioactive cloud.

-- The means of transportation for the evacuation should be fitted out to protect people from the fall of radioactive dust.

The need for all administrative agencies which organize and carry out protection of the population to be constantly aware of the radiation situation requires such a system of radiation reconnaissance (razvedka) as can provide exhaustive information on the radioactive contamination to all levels in the required length of time, regardless of the scale, degree and location of the contaminated regions.

Effective accomplishment of these tasks is based on the principle of integrated utilization of stationary radiation observation points, mobile land equipment, and aviation. The permanent geographical location of monitoring stations of cities, military-industrial installations, and regions already assumes the expediency of a stationary setup for radioactive contamination monitoring points. Such points do not require means of movement; as a result, with the use of relatively inexpensive devices there is achieved an economical system of radiation monitoring.

A very important advantage of stationary monitoring of radiation monitoring is the possibility of continuous monitoring of contamination simultaneously in all the areas being checked, and of taking readings from the instruments at any time. This assures great and constant readiness of the system for operation.

Since the control of the stationary instrument and the scale of readings may appear on the panel of the operator, which is located in a prepared shelter, the net of stationary sensors permits the taking of measurements of any, even very high, levels of radiation, regardless of the fact that the monitoring point may be located in a zone of radioactive contamination.

Having stationary instruments at points where are located economic and military installations, which have telephone, telegraph and radio communications, assures dependable control of the reconnaissance system and timely transmittal of the measurement data.

Some shortcomings inherent in stationary disposition of contamination monitoring points (possible vulnerability of the network, difficulty of any extensive maneuver of the means of reconnaissance, etc.) are completely compensated for by including mobile land equipment and aviation in the system of radiation monitoring. And it is no accident that the development of a stationary network of radiation observation points is getting much attention abroad. In the US, for example, no less than 150,000 such points have been set up, equipped with specially selected and tested instruments for the detection of radioactive contamination of the air and the surface of the ground. In England about 1500 observation posts have been put into operation.

In the territory of the oblasts and republics of our country, radiation observation points can be set up on the basis of various institutions -- for example, in the rural areas, in village Soviets, in the central farmsteads of kolkhozes and sovkhozes, in police stations, equipment and repair stations, posts of the hydrometeorological network, etc. If the above institutions are taken as the basis for the creation of observation systems, then the density of radioactive-contamination instrument-monitoring points, providing they are supplied with dosimetric instruments and they are rationally distributed in the area to be monitored, will in the main accomplish the tasks of radiation reconnaissance imposed on the stationary network. Bringing in, in every way possible, mobile land equipment and the personnel and equipment of civil aviation for this work will make the system of radiation reconnaissance most effective.

It is known that outside the zone of effect of the shock wave and light radiation, but in conditions of lengthy radioactive contamination, industrial enterprises, transportation and other institutions will retain their capability and continue to function if the lives and ability to work of the people serving the industrial process are maintained.

Consequently the main task of protective measures, in the interests of assuring continued operation of industry, transportation, power-supply, communications, and administration, is to prevent loss of workers and employees from radioactive radiation. This in turn requires serious consideration of the problem of developing systems of operation in conditions of radioactive contamination and procedures for putting them into effect.

Unquestionably, the varied conditions of the radiation situation and the nature of production processes make it impossible to solve the problem of the probable methods of operation for all enterprises in the same way. The work routine of each enterprise in conditions of radioactive contamination provides the possibility of designating in advance a period of dangerous radiations for parts of the operation for certain intervals during which people will remain in places with various protection (shelters, working spaces, or outside of any cover), depending on the expected dose of irradiation.

The work routine depends on many factors, chief of which are the following: the expected dose of irradiation; the radiation attenuation factor of the work rooms; the possibility of shift work, and the number of shifts which can be set up from the number of workers and employees of the enterprise.

In all cases the work routine (rezhim) under conditions of radioactive contamination is determined in such a way that with rational utilization of the protective properties of the work rooms and an expedient procedure for changing shifts, taking into account the expected dose of irradiation, the workers and employees are secure against injuries which would put people out of action. If no possible ways of operating can achieve this, the production process must be temporarily suspended till such time as radiation drops to a safe level.

In plants with a continuous process, where stopping production would involve great difficulties and dangerous consequences, the protection of people directly serving the system of control of the operations is achieved by developing individual or group protection in the working areas.

One of the most important measures of radiation protection is setting up a check on the irradiation of the population in general, and the workers of economic installations. It makes it possible fairly accurately to determine the degree to which people have been affected, estimate the probable losses, and, depending on this, decide as to the organization of medical service to the population, the procedure for further use of workers and employees, etc.

Monitoring the irradiation of people involves the solution of fairly difficult problems. First of all, measuring the actual doses of irradiation requires technical equipment (dosimeters). The enormous demand for these if there were to be a mass supply of them to the population would involve great economic expenditures. Therefore it is necessary to seek the most efficient and not too economically burdensome means and methods of monitoring. Here an expedient organization would be one of group monitoring of irradiation, with the use of relatively inexpensive instruments, available to the population.

In the group method of monitoring irradiation, the actual doses of irradiation received by a group of people who have all been together in the same place is checked by one or a few dosimeters. In this way the number of monitoring instruments required is greatly reduced.

In the group method of monitoring, the composition and number of groups of people are determined on the basis of where they live and the place and nature of their work; these groups are sort of primary control units. As the basis for assignment to groups there may be established some distinguishing mark -- that of their work for workers and employees (their shift, shop, brigade, etc.), and that of their place of residence for the rest of the population.

The organization of careful and timely noting of the results of human irradiation monitoring must be considered necessary at all levels of the system of anti-radiation defense.

As to individual means of protection, that is not a very difficult problem, and, in our opinion, there is no special need to deal with it here.

The aspects considered in this article show that protection of the population and installations of the zone of the interior under conditions of radioactive contamination is a fairly difficult and important problem, the successful solution of which will make it possible to save millions of lives and assure the uninterrupted operation of many enterprises of the national economy for the achievement of success in armed conflict.