RADIOLOGICAL MONITORING FOR CIVIL DEFENSE

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For the past year and a half I have been an interested observer of the efforts to create a radiological monitoring system for civil defense purposes. The slow progress in this direction has been of increasing concern and now that some of the state and local authorities appear to have decided not to wait longer for advice from Washington it seems time to speak up. My impression is that too much attention has been paid in the past to instrument specifications and not enough to the team organization and the nature of the mission to be accomplished, and that the latter holds the key to the situation. I want to emphasize that these remarks are my own personal conclusions and do not in any way represent official views of Brookhaven National Laboratory, Associated Universities, Inc. or the Atomic Energy Commission.

The importance of radiological monitoring as a civil defense function has often been greatly exaggerated, but since there is a possibility of a radiation hazard - which cannot be detected by the senses directly - some provision must be made for handling it, if only for morale reasons. Popular ignorance and the natural fear of the unknown have combined to create a situation in which even police and fire departments - who already have far too many responsibilities in the event of atomic attack - are undertaking the functions of radiation monitors, supposedly for their own protection. In view of the general fear of radiation hazards one shudders to think of the panic and confusion that will arise if instruments are used freely by personnel with inadequate training in their foibles and in the interpretation of results. Because of the complexities of gamma, beta and alpha radiations, not to speak of the differences between external radiation hazards and those accompanying inhalation, swallowing or injection with various radioisotopes, no single meter reading can ever be sufficient for all situations. And no matter what care goes into the writing of instrument specs and how much of the taxpayers' money is spent on an instrument stockpile this unpleasant fact remains: the evaluation of a hazard and the supervision of emergency workers in a badly contaminated area require highly trained personnel.

Offsetting the fact that a serious contamination will require the services of skilled personnel with elaborate equipment is the fact that such contamination would exist, if at all, in only a small region - by far the greater part of a county (or any subdivision of comparable size) subject to attack would be completely free of radiation hazard. In fact, except for an underwater burst, which might contaminate say ten square miles, one would expect that well over nine tenths of the territory coming under one civil defense jurisdiction would be completely free of radioactivity. Even in the case of an underwater burst the clean area is many times larger than the contaminated since the average size of the 92 largest cities in the United States is 53.8 square miles. The difficulty lies in the fact that an instrumental survey is needed to determine that a locality is clean - the situation is quite different from that of a fire or other catastrophy, the location of which is obvious.

The whole civil defense radiological problem falls in two parts: (a) to establish as quickly as possible which areas are clean, and (b) to cope with whatever special conditions exist in those areas found to be contaminated. The first part is in many respects the more important since it will probably affect by far the greatest number in their daily lives. Fortunately it requires only simple instrumentation and comparatively unskilled personnel to determine that there is no significant radioactivity in a locality, if we have mainly to consider "fall-out" from an air burst or base surge contamination from an underwater (or underground) burst. It is possible to imagine, of course, situations in radiological warfare where a region showing less than 10 mr/hr on a "gamma only" meter might be unhealthy for long occupancy because of alpha contamination. But this sort of situation would not have the acute emergency character of an attack with atomic bombs, and, furthermore, it is unlikely that the enemy would go to the trouble of removing the gamma emitters from a mixture of radioisotopes just to fool the simpler radiation detection instruments.

It has oftan been pointed out that the ratio between beta and gamma intensities encountered in a contaminated area may vary over a very wide range,and this is used as an argument that the civil defense monitoring instrument must have some response to beta radiation. This argument loses much of its weight, however, when applied to an instrument to be used for a prompt survey whose object is to determine that an area is clean. The abnormally high ratios of beta to gamma activity encountered after the Bikini "Baker" test seem in part to be due to biological concentration which takes appreciable time (especially in the temperate zones). Also, it is very unlikely that, even at the extreme ratios observed, a "gamma only" instrument would report an area clean when it had a dangerous beta contamination, since this still would have an easily detectable amount of gamma with it, not to speak of the bremstrahlung.

Granting the premise that it is important to designate clean areas as such just as quickly as possible, it is obvious that the radiological monitoring problem calls for two types of teams in widely differing numbers with different levels of training and types of equipment. Merely to avoid confusing these, the members of those teams whose function is the simple decision that an area is clean or practically so might be called "radiological wardens," and the term "radiological surveyors" applied to the better trained and equipped personnel. The latter would be able to evaluate dosage from a mixed radiation field, compute permissible working times for emergency personnel required to operate in affected areas, and to accompany such personnel to insure their safety in operations involving risk of really significant exposure (say over 10 r). These comparatively highly trained surveyors should not have to waste their time on initial survey operations. They should be organized on a mobile basis and be at the disposition of the state (or county in some cases) civil defense authorities to be called in when the wardens discover a dangerous situation. This might be arbitrarily set at a gamma reading in excess of some such figure as 2r/hr at 1 hour after the explosion (correcting all readings to this epoch). An eight to twelve man team should be capable of handling any situation which might arise due to fall-out from an air burst, but in case of an underwater burst where the 2r/hr contour at 1 hour would enclose roughly 10 square miles (with Bikini conditions of a 5 mph wind)[1] it would be highly desirable to have at least two such teams present on a mutual assistance basis.

1. Effects of Atomic Weapons, Fig. 8.101)

On the assumption that the surveyors must reach the scene of an explosion within a few hours, a minimum of two teams per state should be organized (except perhaps in the smallest states), and in states having more than one primary target area additional teams might be provided to equal the number of target areas. The teams should not be based within the critical target area and consideration should be given to dispersal of their equipment. I do not know the number or distribution of critical target areas by states but guess that the total number of survey teams desirable would be between 150 and 200.

The cost of equipping one of these survey teams would be rather high, but if the number can be held below 200 it should not be nearly so formidable a problem as trying to supply the wardens with instruments coming anywhere near meeting the specifications issued by the FCDA last December. The surveyors should have instruments (presumably ionization chamber types) capable of differentiating between beta and gamma rays. They must be supplied with individual pocket dosimeters and complete protective clothing. Serious consideration should be given to supplying them with oxygen-generating breathing equipment (such as the "Chem-Ox" mask). Certainly a few of these should be available to each team. Facilities for counting of smears and dust samples (including alpha counting) and for emergency assay of water samples should be provided in some sort of mobile laboratory which would serve as field headquarters for the team. This field laboratory need not be very elaborate since under the anticipated conditions the background would make really low level work impossible. Good communication between the individual surveyors and their team headquarters is absolutely essential if teams of the size contemplated are to have any success at all in coping with the situation. This probably requires the provision of "handy-talkies" or "walkie-talkies."

Members of the survey teams will have to be well-enough trained to permit them to function on detached duty accompanying fire-fighters, rescue squads or emergency teams. In this duty they would have responsibility for the safety of the squad they are escorting and would advise the squad leader on all such matters as safe working times, protective clothing or equipment needed, etc. This degree of competence will be hard to achieve, of course, but if less than 2000 surveyors are required the picture is not too black. Of course, mere technical training is not enough; personality is important since the surveyors will be called on to exercise judgment and provide leadership.

One might summarize the proposed surveyor teams by comparing them in degree of training and equipment to the teams comprising the "interim monitoring network" established by the AEC at various sites, including Brookhaven Laboratory. The members of the teams would have to include some who are sufficiently expert in electronics to maintain the instruments - which, of course, will not be as simple and rugged as those issued to the wardens. Given candidates with a high level of intelligence and preferably some background in engineering or physical sciences, a three weeks' intensive course would probably be sufficient.

The wardens, on the other hand, would require only simple equipment and a very slight amount of training. They would have no need for protective clothing, except perhaps a safety helmet, and pocket chambers rather than personal dosimeters would be adequate. Their instruments should be reasonably rugged and require essentially no maintenance. If they use batteries these should be of the ordinary flashlight type obtainable at any drug or hardware store. A gamma only instrument would be acceptable with a maximum scale reading of perhaps 5r/hr, provided that it does not paralyze but reads off-scale at the high end in radiation fields of several hundred r/hr. The job of locating contamination, if any exists, will be greatly facilitated if the instrument is a Geiger-Müller counter type and provided with headphones. With this sort of equipment a warden can cover clean territory very rapidly. If conditions permit he can ride in a slow moving vehicle; otherwise he can patrol as fast as he can walk.

The warden would be provided with markers or signs to be posted to indicate an area has been found clean, and also to designate any hot areas he might find. If he should discover a region showing more than a predetermined amount of radiation, say 100 mr/hr at 1 hour after explosion, he should report the fact as promptly as possible to his team chief. The latter would be responsible for checking the report and, if verified, for notifying the authorities in charge of dispatching the surveyors. The warden teams would then do what they could before arrival of the surveyors to locate and mark the 2r/hr contour. They should be instructed not to go beyond this point unless specifically directed to do so for some emergency work.

Since the wardens would not be difficult to train nor expensive to equip, it would be possible to have a large number of teams, based on the population density. It would seem feasible to have at least one team per high school throughout the country, with additional teams in cases where the high school has more than 1000 students. This may require a total of about 30,000 teams, each consisting of perhaps eight wardens (male or female) and a chief and deputy chief. A few nights' instruction with occasional refresher drills should be sufficient training for a warden. There should be a somewhat broader training program for the team chiefs. It is quite possible that the surveyors may be used as instructors for the chief wardens, who should be capable of training their own team members.

If schools are set up to train the surveyors it would be a good idea, particularly in target areas, to permit the chief wardens to take the surveyor course if they desire. This would help greatly to improve the teamwork between the wardens and surveyors, at the same time furnishing a source of replacements for the surveyor teams.

This is not the place to go into details of the operations and organization of the classes of monitoring teams, rather it is intended to call attention to the practical necessity for two types at different levels. By simplifying the functions of the lower level teams we can provide them in adequate numbers and at the same time furnish the more skilled group with much better facilities than they would otherwise have. It seems certain that this scheme would provide the population with better protection at a lower overall cost.