Paper

RETURN TO NORMALITY AFTER A RADIOLOGICAL EMERGENCY*

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Abstract—**Some preliminary considerations from the management of post-accident situations connected to large scale and high land contamination are presented. The return to normal, or at least acceptable living conditions, as soon as reasonably achievable, and the prevention of the possible emergence of a post-accident crisis is of key importance. A scheme is proposed for understanding the dynamics of the various phases after an accident. An attempt is made to characterize some of the parameters driving the acceptability of post-accident situations. Strategies to return to normal living conditions in contaminated areas are considered.**
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INTRODUCTION

The Three Mile Island accident in 1979, and the Chernobyl accident in 1986, were followed by a societal crisis which largely overwhelmed the radiological and economical consequences. Although relatively limited in Pennsylvania, the crisis in Ukraine, Belarus, and Russia reached an intensity which has affected the socio-political developments in these three former Soviet Republics over the recent years. Today the situation seems less problematic but the behavior and the attitudes of a large fraction of the population, at the day-to-day level, remain influenced by the mental traces of the accident.

Obviously, many factors specific to the Soviet situation prevailing in the late eighties have played a key role in the development of the crisis. However, it would be an illusion to think that, in the event of an accident in Western Countries, with large releases into the environment resulting in the contamination of a few thousand square kilometers, this so-called post-accident crisis would not appear. Besides the local conditions that existed at the time, which probably exacerbated the process, the experience of Chernobyl has revealed that the set of protection criteria and countermeasures, directly inspired by the usual radiological protection principles to restore acceptable living conditions in the contaminated areas, are inadequate to respond to social demands.

The pre-established radiation protection criteria, as well as those specifically developed in the years following the accident, have not significantly modified the social acceptability of the situation, despite the fact that they have been regularly revised under the general pressure of the public and local authorities. Even the International Chernobyl Project (IAEA 1991), initiated by the International Atomic Energy Agency in 1990, at the request of the government of the former U.S.S.R., had a limited impact on the attitude of the public.

Two opposing interpretations can be given for this situation. One can argue that the criteria were well founded but were misused by authorities and, above all, misunderstood by the general public because of the intrinsic complexity of the topic; or the criteria were simply inadequate and need to be re-examined in light of new dimensions. The first case is a matter of education; the latter is a matter of a revised thinking associated with new theoretical and methodological developments.

In this respect, one of the main merits of the International Chernobyl Project is the fact that it allowed many Soviet, as well as Western experts, to become aware of the need to take into account the societal dimensions of radiological protection in the management of post-accident situations. It is also interesting to note that, despite an extensive response of international organizations to the Chernobyl accident, very little attention has been given to the need of exploring the societal dimensions and the role they could play in influencing radiological protection principles and concepts to restore confidence in the affected populations. It is important to facilitate the return to normal living conditions in affected areas and to prevent, or at least to mitigate, the possible emergence of a post-accident crisis.

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DYNAMICS OF ACCIDENTS AND POST ACCIDENT CRISIS

It is generally accepted that there are two main phases for the radiological management of accidental situations: the acute phase, directly following the accident, during which emergency plans are implemented and remedial actions decided according to criteria prepared in advance; and the post-accident phase characterized by the implementation of countermeasures driven by the justification and the optimization of interventions. In theory, individual dose limits as they apply for practices should not be used for interventions since the establishment of intervention levels is mainly based on the individual and collective doses averted by the countermeasures (CEC 1992).

This simple scheme, however, does not give enough attention to what could be called the accident's dynamics. Any large accident involving an important part of the population can be described by a succession of phases, each of them characterized by its duration, the behavior of the individuals involved, the collective response of the rest of the society, and a given type of intervention. They also appear in an order which seems to be important in allowing the population involved, as well as the rest of the society, to recover from the shock of the early phase and progressively return to a situation which can be considered normal.

The left side of Fig. 1 presents the profile of the ideal post-accident evolution with its successive phases. The process starts with a reflex phase, which is short and characterized by the implementation of pre-planned interventions. The successful management of the reflex phase is crucial because the perception of the following phases is largely influenced by the impressions left by the first actions.

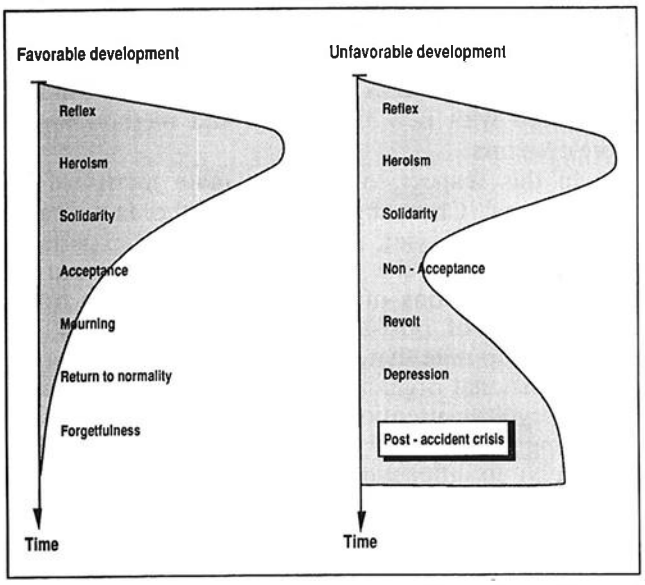

Fig. 1. The various phases of an accident: favorable and unfavorable evolution.

The heroism phase spans a rather short time period during which the affected population and the general public express strong reactions to the accident. Besides an inevitable feeling of revolt, which rapidly turns into a social debate about negligence and responsibility, heroic actions are taken to save potential survivors or to eliminate remaining acute dangers. Next, a strong solidarity is expressed by the non-affected portion of the society as a result of identification with the victims. Experience with large industrial accidents has also shown that, during this period, the affected individuals, and the society as a whole, are able to endure exceptional constraints and particularly higher levels of risk than in normal situations. This can be reflected in the setting of intervention levels considered unacceptable in normal conditions.

The acceptance phase is generally much longer and corresponds to a transitional period dominated by the management of the post-accident situation. From the technical point of view, the objective is to control the residual threat to the population, to repair damages, and to progressively rehabilitate the environment. This can be compared to a convalescence during which basic functions of the society are progressively restored. Parallel to this, a symbolization process around victims and heroes (those individuals who have sacrificed themselves to save lives, for example) is engaged which finally allows the construction of a collective memory indispensable to reaching social acceptance of the accident and its consequences. This last aspect can be similar to a mourning process involving both survivors among the affected population and the rest of the society. As during the previous phase, individuals are still able to tolerate unusual constraints with the belief that there is some hope, or assurance, of a return to normality in the not too distant future.

The return to normality marks the end of the social perturbation initiated by the accident. At this point, all main social functions are available and the population is in a position to forget the accident and its consequences. Society can focus its attention on day-to-day preoccupations. This does not mean that society is behaving like nothing has happened, rather, the consequences of the accident have been fully integrated at both the rational and symbolic levels and serves as a learning experience for the future.

This evolution can be considered ideal when all phases are fully experienced and accepted, without skipping a step, so that the hope for a return to normal conditions can regularly increase. However, sometimes the situation turns into a crisis as illustrated on the right part of Fig. 1. In this case the affected population, as well as large fractions of the population outside the contaminated areas, refuse to accept the situation. It is still not clear how the rejection phase replaces the mourning one. Obviously, this process results from the conjunction of various factors related

to the scale of the accident, the economic and socio-political context, the level of education and information of the population, the impact of countermeasures, and, fundamentally, the perception of the situation by the various actors (Prêtre 1989).

At this point, it is possible to propose a very simple scheme to analyze post-accident situations combining the various aspects that have been delineated so far (Fig. 2). Attention should be placed on the analysis of the mechanisms which drive the emergence of the social crisis or the process leading to the progressive return to normality. It must be noted that the use of the term normality is not without some problems, for example, its definition is too vague and it is often used in a moral sense referring to a standard of conduct or a set of norms. In fact, the intention here is simply to qualify a situation where the basic functions of the society operate as usual and no particular perturbation affects its members. A parallel could be drawn between the state of health of an individual and what could be considered the equivalent for society.

THE ACCEPTABILITY OF POST-ACCIDENT SITUATIONS

Because there have been very few accidents, knowledge is limited about the acceptability criteria of post-accident situations involving radiation. In the case of the Chernobyl accident, for example, the use of classical risk perception concepts (Slovic 1987) does not really help to understand the development of the post-accident crisis.

Another perspective is given by the analysis of the practical experience of those who have been directly confronted with the contamination in the most affected areas around Chernobyl. The preliminary results of a series of interviews of contaminated village residents allow for a better understanding of some of the elements which seem to play a significant role in the perception of the situation by the population and its response to the general management of the remaining consequences (Lochard and Schneider 1992a). In the following, only a few aspects connected to the return to normality are mentioned.

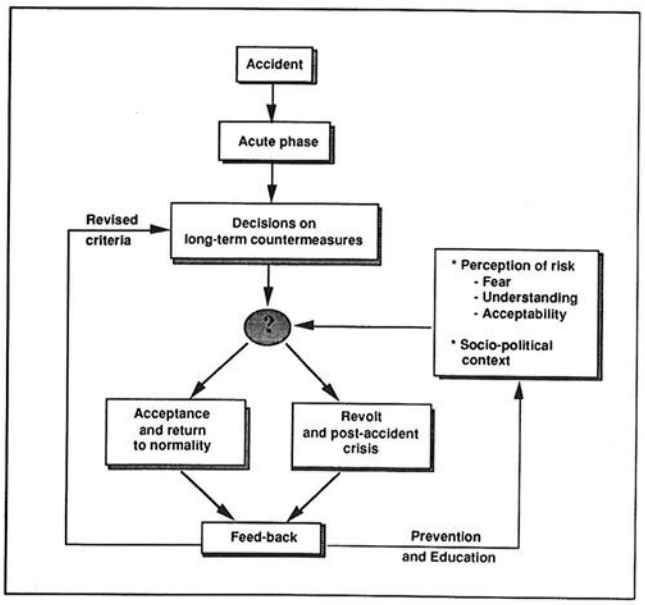

Fig. 2. A scheme to analyze post-accident situations.

The emergence of time

Because the contamination of the environment will remain for many years, the population is directly and permanently confronted with the concept of time. This temporal dimension emerges in daily life through the existence of various restrictions and constraints associated with the management of contamination. This continuously reminds the residents of the presence of the radioactive traces. In everyday life, man is confronted with the cyclical time of the clock, the days, the seasons, the years, but fundamentally he lives forgetting his own mortality and the inevitable fact that each day is bringing him closer to his death. It is only because one can forget time as a linear phenomenon that it is possible to assume the daily worries and, finally, the passing time. The presence of radioactive traces as a manifestation of a pure duration (non-cyclic phenomenon) places everyone in front of his own finitude and generates a lot of distress.

The zoning process

The definition of countermeasures and their implementation inevitably leads to the zoning of the contaminated areas according to different levels of ground contamination. From the acceptability point of view, the consequences of this zoning process are disastrous. It induces behavior very similar to that seen in ghettos. The people living inside the zone are almost considered similar to plague-stricken or leprous persons. As a consequence, not only the land is marked but also the population. Even without the drastic measures of evacuation or relocation, the existence of zones with different practices regarding the management of countermeasures induces a loss of identity and dignity of the population living in these zones in relation with the perception of those living outside.

The reference to the norm

Although, in theory, the concept of dose limits does not apply to post-accident situations, it seems inescapable to make some reference to these well established values for the protection of the public and workers. The general population, as well as its representatives, reject the idea of a double standard. It is clear from discussions that what is at stake is not so much the difference in the level of residual risk associated with different limits but the obvious difference in treatment of the affected population compared to that living outside the contaminated areas. This attitude demonstrates the population's desire to be re-

garded as normal citizens and the need for self reassurance by denying the exceptional character of the situation. This point is strongly connected to the return to normality previously mentioned.

The few aspects described in the above paragraphs provide only a partial view of the dimensions driving the perception and the acceptability of a particular situation. The main point to be emphasized here is the claim for normality from those remaining inside the contaminated areas. This demand is expressed in many different ways by individuals who want to be considered and treated as any other member of the society. Actions which are effective in reducing the difference between the living conditions inside and outside the affected zones (even symbolic actions) reinforce the feeling of security for those living inside and solidarity from those living outside.

The idea of developing accident management criteria with direct reference to the dose limits used for normal situations is controversial, and even heretical, as seen from the radiological protection community's point of view. However, it seems inevitable that effort be devoted to this issue in the future. From the conceptual point of view, it is questionable to develop intervention strategies aimed only at reducing the risk (averted dose), without taking into account the residual dose level. The argument of the difference between practice and intervention is correct, but unfortunately it is not meaningful from the perspective of perception and acceptability of risk.

FROM ACUTE PHASE TO NORMALITY

Based on the considerations developed so far, it is possible to draw a general and preliminary scheme that could be helpful for structuring the management of post-accident situations. This scheme requires respecting the sequence of the phases and allowing for flexibility. The timing of the various countermeasures (not only when they are introduced but also their duration) is of prime importance so as not to create too much distortion with the symbolic dimensions of the situation. For example, it is clear that an evacuation cannot last much longer than the so-called solidarity phase. During a later phase, it is probably better to envisage permanent or temporary relocation. As far as relocation is concerned, it is also important to evaluate, for each situation, the time after which it is unacceptable to envisage the return of the population. In practice, the planning of post-accident countermeasures must take into account the dynamics of the accident. Flexibility is needed to take into account the potential indirect negative impacts of countermeasures which have already been illustrated above.

The proposed scheme is an attempt to articulate the various types of countermeasures with the dimensions of acceptability. Using the Tolerability of Risk model as a starting point (now broadly used in the field of nuclear risk assessment and management), it is possible, with minor modifications, to envisage the following framework for the analysis and design of intervention strategies (Fig. 3).

The upper part of the chart corresponds to unacceptable levels of risk which require severe countermeasures (for example, relocation). Obviously, this covers situations where the levels of exposure are approaching the range of deterministic effects, but it also includes situations where the most basic social functions are not preserved because of disturbances due to the general level of contamination.

The intermediate part of the chart is defined as the tolerability zone which is characterized by limited constraints on the day-to-day life regarding production, distribution, and consumption of goods as well as the functioning of institutions like schools and hospitals. Such temporary countermeasures, adjusted in time and space to the phase of the accident evolution, as well as a set of control and surveillance actions concerning the health and environment of the population, will be implemented. Globally, all measures adopted have to be justified and optimized. Furthermore these measures must be implemented in a transparent and understandable way in order to gain the confidence and the adhesion of the population.

The lower part of the chart corresponds to the levels of residual risks that can be considered negligible. It is characterized by a total absence of restrictions in every day life. This situation could be connected to the forgetfulness and the normality evoked above.

The difficult task to be completed for this general scheme is the definition of numerical values that could serve as references for delineating the borderline between unacceptability and tolerability on the one hand and acceptability and negligibility on the other hand.

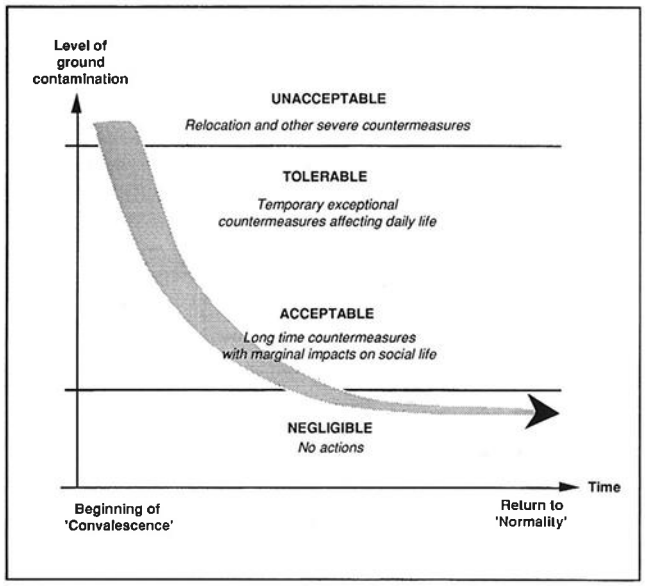

Fig. 3. The tolerability of risk model applied to post-accident situations.

At this point some direct or indirect reference to the dose limits associated with normal operation should be introduced. It should also be noted that the reference to normal situations is also linked to the systems of control and monitoring. It is possible to envisage a link with normality, not only for public but also for occupational protection. Generally speaking, it is only possible to announce a return to normality by using values and controls that are more or less bound to normal conditions (either those prevailing for the public or those applied to workers).

From a managerial point of view, the scheme presented above should be applied keeping in mind two basic objectives:

a) to prevent the emergence of a post-accident crisis, or at least to reduce the probability of the occurrence of such event and to mitigate its consequence if it occurs, and
b) to arrive as soon as reasonably achievable at a situation considered normal for the largest majority of the affected population.

A derived goal would then be to adapt the countermeasures to the various phases of the accident. For example, it is possible to accept an exceptional regime during the heroic and solidarity phases when the main concern is not yet the management of the residual risk level but the mitigation of the direct impacts of the accident. This period normally ends with the setting of exclusion zones if necessary, as well as the relocation of the population if the residual risk is judged unacceptable. The size of the exclusion and relocation zones have a great impact on the perception of the situation, so it is of extreme importance to define them after a close analysis of possible alternatives. During the convalescence phase, if the countermeasures are managed within the range of tolerable levels of risk and adopted on the basis of an optimization process, the situation should be acceptable as long as the residual doses are of the same order of magnitude as other accepted radiological situations like radon, for example. Therefore, it is possible to envisage acceptably higher levels for a minority of the population if the conditions are comparable to normal conditions for occupational exposures.

Looking retrospectively at the situation that prevailed in the late 1980's in the contaminated areas around Chernobyl, it is clear that the main problems arose in the regions where the ground contamination was on the order of 15 to 50 Ci km^{-2} (600 to 2000 kBq m^{-2}) (Lochard and Schneider 1992b). At such levels, the situation is still exceptional and basically unacceptable. It is similar to attempting to extend the heroic and solidarity phase over years and years. It can be calculated that a tolerable situation, as outlined above, will hardly be achievable before a decade (Fig. 4). This is far too long to allow for any hope of improvement in the near future, and the set of constraints imposed on the population inevitably destroys social cohesion. Even though the relocation of the

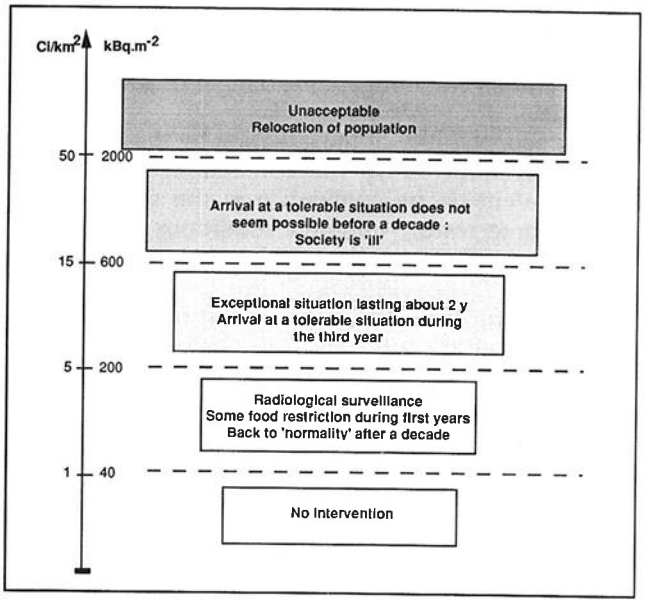

Fig. 4. Simplified scheme for the analysis of the Chernobyl situation in the late 1980s.

population living in these areas was difficult to justify from a strict radiological protection point of view, taking into account the general level of stress, the former Soviet authorities concluded that further relocations were unavoidable.

This experience demonstrates that the transitional period before a return to normality is only tolerable if the levels of exposure are not too much higher than those generally considered as acceptable in normal conditions. One can reasonably think that if the residual level of exposure is in the range of a few mSv y^{-1} for the large majority of the population, a few tens of mSv y^{-1} for the remaining part of the population, and less than 50 mSv y^{-1} for the workers and very specific critical groups, the situation should be manageable. However, during the preceding acute phase, aimed at restoring all basic societal functions under the best possible conditions, one could envisage higher residual risk levels if this phase was clearly perceived by the population as exceptional and short term. As far as full normality is concerned, it seems difficult not to adopt the values of 1 mSv y^{-1} and 20 mSv y^{-1} on an average over five years as a reference for the general public and workers, respectively.

CONCLUSION

This analysis and reflection on the societal dimensions of the post-accident situations leads to these conclusions:

a) Post-accident situations evolve according to successive phases, each having a strong social significance and implication from the acceptability point of view. The practical management of these

situations ought to respect this basic dynamic in order to facilitate a progressive return to normal conditions and mitigate the danger of severe social crisis.

b) The acceptability of the situation by the population directly affected by the contamination is largely dependent on its confidence in the ability of the system to restore tolerable conditions and to progress towards normality within a reasonable period of time.
c) One main concern of the affected public is to restore, as much as possible, normal living conditions in order to escape the ghetto effect induced by the zoning of areas and by different treatment from the rest of the population.
d) For society, a key parameter is the duration of exceptional conditions. These conditions cannot last too long in order to maintain the feeling of time as a cyclic rather than a linear phenomenon.
e) From the radiological protection management point of view, except for the early phase after the accident during which the population is able to support exceptional levels of risk, the residual level of exposure is only tolerable if it remains close to the values considered for normal practices.

Specific attention has to be given to the concept of normality, used throughout this paper. Despite the ambiguity that the term may present, there is evidence for considering this notion as a key element for intervention design, particularly as far as the level of residual risk imposed to the population is concerned. Some other aspects which have been neglected here should also be analyzed in a context close to normality, such as the psycho-sociological impacts of delayed health problems emerging many years after the accident.

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