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EVALUATION CRITERIA FOR EMERGENCY RESPONSE PLANS IN RADIOLOGICAL TRANSPORATION

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Summary

This paper identifies a set of general criteria which can be used as guides for evaluating emergency response plans prepared in connection with the transportation of radiological materials. The development of criteria takes the form of examining the meaning and role of emergency plans in general, reviewing the process as it is used in connection with natural disasters and other nonnuclear disasters, and explicitly considering unique aspects of the radiological transportation setting. Eight areas of critical importance for such response plans are isolated: notification procedures; accident assessment; public information; protection of the public at risk; other protective responses; radiological exposure control; responsibility for planning and operations; and emergency response training and exercises.

Introduction

In recent years, there has been an increasing concern on the part of the government that emergency response plans be developed for nuclear transport, both by truck and by rail. In keeping with Federal guidance, numerous groups involved in such transportation systems such as carriers, shippers, receivers, state and local governments have devised emergency response plans to cope with any accidents which may arise. In spite of this maze of plans, social scientists have as yet not summarized relevant research findings from research on disasters by which others might review and classify such plans as either adequate or in need of improvement. The purpose of this paper is to examine the present state of knowledge regarding emergency response plans for natural and nonnuclear disasters and to show how the information derived from studies of these incidents is related to the problem of emergency planning for transportation accidents involving potential releases of nuclear materials. As a first step, our tone is general; we are attempting to provide a rationale for consideration of eight major dimensions in evaluations of emergency response plans. Our arguments for designating these criteria are developed in terms of three important issues: consideration of emergency response plans versus systems, the characteristics of different hazards, and unique aspects of radiological transport incidents.

Emergency response plans versus systems

Before developing the background for these criteria, it is important to understand the distinction between an emergency response *system* and an emergency response *plan*. An emergency response system is composed of resources (both human and material) which will be used to respond to a radiological incident. A plan refers to designations of authority, agreements, general operational concepts, and emergency policy concepts which form the basis for a coordinated emergency response. Some recent approaches to emergency planning recognize this difference by distinguishing among the general emergency plan, the operational procedures and implementing instructions [17, 22]. In this report, our primary focus for evaluation is the general emergency plan; that is to say, upon the strategies outlined as a means of coping with an incident. Although we devote some consideration to operational procedures and implementing instructions in the elaboration of specific evaluative criteria, these can be expected to differ among plans and jurisdictions, and the examination of such differences generally sheds little light upon the adequacy of a given plan.

It is also important at the outset to establish reasonable expectations about the structure and intent of emergency plans. No plan can be expected to address every conceivable issue or cover every possible contingency. A plan which attempted to do so would probably be so complex and lengthy as to preclude implementation. Hence, plans should be simple and flexible.

Furthermore, emergency plans must make some assumptions about the abilities of individuals and organizations which will be involved in using the plan. When the persons and agencies are ones with high levels of technical training, possessing requisite specialized equipment, who work together with sufficient frequency that they can respond in a coordinated fashion, it is virtually unnecessary to have a written plan. When one or more of these conditions is absent, however, it becomes necessary to specify information which can be used to guide the activities of people or groups who are being called upon to perform what are to them unfamiliar or nonroutine tasks. Hence, the purpose of a written or codified emergency response plan is to ensure that agreement is reached by the parties (organizations) involved regarding the appropriate means for providing an effective and efficient response to a threatening incident. In this context, a response must be effective in that all tasks necessary to mitigate the hazard are undertaken. It must be efficient in the sense that duplications of efforts are minimized and that a minimum of time is lost between hazard detection and initiation of mitigation activities.

There is, unfortunately, an imperfect relationship between the presence or absence of a detailed plan and the likelihood of an effective and efficient response to a radiological incident. There will, in general, be a tendency for jurisdictions with detailed response plans to be more likely to respond effectively than jurisdictions without a detailed response plan.

However, one can expect to find situations in which a detailed response plan produced an ineffective response or an effective response was produced in spite of the absence of a detailed written plan. The former situation would be most likely to occur when the response plan had been formulated but not tested (or, if tested, had not been maintained properly and had been allowed to become outdated). The latter situation could be expected to arise in situations in which organizations have specialized personnel and equipment available on short notice. It would be particularly likely to occur in jurisdictions which respond on a routine basis to a variety of hazardous materials incidents. Such a jurisdiction might have a need for a little beyond a current cell list.

Development of a rationale for criteria for the evaluation of emergency response plans relies, to some extent, on previously published work on the development of state emergency response plans for fixed facility and transportation-related radiological incidents [17, 22]. The research literature on individual and organizational response to natural disasters (especially work on warning systems) was reviewed for its applicability [2, 5, 6, 8, 15, 16].

Characteristics of hazards: natural vs nuclear

Since the selection and definition of criteria in evaluating radiological response plans are drawn from the literature on natural hazard response plans, it is important to consider the relationship between a natural disaster and a nuclear disaster (i.e. a radiological transport incident). The purpose of this section is briefly to review the logical bases for making comparisons of individual and organizational response to natural disaster with that which is likely to be exhibited in the event of a radiological transport incident. This discussion assumes, in a sense, that which is unlikely; when we refer to nuclear disaster, we assume a transport incident has occurred which involves a release of radioactive material in quantities which pass a significant hazard to human health and safety. Such incidents have, in fact, not occurred to date. However, one can provide a logical basis for comparison by reviewing the definition of disaster, isolating crucial dimensions on which disasters may differ, and then examining events which may be classified as disaster, using the selected dimensions as the basis for comparison.

Most people think of disaster as a catastrophic event, often associating the term with the forces of nature: floods, earthquakes, hurricanes, etc. Yet other events—explosions, industrial accidents, wars—are also described as disasters. In establishing parameters for the social scientific study of disaster, Fritz [8] has developed a definition which highlights important distinguishing features of disaster events; namely that they are any event

> . . . concentrated in time and space, in which a society or a relatively self-sufficient sub-division of society, undergoes severe danger and incurs

> such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented.

This definition stresses that disasters occur in a definite time and place, and that they disrupt the flow of social relations for some period. Allen Barton offers a similar definition, but chooses to focus upon social systems, noting that disasters exist "when many members of a social system fail to receive expected conditions of life from the system" [2]. Both Fritz and Barton are arguing that a disaster is anything which results in a significant change in inputs or outputs for a given social system. The important point to be gleaned from this review of definitions is that hurricanes, flood, earthquakes, *or nuclear transport incidents* all fit equally well into either definition. Therefore, at this definitional level, nuclear disaster can (and should) be treated under the same conceptual rubric as other natural and manmade disasters.

Given that natural and nuclear disaster fit well within the same definition, one can further assess the nature of the relationship between the two classes of events by comparing them to specified characteristics of disasters in general. That is, one can specify how the two types of disaster differ in terms of important defining characteristics. Some researchers, albeit only a few, have already approached this problem. William A. Anderson, in his study of the functioning of local civil defense offices during natural disasters, also addressed the implications of his study for performance during nuclear disaster. In prefacing his analysis, Anderson argued that in spite of various differences between the two types of disaster.

> . . . they can be visualized as primarily ones of degree. With the exception of the specific form of secondary threat, i.e., radiation, and the probability that a wider geographic area will be involved, a nuclear disaster would not create essentially different problems for community response [1].

Thus, a decade ago, Anderson began laying the basis of a scheme to compare nuclear with natural disasters; it was indicated that two important distinguishing features were the form of secondary impacts, and the scope of impact. Barton devised a classification scheme for disasters — for which he introduced a more abstract term, collective stress — which builds upon the two characteristics Anderson used. In his attempt to characterize the nature of stress on social systems, Barton chose four basic dimensions: scope of impact, speed of onset, duration of impact, and social preparedness [2]. Scope of impact is a geographic reference indicating that impact involves a small area or only a few people (narrow impact) or large area or many people (widespread impact). Speed of onset refers to the suddeness of impact — the length of the time period between detection of a hazard and its impact on the social system; this dimension is usually classified as sudden (no warning before impact) or gradual (days or even weeks before impact). Duration of the impact itself refers to the length of time that elapses between initial onset of impact and the point at which it subsides. This can be a few minutes (short) in the case of a tornado, or many days (long) in the case of some riverine floods. Finally, social preparedness is used in the context of possible forewarning to indicate whether the current level of technology permits us to anticipate or quickly detect disaster threat.

To complete the list of important defining dimensions, we will retain Anderson's concept of secondary impacts. Virtually all hazards, whether natural or manmade, entail secondary impacts; in some cases the secondary impact is even more devastating than the initial impact. Riverine floods tend to deposit silt and debris over inundated areas, earthquakes often result in urban fires, and hurricanes leave great physical destruction, often creating public health risks. A radiological transport incident involving a nuclear release can involve both an initial impact and a lingering secondary impact, in the form of residual radiation, which could potentially persist as a hazard for some time.

By assembling lists of identifying characteristics such as those elaborated above, one can examine a range of hazard agents and be alerted to important distinctions among them. Table 1 classifies four selected hazard agents in terms of the important defining characteristics. What is important in this table is that (for the selected characteristics) there is as much variation (differences) among the three natural hazards as there is variation between the natural hazards versus the nuclear hazard. Thus, with respect to scope of impact, we see that transport incidents can be classified in a way similar to floods. Radiological transport incidents and floods both vary substantially with respect to the size of the area and number of people affected. Floods can range in their scope from highly localized drainage problems which produce only minor inconvenience to a few people to the catastrophic floods of the Ohio—Mississippi basin which can devastate an entire region of the country. By way of contrast, radiological transport incidents may range in magnitude from minimal overexposure of individuals within a few meters of

TABLE 1

Selected hazard agents classified by defining characteristics of disaster

Defining characteristics	Hazard agent			
	Riverine floods	Earthquakes	Hurricane	Radiological transport incident
Scope of impact	narrow	widespread	widespread	narrow
Speed of onset	sudden or gradual	sudden	gradual	sudden or gradual
Duration of the impact	short (although variable)	short or repeated	short (although variable)	short (although variable)
Secondary impacts	yes: public health problems	yes: physical damage and public health	yes: physical damage and public health	yes: physical and public health (radiation)
Social preparedness (predictability or detection in advance of impact)	yes	not at present	yes	no

a medical or industrial source to a breach of containment and subsequent release of spent fuel. In view of the success to date in preventing major releases of radioactive materials in transportation, one can only speculate as to what a realistic upper estimate of impact for radiological transport incidents might be. Even if the most serious transportation incidents experienced to date had occurred during much more unfavorable environmental circumstances (e.g., heavy rainfall washing released material into streams), the scope of impact would amost certainly not have exceeded that of most flash floods. In terms of speed of onset, transport incidents can be similar to flash floods or earthquakes. In only one of the characteristics do nuclear disasters potentially set themselves apart from all the natural hazards, that is the persistence of the secondary threat. While most disasters involve secondary impacts, the nature of those posed by nuclear disasters are distinctive in form (radiation) and in the long time frame during which at least some radiological materials may continue to constitute a hazard or threat.

It has been argued above that one can appropriately examine nuclear disaster within the same conceptual and analytic framework as any other disaster, whether natural or manmade. The same basic definition encompasses all of the events and when defining characteristics are examined, we find that natural hazard agents differ as much among themselves as they are different from radiological materials. Therefore, a careful examination of the problem reveals no significant reason for treating nuclear disasters as phenomena totally different from other events characterized as disasters in the social science research literature. Hence, one may, with a minimum of qualification, apply findings about human reactions to natural hazards to the problem of radiological transport incidents, as long as careful attention is paid to matching along the defining characteristics.

Unique aspects of radiological transport incidents

The preceding arguments were meant to demonstrate that logical and appropriate comparisons can be made between warning response in natural hazards and nuclear disaster. It was argued that *analytically*, in terms of the present state of hazards research, there is no justification for isolating nuclear disasters in a class by themselves. This is not to say, however, that transport incidents — as opposed to accidents at fixed nuclear facilities — do not involve some distinctive characteristics. Indeed, there are several aspects of effective response to such incidents which are similar to those involved in response to natural disasters. These similarities involve generic functions: the organization of warning systems, construction of warning messages, recommendation of protective strategies such as evacuation, may be the same for nuclear and natural disasters.

Transportation-related radiological incidents, like many natural hazards and unlike fixed nuclear incidents, have a very rapid speed of onset combined with an uncertain locus of impact. Unlike the natural hazards, radiological incidents contaminate property, rather than destroy it. Impact mitigation measures such as decontamination, or for that matter, impact detection in radiological emergencies, require specialized skills and equipment not possessed by many local governmental agencies and certainly not by the average resident or passerby. This significant difference in the nature of the threat does have the capacity to produce corresponding differences in the nature of the response to the hazard. This is not to say that the fundamental categories of response will change. In virtually any disaster situation, the same phases of social response are in evidence: threat detection, threat evaluation, information dissemination (notification), and response. However, systematic differences in length of forewarning, scope of impact and other factors will affect the manner in which the response is implemented. In light of the small (compared to fixed nuclear facilities) inventories of material that are transported in any single shipment and the substantial engineered barriers to release, it is most probable that the scope of impact of transportation-related radiological incidents will be narrow. As with other transportation incidents, one would expect that these events will continue to require response that is largely characterized by efforts at population protection and physical cleanup. The "subtlety" of the threat, due to the inability to detect the presence of radioactivity without specialized sensing instruments, combined with its persistence, makes it particularly important to develop plans which provide for quick and comprehensive response.

Although we shall not discuss pre-impact mitigation measures (as distinguished from postimpact mitigation measures) to any significant extent, it should be noted that these may have the potential to alter significantly the course of the response to an incident. An important factor in many disasters is the length of the period of time between the onset of the threat and the notification of those who have the capability to respond appropriately. Another factor of some significance, given the remoteness of many accident sites from the location of the skilled personnel and equipment, is the length of time that it takes to assemble radiological assistance teams at the scene. Past experience with transportation-related radiological incidents has suggested that a variety of measures could be undertaken to decrease the likelihood of unacceptably long delays at each of these steps. To some degree, it is difficult clearly to distinguish plans from other types of preimpact mitigation measures. The most important distinction in this context is that plans address the means by which a response will be executed while preimpact mitigation measures more generally are considered to be actions that act directly to reduce probability or magnitude of the threat.

In summary, we have argued that radiological transport incidents — and nuclear disaster in general — fit into the definitional and classification framework used to examine natural disasters. It has been stressed that the focus of the research literature is upon a class of events which can be designated "disasters". Even though specific events may differ from one another, they may still all be treated within the same conceptual category. Furthermore, we have suggested that radiological transport incidents do have one distinctive characteristic: the persistence of the secondary threat. It is vital to remember, however, that this so-called "unique" characteristic is *not* justification for separating the analysis of nuclear and natural disasters. Instead, such a distinguishing characteristic is acknowledged and treated only as a factor deserving special attention in the context of choosing elements to be included in the development of criteria for evaluating emergency response plans.

The evaluation criteria

Criteria for the evaluation of emergency response plans can be considered to fall into two classes: substantive criteria and supporting criteria. Substantive criteria deal with the adequacy of the content of the plan. This includes the areas of notification, accident assessment, public information, protective response and radiological exposure control. Supporting criteria refer to those aspects of the plan that address nonoperational or noncrisis needs. These criteria, responsibility for planning and operations, and emergency response training and exercises, deal more with the initiation and maintenance of the plan than with the operation or implementation of the plan.

Notification

Discussion of substantive criteria logically starts with the onset of the threat — that is, the point in time at which the accident occurs. It is at this time that the notification process begins. The notification process phase ends only when all of the parties who have a duty or a capability to respond have been informed of the occurrence of an accident. In order to ensure that all who have a need to know about the incident are alerted, it is necessary to develop an explicit set of criteria for determining who is likely to initiate the notification process, which parties they should notify, which communications channels are available and should be used, and what information should be transmitted. In most cases, it is to be expected that the driver of the truck or crew of a train will, as employees of the carrier, make an attempt to notify their dispatcher and a state or local police office. In any event, it is quite likely that local or state police will be the "first agency on the scene". The first on the scene will, in turn, notify other local and state agencies including the lead state agency which will inform still other agencies at the state and local level and make the link to the federal response system. In view of the preeminent responsibility of the states for the health and safety of their citizens and the role of the carrier as an agent of the shipper, it is common for these parties to play leading roles in responding to the incident. The length of time that it takes to notify these lead parties could, under certain circumstances, take an appreciable period of time. A serious truck accident involving the death of a driver, might, for example, produce such a delay. To date, however, notification times have been reassuringly small. Hornsby, Ortloff, and Smith, for example, reported on a yellowcake spill in southeast Colorado in which the shipper was notified within approximately one hour of the truck wreck by the local county sheriff's office. This was in spite of the fact that the accident took place in a rural area in the middle of the night and the driver of the truck was pinned inside the truck cab [13]. Taylor reports notification times of 10 and 20 minutes for a train derailment and a truck accident, respectively [23]. He also notes a one-and-a-half hour lag in receiving notification of a different train derailment. In all three cases, these times refer to the length of time it took to notify the *shipper*. He does not report the length of time that it took to notify the local authorities.

The presence of shipments of radioactive materials in transit around the clock makes it essential that specialized knowledge of radioactive materials and their handling be available 24 hours a day. This means that both communications channels and personnel should be available for quick response.

Finally, there should be a recognition that the information to be transmitted to the state's lead agency for radiation control will be coming from personnel who may have little familiarity with radioactive materials. Consequently, it is desirable to have standardized forms available to agencies likely to be first on the scene so that the appropriate information can be obtained in a timely manner.

Accident assessment

Specialized instruments are required to assess accurately the magnitude and location of a release of radioactive material or to confirm that no release has occurred. This can pose a more substantial problem for emergency workers than does the need for speedy notification. Although information can be transmitted instantaneously, the transport of specialized equipment takes time. In some situations, this means that uncertainty persists for some time as to the location and magnitude of release. In some incidents, knowledge of the nature of the material being transported, together with the visual inspection of the integrity of the container, can reliably confirm that no release has taken place. In other situations, only the use of the appropriate sensing instruments can be expected clearly to identify the location and magnitude of the hazard. Speedy deployment of these instruments to the incident site can be greatly facilitated if there is a centralized inventory of resources available for radiological assessment. This should include the location of instruments and the identity and location of personnel trained in their use.

Public information

One of the most significant problems in dealing with the public in an emergency is the tremendous confusion that can be generated when each involved party supplies information directly to the public. The ambiguous or conflicting statements that can result shake the public's confidence in the ability of those in authority effectively to safeguard lives and property. Previous research on natural disasters indicates that the public is disposed to comply with the legitimate requests of those in authority, even if the requests result in some level of discomfort or extra effort and expense [7, 18–20].

Some aspects of the public information process are merely advisory. That is, there is an effort to disseminate information about the incident to those who are believed not to be at risk. Conflicting or ambiguous statements can, in this situation, produce mistrust and suspicion that something has happened that must be "covered up". This can, of course, produce unnecessarily negative reactions to the prospect of future transportation of radiological materials.

Protective response

In any incident involving a continuing threat to health and safety, it is desirable to evacuate the population at risk to safety, to define a controlled access area and to institute other protective action as required. In most transportation incidents to date, the population at risk has consisted of travelers passing the scene of the incident. Even with the release of a more substantial volume or a more highly radioactive inventory of material, it is unlikely that it would be necessary to evacuate to a distance greater than a few hundred meters. In such an event, however, it would still be necessary to observe a few principles which have been found in the natural disaster literature to be effective determinants of compliance with requests to evacuate.

One of the most important findings relative to natural hazard evacuation planning is that many people do not evacuate immediately when they are asked to do so [20]. This reluctance to leave has been documented by a number of studies of individuals' evacuation decision-making processes. Although only a few investigators have done so, the results of studies of individual response to warnings can be used in emergency response plans by considering actions which could be taken to enhance citizens' tendencies to comply with evacuation warnings [4, 5, 21]. In this way, attention may be directed toward the development of *incentives to evacuate* which promote citizen compliance. In this context, an "incentive" is any procedure or provision devised by authorities and incorporated into emergency evacuation plans which increases the probability that threatened individuals will comply with a warning to evacuate.

A careful review of the empirical literature on individuals' responses to disaster warning indicates that five major issue areas merit carefult consideration. Adaptive plans, warning confirmation behavior, the role of the family, security and property protection, and sheltering have all shown to be associated with the degree of success of an evacuation program.

Studies of evacuation indicate that in order to clear an area effectively, residents must either have prior knowledge of some standing evacuation plan or be informed of such a plan at the time of warning. The problem of families *not* evacuating (or evacuating to an even more dangerous location) when evacuation routes and destinations are not well known has been widely documented. It is particularly important to make detailed evacuation information available at the time of warning. In most transportation incidents, evacuation warnings can be issued on a face-to-face basis; designated emergency officials — often fire fighters or police officers — issue the warning to each house in the threatened area. In such cases, officials could explain the warning and give residents the appropriate instructions.

Another incentive to evacuate can be derived from addressing the problem of transporting evacuees to shelter. Most evacuation plans assume that the majority of evacuees will supply their own means of transportation. Limited official transportation is made available to those who cannot otherwise arrange transportation. Another incentive to evacuate consists of making transportation readily available.

Virtually all research on evacuation states that people attempt to *confirm* the warning message. This is particularly important when an evacuation warning is given on anything other than a face-to-face basis. Warning confirmation may include observing the response of neighbors, talking to friends or relatives, or contacting some official source. While the consequences of this confirmation process sometimes include jammed communication lines as well as information which may conflict with the initial warning, it is important to remember that people who fail to confirm a message tend not to evacuate.

Another incentive, then, would involve developing warning confirmation centers rather than leaving confirmation as a haphazard process. Citizens could be instructed to contact these centers for warning confirmation or more detailed instructions. Such a system could be based on telephone contact and would also serve a rumor-control function. Furthermore, since confirming instructions could be somewhat standardized, such centers would minimize problems which traditionally arise when citizens receive contradictory or conflicting warning messages and instructions while seeking confirmation.

Telephone convergence on a disaster area is a significant problem. In fact, many disaster planning handbooks emphasize that one should never advise citizens to use their telephone [11, 14]. It is also well known that such rules are systematically violated; people call into an area to check on relatives; and residents call out to issue reassurance to friends and relatives as well as to call for official warning confirmation. The small scope of impact associated with transportation-related radiological incidents suggests that this recommendation may, however, not be appropriate.

It has long been known that families tend to evacuate as units [3, 4] and that the separation of family members often involves anxiety and attempts by evacuees to reunite families, sometimes by returning to previously evacuated areas. Keeping families united may not be as important as simply having information available regarding the whereabouts of family members [9, 10]. This suggests that evacuation would be facilitated if some means were available through which families could communicate if separated. The establishment of "family message centers", where *evacuees* would obtain information on the whereabouts and condition of family members, could be included in evacuation shelter planning.

There is a large volume of field research which indicates that the problem of looting is rare in a natural disaster [19]. However, the best available information on evacuee perceptions suggests that security remains an important concern [20]. As part of an evacuation incentive program, local communities should communicate to the public the general nature of whatever official security measures will be undertaken. Such measures need not elaborate; the purpose of communicating them is to inform potential evacuees that some measures *are* being taken.

This review of incentives to evacuate describes important issues in individuals' evacuation decision-making processes and suggests ways in which such information might serve as stimulants for compliance with evacuation plans. The practicality of each of these evacuation incentives will depend critically upon the conditions which are present when the plan is actually executed. These conditions include the size of the population at risk, the capacity and vulnerability of evacuation routes, as well as the type of radioactive material involved.

In some transportation-related incidents, it may not be possible for the employees of the carrier, personnel from the first agency on the scene, or other responsible parties immediately to isolate the area affected by the accident and to control access to this area. In such cases, it is desirable that those not experienced in the handling of incidents involving radioactive materials be made aware of the necessity of accounting for persons who might have been exposed to radiation so that they may be examined for evidence of contamination or, subsequently, for adverse effects of exposure. Inventories of equipment suitable for establishing an exclusionary area should be available on a ready basis to local emergency services personnel; if not, they should be carried on the transport vehicle. The location of medical facilities available for the treatment of contaminated emergency response personnel and victims should be accessible on short enough notice that this consideration would not be an obstacle to rapid treatment of victims.

Radiological exposure control

Even more desirable than detaining persons possibly exposed is the rapid achievement of an onsite capability for radiological monitoring and decontamination of emergency personnel and others. Protective action guides should be made available in order to regulate the exposure of emergency personnel to radiation.

Responsibility for planning and operations

The radiological emergency response plan for each state should clearly indicate the authority under which the plan has been written, and by which assignment of responsibility for various functions under the plan have been assigned. There should be documentation that potential interorganizational ambiguities have been resolved to the satisfaction of all parties likely to be involved. These interorganizational problems include relationships among agencies at a given level of government, interlevel relationships as well as relationships between public agencies and private (e.g., shipper and carrier) sector parties.

Emergency response training and exercises

Perhaps the most frequently slighted of all the desired characteristics of an emergency response system deals with the level of effort put into testing the system to determine its effectiveness and efficiency under fairly realistic conditions. Exercising the system requires that all parties have copies of the plan, are aware of their responsibilities, and follow through the steps necessary to perform their functions. This requires regular — at least once a year — exercises of the plan which need to be observed and critiqued by qualified observers. In some jurisdictions, certain *portions* of the plan will be tested many times a year by actual incidents. This may give grounds for confidence in the ability of the agencies involved in low-threat incidents to respond effectively, but should not lead to overconfidence in the ability of the plan as a whole to produce effective response in situations which have not been tested.

Among other valuable contributions, exercises can identify hidden problems that might delay or even prevent successful accomplishment of an agency's prescribed response function. In one exercise for a fixed nuclear facility, the agency responsible for identifying evacuation areas did not discover until the plant personnel notified them of the affected zones and sectors that their map of the county did not indicate true north. As a consequence, they could not orient their overlays so as to identify accurately the areas requiring evacuation. In a real incident, this would have resulted in a significant delay in the initiation of evacuation and unnecessary exposure of residents in the vicinity of the plant.

Exercises can also serve as a critical test of the reasonableness of the levels of training assumed in the plan to be possessed by the individuals responsible for functions addressed in the plan. As an illustration of this point, it can be noted that the same fixed site drill uncovered a deficiency in the training of those individuals responsible for calculating expected doses to the population exposed to the (simulated) plume. Federal observers noted that projected exposures were laboriously calculated by hand rather than by reference to nomographs. As a result, the projections were neither timely nor accurate.

Summary

The criteria listed above should not be seen as an exhaustive list of all important factors in emergency response plans for coping with radiological transportation incidents. Instead, they should be considered as representing eight major issues, selected on the basis of their critical importance in emergency plans for other types of hazards and their relationship to special characteristics of the radiological transportation process. These criteria can serve as an organizing framework within which more specific factors can be elaborated.

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