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Coordinating, Integrating, and Synchronizing Disaster Response: Use of an Emergency Response Synchronization Matrix in Emergency Planning, Exercises, and Operations*

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A graphical depiction of the entire emergency response process via a synchronization matrix is an effective management too for optimizing the design, exercise, and real-life implementation of emergency plans. This system-based approach to emergency planning depicts how a community organizes its response tasks across space and time. It gives responders the opportunity to make real-time adjustments to maximizing the often limited resources in protecting area residents. An effective response to any natural or technological hazard must involve the entire community and must not be limited by individual jurisdictions and organizations acting on their own without coordination, integration, and synchronization.

An emergency response to an accidental release of chemical warfare agents from one of this nation's eight chemical weapons stockpile sites, like any other disaster response, is complex. It requires the rapid coordination, integration, and synchronization of multiple levels of governmental and non-governmental organizations from numerous jurisdictions, each

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with varying response capabilities, into a unified community response. The community response actions occur in an area extending from an on-site storage location to points 25 or more miles away. Actions are directed and controlled by responding local governments and agencies situated within the response area, as well as by state and federal operations centers quite removed from the area of impact. Time is critical and the protective action decision-making process is greatly compressed. To ensure an effective response with minimal confusion, given the potential catastrophic nature of such releases, the response community must carefully synchronize response operations.

In 1986, Congress directed the U.S. Army to destroy the nation's stockpile of 30,000 tons of lethal unitary chemical warfare agents and munitions stored at eight locations as part of a chemical stockpile disposal program (CSDP) (Public Law 99-145). In 1988, the U. S. Department of the Army (DA), with assistance from the Federal Emergency Management Agency (FEMA), established the Chemical Stockpile Emergency Preparedness Program (CSEPP) to provide a consistent framework for emergency planning and management and to enhance existing response capabilities at each storage location and in the adjacent communities (DA 1988). Consistent with an emergency response to other technical hazards, emergency planning by a CSEPP community involves a variety of governmental and nongovernmental entities from many jurisdictions, both near and distant. For example, the community response at one storage site involves an Indian nation, two states, four counties, and several cities and towns; another community's response consists of one state, ten counties, and numerous cities and towns, not including the federal and national nongovernmental responders to all sites. Although each jurisdiction develops its own emergency operations plan and procedures, all jurisdictions must be tremendously interdependent during a response. Typically, one jurisdiction's population warning processes and protective actions affect a neighbor's response decisions. Often, a jurisdiction relies on its neighbors to take actions to support its response and shelter its citizens.

Theoretical Background

Emergency planning by state and local government emergency management agencies typically results in multi-chapter and multi-volume emergency operations plans, standard operating procedures and checklists that are updated infrequently. FEMA recommends that such plans contain eight annexes for "core" response functions and up to an additional eight annexes for specific hazards (FEMA 1996). Generally, the plans, procedures, and checklists take into account the potential needs of the general public, special facilities (such as schools, correctional facilities, nursing homes, and hospitals), individuals with special needs (a person with physical disabilities or a public-transportation-dependent senior, for example), and responders. They also consider the resources and capabilities over which the agencies have direction and control. These response plans can become quite complex as communities wrestle with differing approaches and procedures for protecting the public from the effects of each identified potential hazard, accident, or disaster. While emergency management agencies develop response plans and procedures for the array of hazards within their jurisdictions on the basis of their own specific needs and considerations, their plan development seldom includes interjurisdictional coordination (Tierney 1980; Quarantelli 1988, 1995). Should a fast-paced, terrifying disaster occur, such as can be expected in the unlikely event of an accident at a chemical weapons storage facility, well-developed predisaster planning and the coordination of responder actions at all levels and within and among affected jurisdictions are imperative. However, as Quarantelli (1988) points out, these plans often fail to incorporate a unified community perspective for the response process.

Common factors that affect a jurisdiction's disaster response include the enormity of the consequence, the involvement of multiple levels of governmental and nongovernmental organizations from numerous jurisdictions, and the rapid and close coordination necessary to respond effectively. Dynes and Warheit (1969) identified ✡more than sixty discrete units of government ranging from volunteer fire departments to the Executive Office of the President" as having responded to a tornado in Topeka, Kansas. Drabek, et al. (1981) and his colleagues indicate that a response to even a "minor disaster" requires the involvement and interaction of 10 to 80 governmental and nongovernmental organizations. Likewise, Quarantelli (1988) reports the surprise of local emergency personnel "at the number and diversity of responders from both within and outside the community which converge on the disaster site."

Researchers also agree that a successful response involves coordination and communication both in predisaster planning and during the response. Quarantelli (1987) states that "emergency management can be considered successful if there has been . . . the development of interorganizational coordination." Lindell and Perry (1995) similarly stress that "The success of disaster response operations is substantially affected by the achievement of effective interorganizational coordination among responding groups and organizations." After examining recent disaster experiences, Sylves and Waugh (1996) recognize that same central theme—a "need for all levels of government to develop a cooperative plan for and response to emergencies." Following a proliferation of major incidents and crises in the United Kingdom, the government enacted civil protection measures to create an integrated emergency management policy in which the main role of local authorities is identified as developing "an integrated approach to emergency management" (Coles 1998).

Response to a disaster without such coordination, integration, and synchronization will most likely stress and overextend the limited and dispersed capabilities and resources of individual emergency response organizations. And, according to Toulmin, Givans, and Steel (1989), unless the inherent governmental distances caused by differing procedures and approaches among organizations in different functional areas at various levels of government are addressed in advance of a response, a communications disaster will occur as well. In describing a hypothetical sarin disaster, Caro (1999) laments the fact that the disaster plan of each governmental department was never coordinated and integrated with others nor tested as such.

Detailed coordination within and among responding organizations increases the length and complexity of response plans, which poses a significant response problem. For example, the CSEPP Annex and associated operating procedures found in one county's emergency operations plan (EOP) exceeds 230 pages as it identifies numerous interactions between both its internal responders and other responding jurisdictions (Madison County 1997). The underlying EOP for Madison County is even longer. This complexity is typical of plans and hazard-specific annexes found across the country in jurisdictions participating in the CSEPP or in FEMA's Radiological Emergency Preparedness (REP) program. These large and detailed plans tend to be ignored by those charged with implementing them (Dynes, Quarantelli, and Kreps 1981; Tierney 1980). Quarantelli (1985) goes so far as to suggest "that some of the best preparedness planning exists in organizations and communities which **do not** have much in the way of written plans" [bold added].

Human factors studies tell us that as complexity and volume increase demand on the human brain, the entire problem—in this case, the planned response to a disaster—can no longer be adequately managed in active memory. A person's cognitive, motor, and perceptual resources "are typically limited in the sense that each can normally be used for only one task at a time" (Freed 1998). Therefore, as the complexity of emergency response planning increases because of an expanding level of interjurisdictional and interorganizational activity, it becomes more difficult for a person to understand the community's complete plan and manage the overall response. Tierney (1980) tells us that "If a disaster plan is to work when needed, both its content and its intent must be conveyed to those who will be involved in the response. . . ." She further indicates that "members of responding organizations must know not only what to do, but also what role their organization is seen as playing in the larger response." While most governmental and nongovernmental organization emergency response directors have an overall sense of their response plan and procedures, the actual implementation details can be overwhelming. And, since many responders and staff members are volunteers who are infrequently involved in planning, the response can become paralyzed as they try to develop or refresh their understanding of the emergency plan, procedures, or checklists by reading them while engaged in implementing the response.

Existing research seems to indicate that, even with a moderately complex plan, a concise method of portraying its details is required to reduce the recall process and to support the mental analysis needed to implement the interactions and resolve inconsistent interrelationships. Quarantelli (1995) calls for a systems approach to planning that incorporates a community perspective. A problem-solving model for emergency planning is recommended by Dynes (1994). In industry, project managers use graphic summaries, such as program evaluation review technique (PERT) diagrams and Gantt charts, to resolve this problem for long-term, complex projects. However, these tools have not been successfully used in the dynamic environment of response management because of their inability to easily integrate dissimilar plans. Dynes (1994) feels that military planning models—specifically, the command and control model—are bad analogies for disaster planning. However, Quarantelli (1989) suggests that the military's distinction between strategy and tactics might be followed and that planners use an overall strategic approach to plan for and solve the general problems associated with coordinating disaster response.

Emergency planners are faced with a dilemma. How do they develop a plan that is "just right" in the amount of detail (i.e., not so large that it discourages reading and use), takes a systems approach, coordinates the responding agencies, and integrates the response into a community effort? We feel that an adaptation of a U.S. Army planning model (the Military Decision Making Process) and one of its tools (the synchronization matrix) provides the methodology to integrate and concisely depict complex disaster plans.

Adapting the Military Decision-Making Process

In the late 1980s, the U.S. Army was faced with a problem of operational complexity similar to that of emergency planners as it implemented its Air-Land Battle strategic concept. This strategic concept required the integration, coordination, and synchronization of military unit actions over a large geographic area. To be able to integrate and synchronize combat operations, the Army examined the battlefield and took two steps toward improving its planning process: (1) broke combat operations into functional operating systems called Battlefield Operating Systems (BOS); and (2) organized the battlefield and support areas to reflect the space in which they were occurring, by identifying deep, close, and rear components (DA 1991). Linking these operational elements with time and expected enemy actions set the framework for the Army's solution to the complexity problem, the creation of a synchronization matrix. The development of a synchronization matrix is now part of the Army's decision-making process performed prior to writing an operations plan (DA 1997).

In an effort to provide a solution for emergency planners and responders in integrating, coordinating, and synchronizing their emergency plans and procedures, the authors constructed a response management tool based on the Army's proven synchronization matrix and decision-making process. Similar in purpose to the Army's synchronization matrix, the emergency response synchronization matrix (ERSM) is used to organize the increasingly complex interjurisdictional response necessary to meet CSEPP response requirements. In adapting the Army's concept, the authors first had to identify a set of functional operating systems used in emergency response and determine and allocate the spatial configuration of a response. They then assessed whether an ERSM could accurately and easily depict the complex flow and multiple, interdependent actions within and among jurisdictions and various levels of governmental and nongovernmental organizations during a response. Finally, the Army's synchronization matrices were designed so they could be prepared for each phase of an operation just prior to it occurring, usually using "pencil and paper." To complete the adaptation, the authors developed software that allows emergency managers to develop, store, and later revise an ERSM as part of their continuous planning process.

Developing Response Operating Systems

In order to take the systems approach to planning recommended by Quarantelli, those systems first have to be identified. Several sources offer insights into possible functional operating systems for emergency response. Lindell and Perry (1995) identify four generic emergency response functions and associated "specific actions" that apply to a broad range of emergencies. FEMA, in its *State and Local Guide SLG 101* characterizes emergency response with eight "critical emergency functions that the jurisdiction will perform in response to an emergency"(FEMA1996). The national Response Team (NRT) identified

Table 1. Comparison of Emergency Response Functions

Lindell and Perry	FEMA SLG 101	NRT-1
Emergency Assessment:	Direction and Control	Initial Notification of Response Agencies
Threat Detection		
Emergency Classification	Communications	Direction and Control
Hazard Monitoring		
Environmental Monitoring	Warning	Communications (with Responders)
Population Monitoring		
Population Assessment	Emergency Public Information	Warning Systems and Emergency Public Notification
Damage Assessment		
	Evacuation	
Hazard Mitigation:		Public Information/Community Relations
Hazard Source Control	Mass Care	
Impact Mitigation		Health and Medical
	Health and Medical	
Protective Response:		Response Personnel Safety
Protective Action Selection	Resource Management	
Population Warning		Personal Protection of Citizens:
Protective Action Implementation		Indoor Protection
		Evacuation Procedures
Access Control		Other Public Protection Strategies
Security		
Victim Reception		Fire and Rescue
Victim Care		
Search and Rescue		Law Enforcement
Emergency Medical Care		
Hazard Exposure Control		Ongoing Incident Assessment
Emergency Management:		Human Services
Agency Notification		
Agency Mobilization		Public Works
Facility Mobilization		
Equipment Mobilization		Others
Internal Direction & Control		
External Control		
Public Information		
Admin/Log Support		
Documentation		

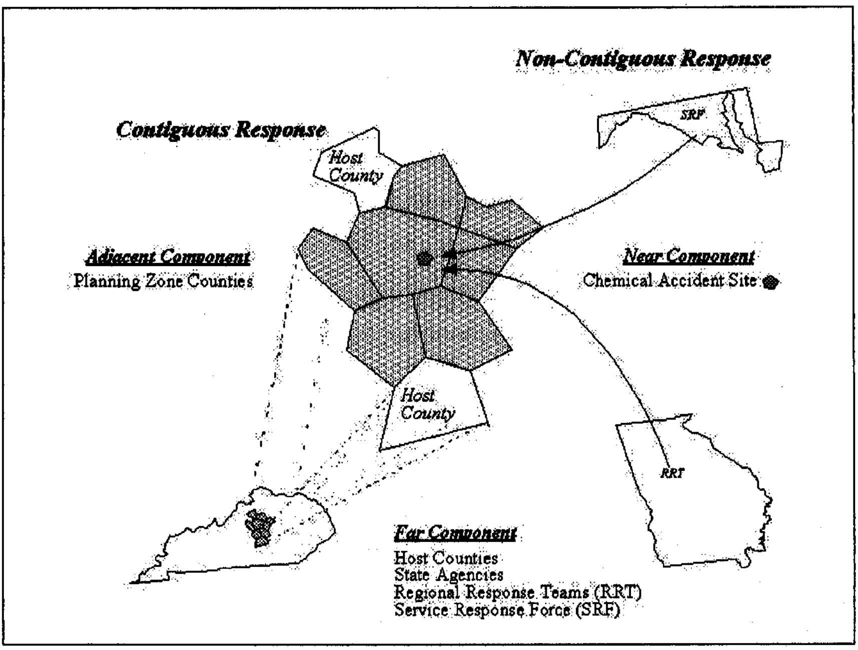
Table 2. Proposed Response Operating Systems

Operating System	Associated Functions
Emergency Management	Direction, Control, Coordination Public Information Resource Coordination
Hazard Mitigation	Incident Containment Site Mitigation
Emergency Assessment	Hazard Analysis Monitoring/Sampling Classification and Notification
Protection	Traffic and Access Control/Security Transportation Protective Action Recommendation/Decision/Implementation Population Warning Schools Special Populations/Facilities Worker Support
Victim Care	Initial Treatment and Evacuation Treatment Facilities Decontamination Remains
Evacuee Support	Reception Centers Shelters Services Non-Government Support

14 response functions in *NRT-1: Hazardous Materials Emergency Planning Guide* (NRT 1987). Each of these sources presents a task-oriented approach to response planning. Table 1 gives a comparison of the emergency response functions of these three sources.

Building on more than two decades of experience evaluating both response plans and operations during annual REP and CSEPP exercises at facilities across the United States, the authors refined these functional patterns into six response operating systems (ROS) (see Table 2). For the ERSM, each ROS covers a broad, critical, major function performed by governmental and nongovernmental organizations to respond successfully to a disaster and to protect the public. Similar to Lindell and Perry's (1992) view, each ROS is subdivided into a set of supporting "task groups" or "functions." The authors did not identify "communications" as a separate operating system or function, because it is an activity that is integral to each response function and therefore occurs across the entire response.

Figure 1. Disaster Response Space for Chemical Warfare Agent



Organizing Disaster Response Space

Disaster response space is that area in which emergency managers conduct response operations. Response space can be separated into three distinct locations: near, adjacent, and far. The affected space can expand or contract over time on the basis of the nature and threat of the hazard, number and variety of responding agencies, and mitigation rendered. Figure 1 depicts the organization of the disaster response space for an incident at a chemical warfare agent stockpile.

The near component of the response area is delineated as the actual accident/emergency/ incident site. Examples of near component areas are the proximate scene where a chemical agent incident occurred or the belt or swath damaged by a tornado. In the near area, responder involvement is immediate; that is, it starts in less than 15 minutes after the incident. For a chemical weapons stockpile site, government or government-contracted first responders and incident commanders have total responsibility for the response in this near component.

The adjacent component includes the area immediately surrounding the disaster scene that has been directly affected. In a hazardous materials incident, the adjacent component consists of downwind areas containing a population, facilities, or infrastructure to be protected from the effects of a release. For a natural disaster, the adjacent component is that portion of a host jurisdiction or an undamaged contiguous jurisdiction where resources can be rapidly mobilized to support response in the near component. Another example of an adjacent component is the set of emergency planning zones associated with the CSEPP or REP. While response in the near component may be the responsibility of a private concern (e.g., a chemical manufacturing plant's internal HAZMAT team) or public unit (e.g., fire department or HAZMAT team), response in the adjacent component is typically the responsibility of municipal or county governments. In general, responders are deployed in the adjacent component anywhere from 30 minutes to two hours after the incident.

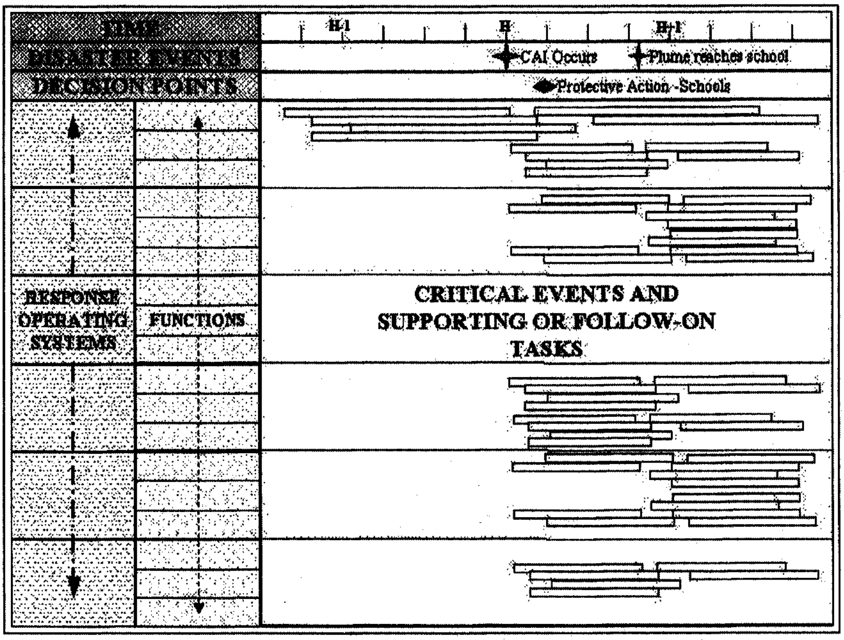
The far component includes areas situated outside the spatial boundaries of the near or adjacent components; they are not always contiguous to the other two components. These locations are where governmental and nongovernmental organizations direct or coordinate their responses or stage their support activities. These locations "contain" state agency and department, federal government, and nongovernmental organization response elements. For example, federal agencies providing response assistance may coordinate operations from regional response centers or may stage equipment and personnel at locations hundreds of miles from the incident site. Typically, the direct involvement of those located in the far component is greatly delayed, usually taking more than two hours to deploy. These organizations require time to activate and mobilize before they can be integrated into the response.

Though they may be conducted or controlled by a variety of organizations, the response activities that occur in each of these three spatial components are not separate or detached. The actions of responders in the near component must be closely coordinated, integrated, and synchronized with those occurring simultaneously in the adjacent and far components. Likewise, the actions in the far component must occur at the appropriate time so that suitable and sufficient resources can be injected into the response activity at the correct time and place to optimize public protection efforts and the mitigation or amelioration of the effects of the accident.

The Emergency Response Synchronization Matrix

The ERSM is a systems-based graphical portrayal of a response. It depicts the a jurisdictional or organizational response by using the ROS,

Figure 2. Layout for the Emergency Response Synchronization Matrix



spatial representation, and arraying response activities, decision points, and hazard actions in relation to time. The design of the matrix incorporates the ROS and associated functions listed on the left side (vertical axis); the disaster time line, decision points, and tasks associated with the ROS are portrayed on the top (horizontal axis). Figure 2 depicts the layout that the authors have developed for the ERSM.

An ERSM for a specific site is constructed using a series of five steps. The first step is to establish a prescribed time line or a set of predetermined phases of a response. Time entries are based on set intervals (hours/minutes, days/hours, etc.) before or after a disaster occurs. Phases are defined as broad process intervals, such as the phases of emergency response (i.e., preparedness, response, recovery, mitigation). Time line intervals are determined by the nature and potential threat of the hazard. For example, the interval for a chemical warfare agent accident may be minutes and hours, while the interval for a hurricane during the preparedness phase (tracking the hurricane) may be hours and days. The second step is to record points at which significant disaster events would occur, such as a chemical plume tip reaching a discrete receptor. These data provide the assumptions about the hazard upon which response actions are based. The third step involves entering decision

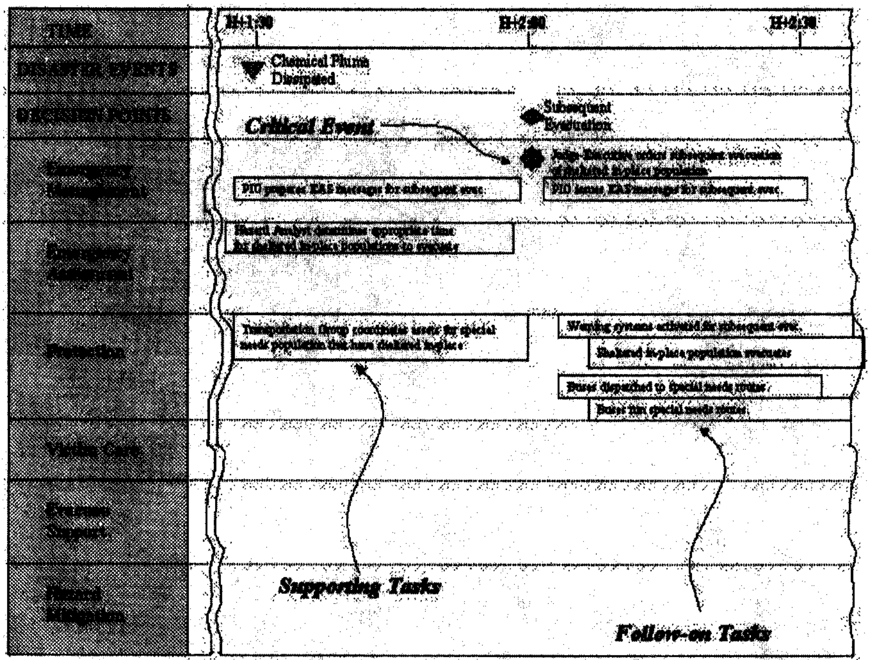


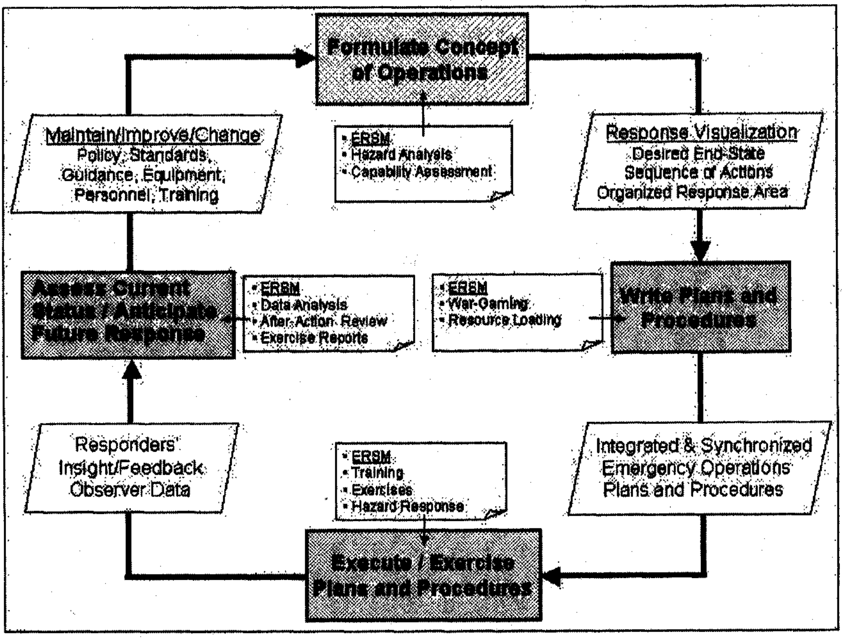
Figure 3. A Sample ERSM

points, that is, points at which emergency managers must make decisions, typically about a critical event, in order to have the best chance of achieving the desired response and end state. Decision points do not dictate what the decisions are, only the points in the response at which they should be made. The fourth step is to indicate critical events. They can be one activity that would directly influence the response by triggering a sequence of follow-on, diverse, single response and actions; a set of complicated actions (such as making all traffic on an interstate highway flow in one direction); or a set of essential tasks (such as the process of opening shelters after an evacuation is ordered). The fifth step is to enter all of the supporting or follow-on response tasks and activities. Both critical events and supporting tasks and activities are entered into the ERSM in relationship to the ROS, disaster time line, and decision points. Figure 3 is an example of a response action flow.

Systems-Based Emergency Planning and Exercises and the ERSM

The systems-based emergency planning and exercise concept consists of a continuous cycle of processes and outcomes that lead to ever-evolving response plans (see Figure 4). The four-step cycle starts

Figure 4. Flow Chart for the Emergency Planning Cycle



with the development of the concept of operations. The visualized concept of operations leads to the writing and execution of plans, procedures, and checklists. The exercise and execution of these plans, procedures, and checklists offers the opportunity for assessment and validation. An assessment of current status and the anticipation of future responses can affect the concept of operations and thus lead to a reformulation of the concept of operations. This emergency planning cycle can be repeated continuously or can be initiated at of the process depicted in Figure 4.

Formulating a Concept of Operations

A concept of operations is formulated on the basis of federal, state, and local governmental and organizational policies, standards, guidance, equipment, personnel, leadership, and training, as well as hazard analyses and capability assessments. The highest planning level involved in the response (e.g., the state emergency management agency for a multicounty response; the county emergency management agency for its departments and agencies involved in a response) develops the concept of operations on the basis of a visualized response to hazards.

Planning assumptions, derived from the aforementioned internal and external factors provide the basis for preparing and an ERSM. The ERSM portrays the entire response scheme in a general manner for a particular hazard. For example, lead planners from affected states, counties, and a large hazardous materials storage site would collectively prepare a concept of operations matrix depicting the general response tasks to be carried out by the storage site (near component), the counties (adjacent component), and the states' agencies and departments (far component) in the event of a catastrophic accident at the specified storage site. Organizations can be included in the near, adjacent, and far component depending upon their affiliation and operational base.

The outcome of a concept of operations development process is a visualization of the response that can be used for detailed planning and for conducting the response operation. The concept of operations should indicate to planners the desired level of protection for the public, desired end state of the response (e.g., evacuation of all areas affected by a chemical plume), the organization of the response area (near, adjacent, and far components as appropriate), and the general sequence of actions. The latter two items are found in the concept of operation ERSM. Continued reformulation of a concept of operations is based on changes in policy, standards, guidance, equipment, personnel, leadership, and training, as well as updated hazard analyses and capability assessments. Assessments of a response organization's current status derived from exercise or actual response activity, coupled with anticipation of future responses, would also cause an concept of operations to be reformulated.

Writing Plans, Procedures, and Checklists.

A general concept of operations ERSM is provided to all of the jurisdictions collectively involved in the disaster response. Each jurisdiction (or department or agency) then prepares a detailed jurisdictional ERSM for the portion(s) of the general response that it is responsible for executing. Through a process of "war-gaming" and resource loading , details are added to the tasks found in the concept of operations matrix. Decision points are added or adjusted, agencies and departments are assigned task responsibility, and a more realistic picture of how the response unfolds is presented. This more detailed matrix becomes the jurisdiction's ERSM from which initial draft plans. Procedures, and checklists are written. Before the documentation is "made final," all jurisdictional matrices need to be "rolled-up" and analyzed for gaps in the response, missed relationships and responsibilities., inadequate coordination, and response timing that is out of synchronization. The jurisdictions meet and review the roll-up matrix, matching, and modifying timing and jurisdictional interactions. Jurisdictional matrices and if appropriate, the concept of operations matrix, are adjusted to reflect the results of the community matrix review. Draft jurisdictional response plans, procedures, and checklists are revised on the basis of these adjustments and final versions are prepared. The outcome is a set of coordinated, integrated, and synchronized emergency plans, procedures, and checklists for each jurisdiction.

During concept pilots conducted in 1998 and 1999 in the state of Utah, the authors were able to show that this planning process can be reversed and that an ERSM can be developed from existing response planning information. In this situation, the jurisdictional matrices are constructed by using data derived from emergency plans, mutual aid agreements, standard operating procedures, implementing procedures, checklists, and interviews. Once constructed, the jurisdictional matrices are rolled up to match timing and jurisdictional interactions. Lead planners then meet and look for gaps and discrepancies among the individual and collective planned responses of each jurisdiction in the rolled-up matrix. Once the jurisdictional matrices have been reviewed and modified, detailed tasks are consolidated, and the general concept of operations matrix is prepared. Individual emergency operations plans are subsequently revised, as needed, resulting in improved emergency plans.

Evaluating Plans, Procedures and Checklists.

Evaluation of emergency operations plans, procedures, and checklists is an essential aspect of the planning and preparedness process. This task is normally performed by observing and analyzing the execution of response processes during training drills; table-top, partial, or full-scale exercises; and actual response operations. The graphic depiction of the entire response process provided by an ERSM offers many advantages to an exercise or evaluation team.

Exercise Design. Exercise designers can use an ERSM as a tool to fashion a robust simulated event environment that allows for realistic participant response, with scenario progression based on participant actions and decisions. The exercise scenario is superimposed on the ERSM, and the disaster event time line assumed for planning purposes can be adjusted to that of the exercise scenario. By using the synchronization matrix and negotiated extent-of-play agreements as a guide, expected player responses are war-gamed and appropriate implementers (often called exercise injects) are written to reflect war-gaming scenarios. For example, if a jurisdiction's operations plan directs the dispatch (the task) of five traffic control points (TCPs) and only two are to be demonstrated (as indicated in the extent-of-play agreement), then the arrival of law enforcement units and other designated support personnel at the three nondemonstrated TCPs would be simulated through suitably timed exercise injects given to the appropriate player(s). Likewise, if during the war-gaming process the activation of one or more of the planned TCPs is delayed because of problems with traffic congestion caused by an evacuation, this prescripted information would be indicated through exercise injects to the appropriate player(s). Prescripted implementers can be developed for a decision's options (for example, the set of four possible protective actions) and the resulting follow-on actions (subsequent operations based on the outcome of the decision). These implementers are tied directly to response actions on a jurisdiction's synchronization matrix.

Exercise Control. As a control document, the ERSM provides the capability to ensure that implementers are injected at the appropriate time on the basis of real-time player actions and not at artificially estimated times. Because implementers are tied directly to response actions on a jurisdiction's synchronization matrix during exercise design, exercise controllers have a ready guide to indicate when implementers should be injected into play. Controllers inject implementers on the basis of when player actions occur. As an exercise unfolds, early or delayed actions are reported from field controllers over a separate controller communications network. These actions are also tracked by other controllers, located in an exercise control cell, who use the ERSM as a reference. The exercise lead controller then ensures that the exercise control staff and field controllers adjust the timing for injecting implementers to match the speed of play in the exercise.

Exercise Analysis. When an ERSM is used, determining exercise results is a two-step process: (1) collection of data in the form of evaluator observations and (2) analysis team examination of the data in the context of the hazard scenario. The ERSM is the tool that links these two actions.

Data Collection. Even skilled evaluators cannot observe every action of every individual, team, section, or organization involved in a response. Evaluators must focus their observations on the critical response actions required to achieve the response goal. To do this effectively, they must identify the key events and then position themselves in the right place at the right time to observe participant actions. By indicating these critical tasks, the ERSM serves as a positioning guide for the evaluation team, thus contributing to optimal data collection. Evaluators also are able to make notes on the ERSM to aid in their assessment of the exercise. Typical annotations would include the exercise start time, the actual time a task is started or completed, whether a task actually is accomplished, and any new or different consequential actions.

Data Examination. By using a process similar to that used when an ERSM is initially constructed, analysts are able to use the ERSM to organize their assessment of the response and to formulate a picture of what happened at their locations during the exercise. Evaluation team leaders can walk evaluators through the exercise play to ensure that all functions, organizations, and operating systems have been addressed and that actions have been examined in context (What was supposed to occur? What actually occurred? Why was there a difference?). During this process, the evaluation team identifies actions and issues that may have been influenced by the actions, inaction, and decisions of other jurisdictions. It then seeks input from evaluation teams from other jurisdictions for additional perspectives on these interjurisdictional relationships. This input leads, in turn, to consequence analysis and answers the following question: "Did the actions achieve the desired end-state for the response?"

Exercise Reporting. The ERSM can be used in two ways to report exercise results. First, it can be used in a manner similar to the way it was used for results analysis: to provide an after-exercise review to a jurisdiction. By employing each jurisdiction's synchronization matrix, the exercise leader has a graphical aid for presenting a picture of each jurisdiction's own response. On the basis of the analysis, the evaluation team leader can show exercise participants the flow of the response and what worked where, explain the effects of early or delayed action, identify gaps in plans or procedures, and provide a consequence analysis. Second, as an addendum to the written report, the ERSM can give each jurisdiction a tool from which to develop changes to plans and procedures.

The ERSM in Emergency Response Operations

The ERSM can serve as a real-time aid for coordinating, integrating, and synchronizing the disaster response in real-time. The general concept of operation matrix enables all jurisdictions to see how they fit into the overarching response as it progresses. The jurisdictional matrix enables them to determine how their respective departments and agencies are progressing in meeting the jurisdiction's responsibilities in the specific disaster response being orchestrated. If an action occurs early or late or not at all, a jurisdiction is then able to see whether that action affects not only its portion of the response but also the overall concept of operations. Appropriate adjustments to the disaster response can then be made both within each jurisdiction and across all jurisdictions.

Individuals from many jurisdictions and levels of government are relied on to effectively and efficiently respond in a timely manner. The ERSM enables these individuals and their organizations to assess quickly where they fit into the ongoing operation and to understand the progression of the response. It also facilitates rapid assimilation of response "outsiders" into a community's response efforts.

Conclusions

While a decade of research has stressed the importance of coordination and cooperation during a response, most jurisdictions still practice self-reliance and self-sufficiency in emergency response planning. As the numbers of potential disasters currently threatening communities to expand to include more devastating types and magnitudes of chemical, biological, and technological terrorist actions, an even greater reason exists for an increased level of cooperation among all levels of jurisdictions in a widening response space. In this new, more complex, fearsome response environment, the multichaptered, multivolumed emergency operations plan, myriad of procedures, and multiple checklists may not be the most appropriate tools for responders, because it is often too complex for responders to implement effectively.

Emergency planning must follow a new paradigm, and it should draw heavily on the proven Army Air-Land Battle concept, which relies on the integration, coordination, and synchronization of military unit actions over a large geographic area for an extended period of time. The ERSM is an adaptation of this concept, offering a proven successful means to articulate and direct a community's synchronized emergency response across time and space. It also provides a process by which planners can develop a clear understanding of what is going to be involved in a response to a particular hazard. It clearly discerns the desired end state (more than protecting the public) and a feasible outcome. It provides an all-hazards planning and exercise too that allows any individual, jurisdiction, or organization responsible for planning evaluating, or conducting emergency response to do so in a coordinated, integrated, and synchronized manner. It ties together all aspects of the emergency planning cycle and captures the many dimensions of a complex response for any type and magnitude of potential disaster currently facing a community.

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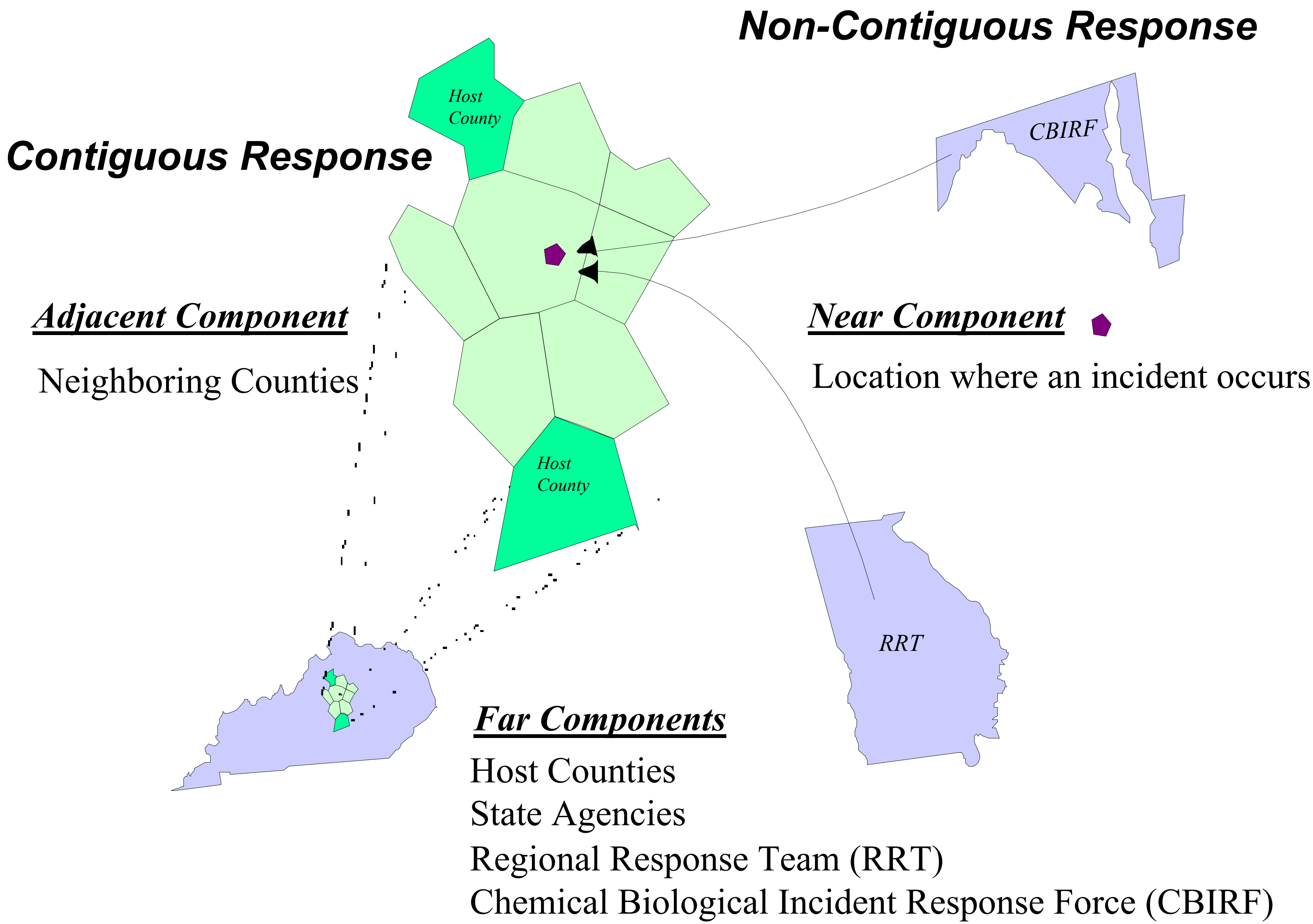

Figure 1. Disaster Response Space for Chemical Warfare Agent Accident

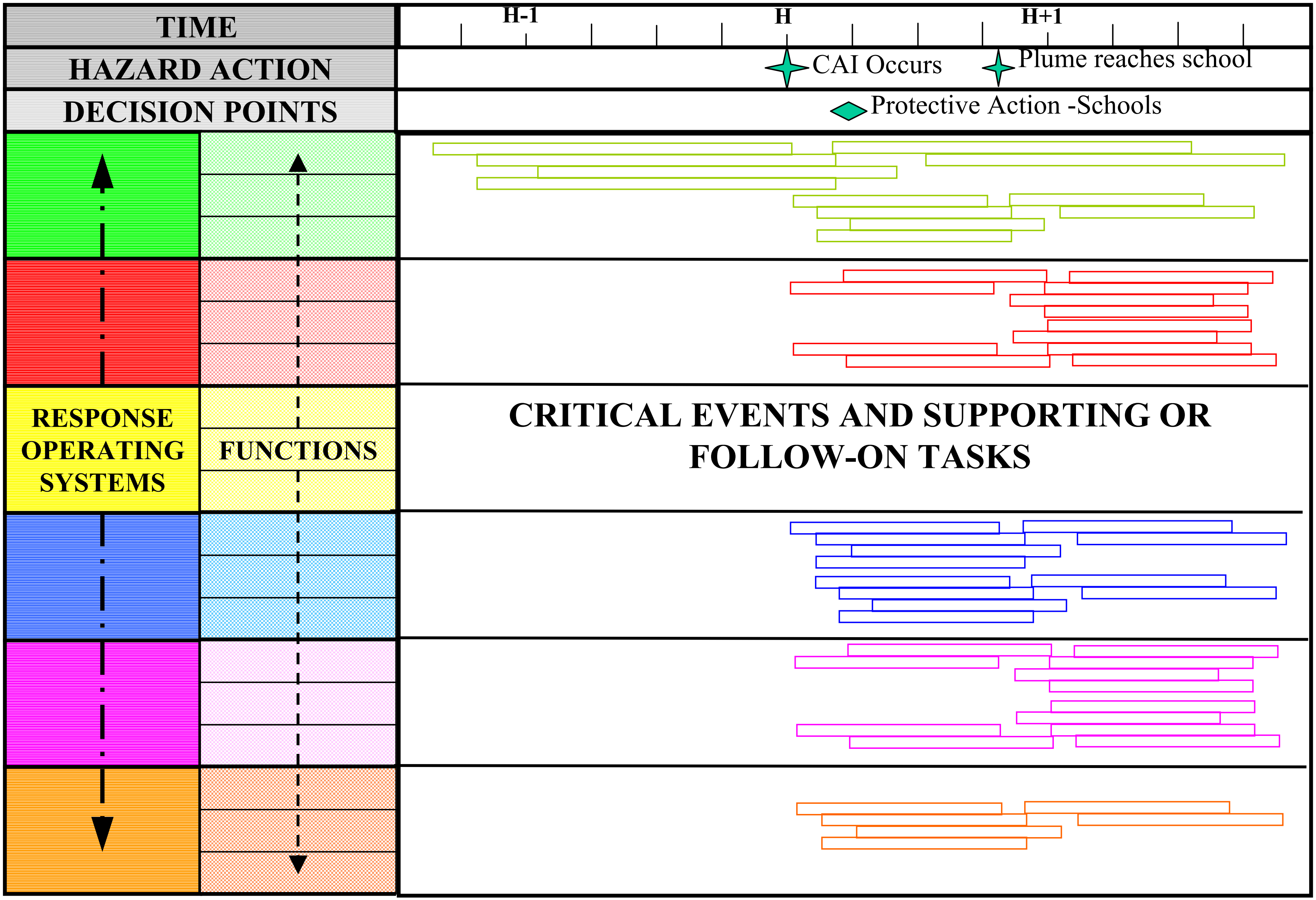

Figure 2. Layout for the Emergency Response Synchronization Matrix

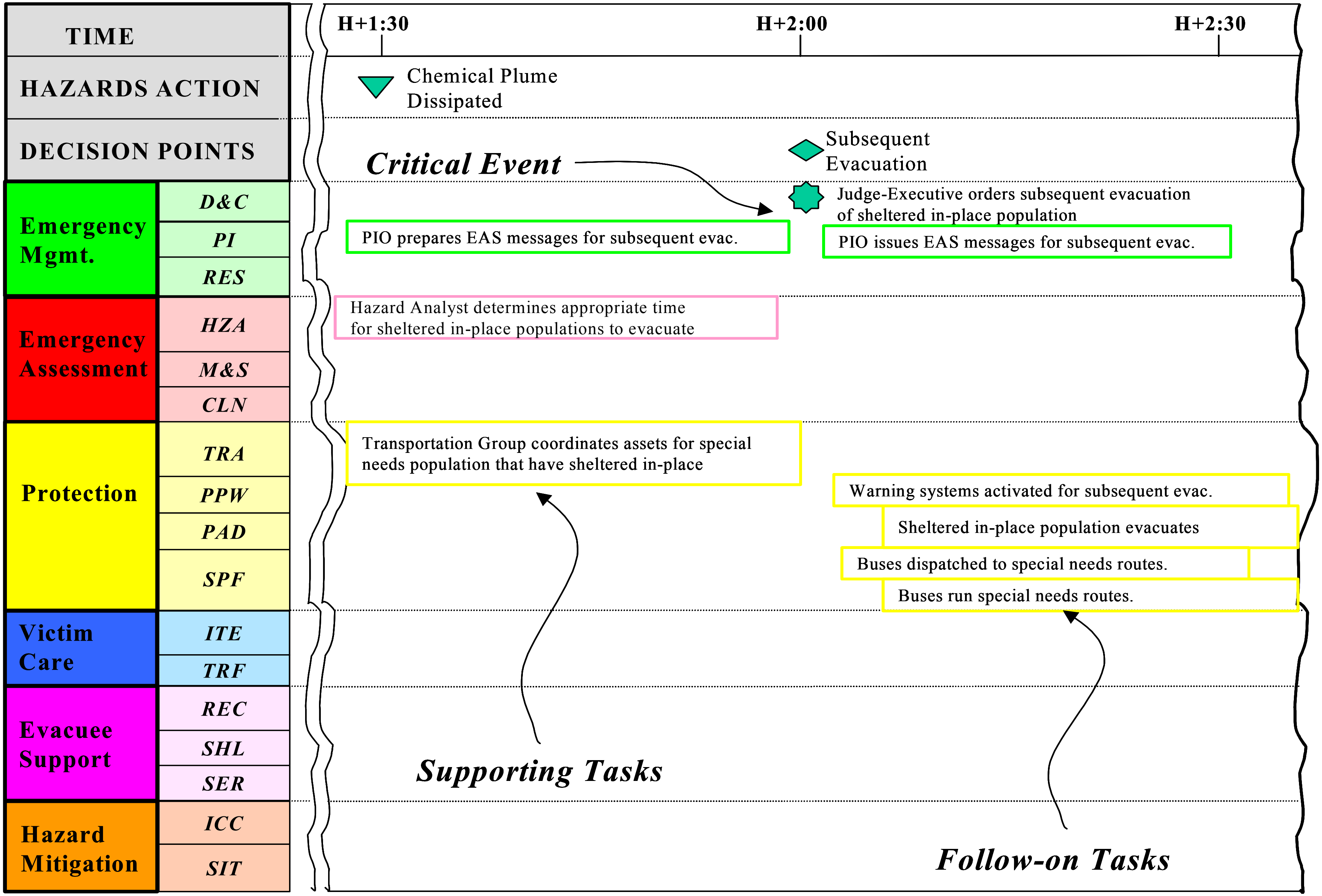

Figure 3. A Sample ERSM

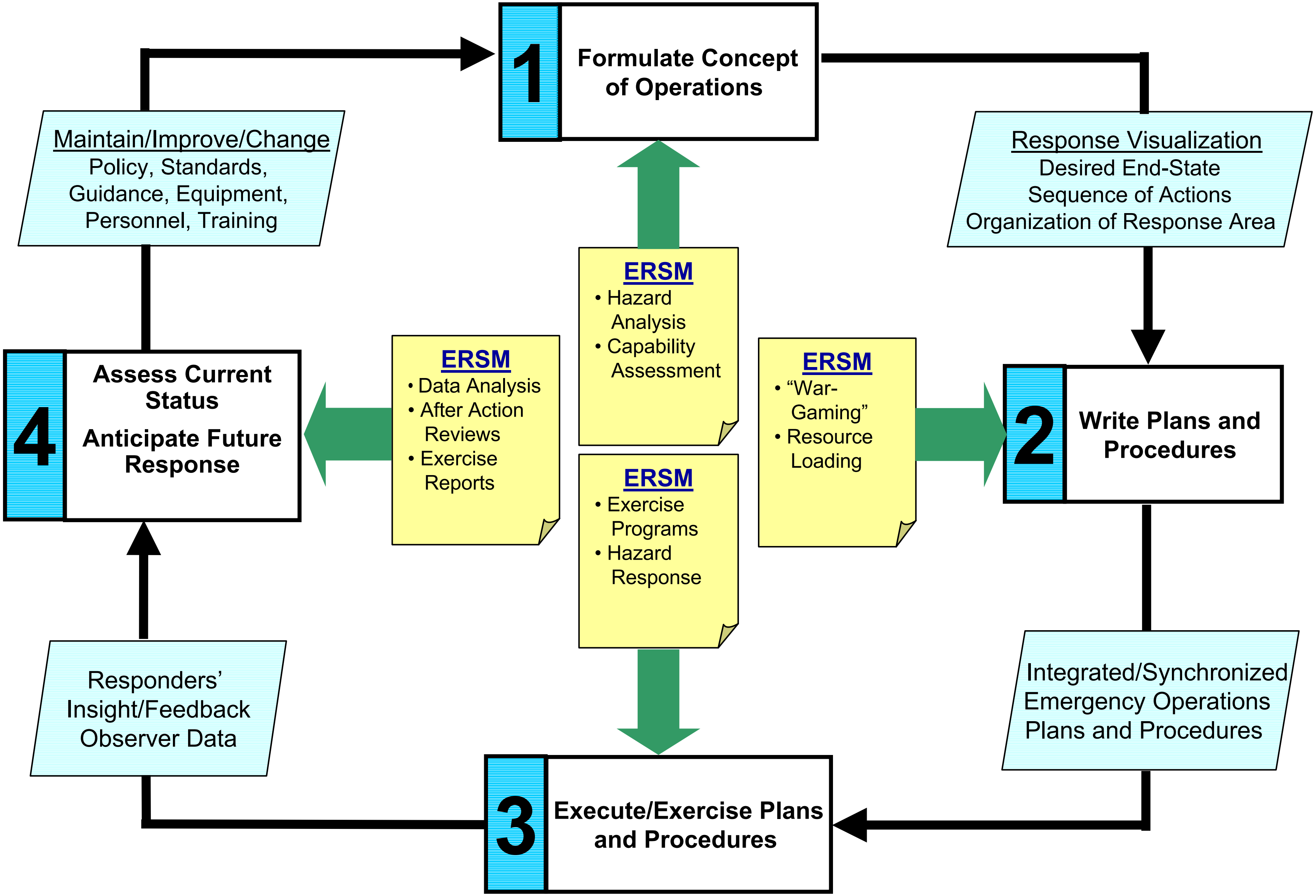

Figure 4. Flow Chart for the Emergency Planning Cycle