The ASPEP Journal 1998

ASPEP

AMERICAN SOCIETY OF PROFESSIONAL EMERGENCY PLANNERS

THE JOURNAL OF THE AMERICAN SOCIETY OF PROFESSIONAL EMERGENCY PLANNERS

ASPEP

The American Society of Professional Emergency Planners (ASPEP) is a professional organization of certified emergency managers dedicated to the advancement of knowledge about disasters and to the improvement of the practice of emergency management. ASPEP works toward these goals through continuing education, through professional development and exchange, and through the publication of an annual Journal.

THE ASPEP JOURNAL

The *ASPEP Journal* is published annually in the fall in time for release at the yearly conference of the International Association of Emergency Managers. The *Journal* is dedicated to the sharing of ideas, research, lessons, practice, and opinion and serves as a forum for all disciplines involved in emergency management. A formal call for papers is issued in early January of the year of publication. Articles or papers which will contribute to the goals of ASPEP are welcome.

A call for papers will be issued about January 1, 1999 for papers to be included in the 1999 *Journal* which will be published in November, 1999. The future may bring either electronic publication or more frequent print publication.

TYPES OF PAPERS

Articles or papers which will contribute to the advancement of knowledge and to improvement in the practice of emergency management are welcome. We encourage breadth of subject matter and depth of discussion.

Examples of subject matter which would be appropriate include:

> The state of the profession of emergency management: where it has been, where it is, and where it is going or should go.
>
> Research which will lead to a greater understanding of disasters, to their prevention or mitigation, to more effective response, or to better recovery practices. Research which will establish a base for further research.
>
> Discussions of particular emergency management problems, resources, or procedures which have not been well addressed in the past.
>
> New ideas which will lead to improved understanding and practice.

Studies of events or exercises and the lessons which may be drawn from them that would be valuable to practitioners in a similar situation.

Programs which may be used by other emergency managers.

Practices which have proven successful.

Since the *Journal* is published only once a year, we prefer papers of lasting interest. You should be sure that the paper you start in January will still be of interest in November.

The *Journal* cannot accept papers which are advertisements or infomercials for particular products.

The usual length of our papers is between 1500 and 4500 words. Shorter articles may be published in the monthly *Bulletin of the International Association of Emergency Managers*. We recommend that you look at the earlier issues of the *Journal*. If you are in doubt contact us.

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The Journal of the American Society of Professional Emergency Planners

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American Society of Professional Emergency Planners

VIRGINIA'S EMERGENCY MEDICAL SERVICES TASK FORCES: A MODEL FOR STATE LEVEL RESOURCE RESPONSE

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BACKGROUND

In June 1995 Madison County, Virginia, was devastated by fast rising flooding resulting from a prolonged rain event over the Blue Ridge Mountains. The extent of destruction in this rural county is captured by three statistics: 65 homes destroyed and 755 damaged; 35,000 acres of crops destroyed or damaged; 80 bridges destroyed and 200 damaged (Virginia Department of Emergency Services, 1995, hereafter VDES). At one time every road, including every gravel road, into the county was blocked. Madison County Emergency Medical Services officials requested state assistance, and the state Office of Emergency Medical Services sent approximately 13 ambulances, a crash truck, a mini-pumper, and a fire engine over a four day period (Virginia Department of Health, Office of Emergency Medical Services, 1955, hereafter VOEMS).

The reader will notice the word "approximately." Because the Office at the time relied upon the District Rescue Officers of the Virginia Association of Volunteer Rescue Squads to call for volunteers, the staff in the Emergency Operations Center did not know what single resources were sent, when they arrived, or when they went home. No procedures were in place to advise local officials of what assistance was on the way, and there was no way to assure accountability for safety. Finally, there was no provision for logistics support; resources that showed up were competing for scarce supplies with local agencies and with the citizens.

When the mud settled, the staff of the Office of Emergency Medical Services decided that never again would they incur such liability or fail to provide effective, measured support to meet local needs. The solution adopted, the establishment of state level volunteer emergency medical services task forces and a system to manage them, grew out of the next hurricane season. On 11 July 1996, the first Task Force, Lord Fairfax 1,[2] was organized based on an electronic mail request (Butler, 1996). This relatively informal start has evolved into a well-structured, permanent system with four operational Task Forces and six others in various states of organization. The eventual goal is for the Office of Emergency Medical Services to be able to field 22 operational Task Forces. This number would provide the capability to respond anywhere in the state by road within two to three hours, and to field a substantial amount of resources even if half the regions are effected by a disaster's impact.

DEFINING THE TASK FORCE

The classic definition of a Task Force in Incident Command System terms is "a group of resources with common communications and a leader temporarily assembled for a specific mission" (Carlson, 1983, pg 220). Unlike a Strike Team, a Task Force is not composed of only one type of resource, ie, all basic life support ambulances or all fire engines. Rather it is a mix of types of vehicles, equipment, or people tailored to do an assignment that requires the particular blend of capabilities and expertise. In the National Interagency Incident Management System (NIIMS) concept of operations, a Task Force is transitory, being formed when needed and disbanded as soon as the specific operational task is completed (NIIMS, undated b, pg 16).

In planning to meet Virginia's needs, it rapidly became apparent that existing models were not adequate for the state's requirements. The NIIMS model had the significant limitation of being transitory; as a result, there was no mechanism for mobilizing resources, providing trained leadership, and ensuring responder safety in the context of a state with over 700 licensed EMS agencies and 35,000 certified providers. The second model considered, the Federal Emergency Management Agency's (FEMA) Urban Search and Rescue Task Forces, appeared to be too large and complex for the need (FEMA, 1993, Buff III-1). The size of the Task Force would exceed the capability of volunteer systems to provide the required number of people for response outside the region. One final model was also considered, the Emergency Management Assistance Compact (EMAC) Type I Medical Support Strike Team. This Strike Team is based on five Advanced Life Support Ambulances with 5 emergency medical technicians as drivers and 10 paramedics (Edmonson, 1997).

Defining the need for resources became the central issue. When Emergency Medical Services personnel talk about disasters, the universal topic of conversation is mass casualty events. Yet, when Virginia started to look at how to meet local needs for emergency medical services assistance during disasters, it became readily apparent that mass casualty incidents are not the real problem. Of 20 Presidentially declared disasters since 1969, only two, Hurricane Camille in 1969 (Godwin, 1969) and the Petersburg tornado in 1993, generated significant numbers of dead or injured (VDES, undated).

The actual problem is resource exhaustion. In both cases where state emergency medical services assistance was requested by localities in the period from October 1994 through June 1998 (Madison County in 1995 and Washington County in 1998), the request was based on the need to provide relief for local agencies whose crews were exhausted. Virginia emergency medical services disaster planners approached the problem not as one of how many ambulances would be needed, but rather what capabilities the local jurisdictions would need.

This drove the development of the resource mix for the Task Force. Given the apparent need for replacement of capabilities that were run down by fatigue, the question became what do you replace? In Virginia, as in most states, a large percentage of emergency medical services agencies operate from a station concept.[3] Most agencies have sufficient vehicles to provide the following selection of vehicles and capabilities at any given time:[4]

Table 1. Typical EMS Agency Resources

Vehicle:	Capability:
Quick Response Vehicle	• initial treatment
Crash Truck	• gain access to patients • stabilize wreckage and debris for rescuer safety
Basic Life Support Ambulance	• treat and transport 1 patient not requiring advanced life support
Advanced Life Support Ambulance	• treat and transport 1 patient requiring advanced life support

Conceptually, for Task Force assistance to be useful, it should be able to replace the contents of one station for a shift; therefore, that model was chosen as the basis for the Task Force basic complement in preference to the EMAC Strike Team.

The resulting Emergency Medical Services Disaster Task Forces have been developed as a system with six key components:

(1) Appropriate response vehicles.

(2) Trained and certified emergency medical services providers.

(3) Trained leadership.

(4) Logistics support.

(5) Standard operational procedures.

(6) A command and control system to receive tasks, alert and deploy Task Forces, and monitor their operations.

Implicit in this is the final, and most important, element, that Task Forces are permanent units of people who know each other, train together, and have a clear understanding of their mission.

The current configuration of vehicles and personnel in Task Forces is shown in Table 2. Although this combination has evolved, certain features have remained consistent and are worthy of note. Each Task Force has a designated Task Force Commander, who is considered to be a Command Officer equivalent to a Fire Battalion Chief in responsibility and authority, and who serves as the Task Force Leader in an Incident Command System structure. Each individual resource has a Unit Leader, addressing clearly who is responsible for tactical and task level decisions in the crew of that resource,[5] and each component of the Task Force has a defined role and understood capabilities in a response.

Table 2. Virginia EMS Disaster Task Force Resource Mix

Vehicle:	**Crews:**	**Capability:**
Quick Response Vehicle	Task Force Commander + 1 BLS or ALS provider	• reconnaissance to locate the best access routes • platform for command • triage • treat GREEN patients
Crash Truck	2 BLS providers (1 as Unit Leader)	• gain access to patients • stabilize wreckage and debris for rescuer safety
Basic Life Support Ambulance	3 BLS providers (1 as Unit Leader	• transport 2 RED or treat and transport 2 YELLOW or 4 GREEN patients
Advanced Life Support Ambulance	2 ALS and 1 BLS providers (1 as Unit Leader)	• treat and transport 2 RED or 2 YELLOW patients

Source: Virginia Department of Health, Office of Emergency Medical Services, *Task Force Commander Course*, ed. 3.0. Richmond: Virginia Office of Emergency Medical Services, 1997. pg 29.

Note: BLS is Basic Life Support, in the Virginia system an Emergency Medical Technician Basic. ALS is Advanced Life Support, Emergency Medical Technicians - Shock Trauma and Cardiac Technician and Paramedic.

In the process of determining the vehicle mix significant lessons were learned. Original concepts called for the crash truck to be a heavy or medium duty truck to provide the capability to do significant structural rescue work (SOP, 27 December 1996, pg 2). These large vehicles, however, are slow, costly to operate, difficult to maneuver, and heavy enough that their use on disaster damaged roads could be problematical. The requirement was dropped to allow any crash truck to be used, and most Task Forces are using light duty trucks.

The original concept also envisioned the use of mass casualty supply trailers. The idea of towing a heavily loaded trailer on icy mountain roads in winter responses proved to be too much of a challenge to common sense. As a result, although the mass casualty trailer remains an optional capability Task Forces may choose to provide, its use in anything short of a truly catastrophic mass casualty event has been abandoned.[6]

Finally, the quick response vehicle was added as an optional vehicle in 1997, originally for logistics support (SOP, 27 May 1997, pg 2). The added vehicle proved its worth in January 1998 when Task Force Crater 6 took a brush engine with them to southwestern Virginia. The addition of another winch was invaluable in opening roads blocked by debris. In the latest edition of the Standard Operating Procedure, Task Forces have effectively adopted a four vehicle configuration including the quick response vehicle. This addition provides greater tactical flexibility by allowing the Task Force to operate from a station as four vehicles in high hazard or large task dispatches, as pairs of vehicles under difficult conditions, or as single vehicles during essentially normal conditions (SOP, 15 May 1998, pp 9-10).

LOGISTICS

Logistics support has been a major concern from the outset. Each Task Force is expected to develop the capability to be largely self-supporting for 72 hours. This has been achieved in food, clothing, sleeping bags, sanitation, and similar areas in which the volume of supplies is manageable within the available space in vehicles. Shortfalls are expected in water (using the best tables available from US Army logisticians, the water requirement for a 10 person Task Force can be computed at a minimum of 168 gallons for 3 days)(Edwards, 1993, pg 71), fuel, and medical supply. The medical supply issue remains a critical one given the decision of hospitals to stop restocking ambulances. This was a result of an opinion of the Inspector General of the Department of Health and Human Services that such free provision of supplies criminally violates the anti-kickback provisions of Medicare regulations (Thornton, 1997). The Office of Emergency Medical Services, however, has made preliminary arrangements with vendors for rapid resupply.

Logistics coordination has become a serious enough issue that the decision was made in April 1998 that whenever a Task Force is deployed it will go with a two person Coordination Team (C Team) to coordinate on-site logistics support. The C Team also provides a command and control element to interface with local authorities or, if needed, to augment the emergency medical services function in the jurisdiction emergency operations center (VOEMS, 1998b). The C Team concept was successfully tested in a May 1998 deployment to Danville, Virginia.

TASK FORCE DEVELOPMENT

Training

Traditionally emergency medical services providers operate as one ambulance with one crew; this model prevails in the vast majority of responses, and in rural agencies forms the focus of how the agency works. Task Forces ask people to work as a team in an organized structure in a way with which they are largely unfamiliar. Training leaders has become a high priority to ensure the system would work and that safety and accountability would be maintained. The first step was the roll-out of an 8-hour Task Force Commander Course in November 1996 at Mount Jackson, Virginia. This course trains Commanders in the missions of the Task Forces, command and control procedures, guidelines for employment in the field, safety concerns, and logistics. In May 1998 a 4-hour Task Force Member course was pilot tested in Hanover, Virginia, to provide members the information they need to function effectively under the leaders.

Emergency Support Center

The need for training was increased by the parallel development of an Emergency Support Center (ESC) in the Office of Emergency Medical Services. This facility is a specialized health and medical emergency operations center that mobilizes, monitors the status of, dispatches, and tracks Task Force deployments. The ESC uses standard voice format templates (see Table 3 below) to rapidly relay alerting and mission tasking information to the Task Forces (SOP, 15 May 1998), a process that has required regular training on both ends to ensure performance. The command and control process works well. This was clearly demonstrated by the ability of the ESC to rapidly task resources and to keep the emergency management staff of Washington County continuously advised of when to expect assistance during a severe snow and ice event in January 1998 (VOEMS, 1998a).

Table 3. Virginia Health and Medical Alerting Voice Format

THIS IS ACTUAL (or THIS IS EXERCISE) THIS IS THE EMERGENCY SUPPORT CENTER. PUT YOUR TASK FORCE ON ____ 12 HOUR ALERT ____ 6 HOUR ALERT ____ 3 HOUR ALERT ____ 1 HOUR ALERT ____ STAGED AT HOME ____ RELEASED EFFECTIVE (24 hour local time) FOR (name or type of emergency event) SPECIAL INSTRUCTIONS (a brief summary of any special requirements)

Virginia Department of Health, Office of Emergency Medical Services. *Standard Operating Procedure for Virginia EMS Task Forces,* ed. 15 May 1998. Richmond: Virginia Office of Emergency Medical Services, 1998, attachment 5.

SUMMARY

This model merits consideration by any agency considering establishment of response task forces or strike teams. It has been exercised regularly in alerting and tabletop exercises and Task Forces and Coordination Teams have been deployed successfully in real events. The structure adopted was carefully planned to meet the demonstrated needs of local jurisdictions, rather than simply duplicating a five vehicle formula used in the FIRESCOPE program.[7] Perhaps most importantly, the Task Force is a system of people and equipment with all of the supporting components that allow it to function effectively in the field. This systems approach has resulted in teams with a strong sense of identity and pride in their operational capability and emerging traditions.

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NOTES

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2. This Task Force set the precedent of naming Task Forces after the emergency medical services region in which they were raised. Virginia is divided into eight regions, four of which have active and more or less formally organized sub-regional structures. The Lord Fairfax EMS Council is a subregion in the Virginia Federation of EMS Councils, Inc.

3. This is the case for volunteer agencies and most government agencies. Some government agencies and an increasing number of commercial providers have adopted systems status management concepts which keep vehicles either posted at high probability locations for rapid response or in motion for their entire shift.

4. The ability to staff this many vehicles is a different issue. Although actual staffing capability has not been studied in Virginia, experience indicates most volunteer agencies can reliably respond with one vehicle to emergency calls for assistance almost all of the time. The ability to respond with second and third vehicles is a function of organization size, leadership, and call volume.

5. One important lesson learned in this process was that there was no commonality in perceptions of who was in charge of an ambulance. By Virginia regulations, the senior provider serves as the Attendant-In-Charge (AIC) responsible for patient care. By custom the Driver drives the vehicle with little input from the AIC who is in the back with the patient half the time. Neither necessarily had a defined role of unit leadership.

6. Mass casualty trailers remain an important element in local planning, but in most cases a Task Force will arrive after most of the initial mass casualty response has been completed.

7. The California FIRESCOPE program established five vehicles as the basic structure for Strike Teams (US Federal Emergency Management Agency, Emergency Management Institute, 1987), a structure repeated in the ICS-420-1 *Field Operations Guide*, National Interagency Incident Management System, undated.

CONSOLIDATING RESOURCES MAKES SENSE

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INTRODUCTION

The Wisconsin State Emergency Response Board (SERB) was created by 1987 Wisconsin Act 342. At that time, the Board was responsible for administering the provisions of Title III of the 1986 Federal Superfund and Reauthorization Act and Wisconsin Act 342 which both pertain to hazardous chemical substances.

Under 1991 Wisconsin Act 104, the SERB was given the additional responsibility of contracting with no fewer than seven, and no more than eleven, hazardous material response teams. Each team's purpose was to assist in the emergency response (ie, protect life, identify and control sources of spills or releases, and to prevent or abate migration of spills or releases) to Level A Releases in a region designated by the Board. A "Level A Release" is a release of a hazardous substance that necessitates the highest level of protective equipment *for the skin* and respiratory systems of emergency response personnel. A "Level B Release" means a release of a hazardous substance that necessitates the highest level of protective equipment for the *respiratory system* of emergency response personnel, but less skin protection than a Level A Release, because operations at the site of the release don't involve a high potential for exposure to liquids or particulates that are harmful to the skin or capable of being absorbed through intact skin. The Act ran into funding problems and there was a delay in finalizing contracts until 1994.

A train derailment on the Nemadji River in Superior, Wisconsin on June 30, 1992, which exposed people and the environment to multiple extremely hazardous materials, persuaded the State Legislature to act. The response to that incident illustrated that the sophistication needed to respond to a spill or release of most hazardous materials exceeded the capability and fiscal resources of most communities in the state. A contract designed for the delivery of regional hazmat response services was outlined by the State and the Request for Proposals (RFP) was issued to prospective bidders in October 1992. Private environmental response and clean-up companies were ineligible to bid, which meant that fire departments became prime contenders.

As early as 1980, the City of Oshkosh, located in northeastern Wisconsin, recognized the increasing risks presented by hazardous materials being used in and transported through their jurisdiction. A specialized team from the Oshkosh Fire Department was trained and equipped to respond in the event of a hazardous material incident. (The City of Oshkosh Fire Department's Hazmat Team served the State of Wisconsin for more than ten years from 1980 to 1991 as the only regional hazmat team in the state.)

During 1987 and 1988, Manitowoc and Sheboygan counties, also located in northeastern

Wisconsin, recognized that expertise was needed to respond to a spill or release of hazardous material. They each trained hazmat teams, purchased equipment, and developed the capability to respond to incidents occurring in their jurisdictions,

NORTHEAST WISCONSIN HAZMAT TASK FORCE

In August 1992, representatives of these veteran hazmat response teams and emergency management directors from WInnebago (City of Oshkosh), Manitowoc, and Sheboygan counties met. (The original prospective group numbered five units. The cities of Green Bay and Appleton fire departments were asked to be part of one unified task force with Oshkosh, Manitowoc, and Sheboygan, but chose, in the end, to bid on their own.) It was determined that there were distinct advantages to the 650,000 residents of northeastern Wisconsin (in the assigned coverage area) and to the SERB in functionally consolidating the resources of three individual hazmat teams into a single, regional hazmat response organization. Inter-governmental agreements forming the organization known as the Northeast Wisconsin Hazmat Task Force (NWHTF) were adopted and an RFP was filed with the SERB.

The bidding document explained that the eighty-five member task force is strategically located in three communities and forms a triangular blanket of coverage for a multi-county region. The task force has a wealth of resources, both in personnel and equipment, as well as in training and experience. It can put a fully equipped response vehicle and staff on the scene of any Level A incident in its coverage area in thirty minutes to an hour.

The unmistakable advantages of having three teams make up one regional team include:

Faster response time to a large geographic area,

Members from both public and private orientations,

Most cost-effective way of responding to a multi-county area,

Elimination or reduction of overlapping and duplicate services,

Cost reductions through volume purchasing,

Depth of resources (personnel and equipment) which eliminates the depletion of host firefighting agencies when the task force is called out for a regional response,

Twice the hazmat officers available for any incident, with backups still available,

Political acceptance from the originating communities since three highly trained and equipped teams remain viable for local response,

Availability of a variety of experienced, qualified personnel, drawn from three communities, for almost every aspect of operations, Specialization in various response functions and capabilities because of task force size and geographic placement, and

Specialization of key equipment needed to address hazards specific to each response area.

On August 2, 1994 the NWHTF and SERB signed a five year contract for Level A regional hazardous material emergency response coverage. The Task Force's assigned area covers nine counties and half of two additional counties with an area population of 646,443 people.

The Task Force has two sources of funding under the agreement, stand-by costs and response reimbursement. The State of Wisconsin agreed to pay the NWHTF $900,000, which the three units of the Task Force split, for stand-by costs for the duration of the five year contract. Stand-by costs include specialized training expenses, medical surveillance, response vehicles, and equipment purchases. Response reimbursement includes those expenses billed by the Task Force to the responsible party, such as the use of vehicles and apparatus, personnel expenses, and emergency expenses.

The NWHTF has not been called to an incident that has required all three units during the three and one-half years of its existence, however, two of the three units have worked several stand-by requests. (One unit responded and a second stood ready as a back-up.) The three units frequently train and exercise together to keep their skills honed. The command officers forming the core of the Task Force meet on a continuous basis.

The units have responded to nineteen Level A incidents since 1994. The majority of the responses occurred in the jurisdictions where a Task Force unit is located. The chemicals involves in the incidents included nitric acid, anhydrous ammonia, phenol, formaldehyde, chlorine, and phosphoric acid. The average cost of a response to the spiller has been $4,733.

SUMMARY

The partnership between the State of Wisconsin and the NWHTF has been a resounding success. The Task Force has matured into a highly-trained, well-equipped, professional organization. It is unlikely that any of the units, as stand alone hazmat teams, would have reached this pinnacle in three and one-half years if they had had to rely solely on their own jurisdiction's financial support.

As contracts begin to expire, the future of the NWHTF and the other regional teams in Wisconsin is unknown. The State Legislature will undoubtedly take an in-depth look at the cost of providing regional hazmat teams before committing future funding to extending contracts. The stand-by costs can be reduced in the next contract for most of the teams, since the start-up costs will not recur in the next cycle. The major expenses for the established teams are on-going medical monitoring of team members, maintenance, training, depreciation on equipment and vehicles, and compensation to members or their departments for stand-by readiness costs. For State legislators, the temptation will be to reduce the number of teams in Wisconsin in order to cut support expenses. In northeastern Wisconsin, the functional mergers of three (or more) individual hazmat teams into one response organization is a cost-effective, efficient means for the State and local jurisdictions to provide hazardous material response services to a large geographic area of Wisconsin. Perhaps similar consolidations are feasible with other regional teams.

As we enter the 21st Century, we will undoubtedly see changes in the way hazardous materials are manufactured, stored, used, and transported in Wisconsin. We have already seen significant modifications in storage and use since adoption of Title III of the federal Superfund Amendment and Reauthorization Act. Wisconsin users of hazardous substances are constantly looking for ways to reduce their hazardous material inventories to lessen the costs of fees paid to the State to carry those chemicals. It is unlikely that we will ever see the complete eradication of hazardous material in our communities, thus emergency management must be ready with plans and cost-effective response resources to tackle the problems that arise with these products. Pooling response resources, both equipment and personnel, in consolidated groups like Wisconsin's NWHTF makes sense to those who know the principle works.

NOTES

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THE HISTORIC FLOOD OF 1997 AT LOUISIANA STATE PENITENTIARY

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Most emergency managers will deal with the full range of emergency management activities - mitigation, preparedness, response, and recovery - at some point in their careers. In most communities this is a shared responsibility. Business and industry, for instance, have their own plans, and much of the public will look after its own needs, such as evacuation and sheltering. What happens, though, when the whole community is your responsibility; you own the agriculture and the industry; and you must ensure that the residents stay exactly where you want them to stay 24 hours a day?

This was the situation at the Louisiana State Prison at Angola during the floods on the lower Mississippi River in the spring of 1997.

THE PRISON

The Louisiana State Penitentiary (LSP) at Angola is home to over 5100 adult, male, maximum security inmates. Comprised of 18,000 acres, it is the largest state maximum security prison in the United States. Once called the "Alcatraz of the South", the prison has no continuous fence along its perimeter, however it is bordered on three sides by the Mississippi River and on the fourth side by the rugged Tunica Hills. Rather than a walled prison, LSP consists of a Main Prison Complex, housing approximately 2600 inmates, and five Outcamps, housing approximately 2400 inmates. The Main Prison Complex and each outcamp are penitentiaries (mini-prisons) in themselves, as each is staffed with its own warden, security staff, kitchen, laundry facility, classification staff, primary medical staff, religious staff, and canteen and clothing rooms.

LSP employs approximately 1466 security officers who administer the care and control of inmates as well as public safety. There are also nearly 400 administrative employees who oversee various departments (Treatment, Health Services, Business Services) to ensure the smooth operation of the penitentiary. In addition LSP is also home to nearly 600 residents, employees, and their families, who reside in a residential area known as B-Line. There are 115 houses and 100 mobile homes located on the prison grounds. Due to the remoteness of LSP, it is essential to maintain a 24-hour security force on the grounds to respond to any emergency situations.

LSP is also home to Prison Enterprises operations. Prison Enterprises is a Department of Corrections (DOC) agency that produces agricultural and industrial products that are sold to other state agencies, including the prisons of Louisiana. Nearly 4 million pounds of vegetables were grown on the sprawling Angola farm during 1996. The largest rowcrops are corn and soybeans. The penitentiary also maintains a beef herd of approximately 2500 head of cattle and a dairy herd of 300 head. One hundred and sixty-four milk cows produce approximately 40,200 pounds of milk each week. The industrial compound includes a license tag plant, silk screen shop, mattress/broom/mop factory, and print shop.

LSP is a unique operation. In order to keep the inmate population informed of current events, important issues, and penitentiary policies, the penitentiary publishes a bi-monthly newsmagazine and operates a radio station. The *Angolite* is an uncensored inmate publication which has world-wide distribution while KLSP, the "Incarceration Station", is the only FCC licensed radio station operating inside a prison in the United States. LSP also attracts thousands of spectators to the annual Angola Prison Rodeo, held every Sunday in October, and the annual Arts and Crafts Festival, held each Spring. The rodeo is famous for its unusual, non-traditional events and attracts over 20000 spectators each year. The Arts and Crafts Festival held each Spring highlights all types of inmate artwork - from woodwork to leathercraft to paintings.

Recently LSP has attracted a considerable amount of media attention. The movie *Dead Man Walking* was filmed at Angola, as it was the actual setting for the real-life events. Angola has been the site for filming of documentaries and television specials, as well as newspaper and magazine articles written for nine foreign countries and numerous national publications. LSP conducts tours for universities, high schools, middle schools, church groups, and criminal justice organizations from around the nation on a daily basis.

CONTINGENCY PLANNING

In late February, 1997 the National Weather Service issued notices regarding the potential for serious spring flooding in the lower Mississippi Valley, and on March 4, 1997, Governor Foster of Louisiana issued a proclamation which stated, "I do proclaim a state of emergency to exist within the state of Louisiana". The proclamation also stated that "heavy rains have caused flooding and damage in the parishes of Louisiana to both private and public property; and emergency measures must be taken to minimize the effects of flooding throughout the State; and response may exceed the capability of local government".

Warden Burl Cain began a series of meetings with both employees and inmates in order to provide updates and advisories. These meetings continued throughout the emergency and proved to be essential in securing and maintaining the safety of the entire prison.

Original contingency plans for the evacuation of LSP involved transferring the inmates to other prisons around the State, however, Corrections Secretary Richard L Stalder and Warden Cain realized that inmate labor would be essential in the protection of Angola (the institution is valued in excess of $300 million) and in the clean-up efforts if the prison was inundated by the Mississippi River. Transporting inmates to other facilities would also limit the attention that these facilities could spend on neighboring communities that might need their assistance during this time of high water. The decision was made not to evacuate inmates to other State facilities. Rather, inmates would be evacuated to high penitentiary ground. Tent cities would be constructed around the Reception Center (located near the front gate) and on other prison property located five miles outside the prison gates. Detailed planning was begun for protecting the prison and for a potential evacuation.

On the 7th the National Weather Service issued a flood warning for this section of the river. All essential employees were placed on emergency 'on-call' status and all outside tours and guests were cancelled until further notice. Crest forecast for the 26th at 60.5 feet, below the levees but 15 feet over some of the facilities in the prison.

On the 9th contingency planning was reviewed and confirmed, covering a full range of activities. Among the first to be effected were the prison ferry services. LSP contracts with a private vendor to provide ferry services to approximately 400 employees who live on the other side of the Mississippi River. High water caused the ferry boat operations to be suspended on March 10th and crew boat transportation was activated. Also, while initial inspections showed that the levees were in better condition than ever, a levee inspection routine was formalized. Staff checks were made on inmate capacities and tentage requirements at the evacuation sites and on support needs.

Planning activities continued through the following week. Generators were secured; the provision of water to replace that from wells that would be flooded was arranged; portable toilets were located; and trailers for storage and refrigerated trucks for food and pharmaceuticals were contracted. The construction of tent platforms was begun. The logistics table of needs from the Louisiana National Guard alone included 250 medium tents, 5000 aluminum cots, five mobile kitchens and five shower tents, three 5000 gal water storage tanks, 335 rolls of concertina wire, 100,000 sandbags, field communications equipment, fuel trucks, and lighting equipment.

Determinations had to be made as to which stores and equipment could be left behind and which would have to be moved. Some supplies, such as plywood for tent platforms, could be used up in advance of the flood. Other assets such as the dairy herds and heavy equipment would be moved. New locations were found for archives and prisoners' medical and legal records.

The prison would have to continue to operate. Emergency purchasing authorities were obtained, timekeepers began to monitor flood-related costs, and court approvals were attained to exceed prison population limits. For continued security, jet-skis were arranged for river patrol, chase boats were secured from Orleans parish, and plans were made to evacuate the prison armory and secure the contents on another site. Communications sites on high ground were selected.

THE FLOOD

On Wednesday, March 19, 1997, officials at the prison advised the media that the levee was in the best condition it has ever been. The institution did not anticipate the rising waters of the Mississippi to exceed the crown of its levee system, however river stages were expected to crest at 60.5 feet on March 26th. (This was later changed to 61.1 feet on the 28th, gaining more time for preparations but forecasting a higher crest.) On the other hand, the river was expected to be near its crest for three weeks and many levee problems occur on the falling river. Blowouts would be unlikely, however any break would be major breech.

As safety remained the top priority, contingency plans continued to focus on evacuation to higher ground if it became necessary. The planning involved meeting with the US Army Corps of Engineers to monitor and evaluate the strengths of the levee and to indicate areas of safe retreat. A Corps of Engineers staff member was assigned to the site full time and a 24-hour levee patrol began.

On Thursday, March 20, 1997, as a precautionary measure, 29 chronically ill inmates were moved to nearby Dixon Correctional Institution in Jackson, Louisiana. Also on this date, LSP officials met with National Guard General Bennett Landrenau, Colonel Thomas Rodrigue / Director of Military Support, and Colonel Jim Kroft/Office of Emergency Preparedness, to further discuss contingency plans in the event evacuation of prisoners became imminent.

West Feliciana Parish Sheriff William "Bill" Daniel and West Feliciana Parish School Superintendent Lloyd Lindsey agreed to provide the Tunica Elementary School facility (located 5 miles outside the front gate) to assist with the temporary housing for displaced Angola employee residents. The elementary school students would attend classes at nearby St Francisville schools. Warden Cain shared his plans to securely house approximately 2500 inmates in military tents on prison property located across from Tunica School. The remaining 2500 inmates would be housed on high prison grounds. Warden Cain assured Sheriff Daniel and West Feliciana residents that additional correctional officers would be available to provide security in all temporary inmate housing areas. The Corps of Engineers provided the expertise of Mr James Siffert, Civil Engineer, who remained on-site throughout the ordeal.

On March 22, 1997, prison officials and inmates were busy constructing secondary housing areas by erecting perimeter fences, towers, military tents, when they were advised by the Corps of Engineers that the river would crest later than expected and higher than expected, on March 28th at 61.1 (eventually changed to 61.4) feet. Employees and inmates worked side-by-side, sandbagging and monitoring levee slides and the increasing number of sand boils. Army personnel carriers, which had been previously purchased for the tactical team, were instrumental in moving sandbags to problem areas, where the ground had become saturated making vehicle traffic impossible. Staff were assigned to 24-hour levee patrol on 4 wheel all-terrain vehicles. Essential bedding and clothing was moved from warehouses to trailers located outside the front gate. Temporary storage was provided for inmate institutional and medical records, pharmaceuticals and medical supplies, as well as inmate legal documents. Warden Cain continued to advise inmates and staff on a daily basis about river stages and the status of preparations being made. This open communication between the warden, his staff, and the inmate population proved to decrease rumors and increase morale.

Tent cities were completed quickly (within three days) due to the determination and cooperative effort between staff and inmates. LSP has 35 inmate organizations of which inmates can become a member. One of these organizations is "Vets Incarcerated". The members of Vets Incarcerated, along with correctional officers - many of whom were veterans and/or reserve military - were experienced with organizing the construction of secondary housing areas. Crews worked around the clock.

From the 24th, 24-hr hauling of limestone and dirt was being done. Surveillance was being carried out by vehicle, on foot, by river and by helicopter. Preparations were being implemented and plans were now actions.

EVACUATION

On the night of March 24-25th an area of seepage which was being monitored appeared to be getting worse, and at approximately 2:15am, Warden Cain, after consulting with the Corps of Engineers, decided to initiate an evacuation of inmates as a precautionary measure. There would be a reassessment at day-light. The planning paid off. The movement was orderly. Inmates had been informed of what and why the move was being made. They, in turn, were calm and cooperative. They had also been previously advised of what items they could bring with them (a bible, blanket, sheet, walkman radio, small bag of cosmetics, personal medication, and the amount of clothing worn on the person) and the move was made in an efficient manner. Inmates boarded cotton trailers, cattle trailers, and borrowed busses from other institutions and local sheriff's offices, and were transported to the tent cities. The tent cities were configured in such a manner as to maintain the same living arrangements that inmates had lived in at the Main Prison and outcamps. Nearly 3000 dormitory inmates were moved in this initial phase.

Cellblock inmates would have been moved to secure areas that were built for that purpose and to cells on higher ground, except that conditions became stable before this became necessary. Preparations for housing of cellblock inmates included housing behavioral problem inmates at Death Row and close custody restricted (CCR) areas. Inmates already housed at Death Row and CCR were placed three to a cell during the evacuation of dormitory inmates to make the necessary cellspace for incoming cellblock inmates. No incidents occurred at Death Row or CCR.

Additional personnel from the Corps of Engineers arrived to re-evaluate the levee condition. The Corps agreed that the situation was again stable, but that a monumental effort was needed to ensure the integrity of the Angola levee. Inmates were transported back to their living areas at around 3:00pm on March 25th. All involved were pleased that the contingency plans were effectively implemented and the movement was conducted without major problems.

After a morning of inspection, it was decided that the situation had stabilized enough to end the evacuation and return of inmates to the prison proper. Some precautions remained in effect (sirens which could be confused with evacuation sirens were banned), a 20,000 sandbag reserve was established and maintenance and limestone work continued through Easter. Later, wheelchair inmates were transferred to nearby Avoyelles Correctional Center located in Cottonport, Louisiana. During the precautionary evacuation, it was discovered that they would significantly slow an evacuation attempt.

CONSTRUCTION AND MITIGATION

Prison officials and inmates continued to work to ensure Angola's levee remained stable. US Corps of Engineers staff , National Guardsman, correctional officers from other state prisons, and several contracted employees assisted in constructing a large dirt berm to assist in stabilization of the levee, which would hopefully stop sandboils and levee seepage. Thirty-five dump trucks ran constantly for 48 hours, hauling dirt to the berm site. Warden Cain commented,"I have never in my career seen state agencies work together as much as they have here at Angola". He also thanked the Governor for his support, but stated that without the continuance of this monumental effort, the Angola levee might not hold during the next three weeks of slowly descending water levels.

Further precautionary measures were taken to expedite an evacuation if it again became necessary. Breach analyses conducted by the Corps of Engineers and the Water Resources Division of the Louisiana Department of Transportation and Development revealed that, depending on the location of a breach in the levee, LSP officials would have anywhere from 4 to 24 hours to effect an evacuation. Building elevations revealed that the Main Prison Complex, Outcamps C, D, J and F would be at least 14 feet underwater. In order to "buy time" for an evacuation, generators and lights were placed on rooftops at housing locations. Inmates would be moved to rooftops to await evacuation teams. Ladders were constructed and placed in housing locations to assist in an expeditious evacuation to rooftops.

The Mississippi River crested on March 28, 1997 at 61.0 feet. The river was expected to fall slowly through April 17th. It was noted that the height of the river was still higher than the flood of 1979, when the left bank of the riverside levee was overtopped. Angola was experiencing a record flood.

With the assistance of the Louisiana State Purchasing Department and the US Army Corps of Engineers, an emergency contract was awarded to complete dirt work along the berm. This freed prison employees, inmates, and National Guardsmen to work on other areas of concern along the twenty-one mile Angola levee system. An area of particular concern was the Angola Ferry Landing. Employees utilizing the ferry landing had been crossing the river by crewboat after the river breached the ring levee. Damage caused during the breach was surveyed. There were two gaps , one being 100 yards wide and up to 35 feet deep and the second being 50 yards wide and up to 26 feet deep. It became apparent that when the river reached normal stage, there would be no access road for employees who must travel by ferry. In order to correct this problem, another emergency contract was let to place 9200 tons of Corps-grade stone at the ring levee site. Ferry operations resumed on April 21, 1997.

On April 4, 1997, Warden Cain held a meeting with all top ranking prison officials. Correction Secretary Stalder was present and commended LSP staff for their incredible efforts in preparing for and handling the emergency situation. During this meeting, Warden Cain announced that for future such occurrences of the threat of flood , at the 55 feet river stage projection, the floodgates located at Camp G site would be opened, providing a "spillway" for the waters of the Mississippi River. This would require installation of additional floodgates at that area. Warden Cain met with the Adjutant General Ansel Stroud, who agreed to allow LSP to keep tent cities in place until after the threat of flooding had passed. Inmates who had been transferred to other institutions (wheelchair inmates and medical patients) would not be transferred back to Angola until the river reached the 55 feet stage. Most importantly, Warden Cain informed his staff that the threat of flood still remained. Historically, more floods have occurred on the river downfall.

The cost to protect the prison rose above $1.7 million during the spring flood crisis of 1997. Improvements in the efforts to protect the lives and property of LSP will continue until the levees, noted to be the worst on the entire Mississippi River, are brought up to the standards set for the federal levee system. Governor Foster and Corrections Secretary Stalder have been relentless in their effort to seek necessary funding to ensure the integrity of the Angola levee system.

The greatest lesson learned from this experience is that when fighting Mother Nature, it takes the cooperative effort of everyone. Achieving cooperation in a facility the size of Angola - with so much at stake - takes understanding and determination. Open communication between staff and inmates was a major contributing force to the institution's ability to prepare during a crisis of this magnitude. The assistance from outside agencies and the availability of their many resources, sometimes (most times) on a moments notice, demonstrated the great potential that exists when people pull together to fight for a common cause.

NOTES

1. This paper was prepared by Warden Burl Cain, Deputy Warden Sheryl Ranatza, and Executive Staff Officer Cathy Jett.

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THE DEBRIS MANAGEMENT CYCLE - AN OVERVIEW

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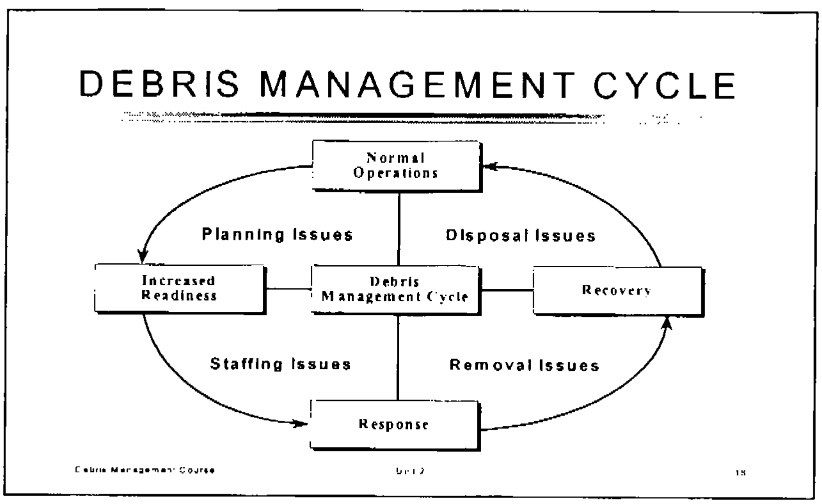
DEBRIS REMOVAL

Each year local and State government entities worldwide are faced with the task of removing and disposing of debris caused by natural disasters such as hurricanes, typhoons, cyclones, tornadoes, floods, fires, and earthquakes. These debris-generating events have significant impacts on the economic and social well being of the affected communities. Debris removal and cleanup will cost more than any other item in a disaster recovery budget. Moreover, responsible officials will find themselves under extreme pressure to institute immediate debris removal and disposal actions unless they have the benefit of a well thought-out debris management strategy.

This paper will use the Debris Management Cycle as the framework to identify universal debris removal and disposal issues, and to show why it is extremely important to have a Debris Management Plan in place before a disaster happens.

THE DEBRIS MANAGEMENT CYCLE

The Debris Management Cycle is a means of visually tieing together the variety of debris issues for those responsible for planning and executing debris clean-up following a major disaster. The cycle consists of four identifiable phases: Normal Operations; Increased Readiness; Response, and Recovery. Specific debris issues can be identified within each phase. By using this model, emergency planners will be able to identify potential issues before they happen and plan accordingly.



Experience has shown that regardless of the type or magnitude of the debris-generating event, the issues identified in the Debris Management Cycle will occur. The only unanswered question is the significance of each issue. The issues will be of minor importance if planned for in advance. If issues are not planned for, however, they will become major issues requiring valuable time and resources.

Normal Operations Phase

Normal Operations is defined as the period of time before a major debris-generating event occurs. This is the period when routine actions necessary to develop or update a Debris Management Plan occur. A well thought-out Debris Management Plan will become the keystone of any debris clean-up operation. The plan should, therefore, be locally developed with external participation to 1) encourage a diversity of strategic innovations; 2) promote active cooperation; 3) develop points of view based on local experience, capabilities, and limitations, and 4) promote information transfer.

Debris Management Plan. The Debris Management Plan should address the following:

> Mission: States how the debris management activities will be facilitated and coordinated.
>
> Organization: Assigns the overall responsibility for managing the debris cleanup.
>
> Concept of Operations: Details how those responsible will manage and coordinate the debris removal and disposal operation.
>
> Responsibilities: Identifies specific responsibilities for each department involved in the clean up operation.
>
> Actions: Details waver procedures and reviews of local ordinances, environmental regulations, priorities, and mutual aid agreements.
>
> Appendices: Provides copies of maps showing locations of landfills, temporary storage sites, critical facilities, etc.

Having a Debris Management Plan available will reduce the significance of the issues that accompany the Debris Management Cycle phases which follow.

Increased Readiness Phase

Increased Readiness is defined as the anticipation of an event, such as a hurricane or flood. This is the time when existing plans are reviewed and updated, if required. All local departments that have debris clean-up responsibilities as defined in the Debris Management Plan should be alerted. Key personnel and equipment should be relocated to safe areas to ensure their availability during the Response Phase of the Debris Management Cycle. Some debris generating events, such as earthquakes and tornadoes will have little or no response time. Many of the actions will, therefore, roll over into the Response Phase.

Debris Staff and Duties. The size and composition of a debris staff will depend on the magnitude of the disaster. A pre-disaster debris planning staff may be quite small. Following a major disaster, however, additional staff members will be required. The key debris staff positions should be full-time personnel supplemented from other staffs and agencies. Prospective staff members should have as much interactive training as possible with other agencies responsible for debris removal and disposal activities, such as the National Guard, State Department of Transportation, State Police, Federal Emergency Management Agency (FEMA), and the U.S. Army Corps of Engineers (USACE).

Key personnel should be alerted and deployed either before or immediately after the disaster and should remain part of the debris staff throughout the disaster clean-up to maintain continuity during the debris removal and disposal operations.

The staff should be comprised of personnel who can perform the following functions:

Administration: Housekeeping, supplies, equipment, funding, and accounting.

Contracting and Procurement: Bidding requirements, forms, advertisements for bids, instructions to bidders, and contract development.

Legal: Contract review, right-of-entry permits, community liability, condemnation of buildings, land acquisition for temporary staging and reduction sites, land acquisition for disposal sites, and insurance.

Operations: Supervision of government and contract resources and overall project management.

Special Engineering: Detailed damage assessment; identification of project tasks; assignments of tasks; preparation of estimates, plans, and specifications; and recommendation of contract award.

Public Information: Coordination of press releases; contacts with local organizations, individuals, and media; and public notices for debris removal and disposal contracts.

The debris management staff should coordinate all debris removal and disposal activities. They should also establish contact with all local, state, and Federal agencies responsible for disaster response and recovery operations. In addition, the staff should develop local contracts for debris removal and disposal services and coordinate requests for additional assistance from FEMA.

The special engineering staff should assess debris characteristics, such as:

Quantities and types;

Rural, urban, and agricultural locations;

Number of private homes, mobile homes, public facilities, and commercial establishments damaged or destroyed;

Miles of roads affected by type such as rural, urban, and expressways; and

Quantity and types of household hazardous wastes.

Finally, the public information officer should inform the public in understandable terms about the magnitude of the disaster and the efforts being taken to expedite debris removal and disposal actions.

Response Phase

The Response Phase follows the debris-generating event. It includes actions necessary to implement the Debris Management Plan and to begin tasks necessary to protect lives and property in the affected community.

Debris is normally cleared from the traveled portion of the main roads, allowing access to key facilities and to expedite the movement of emergency vehicles. If the event exceeds the capabilities of the local Department of Public Works or Department of Solid Waste Management, actions should be taken to obtain additional equipment and manpower through mutual aid agreements and contracting. These actions will be expedited if mutual aid agreements are in place and if sample scopes of work for equipment rental contracts are in draft form within the Debris Management Plan.

Damage Assessment. One of the most important aspects of debris management following an event is damage assessment. The initial damage assessment is conducted to identify necessary life saving actions, assess the magnitude of damage, and determine additional resources required from other local governments and the State. The initial report simply defines the type of disaster; estimated cost, and requirements for State assistance

A method to conduct an assessment is to divide the community into sectors using the following criteria:

Type of debris (structural, trees, sediment, mixed),

Location of debris,

Volume of debris (large versus small),

Land use (residential, business, agricultural),

Location of existing and potential temporary storage and volume reduction sites,

Location of existing and potential permanent public and/or private landfills.

Debris Estimating Formulas. The following formulas are useful in arriving at uniform debris estimates for planning and assessment:

Volume of debris from a one story building:

$\frac{L' \times W' \times H'}{27}$ = bldg volume in cubic yards x 0.33 = reduced volume in cubic yards

Volume of a debris pile:

$\frac{L' \times W' \times H'}{27}$ = cubic yards of debris

To Convert Cubic Yards of Construction and Demolition Debris to Tons:

$\frac{\text{cubic yards}}{2}$ = tons

To convert tons of construction and demolition debris to cubic yards:

tons x 2 =cubic yards of debris

To convert cubic yards of woody debris to tons:

$\frac{\text{cubic yards}}{4}$ = tons

To convert tons of woody debris to cubic yards:

tons x 4 = cubic yards

Recovery Phase

The Recovery Phase may last from a few weeks to many months depending on the magnitude of the debris-generating event. This phase represents the actual removal and disposal actions needed to bring the community back to pre-disaster conditions. This phase will present the most challenges to the debris management staff, especially if they have failed to consider the following disposal issues:

Location and capacity of existing public and private landfills,

Location and capacity of potential temporary storage sites,

Volume reduction methods including burning, grinding, and recycling,

Environmental concerns,

Conversion of contracts from equipment rental to either unit price or lump sum, Contract monitoring requirements,

Volunteers, and

Federal and State agencies.

Volume Reduction - Burning. One of the major methods of reducing the volume of debris to be disposed of is burning. There are three primary burning methods available: open burning, air curtain pit burning, and incineration. Each burning method should be considered before selection and implementation as part of the overall volume reduction strategy.

Controlled open burning is a cost-effective method for reducing clean woody debris in rural areas. Clean woody debris presents little environmental impact and the resulting ash can be used as a soil additive by the local agricultural community. Local agricultural extension personnel should be consulted to determine if the resulting ash might be recycled as a soil additive. This action will help develop support for controlled open burn operations. The controlled open burning option should be terminated if mixed debris enters the waste stream.

Uncontrolled open burning is the least desirable method of volume reduction since it lacks any type of environmental control.

Air curtain pit burning and incineration offer effective means to expedite the volume reduction process while substantially reducing the environmental concerns caused by open burning. The air curtain burning method incorporates a pit constructed by digging below grade or building above grade (if a high water table exists) and a blower unit. The incinerator is prefabricated and can be transported by truck. The blower unit and pit make up an engineered system that must be precisely configured to properly function. The blower unit must have adequate air velocity to provide a curtain effect to hold smoke in and to feed air to the fire. Specifications and statements of work should be developed to expedite the proper use of the system. Experience has shown that many contractors and subcontractors are not fully knowledgeable of the system's operating parameters. Before awarding a contract, the debris staff should assure that contractors are knowledgeable about air curtain burner operating procedures.

CONCLUSION

The Debris Management Cycle provides the debris manager with a framework that identifies when significant debris removal and disposal issues might surface. By knowing when these issues might occur the debris manager will be a position to respond to the pressures from both government officials and the public. Being prepared for the next debris-generating event will reduce the rising costs associated with debris clean-up. Having a Debris Management Plan available is the best insurance policy any community can have to insure that their community and fellow citizens can recover as quickly as possible.

NOTES

1. Robert C Swan is a Debris Management Consultant for Dewberry & Davis in Fairfax, Virginia. His debris management experience was gained under the firm's technical assistance contract with the Federal Emergency Management Agency. He was the technical assistance advisor to FEMA for six months following Hurricane Andrew, and also spent more than 30 days in the Virgin Islands following Hurricane Marilyn where he represented FEMA on all debris removal and disposal actions. He is a regular speaker on debris management workshops and an instructor on FEMA's Debris Management Course. Robert Swan retired as a Lieutenant Colonel from the US Army Corps of Engineers after 23 years service. He holds a Master's Degree in Administrative Science from the University of Alabama, Huntsville.

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FAULT TREE ANALYSIS AND EMERGENCY MANAGEMENT

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INTRODUCTION

The intent of this paper is not to present a new methodology, but to suggest that a proven methodology, long recognized as having applications outside the aerospace industry where it was developed, can be beneficially used in the field of emergency management. This paper draws heavily on the Management Oversight Risk Tree (MORT) analytical methodology developed under the sponsorship of the US Department of Energy at the Idaho National Engineering Laboratory, Idaho Falls, Idaho.

The determination that a new facility or project is ready for operation from the perspective of the emergency manager must be based on objective evidence. Company policies and procedures, or the requirements of an authority having jurisdiction,[2] that require readiness reviews and assessments will result in meaningless lost motion if such reviews do not utilize all the available tools, or lack vigor and the proper mix of subject matter experts.

A number of common failures have been recognized in safety analysis. The following may be recognized as common failures against which to guard in emergency management readiness assessments:

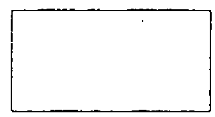
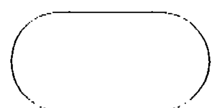
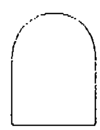
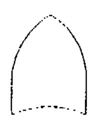
> Failure of emergency managers and those developing procedures to fully understand and react to the actual situational environment of the facility/exposure[3] being assessed.
>
> Failure of facility/exposure occupants and responders to:
>
> - Recognize their own limitations
> - Fully appreciate the hostile environment of an emergency
> - Understand and appreciate the consequences of their actions
> - Understand and appreciate restrictions and/or requirements
>
> Failure to approach the emergency management readiness assessment process in a systematic manner.

Because of the complexity of the many facilities/exposures, not all levels of owner/operator management or the authority having jurisdiction for emergency management have a clear picture of the overall plan and expectations. One approach for ensuring a better and more complete appreciation of the situation by both is a comprehensive, easily developed, maintained, and interpreted analytical tool which can be used as a checklist to enable the evaluation of emergency management concerns by both the owner/operator and by the authority having jurisdiction. The following demonstrates such a use of a Management Oversight and Risk Tree (MORT) based positive analytical tree.

APPLICATION

In *Occupancy-Use Readiness Manual: Safety Considerations*, Nertney, et al states, "In the use of analytical trees, the tendency for the beginner is to be overwhelmed by the apparent complexity of the trees. Actually, a tree need not be any more complex than the subject under observation. For this reason, the tree should be recognized as a tool to assist in performing a task rather than a burden or additional work load."

A short discussion of the standard principles for the construction of a MORT-type positive analytical tree will help the reader to understand the concept more clearly. The construction of a positive analytical tree can be accomplished using the five symbols defined below:

Definition	**Symbol**
A desired event stated by a brief functional description.	
A condition or constraint which affects an event that is assumed to be satisfied or taken into consideration.	
"AND" Gate indicates that all events on the next lower tier are satisfied.	
"OR" Gate indicates that at least one of the events on the next lower tier is satisfied.	
The transfer symbol is essentially an off-page connector, but can also be used to transfer to another location on the same page.	

From top to bottom of a positive analytical tree, the sequence of events is from general to specific. The related events on one tier are joined by a line before being processed through one of the gates (see Figure 1). A vertical line joins a general event at one level or tier with its more detailed elements on the tier immediately below. In its strictest form, all events on the same tier (even those not connected by a common line) should all be at the same level of logic or detail. Occasionally, elements on one tier will be listed ladder-style, one under the other, due to space limitations (see Figure 2).

A review of a tree will help by serving to jog a user's memory about any missing elements. The tree serves as a checklist. As lower tier elements must receive a "ready" status, clearance not is gained to the next upper tier until readiness is achieved.

Our example centers on a hypothetical Building 10 of a plant at a local industrial park. Building 10 is a laboratory which is being remodeled and equipped to conduct experiments and analysis for commercial customers. The building is near the buffer zone of the industrial complex, and various combinations of chemical wastes will be generated in, stored at, or transported from the building. Also in our hypothetical situation, the emergency management representative of the plant which includes Building 10 has worked with a representative of the local authority having jurisdiction and developed the positive tree included as Appendix A.

Interaction between private sector representatives and responders is not unusual and, when applied to the construction of a positive analytical tree, will result in a product that is tailored to the project and assures the consideration of all required details.

The process for analytical tree construction is a logical development of the top event (readiness for occupancy and operation) using deductive reasoning to progress through successively more specific events to basic events. Sequential chains flow upward from these basic events. The various levels of development are tiers and branches of contributory requirements that are sequentially linked by logic gates. Each tier of the tree contains those requirements which, when processed through the logic gate, are necessary to lead directly to the next higher tier. Branching can occur when any of the multiple requirements, which may operate through a logic gate to a common requirement, have substructures of their own.

The positive tree in Appendix A is a composite and, as indicated above, includes both the elements that the plant emergency manager feels are necessary for a safe operation from an emergency preparedness perspective, as well as the more global concerns of the representative of the authority having jurisdiction.

Elements included in the analytical tree are those which must be considered before any determination is made that the remodeled building is ready for operation. As the readiness evaluation progresses, more and more of the elements will be satisfied.

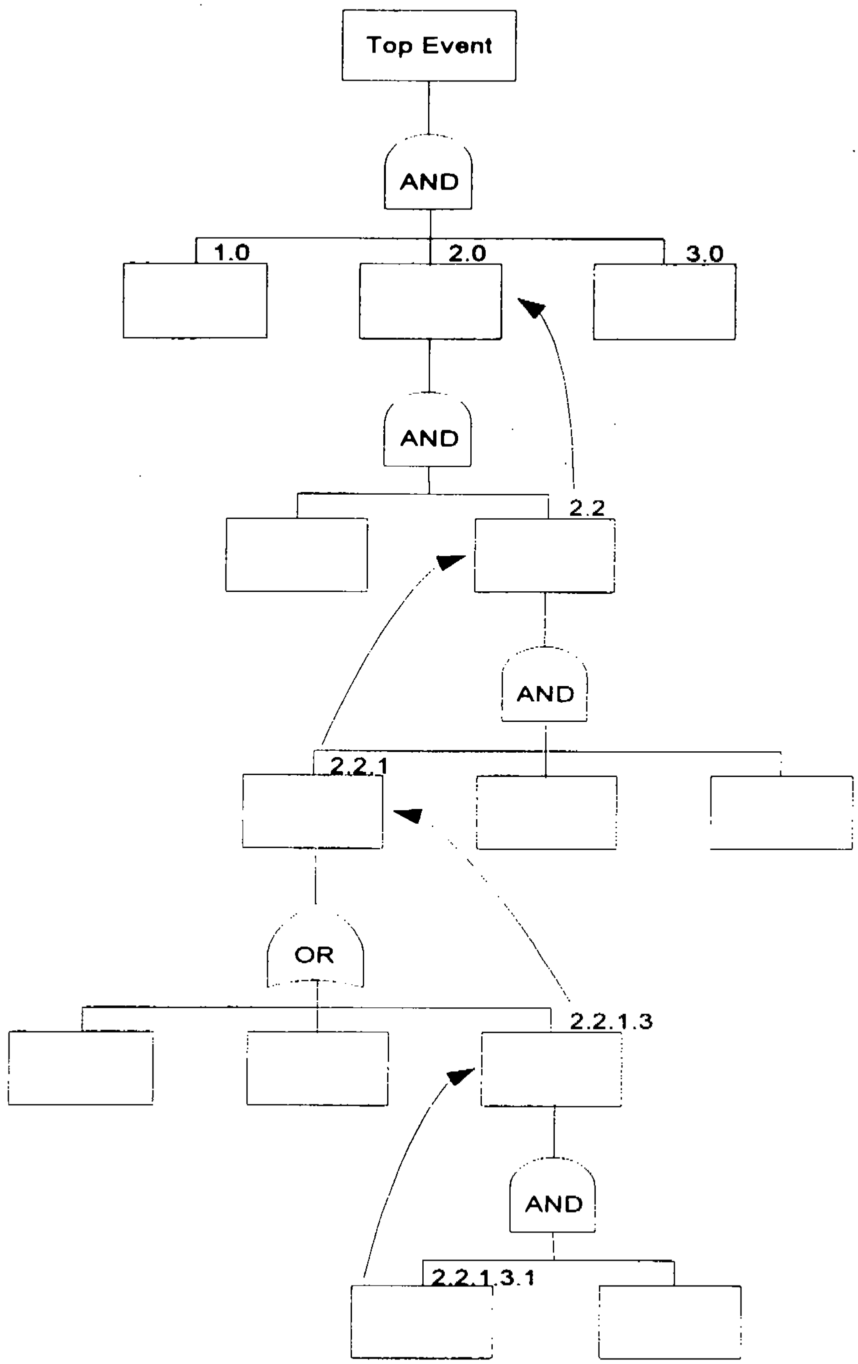


Figure 1. Example of a Basic Positive Analytical Tree

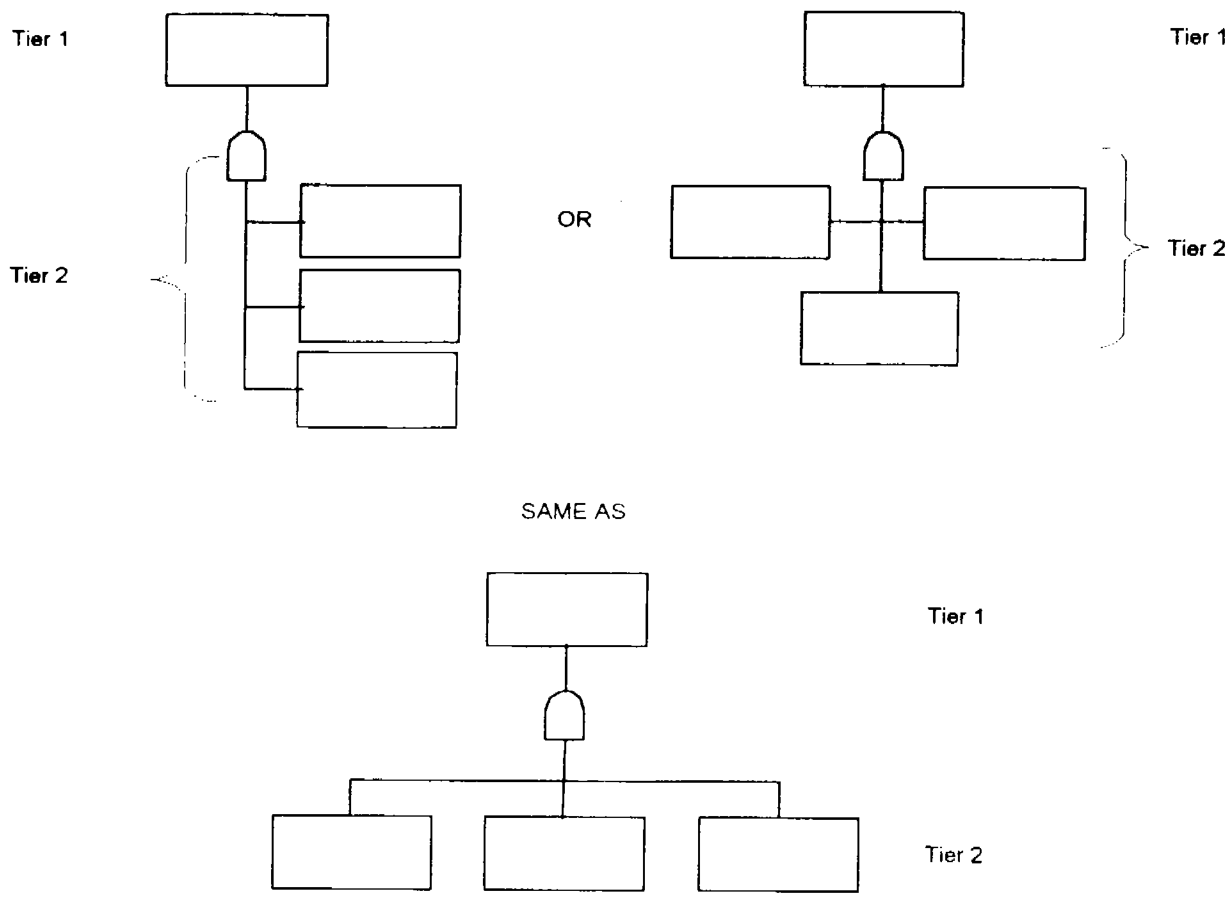


Figure 2. Examples of Element Presentation Styles

To maintain a positive analytical tree, a color-coding system is generally used. This enables a user to tell at a glance the status of a process relative to readiness. For example, a red dot on an element indicates that it is not ready. A blue dot means that more information is required to determine the status, and a green dot indicates that the element is ready. When all of the elements are marked green, everything is ready.

The analytical tree is an all-inclusive look at the level of readiness from the emergency management perspective which will help to eliminate oversights and omissions in plans and preparations. Once all of the applicable elements for a tree have been defined, the interfaces with other involved disciplines are readily discernable. The analytical work from the trees can then be assigned to the responsible group. Duplication of effort is thereby reduced to a minimum.

CONCLUSION

Benefits of using positive analytical trees in determining the readiness state of emergency response organizations alone, or in combination with specific exposures, are many. Such a visual display of the big picture ensures a clear understanding of requirements and organizational interfaces.

In addition, there are very obvious uses for positive analytical trees by members of Community Awareness Emergency Response Groups, sponsored by the Chemical Manufacturers Association in its Community Outreach Programs. Because analytical trees are easy to read and follow, their use in poster sessions or other presentations by plant officials to community groups can help to avoid situations where the public or the media, presented with overly technical explanations, jump to the conclusion that the industry is not being open and honest. Although all industries may benefit from the use of positive analytical trees to determine readiness for operations, industries that raise the level of public concern, like the chemical industry or operations or facilities dealing with nuclear materials, should achieve the greatest benefit. The process can also assist the emergency response community itself to clarify readiness capabilities.

Things are in a constant state of change, but once a positive analytical tree for a facility, class of facilities, or a process (including emergency response operations) has been prepared, it is easy to determine what effect a change or proposed change will have on the overall system.

Benefits from the perspective of the authority having jurisdiction are even more measurable. Once the process has been used to assess the readiness of responders to one plant or facility, a template has been developed that is readily applicable to other facilities within the jurisdiction. The most important benefit to be derived from the use of positive analytical trees, however, may be the high degree of confidence that the owner/operator and the authority having jurisdiction will have in determining that a facility or operation is ready.

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NOTES

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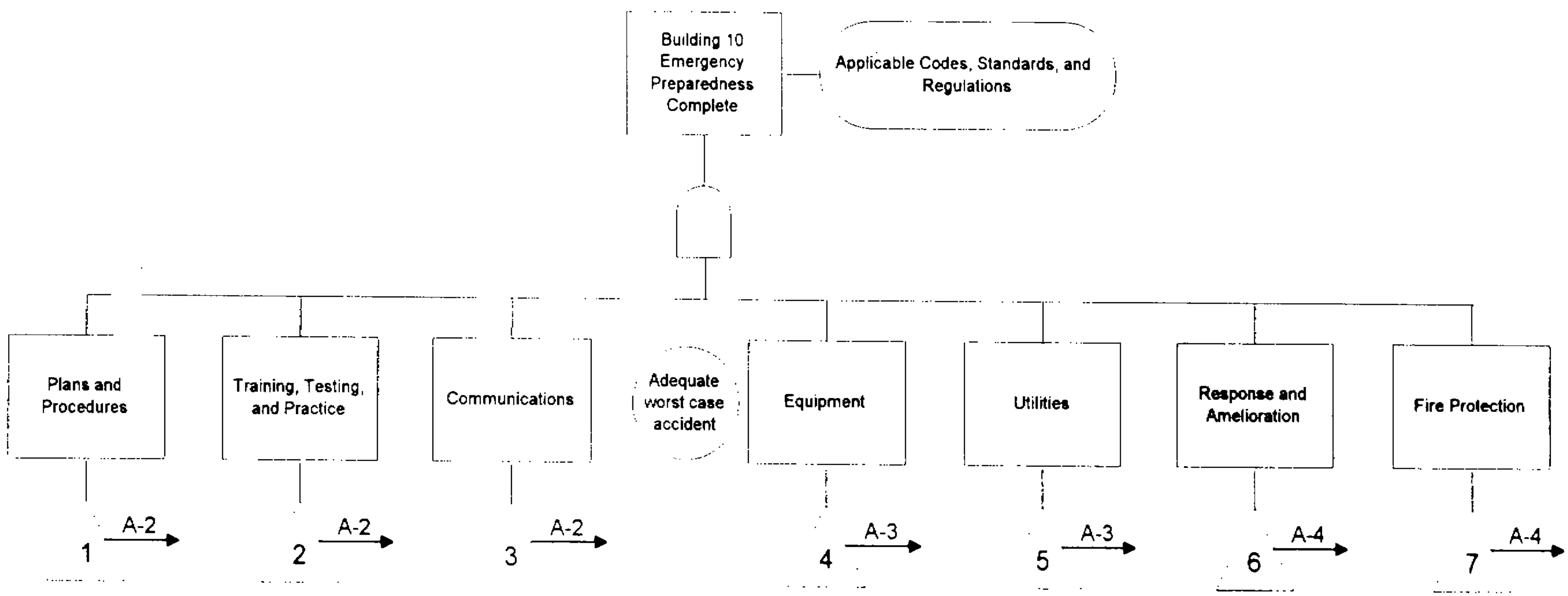
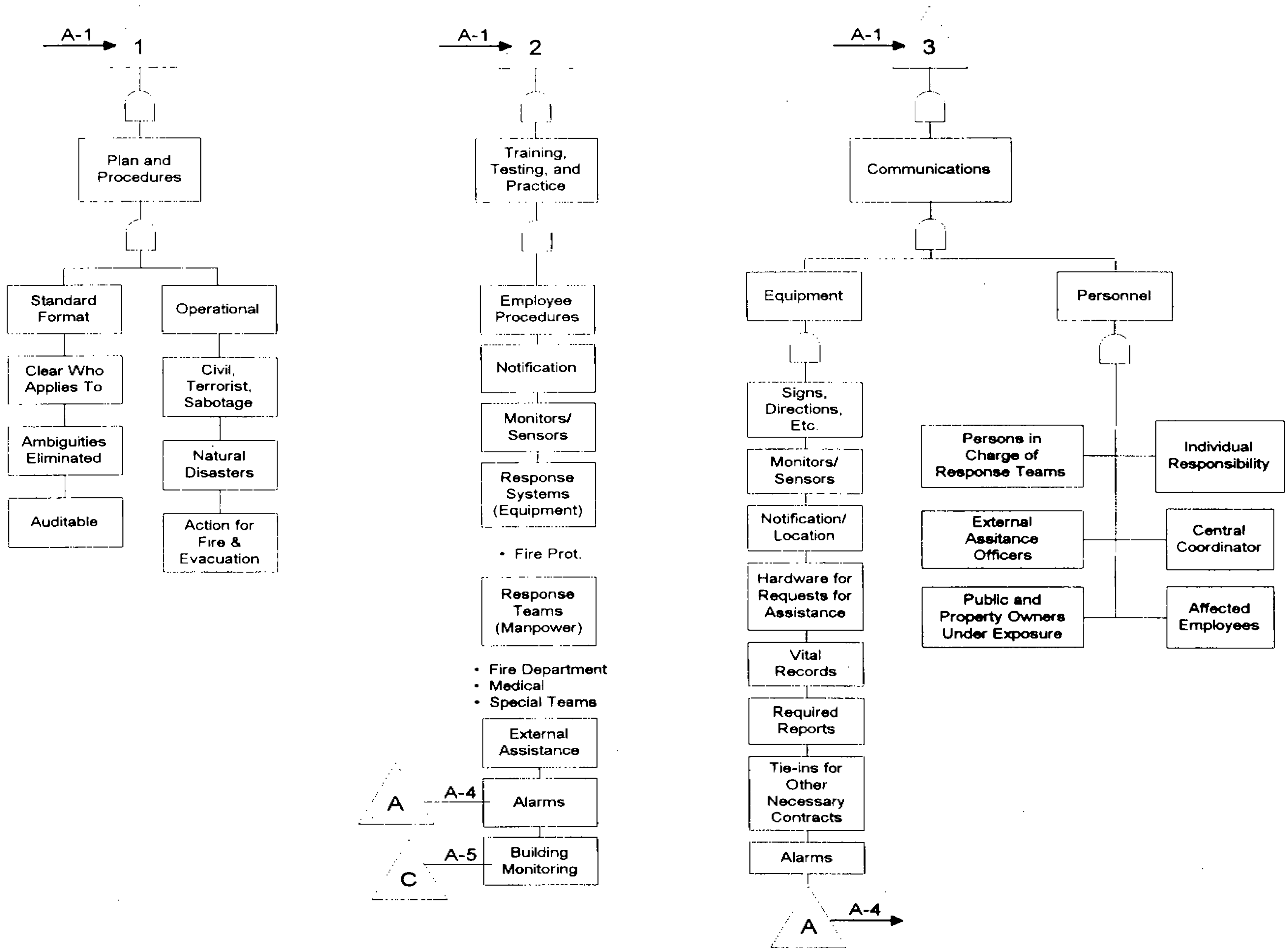
2. As used in this paper, "authority having jurisdiction" is the organization, office, or individual responsible for establishing the acceptable level of risk within the constraints of codes, standards, and regulations, and for approving emergency response procedures.

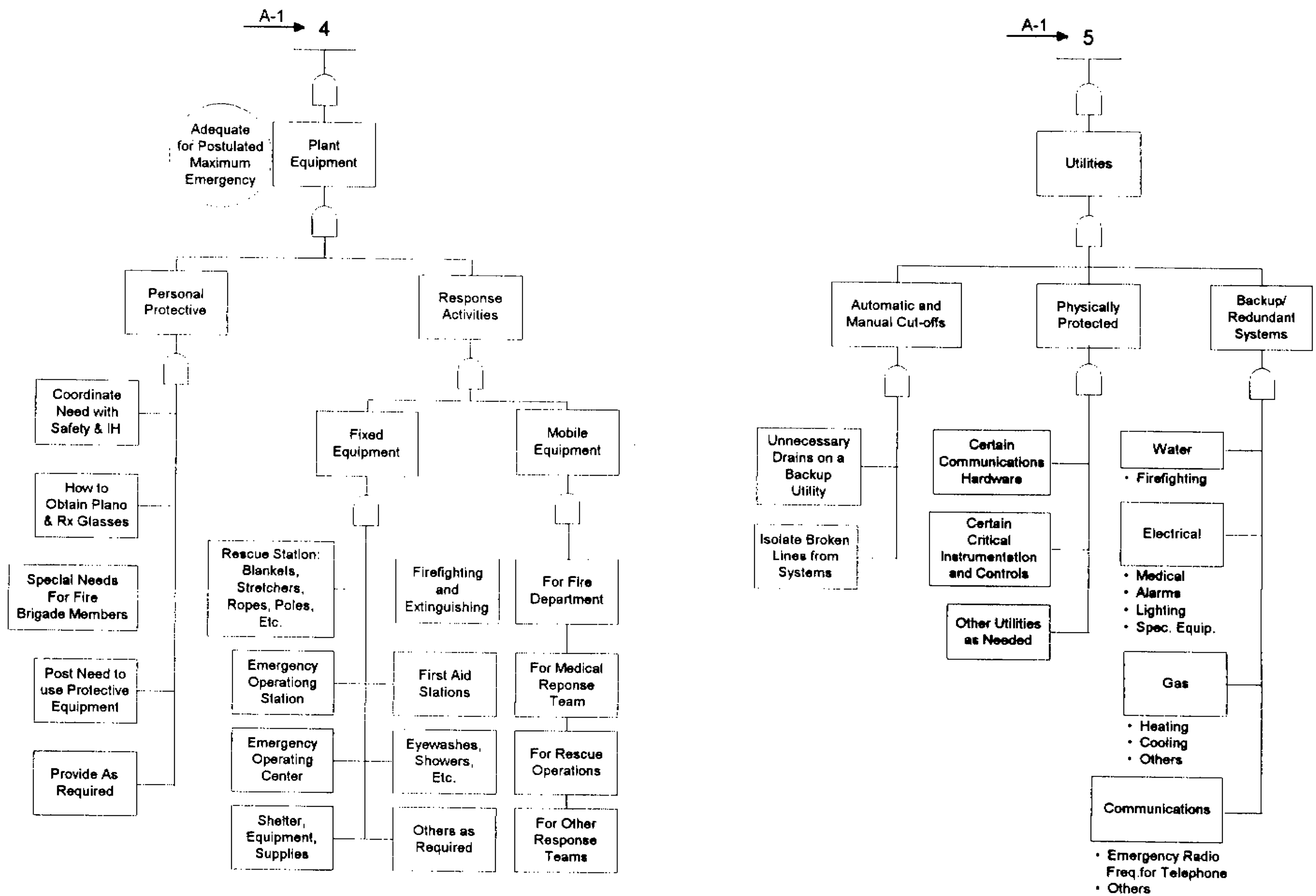
3. As used in this paper, "facilities/exposure" is intended to mean the total exposure as risk as a result of a new operation, or a new or remodeled facility. Whereas an "exposure" to a firefighter arriving on the scene refers to threatened, but as yet uninvolved property.

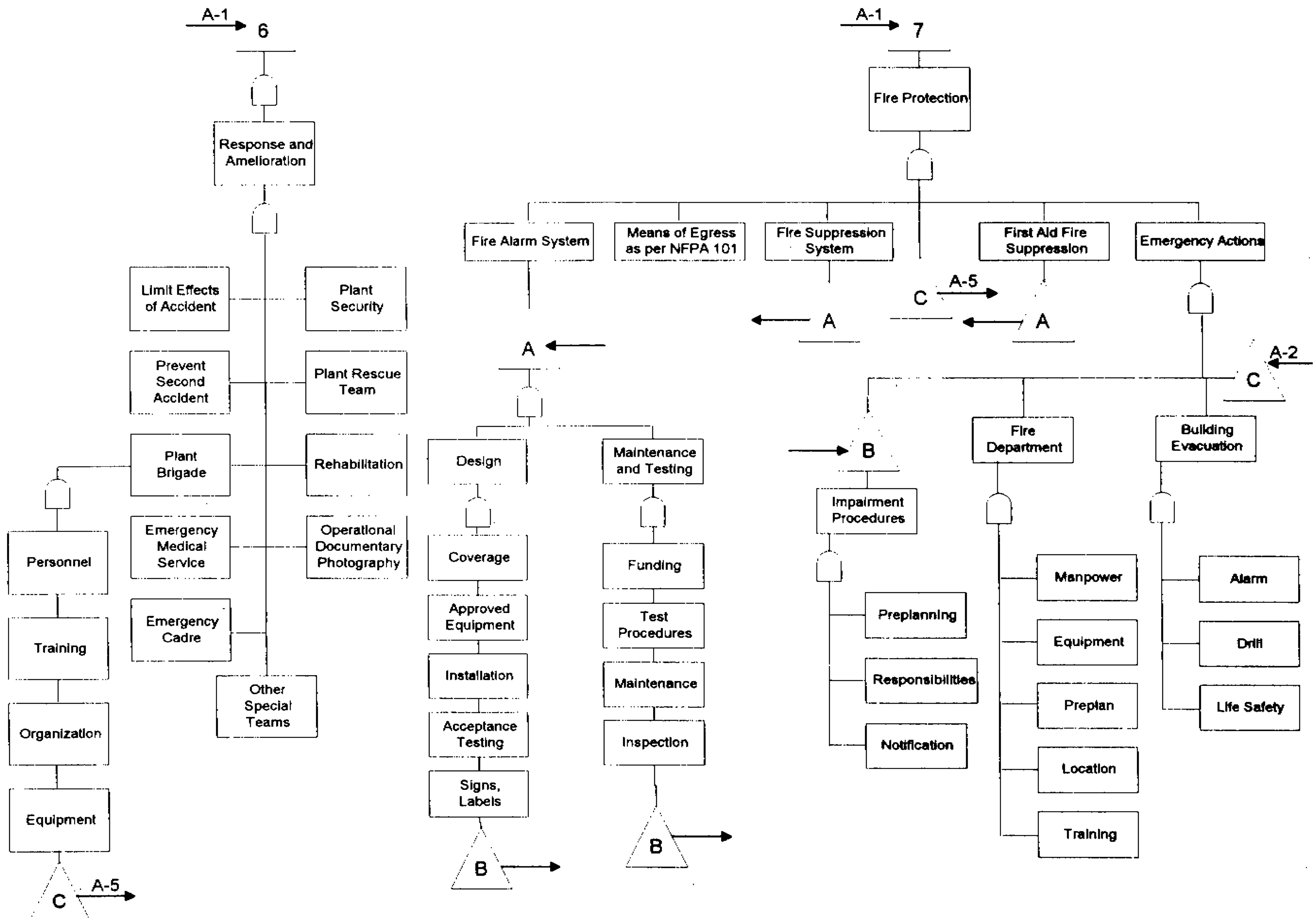
APPENDIX A
Positive Analytical Tree, Building 10

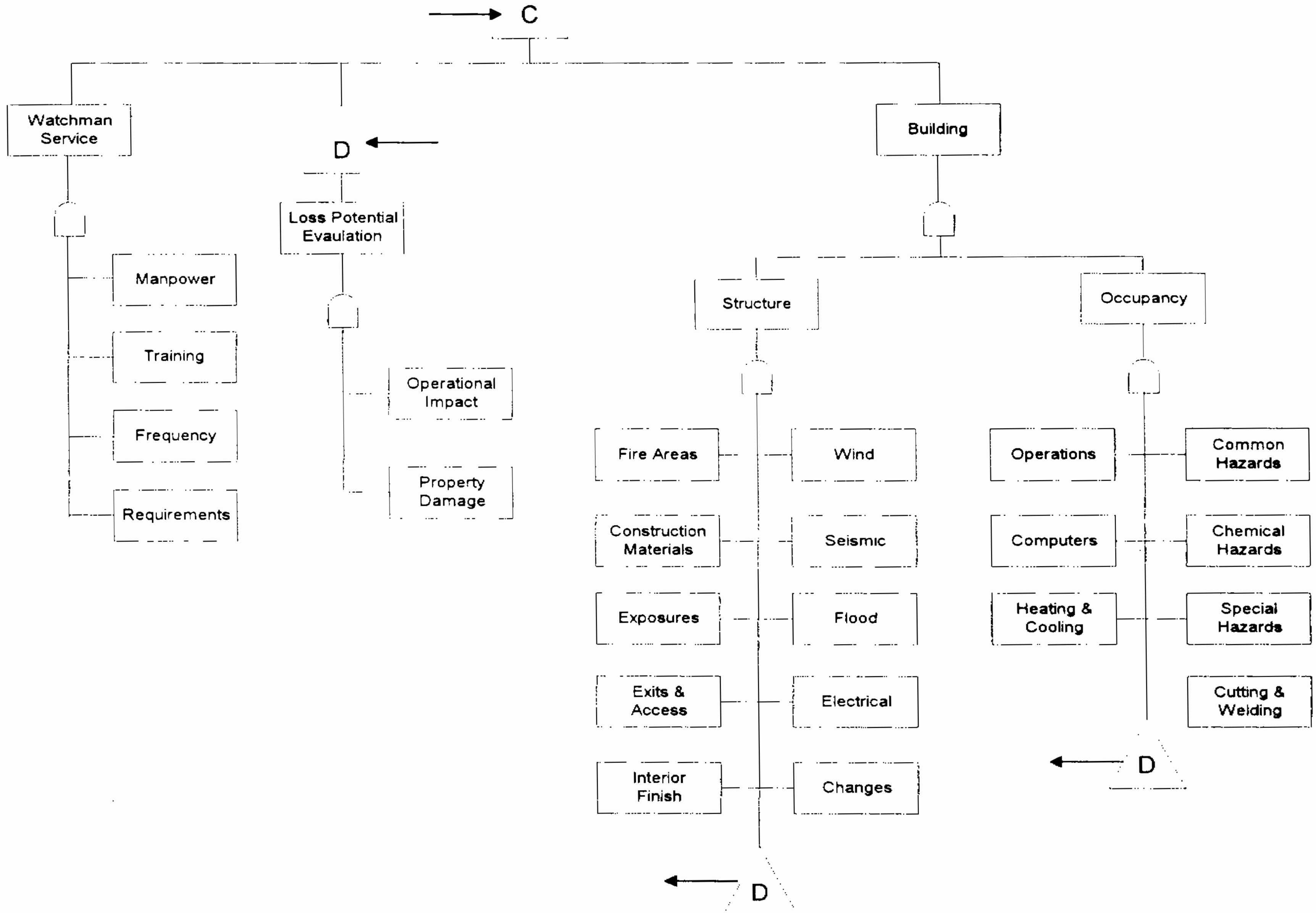




A-1
1
Plan and Procedures
Standard Format
Clear Who Applies To
Ambiguities Eliminated
Auditable
Operational
Civil, Terrorist, Sabotage
Natural Disasters
Action for Fire & Evacuation
A-1
2
Training, Testing, and Practice
Employee Procedures
Notification
Monitors/ Sensors
Response Systems (Equipment)
• Fire Prot.
Response Teams (Manpower)
• Fire Department
• Medical
• Special Teams
External Assistance
Alarms
A-4
A
Building Monitoring
A-5
C
A-1
3
Communications
Equipment
Signs, Directions, Etc.
Monitors/ Sensors
Notification/ Location
Hardware for Requests for Assistance
Vital Records
Required Reports
Tie-ins for Other Necessary Contracts
Alarms
A
A-4
Personnel
Persons in Charge of Response Teams
External Assitance Officers
Public and Property Owners Under Exposure
Individual Responsibility
Central Coordinator
Affected Employees


A-1
4
Adequate for Postulated Maximum Emergency
Plant Equipment
Personal Protective
Response Activities
Coordinate Need with Safety & IH
How to Obtain Plano & Rx Glasses
Special Needs For Fire Brigade Members
Post Need to use Protective Equipment
Provide As Required
Fixed Equipment
Mobile Equipment
Rescue Station: Blankets, Stretchers, Ropes, Poles, Etc.
Emergency Operationg Station
Emergency Operating Center
Shelter, Equipment, Supplies
Firefighting and Extinguishing
First Aid Stations
Eyewashes, Showers, Etc.
Others as Required
For Fire Department
For Medical Reponse Team
For Rescue Operations
For Other Response Teams
A-1
5
Utilities
Automatic and Manual Cut-offs
Physically Protected
Backup/ Redundant Systems
Unnecessary Drains on a Backup Utility
Isolate Broken Lines from Systems
Certain Communications Hardware
Certain Critical Instrumentation and Controls
Other Utilities as Needed
Water
• Firefighting
Electrical
• Medical
• Alarms
• Lighting
• Spec. Equip.
Gas
• Heating
• Cooling
• Others
Communications
• Emergency Radio Freq.for Telephone
• Others


A-1
6
Response and Amelioration
Limit Effects of Accident
Plant Security
Prevent Second Accident
Plant Rescue Team
Plant Brigade
Rehabilitation
Emergency Medical Service
Operational Documentary Photography
Emergency Cadre
Other Special Teams
Personnel
Training
Organization
Equipment
C
A-5
A-1
7
Fire Protection
Fire Alarm System
Means of Egress as per NFPA 101
Fire Suppression System
First Aid Fire Suppression
Emergency Actions
C
A-5
A
A
A
Design
Coverage
Approved Equipment
Installation
Acceptance Testing
Signs, Labels
B
Maintenance and Testing
Funding
Test Procedures
Maintenance
Inspection
B
A-2
C
B
Impairment Procedures
Preplanning
Responsibilities
Notification
Fire Department
Manpower
Equipment
Preplan
Location
Training
Building Evacuation
Alarm
Drill
Life Safety


C
Watchman Service
D
Loss Potential Evaulation
Building
Manpower
Training
Frequency
Requirements
Operational Impact
Property Damage
Structure
Occupancy
Fire Areas
Wind
Construction Materials
Seismic
Exposures
Flood
Exits & Access
Electrical
Interior Finish
Changes
Operations
Common Hazards
Computers
Chemical Hazards
Heating & Cooling
Special Hazards
Cutting & Welding
D
D

PREDICTING THE RISE AND AVOIDING THE FALL?
Computer - Based Simulations and Emergency Planning

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Department of Political Science, Washington State University
Pullman, Washington

At 1:23pm on Tuesday, January 7, 1998, the central United States was rocked by an earthquake measuring 7.6 on the Richter Scale. The main shock lasted 20 seconds. Within the next three weeks there were 2,364 aftershocks, 31 of which were greater than 4.0. The shaking from the main shock was the result of a rupture of the Reelfoot Rift at a depth of 6.1 miles. Strong shaking could be felt in a 10,000 square mile area. Extensive damage was reported as far away as Jackson, Mississippi, a distance of 335 miles from the epicenter. The devastation ranged across an area that extended north of St. Louis, Missouri, to south of Jackson, Mississippi, including the whole State of Arkansas, and from Louisville, Kentucky, on the east to within 50 miles of Joplin, Missouri, on the west. The immediate emergency response was delayed and disorganized owing to the large area of devastation, lack of communications and coordination with established authorities, and the overwhelming and competing demands made by the affected communities.[2]

Few in the emergency-response community doubt that anticipating and planning for a scenario such as that presented above is vital to the success of crisis management. Yet the paradox for planners is that catastrophic disasters are, by nature, largely unpredictable. Furthermore, planning for such events is made more complicated by both the difficulty and undesirability of learning about them in a real-world context.

In this article, we identify computer-based simulations as an important tool that can help emergency-response planners to better train for disasters. We argue that computer-based simulations (CBS) are a largely untapped resource for bridging the gap between disaster planning and emergency response. Computer simulations of disaster situations have the potential to improve both the problem solving skills of key response team members, which, in turn, leads to more effective organizational learning, and the coordination between and among response organizations. In short, CBS are a useful tool as both a heuristic device designed to improve organizational learning, and as an aid in the development of organizational capacity to manage emergency response.

The structure of our argument is the following. First, we will examine the problem that creates the demand for simulations in general, namely that of building organizational capacity for response. It will be our contention that such capacity is built mainly through organizational learning and inter-organizational coordination. In our examination of these two critical dimensions that follows, however, we will identify the limits of conventional real world exercises to achieve sufficient levels of performance. Flowing from this, we then make the case for the application of computer-based simulations to fill the gap. We then proceed to examine the effectiveness of such simulations, reviewing the (rather thin) literature on the evaluation of such tools. We conclude that, although this class of simulation is a powerful tool, it is more adaptable to certain aspects of organization learning and inter-organizational coordination than others. Finally, we will sum up our findings with some prescriptions for increased monitoring of the benefits derived from, and the limitations of, such simulations.

BUILDING ORGANIZATIONAL CAPACITY FOR EMERGENCY RESPONSE

A fundamental problem in the practice of crisis management in the United States and elsewhere is bridging the gap that often exists between disaster preparedness planning and post-event emergency response and recovery (Schneider, 1995; Lindell and Perry, 1993). Part of this gap is a function of the normal errors and miscalculations that occur in policy implementation, but part is also due to the nature of preparing for and responding to low probability, high consequence events.[3] Disaster plans for geographically specific events are typically the product of locally-based planning units, operating under the norms of bureaucratic routine, with sometimes limited input from the community-at-large, and generally emphasize a "command and control" model of response. The emergency response to catastrophic events, on the other hand, features the mobilization of large numbers of groups and organizations (both public and private), decentralized lines of authority, high levels of uncertainty, comprehensive involvement on the part of the community, and behavior patterns guided by "emergent norms" (Drabek, 1985, 1986; Comfort, 1994). After conducting case studies of emergency rescue operations in six major disasters, Drabek and his colleagues concluded, "emergency managers must recognize that disaster response in American society is multi-organizational, emergent, and frequently requires improvisation." (Drabek, Tamminga, and Kilijanek, 1981, pg 243).

Effective emergency response requires both collective action involving multiple organizations, and the capacity of the emergent organizational network to engage in problem-solving in the dynamic, uncertain environment of an emergency. Disaster policy researchers have shown that for emergency response teams to operate effectively, at least five central functions need to be performed both within and between public agencies, within and between levels of governmental jurisdiction, and within and between emergent community groups. These functions are: communication of information about emergency events, setting of priorities for emergency response, coordination of emergency response actions, allocation of resources to emergency response actions, and adjustment of conflicting demands for resources and personnel (Comfort, 1985). The management of these loosely coupled networks poses a legitimate problem for emergency planners and managers.

One method of limiting the size of the gap between planning and practice is for local jurisdictions to develop a flexible, integrative response capacity that takes into account both the limitations of preparedness plans and the problem of coordinating the activities of multiple organizations. Gary Kreps (1991) asserts that the twin foundations of emergency management are improvisation and preparedness. Case studies reported by Kreps (1991, pg 30) show that "improvising during an emergency is a basic strength of local communities and the ability to improvise can be increased by modestly preparing before hand." If this view is accurate, emergency managers must develop disaster plans that incorporate the capacity for organizational learning within the context of multiple responding agencies.

Gillespie and his colleagues (1993) conceptualize preparedness as a cycle. The cycle begins with a preliminary level of awareness. Once there is awareness of the threat, key response organizations begin to acquire information to assess the threat. The process of acquiring and assessing information leads to an initial level of knowledge regarding disasters. Better knowledge of potential damage and human needs from a disaster leads to planning for disaster preparedness. Planning is followed by practice or implementation of the disaster plans. Through implementation, the strengths and weaknesses of preparedness plans can be assessed, which leads back to the first level of awareness and potentially adds to it (Gillespie, et al, 1993, pg 139). In theory, organizations and community response organizations learn through experience how to increase the effectiveness of their performance. Indeed, previous experience with disasters is a well-documented correlate of effective response (Anderson, 1969; Drabek, 1986). Learning from experience is costly in terms of destruction, human suffering, community disruption, and spent resources, however. In addition, there are some who question the capacity of response organizations to learn from direct experience. Carley and Harrald (1997, pg 320) argue that "disaster response organizations, in many ways, represent almost a classic example of organizations that have a strong tendency to fail to learn from feedback.

This bundle of problems raises several interesting questions: Can disaster planners and emergency response organizations learn appropriate problem-solving techniques and. effective coordination strategies in the absence of direct experience? Can planners and responders go through the "cycle of preparedness" without assuming the costs of direct experience? Is there a viable alternative to direct experience as a way to fine-tune disaster plans? As we proceed to examine the twin challenges of organizational learning and inter-organizational coordination, our response to these questions will be in the affirmative; simulation of real-world events is the key tool for achieving effective response strategies.

ORGANIZATIONAL LEARNING IN CRISIS SITUATIONS

The role of organizational learning in crisis situations is not well understood. This is partly the result of the gulf that separates the conditions under which effective learning processes take place and the constraints posed by crisis events. March and Olsen (1976) described the learning cycle as a stimulus-response system in which individual actions lead to organizational actions which evoke environmental responses. These responses are reported back to the organization where they affect individual's cognition and preferences and so influence future actions. Learning involves both acquiring new knowledge and discarding obsolete knowledge. As Hedberg (1980, pg 3) points out: "Organizational learning includes both the processes by which organizations adjust themselves defensively to reality and the processes by which knowledge is used offensively to improve the fits between organizations and their environments."

Building on three classical observations drawn from behavioral studies of organizations, Barbara Levitt and James March (1988) view organizational learning as being routine-based, history-dependent, and target-oriented. Thus, organizational learning is conceptualized as a process, not an outcome. Organizational learning is routine-based because "it involves matching procedures to situations more than it does calculating choices (pg 320). It is history-dependent because organizational routines are based on interpretations of the past more than anticipations of the future, and are altered incrementally in response to feedback about outcomes. Finally, organizational learning is target-oriented because organizational behavior "depends on the relation between the outcomes they observe and the aspirations they have for those outcomes." (pg 320) Viewed in this way, organizational learning (that is, choosing appropriate routines based on accurate feedback focused on a well-defined and agreed upon goal) is difficult under the best of circumstances. In the dynamic, uncertain environment of a disaster, learning becomes highly problematic. Routines that are appropriate for "every day" emergencies may be counter-productive in catastrophic events, feedback may be limited or biased, and goals may be ambiguous or contested (Carley and Harrald, 1997).

Learning from experience is complicated. The past is not a perfect predictor of the future because the experimental designs generated by ordinary life are far from ideal for causal inference, particularly in disaster situations. Making organizational learning effective as a tool for detecting and correcting errors in behavior involves confronting several problems in the structure of organizational experience. The first is what Levitt and March (1988, pg 333) call "The Paucity of Experience Problem." Organizational learning "is compromised by the fact that nature provides inadequate experience relative to the complexities and instabilities of history, particularly when the environment is changing rapidly or involves many dangers or opportunities." The second structural constraint is "The Redundancy of Experience Problem." Organizations, like individuals, are creatures of habit. The stability of ongoing routines provides disincentives for the experimentation which is necessary for the process of learning to take place. Finally, there is "The Complexity of Experience Problem." Organizational environments feature complex sets of interactions and complicated causal systems with many variables. Determining how the various elements of these systems fit together to produce learning outcomes is challenging.

Paul t' Hart (1997) effectively demonstrates how non-computer based simulations may be used to solve many of these problems for organizational learning. Particularly in the case of limited crises (those which can be readily contained to one spatial or temporal point by the intervention of the appropriate agencies), non-computer based simulation is an adequate tool. Large-scale, non-containable events (such as earthquakes, tsunamis, tornadoes, floods, and drought), however, are less readily, modeled through non-computer -based techniques. The interaction of a large number of hard-to-predict variables reduces the effectiveness of human manipulation of the direction of the simulation. In such cases, non-computer based simulations may become too transparent to those participating in the exercise, and reduce the effectiveness of the learning environment. Equally so, it may be impossible to adequately and realistically model these events without the aid of computers. This point will be examined in greater detail below.

INTER-ORGANIZATIONAL COORDINATION IN CRISIS SITUATIONS

Response to large disasters calls for the coordinated efforts of a wide range of community agencies, but planning for multi-organizational response to disasters faces a variety of problems. According to Gillespie, et al, 1993, pg 98), "the creation of inter-organizational relations is constrained by insufficient time; staff shortages; incompatible schedules; limited access due to geographical distance; lack of trust, which may be attached to the organization's representative or the organization as a whole; funding cutbacks; perceptions of legal liability, and perceptions that existing relations are sufficient." In addition, as Comfort (1990, pg 90) points out, "conflict among organizations seeking to respond to the sudden, extraordinary demands generated by disaster is a recurring and well-recognized problem."

A number of disaster researchers have found that the degree of integration among organizations that comprise the emergency response network *prior to* disasters is a reliable predictor of readiness and response effectiveness (Drabek, 1986, 1992; Wenger, Quarantelli, and Dynes, 1987; Gillespie, et al, 1993; Carley and Harrald, 1997). In his review of a number of studies conducted by the Disaster Research Center, Quarantelli (1980, pp 50-51) found that ". . . the stronger and more well defined the inter-organizational linkages are prior to an event, the 'smoother' subsequent evacuation related activities will go." In their major study of community preparedness, Gillespie and his colleagues (1993, pp 97-98) concluded that disaster preparedness predicts response effectiveness, and that the structure of inter-organizational relations predicts disaster preparedness. If this view is accurate, one may ask: How can planners and community disaster response teams develop and maintain appropriate procedures and processes that will lead to effective inter-organizational coordination? Louise Comfort (1988, 1990, 1994) has written extensively about the role of "self-evident natural networks" and "self-organization" in emergency response. This view emphasizes the *spontaneous* emergence of order in networks of community organizations in the aftermath of natural or technological disasters. As Comfort (1994, pg 393) states, "recognizing the urgent needs created in stricken communities by a destructive earthquake, hurricane, flood, fire, or release of hazardous materials, people respond voluntarily with their time, material goods, skills, and knowledge to restore order to their communities." Research reported by Lindell and Meier (1994) and Kartez and Kelley (1988), among others, however, shows that communities vary in their capacity to respond to emergencies. Although the value of emergent groups and organizations and the mobilization of community resources under emergency conditions is well-documented (but see Drabek, 1986, pp 154-157), it is not very comforting for disaster planners to depend entirely on spontaneous community self-organization. This raises an important set of questions: Is it possible to plan for inter-organizational coordination? Can steps be taken to develop and nurture "organizational capital"[4] among the key organizations that will form the emergency response team? In effect, is it possible to prepare in advance of a catastrophic event to manage the emergent organizational response?

Once again, the insertion of simulations into the cycle of preparedness as one tool for building effective organizational capacity has been demonstrated as desirable from the previous discussion. Paul t'Hart's discussion of the simulations run by the Crisis Research Center at the University of Leiden emphasizes inter-organizational coordination as the third of the purposes served by those exercises. As we will argue below, under certain conditions, computer-based simulations are a preferable type of learning model to be employed. It is the identification of those conditions to which we turn next.

ORGANIZATIONAL LEARNING, INTER-ORGANIZATIONAL COORDINATION AND THE ROLE OF COMPUTER-BASED SIMULATIONS

The previous discussion offers two challenges to disaster planners and emergency managers: (1) overcoming the problems associated with organizational learning in crisis situations and (2) building capacity for effective inter-organizational coordination. The main value of CBS is in their ability to model chaotic, complex. situations with minimal disruption to real-world structures (Pidd, 1987). Many of the attractions of CBS as a tool for organizational learning can be summarized in their ability to permit controlled experimentation of disaster response. In reality, determination of the effects of a set of phenomenon can be severely hindered by confounding influences of potentially related events. Through a carefully designed computer simulation, an experimenter can isolate a property and its effects by either deleting the competing mechanisms from the model or holding them constant. Not only can a simulation be manipulated, but it can also be subjected to situations without the permanent and potentially harmful consequences that a comparable event might create in the real world.

The ability of the researcher to control the simulation permits replications, instant feedback, and increased access. To establish a generalized pattern, repeated observations are required. A simulation can be assigned the same set of initial conditions and played over and over again, whereas the natural occurrence of the situation might appear infrequently or perhaps only once. Moreover, replications of an operating simulation, and the attendant feedback, may reveal a greater range of alternative responses to a situation than could otherwise be identified.

Increased access to the objects of their research should also lead students of hazards and disasters to consider CBS. Actors in simulated crisis situations can be continuously observed; a detailed set of their written and verbal communications can be generated; their process of decision making and problem-solving can be identified; and they can be asked to respond to interviews, questionnaires, or other test instruments at time-points selected by the researcher. The diversity of means by which data are readily obtained from simulations contrasts with the limited access to the crowded lives of actual emergency managers under conditions of severe stress.

In addition to control, replication, and access, computer-based simulations contribute in at least two ways to theory building. First, the construction of a simulation requires the developer to be explicit about the units and the relationships that are to exist in the model. Thus, in constructing an operating simulation, a relationship between previously unconnected findings may be discovered. Alternatively, a specific gap in knowledge may be pinpointed, and hypotheses required by the simulation may be advanced to provide an explanation. A second value for theory building results from the operating, or dynamic, quality of computer simulations. Static statements of relationships can be transformed into processes which respond to changes in the parameters of the model.

The simple act of taking part in the simulation may also pay dividends. As noted above, networks of inter-organizational relationships emerge in the aftermath of disaster, creating a potentially disruptive form of organizational politics. Pre-event training involving CBS may be a useful way to identify appropriate roles and functions between and among organizations, thereby improving communication flows. Comfort's (1985) work in this respect is discussed in more detail in the following section.

COMPUTER-BASED SIMULATIONS AS LEARNING TOOLS

Having established the case for computer-based simulations in disaster response and emergency planning, it is now appropriate to evaluate the strengths and weaknesses of the computer-based simulation approach. It must be emphasized that all simulations are fundamentally experimental in nature.[5] In this respect, they are evaluation tools that are appropriate for conducting both pre-audits (eg, detecting errors in plans in advance of implementation) and post-audits (eg, detecting errors in implementation after the fact) (Landau, 1973; Landau and Chisholm, 1995). Yet an important component of the application simulations is the evaluation of the simulation itself. In this regard, it is incumbent upon those who advocate the use of such simulations to detail the areas in which such simulations have been shown to be either effective and efficient or less performant than other learning tools.

To date, however, the evaluation of computer-based simulations has been somewhat under-emphasized in the literature. As befits any essentially new technology, evaluation has tended to take a back seat to evolution. The approach is still in its infancy; the modeling of systems is only beginning to reach its full potential, and systematic evaluation data is hard to find. Nonetheless, the limited experience with, and observation of, computer-based simulations in the instructional environment provides some good indications of their strengths and weaknesses. Clearly, computer-based simulations vary across a number of dimensions. Even the definition of "simulation" itself is somewhat fluid, given the multitude of nuances attached to the term in the literature. In the academic world, simulations have been designed and used in many disciplines, each with specific parameters; the instructional environment is often rather different, and the exercises are conducted with diverse ends in mind. As we have discussed, computer-based simulations have an increasing role to play in the professional world. Crookall (1988) notes this variance in simulation exercises and points out that there are other ways in which they may be classified. In reviewing the wide range of goals encompassed within computer-based simulations, Crookall notes that this has, in and of itself, made the evaluation of their effectiveness difficult. Thomas and Hooper (1991) conducted a comprehensive audit of available instructional computer-based simulations across a full range of disciplines. On the basis of the taxonomy proposed by Thomas and Boysen (1984), they classified them into four different categories: experiencing, informing, reinforcing, and integrating.

Experiencing simulations are distinguished by their aim to set the cognitive or affective stage for future learning (Thomas and Hooper 1991, pg 499). In this mode, simulations generally precede any formal presentation of substantive material. They can provide motivation, a structure to organize future information, concrete examples, or show participants their lack of knowledge or prior misconceptions. Studies have shown that experiencing simulations may increase participant application and receptiveness. For example, the early use of a computer simulation in the semester was shown to have an impact upon student assessment of that simulation (Taylor, 1987). Hooper (1986) showed that the use of a simulation led students using it (in a programming course) to produce more sophisticated algorithms in subsequent work than the control group. The drawback to such simulations, however, is that they are harder to evaluate. The effects of them may not be detected in levels of increased knowledge among participants; rather, they are more likely to be felt in the area of knowledge application. Furthermore, one potential liability is that they may actually reduce the propensity for students to propose solutions based on prior knowledge.

Informing simulations are those which are designed to readily transmit information or content to participants. In this respect, they may replace rather than supplement existing modes of knowledge transfer. Studies cited by Thomas and Hooper (1991) show little difference in effectiveness between simulations and classical methods of knowledge transfer, such as textbooks and lectures. In only one study looked at by these authors did simulations show any' measurable superiority as a mode of informing; balancing this is a different study that actually indicates detrimental effects of reliance upon computer simulations as tools for the transmission of knowledge. Thus, they concluded that when a simulation compares favorably with other more direct methods of instruction in transmitting information, the results make a stronger statement about the weakness of other methods than the strength of the simulation.

The third category of simulation discerned in this study are what the authors call "reinforcing exercises". Simulations are considered reinforcing if the knowledge is applied in the same context in which it was learned (Thomas and Hooper, 1991). Clearly, the utility for knowledge reinforcement co-varies with the complexity of the processes that are being explained. Situations in which individual participants have difficulty making the correct response to complex problems, despite prior knowledge or experience, enhance the application of the computer-based simulation as a reinforcing tool. It is important to note that such simulations would need to incorporate some kind of feedback mechanism, in order to correct inappropriate responses. Thomas and Hooper (1991, pg 505) find some indications that these types of simulations are useful in teaching environments; however, they also find that they are not particularly adequate.

The last group of simulations that they distinguish are what they call "integrating exercises". When complex processes are being analyzed in separate components, it is often difficult for students to conceptualize the object at the systemic level; ie, to understand not only the individual components of a process but to grasp the interactions and relationships between them. Computer simulations are a particularly effective tool for mastering the complexity of such a process since the parameters of such simulations can be so easily and efficiently manipulated. Several studies cited by the authors have shown that integrating simulations are particularly useful as diagnostic tools; that is, they allow participants to grasp a process at the systemic level and to isolate particular components of the system when disruptive problems or imbalances are occurring.

Ultimately, Thomas and Hooper conclude that pure computer simulations (defined as those that have inherent goals and which contain manipulable models) are most effective when constructed to perform experiencing and integrative solutions. They tend to be less effective, relative to other methods, for informing and reinforcing. They may have some utility in these areas, but in combination with non-computer based forms of instruction. Very much in line with these findings, Gorrell (1992, pg 365) finds that simulations are more likely to increase experience (knowledge through practice) than to allow participants to acquire new knowledge. This study points out that simulations are most useful when targeted at specific skills or areas of knowledge; it concludes that computer simulations achieve their greatest effects through the power of the computer to provide rapid and varied practice that is not readily obtainable from other forms of instruction.

Looking at the organizational level (both as a deliberative subject of simulation and as a consequence of individual learning), Comfort (1985) identifies the critical role that simulations may play in evaluating so-called "action research" as a means to organizational learning. Action research is the application of different levels of inference to the solution of problems facing organizations or communities; it is to be differentiated from applied research. Comfort (1985, pg 104) identifies six levels of inference that have a hierarchical relationship. The hierarchy begins with relatively observable data and moves through to the effects of living systems upon learning and effectiveness for social units being studied. The problem facing officials and organizations involved in emergency management is that it is difficult to evaluate the results of action research in situations where it is clearly not desirable to actually utilize disasters in the role of controlled experiments. It is in this context that the simulation can perform a critical role; it permits organizations to *apply what they know*.

On the basis of controlled case studies involving simulated emergencies, Comfort (1985, pg 107) describes the striking discrepancy at all jurisdictional levels between the participating administrators' perception of their own performance and their assigned responsibilities as described in the emergency plans. The outcome of the simulation revealed that intra-organizational response was more effective than inter-agency response, confirming the starting hypothesis of the researchers. More importantly for the discussion of the learning role of simulations, on the basis of a comparison of pre- and post-simulation questionnaires, the participants themselves recognized the critical differences between the two sets of responses. Here the simulations clearly fill a need; in cases where applied data is scarce or not feasible to generate (such as disaster response), the simulation may play a critical organizational learning role. Computer based simulations are one subset of such simulations and are probably most appropriate where real world verisimilitude is less desirable and can be sacrificed in favor of complexity and manipulability.

The advantages of computer-based simulation in organizational settings are clearly laid out by Jacobsen and Bronsen (1995). The application of macro-sociological theory to emergency response and disaster management raises important issues that face almost any researcher in the social world; in the case of the specialized arena of emergency response and disaster management, these issues are magnified and sharpened. By nature, disasters tend to be unique, unpredictable (although not always unexpected), and mercifully rare; it is hard to collect reliable and consistent longitudinal data f or this type of phenomenon. The uniqueness of disasters also raises the issue of replication; viewed as distinct cases, it is hard to distinguish what is case specific and what is generalizable. Last, the replication of events that is so desirable in the pursuit of knowledge and theory testing is clearly not desirable for ethical and legal reasons.

In sociological research, computer based simulations may be used to provide theory-testing data that allows researchers to choose between competing theories or hypotheses. In applied settings, computer simulations may help organizations and agency officials to decide between competing strategic orientations or plans. In both cases, simulations are being used not only in the learning capacities outlined by Thomas and Hooper (1991), but as theory-testing or program-testing devices. The particular use of the computer allows researchers and officials to simulate events and phenomena that are impractically simulated through other means. Such an approach has long being adopted, for example, by military planners in the complex formulation of strategic battle plans. Ultimately, the experiencing benefits of computer-based simulations are most likely to have an impact in the area of organizational learning. Integrating advantages are most likely to be felt in the inter-organizational coordination dimension of organizational capacity for emergency response. This is summarized in Table 1; examples of organizational advantage that are to derived from each are displayed.

CONCLUSION

We have argued that computer-based simulations offer many potential advantages to emergency planners as a mechanism for improving disaster response capacity. The use of computers allows the construction of simulations with very specific properties. Computer technology permits more flexibility and manipulability in complex designs than the available alternatives. The application of this kind of technology permits rapid feedback and assessment, which can then be used to re-run the exercise with a high degree of control and confidence. Another advantage of computer simulations is that it enables very precise measurements to be made of the system state at any point in the exercise. The data gathered can be analyzed and compared across events, leading to the generation of knowledge over time. Finally, as has been pointed out above, computer simulations are especially advantageous in situations where traditional methods of learning from experience are either too dangerous or are not feasible for ethical or legal reasons.

Ultimately, it must be admitted that the application of computer-based simulations in the field of disaster planning and emergency response is in its infancy. The most important consequence of this, for the present discussion, is that the evaluation of such simulations is lagging behind application. For those involved in the emergency planning and response community, the gathering of systematic data on simulation evaluation should be a priority. Lessons derived from laboratory and academic research indicate that computer-based simulations are both a powerful new tool in planning for and mitigating the catastrophic consequences of real world disasters, and are here to stay.

Table 1

Emergency Response Problems and the Advantages of Computer-Based Simulations

Class of Emergency Response Problem	Advantages of Computer-Based Simulations
Organizational Learning	**Experiencing Simulation:** Exposes inappropriate forecasts of event likelihood. Demonstrates misunderstanding of nature of event. Reveals misconceptions about organizational ability to respond to event. Shows unintended consequences of organizational action in existing plans.
Inter-Organizational Coordination	**Integrating Simulation:** Brings together individual organizational competencies in one dynamic, complex model. Demonstrates effects of multi-organizational interaction. Exposes limits of knowledge transfer across organizational boundaries. Develops context-specific communication networks between and across agencies, jurisdictions, and private sector groups.

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2. This scenario is adapted from seminar materials developed for the US Federal Emergency Management Agency's Comprehensive Exercise Program. Information' regarding this program can be found on the World Wide Web at <www.fema.gov>.

3. For a classic discussion of the normal errors of policy implementation see Pressman and Wildavsky (1984). Herbert Simon (1973) discusses "ill-structured problems" and the nature of low probability, high consequence events.

4. The term "organizational capital" is intended to suggest that, like "social capital," networks of trust, cooperation, and prior experience are important variables related to collective action.

5. Webster's Dictionary defines an experiment as "a test or trial of something; specifically, a) any action or process undertaken to discover something not yet known or to demonstrate something known, b) any action or process designed to find out whether something is effective, workable, valid, etc."

A PROFESSIONAL EXCHANGE VISIT TO CHINA

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ARRANGING A PROFESSIONAL EXCHANGE

In October, 1996 the National Center for Earthquake Engineering (NCEER) at the State University of New York, Buffalo published a request for proposals for researcher exchange visits between the United States and the Peoples Republic of China to be sponsored by the National Science Foundation. In Pacific Grove we decided to take advantage of this program to extend our own knowledge and establish and renew contacts with the Chinese disaster research community. These grants are usually awarded to researchers at universities such as Stanford or the California Institute of Technology and it might be unusual for someone working at a fire department to receive such a researcher exchange travel grant. Through a fortuitous set of circumstances, however, it appeared that Pacific Grove might be eligible.

The Federal Emergency Management Agency had given national recognition to Pacific Grove in May 1997 in an article, "Pacific Grove - A Model City for Disaster Preparedness", which appeared in the *Compendium of Exemplary Practices in Emergency Management*. In addition, the January 1997 issue of the *Journal of the American Society of Information Science* contained a paper on an analysis of citations and translations in Chinese library and information science literature. Citation data had been collected from seven major Chinese journals in library and information science published between 1983 and 1990. My name was listed in two appendices concerning groups of the most heavily cited and translated authors. What a surprise to see a paper that I had written in 1977 in my starving student days when I was working on my PhD listed as heavily cited! I immediately wrote to the NCEER to point out that the Chinese had found my earlier research useful and that I hoped that some seismologists in Beijing would be given a travel grant to come to Pacific Grove to find out about the useful things in earthquake preparedness that I was now doing!

A proposal was submitted to the NCEER for exchange visits by Chinese earthquake researchers to visit Pacific Grove to learn how a small California city prepares for earthquakes and for the Pacific Grove Fire Department's disaster coordinator to visit China for two weeks to learn how the Chinese prepare for earthquakes.

The NCEER approved my proposal with the stipulation that the travel must be completed before February 28, 1998. I therefore suggested visiting the Chinese Academy of Sciences during the period of October 20-31, 1997. The Pacific Grove City Manager invited the Chinese to visit Pacific Grove during the first two weeks of April 1998 so that they could observe the City of Pacific Grove's participation in the State of California's annual earthquake exercise, usually scheduled for the first Tuesday in April. The

Chinese Academy of Sciences sent me an invitation by e-mail to show to the Chinese Consulate in San Francisco when I applied for my visa. The American Embassy in Beijing was notified by e-mail of my visit to the Chinese Academy of Sciences.

NOT ALL THINGS WORK OUT

An inquiry had also been made to the Chinese Academy of Sciences for a possible visit to the Shanghai Anti-Disaster and Relief Office on October 9-10 before visiting the Center for Disaster Reduction of the Chinese Academy of Sciences in Beijing. I had met some of the five members of the Shanghai delegation to the 2nd International Conference of Local Authorities Confronting Disasters and Emergencies held in Amsterdam in April 1996 when I presented a paper there. Even in organized exchange visits, however, not all things turn out as expected. When I arrived in Shanghai and contacted the Anti-Disaster and Relief Office, the visit could not take place because of the absence of an interpreter.

CENTER FOR DISASTER REDUCTION

The Center for Disaster Reduction of the Chinese Academy of Sciences was established in 1995. The Center's headquarters is located at the Institute of Atmospheric Physics in Beijing. It is a union of more than forty organizations which are engaged in disaster reduction activities. There were 47 research projects underway in 1996.

I gave a seminar on "Emergency Preparedness for Earthquakes in California" on October 28th at the Center for Disaster Reduction. The Director, Professor Wang Ang-Sheng, is also the Director of the Experts Group of the Chinese National Committee for the International Decade for Natural Disaster Reduction. He and Dr Qian Ye (who received his Doctorate from Oregon State University) and Dr Dong Jiarui assisted in arranging other visits for me. A number of representatives of the Institute of Atmospheric Physics, Institute of Geology, and the Institute of Crustal Dynamics also participated in the seminar, and my wife, Ellen, also discussed how neighborhood emergency response teams are organized. Their research community has outreach problems with their administrative community and the Chinese research community seemed glad to hear of the grass-roots public education efforts which emphasize the individual homeowner's taking more responsibility for preparedness.

A small collection of American preparedness literature was presented to the Center for Disaster Reduction. This included copies of publications from various US sources, such as the NCEER, ERRI, the state of California, FEMA, the American Red Cross, IAEM, and public disaster information from several Monterey County organizations. We take much of this information for granted, but there is little access to it overseas, just as foreign literature is not readily available here. This type of literature is very much appreciated when making visits to foreign organizations. Numerous Chinese research publications were given to me. Chinese research into natural disaster precursors and prediction seem promising and would seem to be worth investigating.

Professor Wang Ang-Sheng, Director of the Center, arranged for me to visit the Institute of Atmospheric Physics and the Institute of Geology. I also visited Peking University and Beijing Polytechnic University and met scientists from the Institute of Geophysics and Institute of Crustal Dynamics, State Seismological Bureau, and visited Tangshan, the city which suffered China's worst earthquake disaster in this century.

VISIT TO TANGSHAN

Dr Dong Jiarui took me to visit the city of Tangshan, about 90 miles from Beijing. A magnitude 7.8 earthquake occurred at 3:42 am on July 28, 1976 which resulted in 240,000 deaths in the city. The Peoples Liberation Army responded with 100,000 troops to rescue survivors, treat the injured, build temporary shelters, and feed the earthquake victims. The rebuilding of the city was a classic case of forced urban renewal. The city is now a showcase since most of the buildings are now only ten to 15 years old and the streets are wide with attractive landscaping using many trees and flowers. There is a comprehensive earthquake museum which documents the disaster and the rebuilding of the city.

CHINESE RESEARCH ON PRECURSORS AND PREDICTION

It is curious that research on alternative non-seismological approaches has apparently not been taken seriously in the United States. Large disturbances of the earth's magnetic field have been observed shortly before devastating earthquakes such as the "Good Friday" earthquake in Alaska. The observations were reported in a distinguished scientific journal, but since then they have been almost universally ignored in discussions of the possibility of predicting earthquakes.

I was impressed with the Chinese approach of examining magnetic observatory records to see if there were any precursor indications associated with earthquakes. The United Nations is interested in exploring this approach and had scheduled a workshop for representatives from magnetic observatories in about 15 different countries to come to Beijing for a week in February 1998. The Chinese researchers demonstrated three different methods of analysis of geomagnetic data so that each magnetician could go home and examine his data for precursors of local earthquakes.[2]

It would appear that Chinese research on earthquake precursors and prediction should be looked at seriously in the United States since the combination of several alternative methods seems to have indicated the potential of empirical prediction for large earthquakes even where physical understanding is lacking. It may be prudent and worthwhile for researchers in the United States to investigate some of these alternative non-seismological approaches.

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NOTES

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2. The U N "Global Program" can be found on the Internet at <http://www.shore.net/~globalw/ungp/>.

MANAGING THE EFFECTS OF A VOLCANIC ERUPTION
Psychological Perspectives on Integrated Emergency Management

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INTRODUCTION

A sequence of eruptions a Ruapehu Volcano, a multi-vent, andesite composite volcano in the central North Island (Houghton, Latter, and Hackett, 1987) began on September 18, 1995 and continued through to early November. Volcanic ash falls produced widespread effects (Johnston, Neall, Houghton, Ronan, and Paton, in prep), affecting some 20 communities and large areas of agricultural land, disrupting air and road transportation, and affecting water and national power supplies. This eruption resulted in an unprecedented response to activity at a New Zealand volcano, with some 42 organizations being involved in response activities. This paper discusses the results of a pilot study conducted to examine response issues which organizations perceived as problems and their implications for integrated emergency management (IEM). While structural and procedural aspects of IEM have been well documented, this paper draws upon the organizational and social psychology literature to provide additional insights into the nature of the observed problems and to suggest strategies for their management.

METHODOLOGY

A survey, developed from a questionnaire used by Saarinen and Sell (1985) to evaluate the response to the 1980 Mount St. Helens eruption, was distributed to all organizations which played significant roles in responding to the eruptions. Free response sections, which allowed respondents to qualify and illustrate their responses, were content-analyzed and used to assist in explaining reported problems. The questionnaire was distributed in March 1996. This allowed a sufficient interval between the cessation of volcanic activity and the survey distribution for organizations to evaluate their response. Of 42 organizations contacted, 30 replied, giving a rate of return of 71%.

RESULTS AND DISCUSSION

The problems encountered, their perceived importance, and the proportion of organizations affected are recorded in Table 1. The scores reveal that the problems encountered were perceived as important constraints on response effectiveness. Given its central position in integrated emergency management, we start with a discussion of co-ordination issues.

Table 1

Problems Affecting Organizational Response Effectiveness (N = 30)

Problem/Constraint	Organizations Reporting Specific Response Problems	Perceived Importance [a]	
	%	Mean	SD
Communication issues	46	2.85	.34
Lack of clear responsibility for coordination	45	2.67	.49
Lack of appropriately trained personnel	34	2.78	.44
Management procedures	35	2.33	.71
Lack of equipment	29	2.75	.46
Inadequate coordination of response	32	2.63	.74

a. Scale is from 1 (unimportant) to 3 (very important).

Response Coordination

Two issues, a perceived lack of clear responsibility for coordination (45% of respondents) and inadequate coordination of response (32%), were identified. The eruption effects covered a wide area and generated demands that transcended the expertise and/or jurisdiction of any one organization. Disaster response involves the coordinated activity of diverse organizations who often have little contact with one another under normal circumstances (Auf der Heide, 1989). Although a coordinating group was constituted (Keys and Williams, 1996), the unprecedented nature of the response and the sudden demand for an integrated response involving organizations largely unfamiliar with one another resulted in their interacting in an ad hoc, rather than a planned, manner. While multi-jurisdictional response management can be facilitated using a linked network of emergency operations centers (Hightower and Coutra, 1996), adopting this approach raises several issues.

Inter-organizational differences in operating structures, procedures, and terminology must be identified and the resolution or containment of any potential conflicts emanating from them should be managed within reduction and readiness programs.

Additional issues emerge from the fact that the contribution of several agencies is required to manage the range of demands posed by a disaster. Integrated emergency management thus represents a multidisciplinary, team-based approach. A cohesive and integrated team provides the mechanism by which the benefits of IEM can be realized. Psychological research into multidisciplinary team development and management has identified several problems in getting diverse professional groups to work together. Team development issues are particularly salient here because several team members operate collectively only during the period of a disaster. The benefits accruing from teams frequently remain unrealized because insufficient attention is given to their development and maintenance (Northcroft, Polzer, Neale and Kramer, 1995). Team members are generally selected for their functional expertise, but the implications of the accompanying diversity in attitudes, professional philosophy, personality, and cognitive style, or example, are not considered. This diversity can generate misunderstanding, miscommunication, and mistrust amongst members (DiTomaso, Cordero, and Farris, 1996). In addition, a functionally-selected membership can fuel conflict regarding procedures, goals, and resourcing (Northcroft et al, 1995). While conflict and diverse views represent a strength of teams, their constructive use requires education, negotiation, and the management of team development and performance (Northcroft et al, 1995; Tuckman and Jensen, 1977). One crucial factor in team development and cohesive operation is social (professional) identity (Bettenhausen, 1991; Northcroft et al, 1995; McGill, 1998).

Social identity processes, particularly the stereotyping of in- and out-groups, can limit the ability of official multi-agency relationships to operate cohesively. Developing a coherent sense of identity thus represents an important preparatory activity (Hogg, 1992). Realizing the benefits accruing from a multidisciplinary team effort and promoting effective and cohesive team work requires consideration of: a) how participants define group membership and how it influences cohesion; b) patterns of interaction between group members in relation to institutional policies, structures and culture, and the language and terminology used; and c) contextual factors such as understanding of integrated emergency management policies and practices, the status and power accorded to different members, and resource constraints. These points provide guidelines for multidisciplinary team development activities and underline the need for this process to be managed. Given the ad hoc nature of the "team" responding to the 1995 Ruapehu eruption, organizational representatives would have encountered these problems at the same time as responding to the eruption demands. Dealing with a mix of operational and "team" issues could have contributed to the observed coordination problems.

Resource constraints represent a common source of divisiveness in multidisciplinary groups, even in previously cohesive and effective teams (Hogg, 1992; Northcroft et al, 1995). A decision not to declare a state of civil defence emergency following this eruption limited the resources (particularly financial) available for managing the response. Consequently, responding organizations had to fund their activities from existing resources. The additional strain imposed by funding issues contributed to coordination problems, particularly as they emerged in a context where jurisdictional issues were blurred and "routine" activities were still being performed. At a policy level, the criteria for emergency resourcing should be reviewed. To argue for an integrated response while simultaneously acting to limit its effectiveness is counterproductive. Any short term increase in the financial provision necessary to support a response is more than compensated for by limiting subsequent economic losses. In addition, resource conflicts may compound problems by reducing future group cohesion, rendering the maintenance of an integrated emergency management framework more difficult. If external factors threaten their functioning, however, team integrity can be sustained by focusing on collective strategies for influencing funding, lobbying politicians, or submitting policy statements and plans to decision-making bodies.

In addition to addressing team development issues, team management must be considered. Psychological research into multidisciplinary teams has developed models to assist this process. Two models, the "collaborative team model" and the "metasystem consultation model" (Shute, 1997), deserve consideration in this context. The collaborative team model involves different professionals working as equals, contributing different perspectives to the decision making process. The metasystem consultation model involves the "external" coordination of a collaborative team and the direction of team activities. One advantage of the latter is its ability to accommodate environmental (eg, political and resourcing issues and policy and cultural differences between collaborating organizations) constraints on team performance (Northcroft et al, 1995). Both models provide a framework for the kind of transitory organization required to manage the diverse and multijurisdictional demands that typify the disaster environment.

Communication

Effective communication between organizations is essential for integrated emergency management and for the quality of decision making in an environment characterized by multiorganisational involvement and conflicting and diverse demands. Of the problems reported following this eruption, some were attributed to hazard activity (eg, ash fall affecting communication equipment), but difficulty obtaining information (56%) and making decisions on the basis of available information (41%) were also reported (Table 2).

Table 2

Problems Associated with Information Access and Use

Information Problem	Organizations (%)
Information difficult to obtain	56
Received too little information	50
Problems making decisions with available information	41
Inadequate communication with other agencies	37

In retrospect, respondents considered that their networking with information providers was inadequate, particularly with the Institute of Geological and Nuclear Sciences, the major provider of the scientific information necessary for response management. Seeking information on an ad hoc basis will have contributed to communication and coordination difficulties. Moreover, problems such as "inadequate communication with other agencies" (37%) can be compounded by the organizational diversity characteristic of a multi-agency response (DiTomaso et al, 1996).

Respondents generally acknowledged a need for more comprehensive analysis of their information needs and how it should be formatted and processed to ensure compatibility with organizational needs and decision processes. A lack of processing capability, or the need for additional processing, will introduce unnecessary response delays and affect decision making. The need to develop an organizational capability to interpret and use information, particularly scientific information, was also recognized. Dialogue should be entered into with information providers to discuss how information can be translated or formatted to support response roles and decision making. Organizational personnel should be trained to specify information needs, to interpret it appropriately on receipt, and, if required, to adapt information for different functions and end users. For example, organizations not only require information from diverse sources to manage their response, they may also be called upon to distribute processed information to the community, the media, and policy makers.

Organizational involvement and information needs will change over time. Systems must be capable of responding to changing needs and implications. For example, during a response, liaison with scientific information providers (eg, volcanologists, seismologists, meteorologists) and emergency services will predominate and define interorganisational communication needs. During recovery, liaison with mental health, welfare, and insurance agencies will generate different information needs.

Decision-making was also affected by information availability (Table 2). In addition to considering information needs, decision-making procedures and style deserve consideration. The scale of hazard impact, its multi-jurisdictional implications, and the geographical dispersion of decision makers, signals a need to explore the use of distributed decision-making procedures (Flin, 1996). Moreover, not only might decision-making style differ from that prevailing in routine contexts, it may have to be adapted several times to suit the changing circumstances of the disaster response. A range of thinking skills can be used to reach a decision. First, there is a technique which experienced emergency managers may call "intuition" or "gut feel" and which psychologists label recognition-primed decision-making (Klein, 1997). This is where the manager recognizes the type of situation encountered and "knows" from previous experience what course of action is appropriate. This contrasts with analytical decision-making, where the manager considers possible courses of action and then selects the best option.

When responding to disaster, these styles may all be used to varying degrees depending on the situation. For example, between eruption episodes response plans can be carefully evaluated and compared. In this case, analytical decision making should enable selection of the best option. During eruptive episodes rapid decisions must be made within a short time frame, making an intuitive style more appropriate. The need to develop decision-making capability and style has training implications. An effective intuitive style reflects experience. Given the rarity of disasters, developing this "intuitive" capability requires training within carefully designed simulations.

Management Expertise

A "lack of appropriately trained personnel" was cited as a problem by 34% of respondents. Given the infrequent nature of disasters, training is generally afforded a low priority in organizational thinking (Grant, 1996). Training programs should be based on an all-hazards approach designed to promote a comprehensive and adaptable response capability and facilitate both technical and psychological preparedness (Auf der Heide, 1989; Paton, 1996). Training should be a participative exercise to capitalise on existing expertise, engender acceptability and commitment, and facilitate the development of a response capability that accommodates resource availability and constraints (Grant, 1996; Paton, 1996).

In addition to developing an appropriate knowledge and skill base (eg, information analysis, decision making), training should address how the disaster context influences the applicability of expertise and the initiation and control of response activities (Paton, 1994). This understanding has implications for the design of simulations capable of facilitating the kind of all-hazards response capability central to contemporary approaches to emergency management. For example, Paton (1994) demonstrated how the psychological organizing and response frameworks developed in routine contexts were ill-suited to the disaster response role; but training, designed specifically to prepare for disaster work, reduced stress and enhanced performance effectiveness. According to this model, training program and simulation design require two inputs. One involves the detailed analysis of emergency response roles, tasks, and responsibilities to define the skills and knowledge required for effective response. The second relates to the need for training-needs analysis to consider how the disaster operating context can render operational procedures and expectations inadequate or inappropriate to the needs of the disaster response.

The characteristics of the routine operating environment (eg, clear role/task expectations, hierarchical reporting and command structures) are incorporated into the psychological frameworks (schemata) that guide response and become implicit, or "taken for granted", facets of routine operations. Their importance as determinants of well-being and performance effectiveness, however, may go unrealized until faced with atypical operational demands (eg, scale of infrastructure disruption, multi-agency operating environments, rapid role change) which challenge these assumptions (Flin, 1996; Paton, 1994). This signals a need to develop procedures, and expectations, that accurately reflect the disaster operating context in which they will be applied (Paton, 1994).

Implicit assumptions can affect response in other ways. Following the 1995 Ruapehu eruption, several organizations assumed that Civil Defence would automatically adopt a coordinating role. Problems arose in regard to responsibility for coordination (Table 1) because this assumption was not fulfilled. This example illustrates how planning based upon implicit and untested assumptions regarding operating contexts can undermine response effectiveness. Moreover, it highlights the importance of testing plan assumptions and the value of exercises and simulations that examine procedural and conceptual issues at personal, operational, and organizational levels.

Training, supported by exercises and simulations that involve practicing skills and using knowledge in a wide range of realistic scenarios and conditions, will provide opportunities to generalize understanding and to promote predictability, control, adaptability, and effective performance under a wide range of circumstances. The diversity of potential disasters makes it unlikely that training could prepare individuals for all eventualities, but it can significantly enhance response effectiveness.

Managing these issues has implications for training-needs analysis. Not only must it consider atypical disaster-related demands, disaster training-needs analysis must also accommodate multi-agency involvement and interaction to facilitate the development of knowledge, skills, systems, and procedures capable of supporting an integrated response. While a capability for training-needs analysis may exist, it will have to be developed specifically to identify atypical demands and contextual factors that fall outside usual operating demands. Consequently, a broader range of analytical techniques than those used to support routine activities will be required, and the process will extend beyond organizational boundaries to include analysis of non-organizational personnel who have experienced particular kinds of hazard activity. The analysis process will have to match existing capabilities to those required to meet the demands thus identified and to define residual training-needs.

Organizational Structure and Procedures

Structural and procedural issues were cited as a problem by 35% of respondents. Prior to a disaster, organizational structure and systems function to promote the performance of routine operations rather than to manage crisis demands. Consequently, existing systems are ill-suited to handling emergency management procedures such as the identification, allocation, and management of emergency resources and inter-agency liaison. Emergency management systems, and the staff expertise to use them effectively, must be capable of dealing with sudden and radical changes in the demands made upon them, including:

delegation authority (often with little or no warning);

high demands on, and uncertainty in, information, communication, and decision processes;

transitory adoption of different operating and decision systems and processes;

work with organizations who use unfamiliar procedures and terminology;

management of the transitory transfer of control to external agencies when situational demands require it; and

coordination and task assignment in multi-jurisdictional/organizational operating contexts.

Attention must also be directed to developing steps for adopting emergency procedures and to managing the transition back into routine operational activities, including the management of stress reactions and its implications for routine performance (Paton, 1997). Nor is it just procedures that may differ from the routine. Short term changes in operational structure and philosophy may also be required.

Response effectiveness is influenced by the nature of the organizational bureaucracy. Top-down, predominantly autocratic structures are ill-suited to emergency management in complex multi-jurisdictional settings (Flin, 1996; Hightower and Couta, 1996; Powell, 1991). Persistent use of established decision and operational procedures (even when responding to different and more urgent crisis demands), internal conflicts regarding responsibility, and a desire to protect the organization from criticism or blame complicate the response process (Powell, 1991) and affect the ease with which multi-agency, integrated arrangements will be entered into and implemented effectively. A capacity for adopting a more responsive structure when managing crisis demands should not be assumed, but it can be developed through planning and exercises (Hightower and Couta, 1996).

Future Response Capability

There was general agreement that a future eruption is likely. Despite acknowledged response problems, all but one organization felt well prepared to deal with future, and even more severe, eruptions. While true to some extent, it is pertinent to consider the organizational dynamics that influence interpretation of experience and perceptions of vulnerability and capability to ensure that a given experience does not stimulate complacency and inappropriate inferences about future capabilities.

Emerging from a disaster relatively unaffected, or the perception of effectively managing a specific disaster (as was the case here), can stimulate overestimation of future response capability and underestimation of future risk status. Attributional processes and group dynamics can result in organizations perceiving themselves as responsible for positive performance outcomes and ignoring negative outcomes or inadequacies in emergency management systems or attributing them to other agencies (Dawson, 1986; Staw, Sandelands, and Dutton, 1981). Consequently, review and evaluation processes are insufficiently objective and critical to highlight shortcomings until the organization is faced with a more exacting test of response capability. Particular attention must be directed to ensuring that organizations do not lull themselves into a false sense of security and that review processes are critical and comprehensive.

A positive outcome, in regard to developing a comprehensive response capability, was an expansion in plan coverage. Prior to this event, planning focused on physical response issues (87%), with mental health, community, economic, and political issues receiving considerably less coverage (27-52%). The experience of this eruption increased the salience of these issues.

CONCLUSION

Although generally positive, the effectiveness of the response to this eruption was muted by communication, coordination, training, and organizational constraints. In addition to developing the structures and procedures required for a comprehensive, integrated emergency management system, realizing the full benefits of IEM necessitates a team approach. The effectiveness of a team response in transitory, multi-agency and multi-jurisdictional contexts is influenced by the manner in which team development, social identity processes, group dynamics, and decision-making issues are managed. Attributional aspects of performance review influence perception of future response capability and relations with other organizations. Ensuring these are fair, critical, and comprehensive represents another area where attention should be directed. The future inclusion of community, mental health, and economic issues will render plans more comprehensive. It will also increase the number and diversity of agencies involved, making multidisciplinary team development and management imperative. Accommodating organizational psychological aspects has significant implications for the effectiveness of IEM. If ignored, the benefits accruing from IEM will be less than fully realized.

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EMERGENCY PLANS ARE ONLY A START
A Canadian Municipality Adapts to the Great Ice Storm of 1998

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In January 1998, in what is often the coldest part of winter, one of every five Canadians was left without power for up to three weeks. In terms of persons affected, that was easily Canada's worst disaster, 30 times the 217,000 forced to leave home after a train derailment in Mississauga, Ontario in 1979. The situation was so bad that, in Eastern Ontario, 66 municipalities declared a state of local emergency. The cause of the disaster was an unprecedented series of ice storms that coated trees, power lines, poles, and steel tranmission towers with inches of ice until the extra weight pulled them down.

THE REGIONAL MUNICIPALITY

This article reviews the response to the ice storm by one Ontario municipality, the Regional Municipality of Ottawa-Carleton (RMOC). The RMOC is a regional government responsible for health, social services, water, liquid and solid waste, public transit, Regional roads, ambulance service, and policing for a large urban-rural area of 750,000 people that includes Canada's capital city, Ottawa. The RMOC includes 11 local municipalities that handle local parks and recreation, local roads and sewers, libraries, fire protection, and by-law enforcement. Planning and economic development is shared between the two levels. Private companies provide some services like gas and telephones; and electric power is provided by six public utilities, none reporting to the Regional government.

The RMOC has a three-member Emergency Measures Unit (EMU) that administers the Region's emergency plan. Under that plan, emergencies are managed by an Emergency Control Group (ECG) which includes the elected Regional Chair, the Chief Administrative Officer (CAO), and senior officials including officials from emergency agencies. Emergency response is run from the RMOC's Emergency Operations Center (EOC) located in the EMU. The EOC has its own separate telephone system and separate carrels for various agencies including police, fire, ambulance, health, social services, and OC Transpo, the regional transit system. The EMU and the EOC are located in one of the RMOC's largest departments, Environment and Transportation. That means both the EMU and the EOC have access to such crucial resources as the Regional vehicle fleet.

After briefly describing the storm and its impact, this article examines how the RMOC's emergency plan was adapted for the ice storm. It shows that emergency response is a fluid process. No plan, no matter how well thought out, can meet every contingency - planning is only a starting point for effective emergency response. This article also raises some questions about the limitations of technology. The article draws heavily on a task force report that reviewed the RMOC's response to Ice Storm '98. (Scanlon, 1998) The author was head of that task force.

THE ICE STORMS

Although long-term forecasts based on the impact of El Nino called for more precipitation than usual in 1998, these ice storms were not predicted until a few days before they struck. The first advisory came on January 3rd, a Saturday, when Environment Canada spotted and reported some potential problems:

> "The new models this morning bring the next system for Sunday night further north, indicating a fair amount of freezing rain.... Stay tuned".

The next morning, Sunday January 4th, Environment Canada advised the RMOC that there would be freezing rain that evening (the agency prepares a special forecast for Regional Roads). It added that a "very complex system" was expected during the first half of the week: Eastern Ontario and Quebec might be hit by freezing rain on very short notice. Later that day, it amplified the forecast:

> "The main threat is freezing rain with up to 15 mm of ice accretion possible (even more) tonight through Monday".

On Monday, January 5th, Ottawa-Carleton's MacDonald-Cartier Airport reported 24.4 mm (about one inch), one-third more than forecast. This was the first of three waves of freezing rain that were to devastate the Region.

Things improved slightly on Tuesday, however, that night the evening forecast promised another bout of freezing rain:

> "A series of disturbances approaching from the south will bring us episodes of freezing rain, one after the other. By Thursday morning, 15 to 20 millimeters of freezing rain is expected to have fallen. Thursday night into Friday remains to be seen. Pray for plain rain".

As forecast, freezing rain started early Wednesday morning and continued, with occasional breaks, for 40 hours. The last rain from that second storm fell just before Thursday midnight. The request for a prayer indicated that the forecasters suspected, although they weren't certain, that there was likely to be more freezing rain on Friday, January 9th. The forecaster said that was a "tough call". The following day Environment Canada forecast more freezing rain in parts of the Region, then changed that to a general forecast of freezing rain. In fact, there were six more hours of freezing rain on Friday, January 9th. Over a six-day period, there had been 63 hours and 42 minutes of freezing rain.

The real problem was not the rain itself but the fact that all week long the temperature hovered around the freezing point, preventing melting. The ice from the second storm piled up on top of the ice from the first, and the ice from the third storm landed on top of that. Records for the past 40 years show that, until Ice Storm '98, the largest ice accumulation in Ottawa during a six-day period had been just over 20 millimeters, less than an inch. The total freezing rain for January 4 to January 9, 1998 was 69.6 mm, about two and one half inches, three times the historic high. The situation was even worse in Cornwall along the St Lawrence Seaway (91.4 millimeters over the same period) and worse still southeast of Montreal, where the accumulation was about 100 millimeters (four inches). Montreal itself was not hard hit: the records at Dorval Airport show an accumulation of 41 millimeters, about two-thirds the build-up for Ottawa. Montreal's major problem resulted from power outages outside the city. Ottawa-Carleton's problem, in contrast, resulted from outages within its boundaries.

RMOC'S INITIAL RESPONSE

The RMOC initially saw the storms as a roads issue. Regional Roads supervisors were worried that the continuing ice build-up would require salt and sand trucks to work beyond the limits imposed by Ontario's Highway Traffic Act. They were also worried that the warm temperatures might mean they would need more salt than usual. (The proportion of sand used rises as the temperature falls.) Given the icy state of the roads, it might even be difficult to get the required supplies from a storage location near the St Lawrence Seaway. It was a legitimate concern: the first Ontario community to declare a state of emergency was Akwesasne, an aboriginal community along the Seaway.

Roads staff raised their concerns with senior management and it was decided to meet Wednesday, January 7 at the Emergency Measures Unit. By the time that meeting was held, the problems had expanded. By late Tuesday, the six power utilities were all reporting outages, although most said power would be back overnight. On Wednesday, Nepean Hydro, for example, had 28,000 customers suffer power outages of varying length. By the end of the day, however, all but 500 to 1,000 had power restored. Later, 30,000 customers were out in Ottawa, Rockcliffe Park, and Vanier (all served by Ottawa Hydro) and once again, eighty per cent had power restored by Thursday. Nevertheless, the Region's Commissioner of Social Services expressed concern that persons might have to leave their freezing homes: there would be a need for shelters.

Declaring an Emergency

By Thursday morning, many sidewalks and streets were coated with ice. OC Transpo buses were well behind schedule. Many traffic lights were out. Some schools were closed. Trees were down everywhere (eventually 10 per cent of the trees in the Region were destroyed and 70 per cent damaged) and the forecast was for more freezing rain. Staff at the Emergency Measures Unit called in the Regional Chair, the Chief Administrative Officer(CAO), the Ottawa-Carleton police chief, and the Regional fire coordinator. After a brief debate, the group advised the Regional Chair to declare a Regional state of emergency. He did so at 10 am on Thursday, January 8th. The RMOC was not alone in its decision. Within the Region, states of emergency were declared in the local municipalities of Cumberland, Gloucester, Goulbourn, Kanata, Nepean, Osgoode, Ottawa, Rideau Township, Rockcliffe Park, and West Carleton. Only the city of Vanier did not declare an emergency, although it did open some drop-in centers. There were also states of emergency in nearby communities like Brockville, Carleton Place, Cornwall, Hawkesbury, Kingston, Perth, and Smiths Falls.

The declaration did not mean the RMOC was worried about its own ability to operate. Regional headquarters has back-up power. There is also back-up power on both the water and liquid waste systems. Although this back-up power was required (some staff even stayed in motels near pumps to make certain generators kept working), at no time were any parts of the Region's water or sewer system out of action. There were a few problems at the RMOC's landfill site, but staff there used portable generators to recycle the leachate created by the garbage. (Normally this is pumped out and trucked to the liquid waste plant.) They avoided any spills. Regional Roads crews also kept going, although they continually ran into problems with downed trees and branches and low-hanging powerlines.

DECISION MAKING

Opening the EOC

As provincial law requires, the decision to declare a state of emergency was formally made by the elected head of the RMOC, the Regional Chair. The persons he consulted - the Chief of Police, the Regional fire coordinator, etc - were, as the RMOC's emergency plan specifies, the members of the Emergency Control Group. The RMOC also followed its plan in opening the EOC in the room next to the Control Group. Using phones and other equipment already in place, that room was soon staffed with police, firefighters, health and social services personnel, a representative from OC Transpo, and other personnel. Before long, Regional staff had placed security staff at the entrance to the EMU and arranged food and other supplies for the staff in the EOC.

The RMOC plan makes certain assumptions, however. It assumes that an emergency will be at a specific location and that control of and access to the site will be handled by the police. Since there was no site - the whole Region was impacted - there was no site control. The police played much less of a leadership role than the plan envisaged. The RMOC plan also calls for the mayor or mayors of affected municipalities to join the Emergency Control Group (ECG) during a disaster. Although meetings with all the mayors were held during the emergency, those meetings were not considered meetings of the ECG. A meeting including all the mayors and senior officials would have been an unwieldy body for decision making. (The members of Regional council were welcomed to visit the EOC but were not part of the Control Group.)

There were one or two other minor complications but none led to difficulties. The Regional plan, for example, calls for all shelters to be opened and run by the RMOC. In fact, all the local municipalities opened their own shelters. The RMOC accepted that and simply arranged for health and other staff to check out these shelters. In addition, at the time of the incident, Ottawa-Carleton Regional Police Service (OCRPS) was still in the process of taking over all policing in the Region; some areas were still policed by the Ontario Provincial Police. The two forces worked closely together and the OCRPS chief invited the senior Ontario Provincial Police officer to join police at the EOC.

Information

At its first meeting, the Control Group made one other key decision. It decided to hold twice daily news conferences to keep the public informed about what was happening. The Regional Chair ran those news conferences but instead of dominating the dialogue, he acted as a sort of chairperson of the Board, indicating what topics would be covered, then turning to his officials to provide information and answer questions. This low-key, consultative style made him the leading public figure during the response. The open nature of the news conferences - almost nothing was held back - also made the RMOC the dominant response agency. The news conferences were broadcast live by the local radio station with the largest audience and by the Canadian Broadcasting Corporation's regional television station.

The news conferences were only one part of the RMOC's public information effort. The RMOC has a phone center known as "Window on the Region"to handle incoming calls. All calls coming into the RMOC are handled by a person unless the caller indicates immediately that they wish to be put through to a specific extension. If a Window staff member forwards a call to a specific number and a person does not answer, it bounces back. The Window staff member then asks if the caller wishes to leave a message on voice mail or wants to try someone else. During the disaster, the Window staff was steadily expanded and the head of the service briefed regularly by the Emergency Measures Unit. As a result, callers always were able to talk to a person and receive up-to-date information from that person.

THE REGIONAL EOC

An EOC is supposed to be a place where those involved in emergency response share information and assist each other (Scanlon, 1994). Its purpose is to bring representatives of agencies together so they can coordinate what they are doing. It is not to assemble persons under a single command. The RMOC's EOC functioned as an EOC should. When Social Services got a call about an aging relative who couldn't be reached. the Social Services person notified police who followed up and returned the call. When public health nurses, especially ones who did not normally do field work, felt uncomfortable in going somewhere, the police liaison person arranged for an officer to go with them, not only for security but for moral support. When the Regional Fire Coordinator heard that the media planned to challenge the Medical Officer of Health because he hadn't notified the public about a case of meningitis, he told him what was coming. (The case was not the contagious type that was causing concern elsewhere.) Similarly, when the Regional Fire Coordinator learned that a home for seniors had lost power - and was likely to be out for four days - he came up with a generator from an Ottawa firehall. That sharing atmosphere made all those involved feel good about what they were doing. One member summed it up,

> "It was a pleasure to be down there, even though you got tired. It was very enjoyable because of that interplay. It made you feel like you are really part of a team.

When Social Services announced that a health care facility had to be evacuated, OC

Transpo produced a bus immediately. When the military called out its reserves, OC Transpo had buses to move them on hand in 10 minutes. Some drivers remained with the troops, eating and sleeping with them. On another occasion, OC Para Transpo helped when a public health nurse called in from a shelter to say some seniors had been forced to leave home, but did not want to leave their community (accommodation had been arranged elsewhere). The seniors were desperately in need of personal health supplies. A Para Transpo driver found a 24-hour pharmacy that donated the needed supplies; the driver delivered them to the shelter; and the seniors were able to stay near their homes.

EOC Security

In the early stages of the response, both the inner and outer rooms of the Emergency Measures Unit were crowded as various officials came and went. There was so much activity the manager requested a security guard to assist. After a day or two, regulars were given red badges and visitors were asked to check in, explain whom they wished to see, then wait until that person came out to get them. If a regular attendee certified someone was wanted inside, a new badge would be issued. A few VIP's, such as Regional councillors, were not required to wear a badge. (One mayor refused to wait and walked in: that same mayor refused to wear a badge when one was provided.) Security problems often arise at the start of an incident since it is not clear precisely who is needed in an EOC. At the RMOC, for example, neither the persons dealing with generators, nor the persons handling firewood, were part of the original plan.

EOC Equipment

Although the initial telephone installations at the EMU proved satisfactory, there was a need for a printer, some computers (some laptops were available), and, before long, an extra fax machine. The fax machine already there was always busy with incoming messages so it was impossible to send messages out. Cellular phones backed up the telephone system.

The phones in the EOC did not have voice mail. That proved to be a blessing. Callers either reached the person they wanted or called back. No messages got lost in a long line of unanswered voice mail. On the other hand, when the Region acquired extra cell phones and made them available to various participants, it did not warn them that these phones did have voice mail or tell them how to access it. As a result, a number of messages were lost. The cell phones also caused problems when they were handed from person to person. Callers found it difficult to locate the cell phone that was with the person they wanted.

EOCS IN THE REGION

Although the impact of the storm varied throughout the Region, there were also EOCs operating in all but one of the 11 local municipalities. The way those EOC's were run varied. In Cumberland, the Mayor took responsibility, but left day to day operations to officials. In Rideau Township, the Mayor ran the EOC and Councillors took an active part in meetings of the Township's Control Group. While cities like Nepean, Gloucester, and Kanata had no problem finding a place to operate (their municipal offices had power), the rural municipalities operated from whatever building had back-up power. In Goulbourn, the EOC was in the library, in Rideau and Osgoode, the fire hall. Rockcliffe Park used its municipal yards because the office there gets power from a separate line.

Liaison

During the ice storm, the RMOC held meetings with Mayors of the local municipalities and told them they were welcome at meetings of the Control Group. It faxed news releases to the local municipalities. Public Health staff made daily calls to the shelters. There were police officers in the municipal EOC's who reported to the regular operations meetings of senior police. Public affairs staff called each community daily and made certain any local announcements were included in Regional publicity. Finally, about 12 days after the disaster began, the RMOC sent liaison officers to the local municipalities. In retrospect, that last step - the decision to send liaison officers to the municipal EOC's - should have been taken at the start.

If the Region is to act as an information and coordination center, it is essential that it be informed about what is happening in the local municipalities and that it keeps the local municipalities informed. Specific persons must be assigned to this task. As the competent response to the storm shows, there are many capable persons on Regional staff who could do that job, although those who are selected should receive some training. Being a liaison person requires political sensitivity.

Local Officials

At present, Mayors of the local municipalities are part of the Regional Control Group. As elected heads of Councils they are entitled to access to both the Regional Chair and Regional officials. Mayors have important responsibilities to their own municipalities, however, and they were forced to leave those responsibilities when they attended meetings at Regional headquarters. The task force concluded that, given current technology, it would make more sense to brief the Mayors through a conference call or some other form of electronic communication than to have them as members of the Regional Control Group. The Ice Storm 98 Task Force Report noted the problem of the large size of the RCG created by having all the Mayors at a Control Group meeting. Noting that the RMOC felt there should have been a provincial liaison person at Regional headquarters, the task force concluded:

> "The Mayors should expect a Regional liaison person present at their EOC's. That would seem a better solution to coordination than having all the Mayors come to Regional headquarters. Even if a disaster affects only one or two municipalities, a Mayor may have more essential priorities at home. The Mayors should not be members of the Regional Control Group"

POWER THE PROBLEM

Although the RMOC's own services were functioning and it was efficient at providing public information, the main problem was restoration of power and - because it did not have its own power utility - the RMOC felt unable to do anything about that. As a result, it selected an alternative; it decided to acquire and distribute generators throughout the Region. Before long, an ad hoc generator team was dominating action in the EOC. Also before long, that team had determined a set of priorities for the distribution of generators. The first priority would be emergency agencies, hospitals, and homes for the aged. After that would come individuals who depend on power to sustain life: small generators were sent to individual homes if a public health nurse certified the need. The remaining priority would be agencies that could assist others: that meant that the bulk of the generators went to full-time and volunteer firefighters. They would use them to go house to house providing power long enough to provide a temporary boost to heat. The Region did not provide power to dairy farmers: the provincial Ministry of Agriculture and Food and Rural Affairs was doing that.

Before long, generators weren't the only things being provided by the RMOC. As the extent of the disaster became apparent, all 11 local municipalities opened shelters to receive evacuees. In fact, only 200 persons in total stayed at shelters any single night. Most persons found their own place to stay or, more likely, decided to tough it out at home. Thousands of people came to the "shelters" for a hot meal, a shower, information or just to get warm, however, since many people had no access to TV at home, they watched the RMOC's morning and afternoon news conferences while they were visiting the shelters. To enable the drop-in centers to look after these people, the Region began acquiring and shipping food. Then, as officials realized most persons were staying at home, the RMOC started supplying fuel for camp stoves, water for those whose wells were not working, and firewood for the many stoves and fireplaces being used to provide heat. Soon, there was a supply team and a firewood coordinator at the Regional EOC.

As it became clear that most persons were staying at home in the cold, firefighters, and then others, became concerned that some persons - especially the elderly - would die from hypothermia. Before long, teams started going to door to door, checking on occupants. While some team members were local firefighters and local volunteers, others were health workers and police from the RMOC. The canvasses fitted in with a specific Regional priority: persons who wished to stay in their homes should not only be able to do so - they should get whatever assistance they required to make that possible. Concerned, however, that some persons might not answer or come to the door when their home was being checked, the police asked anyone knowing someone who might be in distress to call them. That way several hundred persons at risk were identified: most were persuaded to move from their homes. On three occasions, police called the family physician when the person refused to leave home. Force was never used: in Ontario there is no clear-cut legal power that will allow police to force persons to leave their homes.

OTHER MAJOR DECISIONS

In addition to its decision to become a center for public information and supplies, the RMOC made two other major response decisions. The first was that it would assist not only its own residents, but also persons living in communities outside the Region[2]. The second was to ask for federal military assistance. (Canada has no equivalent of the US National Guard: all full-time and reserve troops are controlled by the federal

Department of National Defence.) The decision to assist its neighbors pushed the RMOC's response well beyond the Region's boundaries, The decision to call for military assistance helped lead to the largest deployment of Canadian troops in peacetime, more than were deployed for the 1997 Red River floods.

Assisting Other Communities

Both decisions were made informally. The man in charge of generators received a request from a nursing home outside the Region. He asked the CAO what he should do. The CAO replied, "send it". From then on, the EOC responded to requests from its badly hit neighbors, Works crews helped clear sidewalks in neighboring communities so that older persons could walk to the drop-in center. Supplies of beds, blankets, and cots - obtained from the federal government - were trucked to a Regional Roads depot, then shipped as required to drop-in centers and shelters throughout most of Eastern Ontario. Some supplies were even sent to neighboring Quebec.

Military Assistance

The decision to ask for military help was made much the same way. Worried that the need to clean up debris and restore powerlines was beyond the capacity of the Regional staff, the CAO asked how the RMOC could obtain military help. A staff member who was a former Army officer was asked to make some contacts. The RMOC then asked the provincial Emergency Measures Organization (EMO) for military assistance. Asked how many soldiers were required, the CAO said, "perhaps a couple of hundred". He was a few thousand short in his estimate.

In Canada, requests for military aid go through a formal process. The RMOC's request went first to Ontario's EMO, then from Ontario EMO to Land Force Central Area, the military structure responsible for units in Central Canada. LFCA decided the appropriate response to Ottawa should come from the 2nd Mechanized Brigade at Canadian Forces Base Petawawa, a couple of hours by road up the Ottawa Valley from the Region. When the request reached CFB Petawawa, most of the Brigade was still on Christmas leave. Others had just left for Bosnia, however the Brigade issued an emergency recall and 75 percent of the soldiers returned that day. Before nightfall, the advance party was enroute to Ottawa. By morning, the Brigade Commander and his senior officers had been briefed by Regional staff and, with the assistance of the Ottawa-Carleton Regional Police, toured the major impact area inside and outside the Region. They had also decided to call in reserves and made arrangements with OC Transpo to support their deployment.

Although the soldiers who responded had substantial experience, they were stunned by what they saw - not only by the extent of the damage but, outside the Region, by the absence of civilian government. On January 1, 1998 as a result of provincial actions, a number of municipal boundaries in Eastern Ontario had been changed. Many of the councils of the new municipalities had yet to meet. None had emergency plans. In some places, civilian government did not effectively exist. The military's role is assisting civilian government, not taking over control. Determined to avoid having to take over, they pressed the RMOC for assistance and, with its help, set up four rural EOCs staffed by local persons and RMOC personnel and directed by elected persons who agreed to act as heads of government. The RMOC and the Army then helped supply those EOCs, with the RMOC acting for the province as a main distribution center. In less than 48 hours, the Canadian Army had created local governments and then started taking direction from the governments it helped create. Such a process is not uncommon in wartime but it may be unique in peace.

WITHOUT POWER

While the flow of supplies and the creation of EOCs solved many of the problems facing the area, there was a still a major concern - restoration of power - and that was, on the whole, being left to the various utilities. At first, they concentrated on assisting their own customers, often seeking outside help to do so (teams of workers came from utilities all across Ontario and from neighboring US states). Then they began to assist each other. At that point there were a number of conflicts, some of which led to public debate. Most of the debate centered on charges that the provincial utility, Ontario Hydro, was refusing to accept assistance from the local utilities (Ontario Hydro produces power and sells it to the various utilities; it also provides power directly to its own individual customers, most of them in rural areas. Among its customers were persons living in rural and urban areas in the Region). It was alleged that Ontario Hydro was refusing to accept such help because some of the local utility staff was non-union. Although that accusation was not true - and was resolved - there were some serious problems with restoration of power. There were a number of reasons for that. The first was that arriving utility crews found that many power wires had sagged to the point they were a danger to road traffic and a danger to snowmobilers. The first concern was safety, so that situation had to be corrected; but that delayed restoration of power to homes. Next, and more important, Ontario Hydro proved inept in its initial public communications. Power is distributed from the main power grid to sub-stations and from those sub-stations to individual customers. Ontario Hydro would announce that power would be restored the next day to a particular sub-station, say Manotick. Persons in Manotick, hearing that announcement, would assume they would have power the next day. In fact, restoration of power to a sub-station was only the first step. Often it was still necessary to hook up each individual home. In addition, the Manotick sub-station was not necessarily in Manotick - it just carried the name of the nearby community.

The RMOC became so concerned about the public reaction to those misleading announcements that it insisted Ontario Hydro send staff to the Emergency Control Group and to take part in the twice-daily news conferences. The RMOC was determined that the information being given out should be accurate. In spite of that, the RMOC did not play any part in determining the priorities for restoration of power. It left that to Ontario Hydro and the other local utilities. Although the RMOC stayed out of setting power priorities, the local municipalities did not. In Nepean, the local EOC worked closely with Nepean Hydro. In Cumberland, another municipality within the Region, the EOC held daily meetings with Ontario Hydro and twice asked Hydro to adjust its priorities in line with municipal requirements. Ontario Hydro met those requests.

TECHNICAL PROBLEMS

Aside from the lessons learned about the restoration of power over a large area, the most significant result of Ice Storm '98 was recognition that there had been a massive failure of technology. Time after time, sophisticated monitoring systems failed to provide information about what had happened and was happening. Only when there were individual inspections was it possible to tell what, if anything, had gone wrong and what, if anything, needed to be done. This showed up in the case of road sensors, traffic lights, and the distribution of gas, phone service, and power.

The Regional Roads department, for example, uses electronic sensors in the pavement to measure pavement temperature. From those readings, it determines the appropriate mix of salt and sand. Ice coated the sensors, forcing roads foremen to find bare spots and use infrared guns to check the temperature. Similarly, when the system that monitors traffic lights malfunctioned, it was impossible to tell if the lights were out or if the system had failed. It turned out that traffic lights at 80 main intersections had malfunctioned. (Some went off several times as the freezing rain knocked down one line after another.) All had to be fixed by personnel responding to the scene, sometimes responding several times as conditions changed.

The three major utilities, gas, telephone, and power, had similar problems. The gas company's monitoring system malfunctioned, forcing staff to check out the various pumping stations. Those checks showed there were no problems - the only failure was in the monitoring system. In the case of phones and electric power, the problem was that, when telephone remotes and hydro sub-stations failed, it was not possible to tell how much work was required to restore service. It was possible that the problem was solely at the connection point. It was also possible that there were additional breaks at the homes of individual customers. In fact, after personal inspection, it was often discovered that the remotes, substations, and individual service had all been affected. Although the companies made attempts to determine the extent of the problems through aerial surveillance, the entire story became clear only after house-by-house, business-by-business checks, a process requiring extensive use of personnel (the military were extremely useful in doing that surveillance).

SUMMARY AND CONCLUSIONS

Even before the EOC closed, the RMOC asked an outside consultant to form a team to review the Regional response to the ice storm. The team's report concluded that on the whole the response had been effective. There was good planning. There was a well-equipped and well-run EOC. There was excellent public communications. Most important, there was a willingness to adjust, as required, to meet exigencies that did not fit the plan. Nowhere in the plan, for example, was there a perception that the real problem might be a need for generators or a need to supply not only the local RMOC municipalities, but also the RMOC's neighbors. The RMOC did both, and it did both as soon as the need became apparent. It did not allow its plan to hinder an effective response.

The report was critical in only a few areas. It noted that, although there was a wall log, no minutes were kept of decisions by the Emergency Control Group. This created two problems. First, a few decisions were not followed up, although in no case did that lead to serious problems. Second, the absence of such minutes reduced the ability of the task force to assess when decisions were made, what considerations were involved in making them, and precisely how they were communicated to others. The report's most serious criticism was, however, of the RMOC's decision not to get involved in coordinating the restoration of power. The report said that in a disaster, the RMOC, even though it has no power utility, should have become involved in assessing and, if appropriate, setting priorities for restoration of power. That criticism led to strong reaction by the utilities who said the review was recommending political interference with power. (Part of that response reflects the fact that the province of Ontario has been pushing the creation of regional governments and giving those governments extensive powers: there is concern in the Region that the province will force creation of a regional fire service and might also decide to create a regional power utility.)

What the task force did not deal with was the issue of technological failure. Ice storm '98 showed that there can be enormous problems, not only with services such as power, but also enormous problems with the systems designed to monitor those services. The real problems during Ice Storm '98 were two fold. One was extensive system failure. The other was the failure of the system designed to monitor that failure. Restoration required not only extensive efforts by power crews and telephone crews from all over Ontario. It required a massive use of personnel to determine the extent of those problems. In short, the dilemma in Ice Storm '98 was not the ability of emergency agencies to respond to the disaster; it was their inability to determine the extent of the disaster. Ice Storm '98 also exposed the fact that many agencies do not have back-up systems in place. Both inside and outside the region, there was no back-up power at hydro sub-stations or police stations. There were also nursing homes, dairy farmers, and others without power. There were also hundreds of individuals who did not have back-up power for their wells or for the systems they depended on to feed their cattle. Specialists working on plans to deal with the problems of the millennium bug say the experience with Ice Storm '98 may be an indication of what is to come. The problems may well be not only failures in the system, they may include failures that make it difficult to determine just where those failures are occurring.

The RMOC's review of emergency management did not stop with the task force report. EMU and other staff continually assess problems in this area. Soon after the report was completed, for example, Regional staff noted that no one had checked the buildings used as drop-in centers to make certain that they were capable of withstanding a major build-up of ice on their roofs. How these inspections can be done efficiently and quickly is now being examined. The RMOC also took steps to make certain the lessons it learned were shared with others. The complete task force report has been put on the Region's web site and a printed version (with photos) is being published.

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NOTES

1. Joseph Scanlon is Director of the Emergency Communications Research Unit at Carleton University in Ottawa, Canada, and President of Scanlon Associates Inc. He has been doing disaster research for the past 28 years. He has written more than 100 books, monographs, book chapters and articles on various aspects of emergency management and is a regular lecturer at the Canadian Emergency Preparedness College in Arnprior, Ontario. He headed the six-member task force that reviewed the response of the Regional Municipality of Ottawa Carleton to the 1998 ice storm.

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2. The RMOC is surrounded by essentially rural counties. In Ontario, the Municipal Act gives most of the municipal powers to the constituent townships rather than the counties.

PHASED DECISION-MAKING

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INTRODUCTION

This paper outlines a model for phased decision-making during emergency situations which identifies specific time frames and determines crucial actions for a particular hazard event. A hazard event may last from a few hours to several years. It is for this reason that time becomes a valuable commodity for assuring the safety of a community. Working under extreme emergency conditions requires the effective use of time and resources. What immediate action to take and when to carry out that specific action become critical. Time is a system of measuring the duration between points at which something has happened, is happening, or will happen; therefore, time must be effectively managed and accounted for and can be logically divided into distinct phases in relation to the progression of a specific hazard event. The model relates time to response actions, accounts for the establishment of response priorities, and assigns actions to a responsible section or function for implementation.

TIME DELINEATING SCHEDULE

An essential element in safeguarding the life and property of our citizens in a large-scale incident is the ability to warn those in danger in time to carry out effective actions. Emergency conditions require decisive actions, such as evacuation and emergency shelter provisions. Furthermore, time is required to decide and to assure that personnel and equipment are in place to support those emergency response actions. For example, how long will it take to set up traffic control and shelter operations, or to evacuate special needs people? Who will be assigned to complete these response actions? All these factors must be accounted for in order to develop an effective plan for a community. Now is the time to think - in a non-emergent environment - about what needs to be done, when, and who needs to do it.

A way to handle this requirement is to develop a mechanism that promotes phased decision-making, a process by which key emergency response actions are taken at the appropriate time according to the risks to the community. A tool designed to help local officials in Lee County, Florida set up this decision-making process is called the *Time Delineating Schedule* or *TDS*. This model was developed in 1982 by two staff members of the Lee County Disaster Preparedness Agency.[2] It was originally designed for a long-term hazard, such as a hurricane event; however, it can be used in any type of short-term hazard incident, as well. Because it takes into account specific hazard characteristics and the specific time factors for each phase of a major incident, the TDS model can be invaluable in any EOC.

OVERVIEW

Government plays a major role in protecting life and property from the hazardous acts of nature, technology, and human violence. Emergency operation plans guide the community's response to and recovery from disasters or emergencies. Yet, just as a comprehensive land use plan requires a zoning ordinance, development standards ordinance, or administrative code to carry out certain policies governing a community's growth and development, an emergency plan requires tools to steer the complicated decision-making process during a community crisis period. Such a tool must not only clarify what actions are needed and when they should be taken, but also account for the uncertainty present under extreme emergency conditions caused by the characteristics of the hazard event.

The TDS model provides a step-by-step process to trigger immediate actions by decision-makers. It defines ten distinct phases and their time frames for decision-making during a hurricane hazard event (Figure 1). Eight time phases have been identified as: awareness, stand-by, decision, preparation, evacuation, storm event, evaluation, and recovery. The recovery phase has been further divided into three additional phases. They are the immediate emergency, restoration, and reconstruction phases. All ten phases form a logical sequence for implementing the response and recovery actions. These actions follow prescribed needs and priorities. Figure 1 describes the phases in relation to time and activities.

Specific actions are assigned to each phase of the identified event based on what needs to be done, at what time, and lastly who performs the task? The actions meet the intended objectives for each time frame. In addition, one set of actions lays the foundation for the next set of actions in the following time phase. Decision-makers review, analyze, and carry out the emergency response actions that must, or can, be taken based on the hazard's threatened or actual extent and size, and on such constraints as the hazard's speed of onset. Because each phase and its response actions serve as a building block for succeeding phases, the TDS gives the decision-maker a timetable or checklist for completing actions that could delay or hinder other actions from taking place later on in the emergency. Figure 2 gives 38 examples of actions in the ten phases, including who is responsible for doing that specific action and its assigned level of priority. Although we use the Incident Command System, tasks can also assigned to Emergency Support Functions or to specific individuals. Flexibility is the key.

In a hazard event with advanced warning, such as a hurricane, or even those hazards that occur with little or no warning, such as a tornado or hazmat incident, the model can be extremely useful. Using the TDS, a community is able to respond to a short-term or long-term hazard event with predetermined actions in timed phases for implementation and assigned responsibilities, including priority levels. Time is required to organize pre-response or recovery actions, however, worksheets, such as Figures 3 and 4 can be used to guide the process. The first worksheet (Figure 3), can be used to designate phases and time frames by specific hazard event. The next worksheet (Figure 4), will help organize specific actions, predesignate responsibilities and set priorities.

SUMMARY

The TDS time-phased decision-making model helps to define, guide, and document the management decision-making process through various phases of the hazard event. Good crisis management will reduce loss of life and property in major emergency. The TDS model is a versatile instrument used for facilitating coordination of specific emergency response and recovery actions in a timely and orderly structure. The model can be modified to account for the constraints of the particular hazard, the response time available, and other uncertain conditions in the decision-making environment. Finally, this model guides public information on actions the local government has taken to reduce the risks to the public in life-threatening hazards.

The Time Delineating Schedule has provided an additional benefit by helping local officials translate emergency management planning concepts into concrete actions. As a result, this model has served to educate local officials who are often unfamiliar with the emergency management process. This promotes a better understanding of the needs and requirements of a total emergency management program, thereby improving the service delivery capacity required to meet the safety goals and objectives of the community.

REFERENCE

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NOTES

1. David J Saniter, CEM has worked for the Lee County Government in Fort Myers, Florida since October of 1977. In October of 1980, he joined the staff of Lee County Emergency Management and since then has been actively involved in countless localized emergencies, numerous emergency operations center activations, and several Presidential disaster declarations. Currently, he serves as the emergency programs manger for Lee County Emergency Management and is a Certified Emergency Manager.

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2. The TDS model was originally developed by two staff members of the Lee County Government, T E Dillon and David Saniter. Since then, experience and a better understanding of what needs to be done, acquired from past storm events, provided the basis for numerous revisions and modifications. John Wilson supported and assisted in development of the TDS. Christy Hahn and Ken Pineau edited and made suggestions.

Figure 1.
TIME DELINEATING SCHEDULE (TDS)
Hazard Event: HURRICANE

PHASE	TIME/DURATION	DESCRIPTION
Awareness	A period of time, consisting of twelve (12) hours, commencing at seventy-two (72) hours to approximately sixty (60) hours before the arrival of tropical storm force winds.	Increase notification activities. Prepare EOC for activation.
Stand By	A period of time, consisting of twelve (12) hours, commencing at sixty (60) hours to approximately forty-eight (48) hours before the arrival of tropical storm force winds.	Accelerate emergency protective activities of critical/vital facilities and services.
Decision	A period of time, consisting of three (3) hours, commencing at forty-eight (48) hours to approximately forty-five (45) hours before the arrival of tropical storm force winds.	Advise the possibility of evacuation. Commence evacuation/sheltering activities.
Preparation	A period of time, consisting of nine (9) hours, commencing at forty-five (45) hours to approximately thirty-six (36) hours before the arrival of tropical storm force winds.	Re-analysis evacuation potential. Relocate resources for response/recovery activities.
Evacuation	A period of time, consisting of twenty-four (24) hours, commencing at thirty-six (36) to approximately twelve (12) hours before the arrival of tropical storm force winds, continuing until the arrival of tropical storm force winds.	Notification of evacuation. Activate evacuation/sheltering plans. Commence coordination of post-storm activities.
Storm Event	A period of time, consisting of eighteen (18) to twenty-four (24) hours, commencing with the arrival of tropical storm force winds to the departure of tropical storm force winds.	This is the in-place shelter/refuge period. Continue coordination of post-storm activities.
Evaluation	A period of time, consisting of several days to a couple weeks, commencing at that point when sustained winds decrease to safe conditions.	Commence needs assessment. Mobilize resources. Coordinate response plans. Enact local emergency ordinanaces.
Immediate Emergency	A period of time, consisting of a couple weeks to a couple months after the storm event.	Activate response plans and provide immediate emergency assistance to prioritized community requirements.
Restoration	A period of time, consisting of a several months to a couple years after the storm event.	Repair public infrastructure. Focus on social and economic activities that will return the community to pre-storm conditions or better.
Reconstruction	A period of time, consisting of a couple years to several years after the storm event.	Focus on activities that will mitigate future storm damage.

Figure 2..
TIME DELINEATING SCHEDULE (TDS)
Hazard Event: Hurricane

PHASE	RESPONSE ACTIONS (examples)	SECTION	LEVEL
Awareness	Activate EOC with essential personnel. Brief and review assignments with EM staff Activate storm tracking and assessment system. Top off all emergency generator fuel tanks & monitor. Establish liaison, alert and brief governmental and private emergency-related officials/agencies.	Command Command Planning Logistics Operations	S P P P P
Stand By	Fuel county vehicles and essential equipment to capacity. Arrange parking, feeding and sleeping for EOC occupants. Issue clearance badges to EOC officials. Correct any deficiencies found in County facilities and equipment used for emergency activities.	Logistics Logistics Operations Logistics	P P P T
Decision	Activate traffic control plan. Determine closure of public offices Advise cancellation of public social event Notify tow-trucks businesses of storm emergency and pre-determine wrecker locations at critical locations.	Operations/Planning Command Planning Logistics	P S P S
Preparation	Staff, equip and supply Emergency Public Shelters Activate emergency transportation plan. Direct response agencies to record personnel and financial expenditures relating to emergency incident. Continue issuing public information statements.	Logistics Logistics Administration/Finance Command	P P P P
Evacuation	Issue evacuation instructions and other protective action statements to general population Issue warning of evacuated areas via public safety units with public address systems. Activate EOC emergency utility systems. Observe traffic situations and correct deficiencies	Command/Planning Operations Logistics Operations/Planning	P P P P
Storm Event	Monitor storm emergency characteristics. Continue communications. Begin pre-planning of post-storm activities.	Operations Logistics/Operations All Sections	P P P
Evaluation	Determine if primary threat still exists from appropriate agencies. Conduct and coordinate initial impact assessment effort. Determine and prioritize emergency-generated requirements. Enact emergency restrictions or suspensed administrative rules. Determine mutual aid requirements and request assistance.	Command Operations/Planning Command/Planning Elected Policy Makers Command	P P S P P
Immediate Emergency	Activate and support appropriate geographic divisions. Determine long-term relief service or human service delivery needs Activate the Recovery Task Force.	Command Logistics Elected Policy Makers	P P P
Restoration	Perform assessment of community needs. Commence local emergency response issues. Address restoration issues.	Command/Planning Operations All Sections	P P P
Reconstruction	Perform long-term activities or projects focused on improving or strengthning the community's economy. Implement redevelopment plan for areas subject to repeated damages from storm hazards. Implement an acquisition program to acquire storm-damaged property in hazard-prone areas.	Recovery Task Force Planning Recovery Task Force Recovery Task Force	P P P

TDS KEYS --- PHASE: Refers to the specific time frame in relation to the decisions and specific response actions **RESPONSE ACTION:** What needs to be done? **SECTION:** Who is responsible to perform this specific action? (i.e., ICS/IMS sections, Emergency Support Functions or a specific EOC management structure). **LEVEL:** Assign a level of priority for this specific response action (i.e., P= Primary, S= Secondary, T= Tertiary).

Figure 3.
TIME DELINEATING SCHEDULE (TDS)
HAZARD WORKSHEET

Hazard Event:

PHASE	TIME/DURATION	DESCRIPTION

TDS KEYS --- EVENT: Refers to the specific hazard event. **PHASE:** Refers to the specific time frames in relation to the decisions and specific response actions (i.e., name or number). **TIME/DURATION:** Refers to the time period in relation to the specific hazard (e.g., hours, weeks, months, years). **DESCRIPTION:** Refers to the general description of the specific response actions within this particular TDS time phase.

Figure 4.
TIME DELINEATING SCHEDULE (TDS)
HAZARD WORKSHEET

Hazard Event:
TDS Phase:
Time/Duration:

NO.	RESPONSE ACTION	SECTION	LEVEL	STATUS

TDS KEYS --- EVENT: Refers to the specific hazard event. **PHASE:** Refers to the specific time frames in relation to the decisions and specific actions (i.e., name or number). **TIME/DURATION:** Refers to the time phase in relation to the specific hazard (e.g., hours, weeks, months, years). **NUMBER:** Refers to this specific response action **RESPONSE ACTION:** What needs to be done? **SECTION:** Who is responsible to perform this specific action? (i.e., ICS/IMS sections, Emergency Support Functions or a specific EOC management structure). **LEVEL:** Assign a level of priority for this specific response action (i.e., P= Primary, S= Secondary, T= Tertiary). **STATUS:** What is the status of this specific action? (i.e., C= complete, P= pending, NA= not applicable).

EXPERT SYSTEMS IN EMERGENCY RESPONSE

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INTRODUCTION

Expert systems are a type of artificial intelligence. Artificial intelligence (AI) is an attempt to use machines to mimic or enhance human intelligence. Expert systems are used today more than any other type of applied AI technology.

The basic idea of an expert system is simple. Expertise is transferred from an expert to a computer. The expert's knowledge is stored in the computer's memory and users can access the knowledge as it is needed. The expert system can make inferences and arrive at specific conclusions. The expert system is a decision-making or problem solving computer program that can achieve levels of performance comparable to or even exceeding that of a human expert (Turban and Aronson, 1998. pg 197).

HUMAN DECISION-MAKING

Individuals or organizations make decisions by gathering and evaluating information. In the case of a simple decision, the information and factors that go into the decision may be easily obtained and understood by an individual or organization. In the case of a complex decision, however, individuals and organizations often turn to experts for advice. "These experts have specific knowledge and experience in the problem area. They are aware of the alternatives, the chances of success, and the benefits and costs the business may incur" (Turban and Aronson, pg 17). The more undefined the situation, the more specialized and, perhaps, expensive the expertise becomes. Expert systems seek to mimic the way that human experts solve problems.

According to Turban and Aronson (1998), human experts tend to specialize in narrow problem-solving areas or tasks. Typically, human experts possess these characteristics: They solve problems quickly and fairly accurately, explain what (and sometimes how) they do, judge the reliability of their own conclusions, know when they are stumped, and communicate with other experts. They can also learn from experience, change their points of view to suit a problem, and transfer knowledge from one domain to another. Finally, they use tools, such as rules of thumb, mathematical models, and detailed simulations to support their decisions.

These are the same attributes that we expect to see in an AI expert system. The human expert generally solves problems using a two-step process. First, the expert will obtain the information he needs from the external world. This information may be received from people, computers, the expert's memory, or other media. Secondly, the expert uses inductive, deductive, or other problem-solving approaches on the information that has been collected. The result is a "recommendation on how to solve the problem." The expert system (ES) attempts to imitate the reasoning process and knowledge of experts. It, too, will obtain data from external sources, it can consult with mathematical models, and then use its inferencing capability to determine the best course of action. That is, to make recommendations.[2]

Organizations, like individuals, look for successful solutions to problems that require expertise. An expert's recommendation may be part of a solution that involves the broader task of managing knowledge. The expertise of an expert may need to be coupled with "experience", say, a company's knowledge of what has or has not worked before in a given situation, and data resources, including on-line information. These additional factors provide valuable information to the expert and non-expert alike to enhance decision-making performance. When an expert system is coupled with resources such as databases, models, and communications tools, it is transformed into a decision-support system (DSS). Other terms for these configurations are: management support systems, group support systems, and executive information systems. The purpose of these systems is the same: higher decision quality, improved communication, cost reduction, increased productivity, time savings, and improved employee satisfaction. The key to any AI application is not necessarily *what* the systems is called, but whether it can solve managerial or organizational problems faster and better.

Expert systems were developed by the AI community as early as the mid-1960s. Special purpose expert systems were first developed at Stanford University. One of the early Stanford systems was used for the diagnosis and cause of hospital-borne infections. The first expert systems ran on special computers. Since the late 1980s, however, expert systems have been designed which can run on most standard computers, including PCs. Thousands of expert systems are in use today in almost every industry and functional area. For example, COMPAQ, the one of the world's largest manufacturers of PCs, uses an expert system to allow its customers to solve problems with network printers on their own. American Express now makes charge approval decisions in less than 5 seconds, compared to 3 minutes before implementation of its on-line expert system (Turban and Aronson, 1998). Other expert systems operate in such diverse areas as: stock portfolio management, libraries, retail chains, and farm management. Expert systems are in use in military and space programs and throughout industry in a wide variety of applications.

THE RULES-BASED EXPERT SYSTEM

Organizations use expert systems, and particularly a rules-based expert system, for several reasons. According to Turban and Aronson (1998) knowledge is a major resource, and it often lies with only a few experts. It is important to capture that knowledge so others can use it. Experts get sick or become unavailable, so knowledge is not always available when needed. Books and manuals can capture some knowledge, but they leave the problem of a particular application up to the reader. Expert systems can provide a direct means of applying expertise. The purpose of an expert system is not to replace the experts, but to make their knowledge and expertise more widely available. An expert system permits non-experts to increase their productivity, improve the quality of their decisions, and solve problems when an expert is not available.

Typically, an organization will consider utilizing an expert system in the following situations: when the solution to the problem has a high payoff, when the expertise is needed in many different locations, when expertise is needed in hostile or hazardous environments, and when the ES is needed for training as well as decision-making. Other situations favoring the use of an ES include: when the cost of maintaining expertise within the organization is high, when a large amount of data must be sifted through in the decision-making process, when an error in the decision-making process could lead to disastrous results, when there is a shortage of experts available to the organization, or when expertise is needed to augment the knowledge of junior personnel.

Most commercial ES are rules-based systems; that is, the knowledge is stored mainly in the form of rules. These rules are a type of knowledge known as heuristics or "rules of thumb." Rules are typically expressed in the manner of IF/THEN statements. These expert rules are then arranged in a fashion similar to a decision tree matrix. A typical rule may look like this: IF the spill is CHLORINE, and IF the Chlorine is in GASEOUS state, THEN the RESPIRATOR TYPE is SCBA. A rule is said to "fire" when all of the rules hypotheses or antecedents are satisfied. Rules can also be used to activate other areas of the computer system such as mathematical models or databases. For example, a rule may also be constructed as follows: IF the spill is CHLORINE, THEN obtain CHEMICAL PROPERTIES from TABLE W and METEOROLOGICAL DATA from WEATHER TOWER X and activate PLUME DISPERSION MODEL Y and DISPLAY the results graphically over GIS MAP Z. Another example of operation of a rules-base ES system would be as follows: IF the spill is CHLORINE, THEN activate AUTOMATED EMERGENCY NOTIFICATION SYSTEM (autodialer) and SELECT CHLORINE pre-recorded message and NOTIFY chlorine response list.

AN EMERGENCY RESPONSE EXPERT SYSTEM

The idea of using an expert system in real-time for emergency response has been a goal of AI professionals for over a decade. The early concept for an emergency response expert system not only included rules sets and recommendations, but activation of models. In the case of an oil spill expert system, the computer ran a mathematical model of the movement of oil on a body of water. In this way, both the expert and non-expert could see and utilize the results of the model in their decision-making processes much faster than would be humanly possible.

In the early 1990s, an emergency response expert system was prototyped for hazardous material releases in the petrochemical industry.[3] This system was conceptualized as a complete incident command decision support tool. The system contained heuristic rules, a gaseous plume dispersion model, access to maps and diagrams, and it connected to other databases. These other databases included: material safety data sheets, building and tank information, personnel records, notification lists, various checklists, and other information that is valuable to emergency responders.

The system was beta tested in 1993-1994 at a large chemical plant in Pennsylvania. During the beta test phase, the developer decided to couple the expert system with an automatic telephone messaging system. The purpose of this addition was to increase the speed at which the response personnel on site at the beginning of an incident could summon help or notify the community of the situation.

Originally this expert system was DOS based, with stand-alone capabilities, only. The software is now being upgraded to run on the Windows NT operating system. This will allow multiple users throughout a plant or corporation to work on the expert system simultaneously on their individual workstations. This ability to use an expert system cooperatively reflects more accurately the actual needs and usage patterns of members of an incident command team during an emergency or during training.

The NT system will also utilize databases that are resident on other servers, mainframes, or even the Internet. These may include: process control data, personnel or maintenance records, etc. The NT rules will operate various customer-designated mathematical models, from plume dispersion, to blast effects, to oil spills. A simulator program will allow customers to assign a performance time factor to each rule or recommendation. This feature will allow incident command members to check their performances during real-life emergencies or during training exercises. The expert rules will also be merged with the automated emergency notification system which has been now expanded to communicate with the latest alphanumeric paging equipment. The NT system will also display both the latest GIS maps and CAD overlays. New software technology will enable "on-line chat" among incident command members over the local area network, while working inside of the expert system program. This feature adds an important internal communications tool to this decision support system. Finally, the ES will accept digital or analog signals from various parts of the distributed control system (process controls, alarm management), which will then trigger rule firing and display specific recommendations.

IMPLEMENTING A SYSTEM

Purchase and implementation of an emergency response expert system at a major petrochemical plant is a process that involves a number of people, both inside and outside the organization. The purchasers of these systems typically tend to be the emergency response managers and fire chiefs of these plants, with approval of the plant manager. The users of the system are the members of the incident command teams, shift supervisors, dispatchers, and hazardous materials technicians. The corporate management information systems (MIS) department is usually involved in the implementation of the system and the integration of the expert system software with the existing software and hardware at the plant. At the corporate level, the environmental, safety and health departments, corporate crisis management teams, and information systems departments will look at and evaluate the system for company-wide applicability.

In order for the company's rules and corporate knowledge to be incorporated into the rules-base within the ES, a knowledge engineer (part of the expert system developer's staff) works with domain experts[4] (from within the company or from outside consultants) in a collaborative approach to transfer the expert's knowledge to the machine. This is the process of rules creation.

The system users are also important in the process of configuring the ES. User input will help assign the maps and CAD overlays, specify the order of cues, identify plant-specific recommendations, and add other similar elements of customization. Because an expert system evolves, it is never really done. The user will also be involved with system maintenance. The ES must be revised on a regular basis with regard to the applicability of the rules, the integrity and quality of the data feeds, the use of the interlinked databases, and so on. New "rules of thumb" become available, as the state-of-the-art in each domain area improves. Experts are constantly training themselves on new situations, or reorganizing their knowledge to account for previously unencountered situations, and an expert system must be adjusted for these cases. In addition, software and hardware bugs must be fixed as found and the system must be upgraded to run on new software and on new hardware platforms as the organization adopts them.

THE FUTURE

The "first generation" of AI has seen the development and commercial acceptance of expert systems, and rules-based systems in particular. The second generation of AI is focusing on a concept called "machine learning" where programs allow computers to "learn" from their surroundings. This is also called neural computing. Neural computing is a technology that endeavors to use pattern recognition as a means of computer learning. Thus, a computer may look for patterns in data and, based on algorithms, develop rules or recommendations based on those patterns in the data. In this way, raw information is converted into knowledge by the computer. That knowledge can then be acted upon by other programs, such as expert systems.

Another way of looking at this is that neural computing is a way for a computer to obtain heuristic "rules of thumb" without having that knowledge directly transferred to it by human experts. According to Turban and Aronson (1998, pg 674), "An artificial neural network (ANN) can be useful for fast identification of implicit knowledge by automatically analyzing cases of historical data. The ANN analyzes the data sets to identify patterns and relationships that may subsequently lead to rules for expert systems." ANNs learn from historical cases. The learning (training) produces the required values or weighting of information, which make the computed outputs equal (or close) to the desired outputs. For example, neural networks are used by John Deere & Co to invest part of its pension fund.

Another branch of AI is called "genetic algorithms" (GA). This area of AI has been defined as an "iterative procedure maintaining a population of structures that are candidate solutions to specific domain challenges." (Turban and Aronson, pg 702). A GA system is in use by United Distillers, to control blending of whiskey and minimize the movements of whiskey casks. One of the latest areas of AI is "fuzzy" logic. This area of AI deals with the problem of uncertainty. Fuzzy logic uses the mathematical theory of "fuzzy sets" to simulate the process of normal human reasoning by allowing the computer to behave less precisely and logically than conventional computers do (Turban and Aronson, pg 706). In a standard rule-based system, a production rule has no concrete effect at all, unless the data completely satisfy the antecedent of the rule. The operation of the system proceeds sequentially, with one rule firing at a time; if two rules are simultaneously satisfied, a conflict resolution policy is needed to determine which one takes precedence. In a fuzzy rule-based system, in contrast, all rules are executed during each pass through the system, but with strengths ranging from "not at all" to "completely", depending on the relative degree to which their fuzzy antecedent propositions are satisfied by the data.

As the area of AI develops, new techniques for improving emergency response decision support systems will be incorporated into existing and new computer software. In the not too distant future, such decision support systems may operate over the Internet and may keep themselves automatically refreshed with new rules and new relevant data by sifting through data on the Internet.

REFERENCE

Turban and Aronson. *Decision Support Systems and Intelligent Systems.* Englewood Cliffs, NJ: Prentice Hall, 1998.

NOTES

1. Albert Slap is the Vice President of Marketing at GeoSphere Emergency Response Systems, Inc. Daniel Hillman is the president of GeoSphere. David Moore, PE, is the president of AcuTech Consulting, Inc, a firm specializing in process safety and emergency response consulting.

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2. It has been estimated that the top 10% of all experts in a particular field perform about three times better than the average expert in a field and about 30 times better than the lowest 10% in the field. This distribution suggests that the overall effectiveness of human expertise can be significantly increased (up to 200%), if we can make the top level expertise available to less knowledgeable decision makers.

3. This system was PlantSafe, an expert system, and was coupled with TeleSafe, an automatic telephone messaging system. The authors are developers and suppliers of PlantSafe and TeleSafe. Users of the PlantSafe system include: Dow Chemical, Du Pont, Exxon, Rohm and Haas, Rhone Poulenc, PPG Industries, Bristol-Myers Squibb, and others. Since 1994, the PlantSafe and TeleSafe systems have gained commercial acceptance at some of the largest chemical plants and refineries in the world .

4. In this context, "domain" means the specific area of an expert's knowledge eg, emergency response, terrorism, earthquakes, oil spills, etc.

KOBE: THE GREAT HANSHIN EARTHQUAKE OF 1995
Three Papers

VOICES FROM KOBE: THE GREAT HANSHIN EARTHQUAKE "ON THE GROUND"

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Kobe is a beautiful city, between the mountains and the sea . . . No one ever expected an earthquake to happen in Kobe. Conventional wisdom had it that Kobe was the safest, most livable, and most attractive place in Japan.

Three years have now passed since the national and civil faith of Japan was shattered in those 22 seconds of the Great Kobe Earthquake.[2] The powerful 7.2 earthquake on January 17, 1995 was one of the worst natural catastrophes of this century. It devastated Japan's foremost international city and its surrounding communities - collapsing houses, destroying freeways, roadways, and railways, and igniting fires which spread throughout what had been Japan's most innovative social and industrial hub and a showcase for 21st Century societies.

More than 6500 people perished, over half of them elderly. Upwards of 400,000 houses and buildings lay in ruins and at least 310,000 people, one-fifth of the city's population, became temporarily homeless, afraid of continuous aftershocks, without food, without water, without warmth. In the aftermath of this devastation, Kobe and surrounding cities had no water for over two months, no gas for three months, no waste disposal for over a month, and no power for a week.

The damage to public and private property is now estimated at over $120 billion, half the normal yearly economic output of the mighty Kobe-Hanshin industrial region. Seven major rail links, subways, and commuter train lines were rendered completely inoperable and took three to seven months to restore. Express highways collapsed, creating unimaginable traffic jams; the entire port area of 116 km of docks was destroyed. Of the 345 public schools, thirty-five were destroyed and 295 were damaged. The human costs and suffering have riveted our attention to the possibility of immense damage in any 'modern', developed, and supposedly invulnerable urban center.

THE QUAKE

According to many Kobe people, the full moon at the beginning of the cold January night before the earthquake was a strange, blood-red color. The earthquake hit at 5:46 am, as most people in Kobe and the surrounding area were sleeping peacefully. Some said it was preceded by bright flashes of light; others said it was the loudest noise they ever heard, but for many there was only utter silence, the silence of deep sleep, the last moments of quiet before violence. Almost everyone agrees that the actual quake first came as a violent rumbling and shaking. A few seconds of quiet followed, then the worst part of the quake - a massive upward thrust that affected the entire area. Most of the destroyed buildings collapsed instantly. What was left was devastated by the next series of roiling, thundering quakes. The Great Kobe Earthquake was unique because of the combination of horizontal and vertical shaking. It also occurred surprisingly near the surface compared to most earthquakes, in a densely crowded urban area.

Jalal, a friend who runs an Indian restaurant, was awake when the earthquake hit. Clearly humbled by the awesome power of nature he witnessed, his description is vivid and spine-chilling. Sensing something strange just before the first shaking, Jalal looked outside from his ninth floor apartment near the Kobe Zoo. He looked towards downtown Kobe and in the direction of the quake epicenter. He told me with wide eyes what he saw,

> "Streaks and streaks of electricity, bands of electrical shock waves shooting up and down, from the sky to the ground and from the ground to the sky, from the sea to the mountains and back. Following each wave, each sheet of electricity, there was an immediate domino effect, buildings collapsing one after another, a fine powdery dust rising in great clouds."

The driver of a returning ski-trip bus I talked with saw the end of the world - cars disappearing in front of him as the overhead roadway collapsed. His brakes screeching, his bus stopped with its front half dangling in mid-air at the edge of a vanished highway. He and his passengers gingerly climbed out the back door of the bus and jumped to the pavement that remained below the back wheels.

A young woman friend was also returning from skiing in the Japan Alps and had just taken a taxi to go up the mountain from a railway station to her home. She and the driver experienced an eruption of brilliant flashing lights, violent shaking, undulating roadways, and the heavy smell of burnt rubber all around their car. Another taxi driver told me he was on the main bridge to Rokko Island, the huge man-made island, during the earthquake. This huge 8-lane double-decker bridge twisted and turned again and again. The driver saw the railway lines on either side of the bridge collapse. He, too, thought it was the end of the world and was just waiting to die.

Yuka, the daughter of friends in our building, was on her way to work at the Hyatt Hotel in Osaka. She was on the railway line that the taxi driver saw collapsing, an elevated line high above both the ocean and the land. Luckily, her train did not fall. Sections in front and behind collapsed, leaving her unhurt but stranded for eight hours.

As for our family, my 15 year old son, Luke, and my wife, Fumiko, awoke very quickly when the shaking began. (I was in Seattle on a short sabbatical.) Luke says, "I dreamed books were falling all over me. I woke up . . . and they were. Our bookcase was all over me. It was so scary." Our building was relatively solid, but everything stopped - electricity, gas, telephone, water. Fumiko, being from Tokyo where earthquakes are frequent, assumed it was not too bad and went back to sleep. Luke, though, said it was the longest and darkest morning before dawn that he had ever experienced. For a week after that he went to bed with his clothes on, ready for the next one. When I first talked to them by phone later the day of the earthquake, Luke told me how strange the Rokko Mountains, towering over the city, looked until he realized what he was seeing. Those many long, strange yellow streaks were severe landslides. Later, we learned that many senior citizens who went to the mountains for early morning walks had been buried alive.

One of Luke's teachers had been killed instantly, freakishly, as the entryway of his house fell on him as he was leaving for an early morning jog. The rest of the house was untouched - his parents in a state of shock at what had happened. A friend and his wife thought they were about to die, "We were riding our bed like a boat tossed on the sea." Later their daughter heard the voices of the dying including an old woman whom they knew. Asking for help from the house next door, her voice became fainter and fainter. She died soon afterward. A close friend of Luke's, a fellow soccer player named Joi, barely survived. His mother told us how the house lurched to one side, sending everything crashing. The doors were blocked and there was only one way to get out, by crawling through a gap in a second floor window. They stayed in the building until some hours later, though, because the building was leaning crazily, tottering as if any small movement might send it crashing on top of them. They somehow escaped, but went to live on a school playground for some weeks.

Fumiko's university colleague was taking a walk early in the morning for the first time in a long time. Deep cracks were created before her eyes, literally running along the road in front of her at the same time as houses were collapsing all around her.

Maho, a former student of mine, told me how her 12-story apartment building was trashed in an instant. All the windows were shattered. At the same time, gas was escaping and the whole building smelled of gas. She and her family rushed to the veranda and scrambled down an emergency rope ladder through one hatch after another, down six floors and out into the street in their bare feet. There was no way to get their shoes, and there was no time. People were dead or dying in buildings around them as they ran to the open spaces of nearby Nada High School. Maho tells me she wept copiously, continuously, for three days afterwards.

Other friends tell of flying televisions, fridges, dressers, and other heavy furniture. Some of this furniture made it all the way from the first to the second floor! One elderly friend bolted out of his low bed just as two huge dressers fell onto the bed. He knows he is alive only because he was so quick to get up.

TRAPPED

Another friend was not so lucky. Ozawa-Sensei was home alone when his two-story house collapsed around him. For nearly three hours, he was trapped under splintered timbers, breathing a fine dust blown up from the debris. Breathing this dust would later have a terrible effect. Although he was rescued by neighbors, within a week he was hospitalized in the emergency room of a Kyoto hospital with sudden high fevers. In intensive care for a month, Ozawa-Sensei barely survived the five types of lung disease he had contracted simultaneously.

Mrs Ishihara, the mother of my colleague Toshiko, says that even from under the covers, she could see the spectacular "pika pika" flashing of lights during the earthquake. What was worse for her, however, was the aftermath. Mother and daughter got up and stared silently for a long time down the mountainside, looking out over the city. A thin, ubiquitous, white film covered everything, all the houses, everything. Stunned, Toshiko and her mother could only look at the devastation spread before them, afraid to mention this white dust of death. Finally, Toshiko's mother spoke in a whisper, "Did you . . . ?" "Yes, mother, I saw it, too, but I was afraid to mention it to you." The dust disappeared within a half hour of sunrise.

TRAGEDY

Just below Toshiko's home, near the Hanku Railway's Rokko Station, one of my former students, Makiko, was killed instantly as she fell out of the second floor where she slept and was crushed by the collapsing building. Her parents and her 15 year old brother, who had been sleeping on the first floor, miraculously survived. My students who went to the funeral said they had never seen so many tears, especially those of the younger brother.

A friend told of going with his friend to search for his recently-discovered new love, with whom he was madly, passionately in love. They met an old grandmother outside, next to the collapsed house, who told them that the bodies had been pulled from the wreckage two hours before.

On that day, dazed survivors, often single children, walked to the local ward offices to report the deaths of all the members of their families. What else was there for them to do?

THE AFTERMATH

As the second day dawned, 70,000 or more people had to be evacuated from the area around Rokko Island. A large tank farm, storing over 60,000 tons of LPG, was leaking. Fumiko and Luke were evacuated from one end of the island to the other, then told later that day to return, that everything was under control. The newspaper reported five months later that the tanks had been full and had actually continued to leak for six days. A professor of chemistry at Kobe University was quoted as saying that it was only luck that prevented a 20 km fireball. Meanwhile, not far away, entire sections of the city wee being consumed by flames.

Fumiko and Luke soon left, refugees from this tremendous disaster. She wrote,

> "Five days after the quake, my son and I left our home for my parents' house in Tokyo. The life without water and gas had become too inconvenient. We walked along the collapse highway and past hundreds of shattered houses for the few hours it took us to get to the nearest functioning station. The roads were chaotic

with ambulances and fire engines; the sidewalks were full of pedestrians and cyclists going toward Osaka, the next city, but a city that had escaped the destruction. I was more amazed by the energy of those people trying to get food and other supplies than I was frightened by the sights and possible dangers . . ."

A friend said,

> "I recall with a sense of unreality my first train ride to neighboring Osaka about the first of February. It was as if I had stumbled into a nightmare *Back to the Future* - I boarded a train in a bombed-out neighborhood in a post-war Japan and twenty minutes later got off in the 21st Century. A twenty-minute ride like that can be un-nerving. Imagine the ride back . . ."

SERIOUS FLAWS IN OUR UNDERSTANDING

There are some serious flaws in our understanding of earthquakes that were revealed by the Kobe earthquake. First is the scale we use in measuring earthquakes. We need a new scale that the common people can understand. The present scale reflects a far more dramatic rise in intensity than most people can understand. As one geologist explained it, if we compare a magnitude 4 earthquake to a magnitude 8 earthquake (Kobe was 7.2) the increase in energy released is a million times greater.[3]

Another flaw is the idea that the destruction resulting from the earthquake radiates outwards evenly from an epicenter. The power of an earthquake in any given area depends on many factors. Our area of Kobe was the worst hit because of soil compaction, the siting on an alluvial fan, and the hard granite deep down that caused the shock waves to ricochet back and forth. The estimates for the strength of the quake here far exceeded what was measured at the epicenter on Awaji Island. The devastation on Awaji was terrible, many cracks in the earth, many lives and buildings lost, but the scale here in Kobe was far more devastating.

More understanding is also needed on the validity of animal and geological predictors of earthquakes. There were many curious indications before the Kobe earthquake such as strange animal behavior and abnormal radon gas discharges. Fisherman reported unusual fish behavior the day before the earthquake, fish jumping crazily out of the water in large numbers, spinning wildly. Dogs and cats appeared extremely anxious before the earthquake, according to many people. For some hours after the earthquake, when nearly all human and machine sounds were stilled, huge numbers of birds flocked to Rokko Island, swarming and making loud, agitated, chattering noises. Later, reports from a sophisticated seismic study indicate that there were large discharges of radon gas in the preceding months in the area of the quake, a phenomenon linked to previous earthquakes in other locales.

THREE MONTHS LATER: DECAY, DETRITUS, AND DESPAIR

Three months later, when I made it back to Kobe, the smell of concrete dust was still everywhere, likely mixed with blue and white asbestos (the level is said to be anywhere from 20 to 80 times the permissible health standards) and dioxin. Some people wear gauze or industrial masks over their faces. Many people don't. I bicycle up and over the huge bridge to the mainland, wearing my mask and choking on the dust, my eyes welling with tears from flying particles, my feet furiously pumping to get me to the nearest station along with the throngs of other bicyclists. It is not easy cycling. Pavement abruptly thrusts up, curbs are askew, huge holes await the unwary; traffic streams toward me just a few feet away. I cycle through block after block of now-abandoned Sake distilleries. Nada was the most famous place in Japan for Sake, but now the factories are piles of bricks, collapsed cement walls, tangled pipes, and jagged metal - a thriving district silenced.

There are stark contrasts. I am reminded of parts of India, those hellish slums that are so unforgiving, so gloomy, and so heavy . . . we are just a thin veneer on this earth. The psychological impact of seeing hundreds and, if you travel just a few kilometers, thousands of destroyed buildings is difficult to describe. They have been wrenched from their foundations, collapsed into kindling and splinters, and twisted into hideous shapes. And yet some hope . . .

HOPE

Akimoto-Sensei, one of Luke's teachers, tells how you see the precious value of ordinary items like water, gas, electricity, telephones, communications that you normally take for granted. After the earthquake, Akimoto-Sensei bicycled all over Kobe to visit the homes of as many former students as he could. Since he had taught in so many schools in the worst-hit areas, he saw many poignant scenes. One that really stood out for him was how people forgot prejudice, how Japanese and Koreans and Buraku (untouchables) and foreigners worked together. Large contingents of helpers arrived from Korea, volunteers ready to help in whatever way they could. Yet the Korean community was seriously worried right after the earthquake about lynching - with good reason. After the 1923 earthquake in Tokyo/Yokohama over 10,000 Koreans were killed when rumors of them poisoning water supplies spread . . . and in 1995, the memories of 1923 were not so far away.

This time, though, all is harmony and working together, calmness, patience, composure, poise. Still, there were many stresses to cope with. As Fumiko noted in a letter she wrote two months after the earthquake,

> "Although I did not lose my place to live or get hurt, I am having a hard time, both psychologically and physically adjusting to these changes. I do not know how to deal with the contrast between the two worlds, one like my place where there is not much damage, and the other which is heavily ruined. Things around me look the same as before. The moment we get on the road out of the island, however, we see the ruins all over; the ends of the broken bridges sticking out in the air above the ocean, train tracks tilted towards the roads our busses run on, remains of buildings that turned into twisted iron bars and concrete gravel - and on and on.

"When the bus I was riding in was running slowly, I could see all these so closely. I felt like crying. I know it was not sorrow for the destruction. I am not sure what it was, but maybe it was a helpless feeling for what we never dreamed could happen; a power far bigger than we humans can deal with. Nobody at this moment can foresee what the life in Kobe will be like. Yet, it goes on even after such sudden and drastic changes . . ."

The final statistics were 6336 dead, tens of thousands seriously injured, 370,000 dwellings destroyed, 300,000 persons 'temporarily displaced', 369 children under 19 losing one parent, 88 children under 18 losing both parents, a price tag of $120 billion for repairs, 20,000 people out of work, 11 million tons of rubble . . .

Kobe . . . a beautiful city, between the mountains and the sea . . .

LEARNING FROM DISASTER
ELEMENTARY SCHOOLS, CHILDREN, AND TEACHERS

Masayuki Suzuki, David Willis, and Yukari Takimoto
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Three years have passed since the Great Kobe-Hanshin Earthquake struck Kobe and the surrounding areas. The effect on education was especially devastating. Schools lost 178 pupils and 11 teachers. Thirty-five schools were destroyed and 295 of 345 public schools were damaged. Losses to the school system were estimated to be $500 million. The loss in human life and damage would have been far greater had the earthquake struck during regular school hours.

At the peak of the recovery efforts, 218 (63%) of the public schools were evacuation centers and had taken in 136,295 (60%) of the refugees. Many of the other refugees were in private schools and other educational facilities. Although life has gradually been returning to normal, now is the time to reflect on what we learned from this terrible disaster.

Teachers especially suffered. Although many lost colleagues, students, and their own homes, they carefully attended to students and supported them, often trekking far from their damaged homes or refugee centers to be at their posts. Many teachers were also deeply involved professionally and personally in the suffering and hardships of the earthquake victims on their school grounds. Seeing schools as public shelters, educators in Kobe learned powerful lessons. By helping, sharing, and encouraging others, while being committed to the solutions of survival, teachers' humanitarian energy and social responsibility was generated on-the-ground and utilized effectively where it was most needed.

Disasters are part of the human condition, not just something that appears suddenly in the media in some far-away place, only to fade away after a few days. The Kobe Earthquake was a human disaster, with human shortcomings, human courage, and human lessons.

ELEMENTARY SCHOOLS AND TEACHERS IN THE MIDST OF DISASTER

The roles of elementary schools and children in the midst of this disaster were particularly moving and powerful. Schools are common assets of communities, yet they have often been separated from their communities, even in Japan. As refugees began streaming into school buildings and campuses, the nearest and safest centers for refuge, teachers and schools emerged unexpectedly with key roles in relief efforts. During and after the earthquake, schools were transformed into community and information centers, hospitals, even morgues, while also continuing their educational functions.

Schools were suddenly faced with obligations other than their essential function as a site for studying. Teachers had to devote themselves to new work which was far different from their usual responsibility of teaching. The longer people stayed at the schools, the more the schools were plunged into the dilemma of both supporting victims and providing children with a place and time for study. It was the setting of school buildings, rooms, and grounds which became the sites of the most intense relief efforts after the earthquake. Many schools playing fields were soon dotted with scores of tents, and later, evacuee housing. Throughout this crisis, children revealed unexpected strengths and insights that encouraged and supported adults in surprising ways.

SCHOOLS AS COMMUNITY EVACUATION SHELTERS

Four functions of schools as evacuation shelters were fulfilled by teachers acting in teams. Schools became distribution centers (for food and relief goods), information centers (for transmission and exchange of information), medical treatment centers (for field medical treatment and as morgues), and accommodation centers (until other facilities could be built). These roles were in addition to the teachers' regular school duties of class supervision and school administration. (In Japan, many school administrative duties are carried out by teachers.)

In addition to normal educational duties, the roles of teaching staff included: Educational Duties (accounting for students safety and the conditions of their families, safety education, mental and physical health, make-up classes, and student registration changes); and Evacuation Center Management (safety and health measures, anti-panic measures, emergency repairs, adjustment of facilities, collection and distribution of water and food, information collection and transmission, provision of warmth for refugees, secondary disaster countermeasures, and night/daytime watches).

Management of evacuation centers and support to students and refugees became a prolonged and difficult job. Many volunteers came from all over Japan and other countries to help, but the main responsibility and work necessary was entrusted to the teaching staff of schools.

CHILDREN AND THE EARTHQUAKE

It was children who were most deeply affected. The memories of the Great Hanshin Earthquake will live inside children's hearts and minds for the rest of their lives. The following are their voices, excerpts from essays of elementary school children on the earthquake and its aftermath.

During the Earthquake

"Father said, 'Earthquake!" I was astonished. My brother and mother hugged each other and prayed, 'God, please save us.' I myself prayed, too." - Hidemi Ryo, 4th Grade, Suwayama Elementary School.

"As we gathered together in our living room, the aftershock continued shaking us. When we heard a dog and a cat whine and mew, we went outside to see what was happening. They were trembling together, so scared, so we took them inside." - Eriko Kakuishi, 5th Grade, Suwayama Elementary School.

"My bed was shaking heavily as if a giant had held up the bed and brandished it. I was almost falling down."

"I covered myself with a blanket and couldn't move at all. I completely lost my presence of mind. We have been taught when a quake happens that we should dash to escape under a desk. Who could ever do this calmly?"

"I thought my life was over."

"'Dangerous! It's dangerous now!' In spite of my shout, my mother dashed up to help my sister who was locked in the second floor. She didn't listen to me. I found how strong a mother was who always cared for her own children."

"I had never imagined death as scary, however in the earthquake, I understood the fear of death and I thought from the bottom of my heart, 'I don't want to die!'"

- Fukuda Junior High Schools students.

The Deaths of Relatives

"I couldn't stop weeping because my grandmother was buried alive. She was sleeping on the first floor of the two story house and the first floor was crushed by the earthquake. She was alive when she was taken out of the house, but couldn't be carried to a hospital and died on the spot."

"Mother threw herself down crying and so did I. We heard my grandmother had been buried alive. Her dead body was put down along with many others. The people who died from burns and the remains of arms or legs without bodies were put on a kind of cushion with name tags. She was plump and had gray hairs. and all the more, she was always smiling. That was my grandmother."

"Tears cascade like the piles of newspapers I look at whenever I am getting the trash ready to throw out..."

- Fukuda Junior High School students.

The Deaths of Classmates

"The saddest thing for me is that I lost my classmate. The last time I saw her, we quarreled. I wish I had been friendly with her that last time." - Chikako Kyomina, 4th Grade, Suwayama Elementary School.

"February 5th. I was tired. It was somehow dark on that day. Clouds in the sky looked like a line of dead people. 'Is my friend Su-chan there?'" - Akiko Yodogawa, 6th Grade, Sumiyoshi Elementary School.

Memories of Fire

"When I looked back, I saw the fire coming. When I looked again, I saw the house burning. The doll my parents bought for me when I was a baby, the piano, the newspaper with the picture of a parade. Everything was burning. I hid my tears with a jacket." - Eri Motomiya, 3rd Grade, Nishisuma Elementary School.

"I heard that an elementary school boy died, burned in front of the people who tried to rescue him. Tears ran down my cheeks." - A Fukuda Junior High School student.

"Suddenly tears poured out and my whole body started to shake. I walked in my bare feet on the broken glass, wearing only my pajamas. Finally somehow I got out of the house. Although it was dark all around there, it felt even more gloomy. 'Fire!' somebody shouted. It looked as if God was building a bonfire. The flames looked like the face of God with a loud laugh. It was a voice I could hear so clearly." - Shoko Okada, 6th Grade, Shizuike Elementary School.

Farewell to Friends

"February 13th. I went to school. Twenty students came, ten boys and ten girls. I was lonely because some of them would transfer from our school. The teacher was crying, too. Funabiki-san, Suzuki-san, Araki-san, Ishida-kun, I cannot see them any more. If the earthquake had not happened, this kind of thing would never have happened. I am very lonely now because I have lost so many friends. I studied in the classroom of the 5th Grade. The high desk there troubled me. I want to go back to the classroom of the 1st Grade." - Ayako Kochi, 1st Grade, Nishisuma Elementary School.

Life at a Refugee Center

"On that night, I slept at a school. The music room where I slept was so cold and dark. I became very scared because I felt as if the eyes of the pictures of Beethoven and Schubert on the wall were flashing at me." - Ayako Shirai, 6th Grade, Onogara Elementary School.

"We went to school because we heard that schools were safer. I was very scared at night because we were living with only a candle and no electricity. A baby next to me kept wailing." - Saori Takizawa, 3rd Grade, Onogara Elementary School.

"I joined a junior volunteer club at a refugee center. Relief goods were delivered by us, a medical room was made and a refugee newspaper was published. The school was also re-opened. It is like a dream that we can study here.

The people in our room at the refugee center were so kind. They treated us like a real family. When some sweets were distributed, we were given extra although everybody needed them. When we were given water, they always said, 'You first.' There were people who cared about us when everybody had to think about themselves first. I thought we always had to cooperate with each other, not only after an earthquake but also at any time. I want to become an adult like that, who can think of other people's feelings all the time." - Ayako Hasegawa, 2nd Grade, Nunobiki Junior High School.

"After I used the rest room, I often flushed out of habit. But what waited for me after the earthquake was drawing water (and flushing with buckets). The work was like a hell." - Yasushi Kuroda, 5th Grade, Nishisuma Elementary School.

"We were told that we must not eat more than one rice ball a day. We decided not to eat more than necessary."

"I have never gone through such hardships to get water and have never spared to use it carefully."

"I wonder whether people had ever helped each other like this. I had never thought of how thankful I am that water comes out of a tap, that electricity is on, that gas flows out, and that we can take a bath."

- Fukuda Junior High School students.

WHAT WE LEARNED: REFLECTIONS OF EDUCATORS

Teachers increased duties continued for different lengths of time, depending upon the damage to the neighborhood and the building of prefabricated housing units for refugees. Most schools were in full operation again by the fall. Though many had to make-do in prefabricated classrooms, most schools no longer had to function as evacuation centers by then. Two years later, what teachers learned can be summarized in seven lessons:

The power of life and the significance of human lives.

The crucial importance of 'lifeline' needs - water, gas, electricity. etc.

The value of human relationships and human solidarity.

The importance of family and community ties with schools as a focal point.

A spontaneous spirit of neighborhood concern.

Fortitude and self-control in a crisis.

Hope as an indispensable element of survival and recovery.

Schools played key roles as the main shelters for the community. The Great Hanshin Earthquake gave people a chance to review what a school should really be. When we face a new reality we cannot look away.

Catastrophes present us with the picture of a stream leading to the future, to a new century. The terrible events of 1995 in Kobe and their aftermath taught us that, in the next century, we will need even more focus upon citizenship and community. They taught us that we have strong grass-roots responsibilities as educators, as teachers, as students, and as community members. As educators, we especially realized how we need to eliminate the borders between people when we are in the midst of crisis and disaster. After the terrible disasters of this century, the challenges of a new human century are dawning, Beyond what we learned in the particular catastrophe of Kobe are the lessons for all of us as teachers, lessons in awareness, strength, and the possibility of solidarity in the human community.

Extensive research in Kobe has focused on the use of schools as centes of response and community. The new disaster and relief plans for Kobe City and Hyogo Prefecture both use schools as evacuation and relief sites, a lesson derived from the practical reality of what happened in 1995.

SCHOOL CHAOS AND TEACHER'S VOICES LEARNING FROM EDUCATIONAL CRISIS MANAGEMENT

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As refugees began streaming into school buildings and campuses, the nearest and safest centers for refuge, teachers, students, and schools emerged with the key roles in relief efforts. As educators who live and work in Kobe, we realized that we had learned important lessons from our experiences with crisis and chaos that might help prepare educators in other countries who might suddenly find themselves facing similar disasters.

Perhaps most importantly, this sudden and totally unexpected disaster revealed lessons about the human condition in the late 20th Century, lessons concerning vulnerability, urgency, and agency.

SOCIETY, AUTHORITY, AND DECISION MAKING IN CRISIS

Facing the devastation of the huge earthquake, the Japanese-style of management, especially crisis management for the safety and security of its citizens, worked poorly due mainly to Japan's traditional vertical system of organization. Conservative, stubborn, and thoroughly entrenched in Japan's society, this system has demonstrated its effectiveness and power when building the long term strategies and relationships that have made Japan the second largest economy in the world. These same characteristics caused the system to fail, however, when confronted with the sudden catastrophic reality of the earthquake.

The Japanese system is characterized by compartmentalization of tasks and tenuous decision-making links that need time for articulation while all parties are being consulted. This source of Japan's great strength is also, paradoxically, its Achilles' heel. Consequently, national, prefectural, city, and local authorities were slow and ineffective in dealing with this crisis. There was a severe management failure and at least some of the victims in the first 24 hours did not have to die. After such a sudden, devastating earthquake, every level of government will be in a chaotic situation, but the reactions and the results in Kobe were those of deadly confusion. The questions still remain unanswered for the Japanese people, "What is leadership in a crisis? Who will make swift decisions in a crisis from now on?"

What made the matter worse was the poor infrastructure which supported the safety and security of citizens. Water supply systems for firefighting were severely damaged or simply did not exist, and firefighters who had come to help from other prefectures had to watch in vain as flames raced through Kobe, consuming large sections of the city. Parks and open spaces which could prevent the fires from spreading to adjacent blocks were few in the city.

It has also become clear that the highly developed economy and the highly advanced technology, transportation, and communications of Japan have been constructed for the sake of productivity, profitability, and development, and not entirely for the well-being of ordinary citizens. The weakness of Japan's social investment and welfare in crisis again powerfully symbolized the immaturity of Japan's impoverished approach to human welfare and human rights. Even beyond problems with disaster-planning and prevention, the daily needs of the weakest sections of society had been greatly neglected in Kobe city. The satisfaction of these needs should be measures of the effectiveness of government in this post-modern age in all countries and localities. Kobe faced the disaster with a lower availability of social services than the rest of the country. For example, day services available to the elderly average 55.8 days per 100 persons in Japan as a whole, but only 14.0 in Kobe. Home helper services are available 116.6 days a year in Yokohama and 61.9 nationwide, but only 34.6 in Kobe. Public kindergartens have two year programs in much of Japan, but only one year in Kobe.

The media also played a role in the difficulties in Kobe's response and recovery. On television, for instance, there were many talk shows and scientific lectures with analysis of the earthquake by famous scholars and commentators. One well known scholar mentioned that it was fortunate that the earthquake had not happened in Tokyo since a similar event there would result in 60,000 deaths and property damage of $3.3 trillion. Many evacuees were shocked by the academic tone of this coverage as they watched TV, huddled in their cold school gymnasiums, converted classrooms, makeshift shelters and tents. It sounded as if the tragedy had happened in another world, in a far distant country, as if the importance of Kobe was simply dismissed. Kobe suffered another disaster with the nerve gas attacks in the Tokyo subway - interest shifted to the events in Tokyo and Kobe disappeared from the national media. All this while, people in Kobe were still living a very real nightmare, struggling in fear and despair. What people needed was clear and direct support from the central and local governments and media.

The real lessons in leadership and decision-making in Kobe came from the grass roots, especially from the schools and educators. Only in the schools did people overcome the traditional vertical ordering, thereby addressing the monumental, pressing needs with originality, energy, and vision. A sense of neighborhood concern, solidarity, self-help, community autonomy, and volunteer spirit among citizens and students, regardless of wealth or poverty, creed or race, city or prefecture, religion or nationality, was born and fostered through this tragedy; schools stood as the centers of community. Thousands of volunteers from outside the city and Hyogo Prefecture came to Kobe every day and worked with evacuees and refugees. Teachers dedicated themselves to relief and rehabilitation activities, well beyond their normal duties.

HOMEROOM TEACHERS IN THE AFTERMATH

An especially important role was played in the aftermath by homeroom teachers, those teachers in charge of a particular class for the three years of junior or senior high school. The function of the homeroom (gakunen seido) is as a "home" in school life. There is a national consensus that a strong humanistic tie between teachers and their students through the homeroom system is really vital in education . Students take most of their classes with the same homeroom group, at the same desks, in the same homeroom class, every school day. The homeroom environment gives each student a fixed set of classmates, a sense of familiarity, a feeling of belonging, and a strong solidarity. Japanese teachers, who have experienced the complexity and depth of human relationships as homeroom teachers (gakunen sensei), were singularly effective in the management of evacuation centers in each community.

Most teachers stayed at school, day and night, in turns, to take care of the refugees in addition to their normal educational duties. These conditions continued for more than six months after the quake and many teachers became tired and worn-out. Not a few died of overwork. The long-lasting management of schools as refugee shelters began to reveal the problems of this vertical society. There was friction and misunderstanding between teachers and those few city officials sent from the city or central government. Bureaucratic thinking and the vertical order (officials) clashed with humanitarian approaches (teachers) toward the refugees and students, but what had to be done was done. The contribution from teachers, from elementary school to college level, began the moment schools became make-shift shelters. Teachers helped students and evacuees in their community as managers, counselors, mental and physical therapists, and good listeners.

VOICES OF HOMEROOM TEACHERS

Unimaginable Duties , Unforeseeable Circumstances

"On the day after the earthquake, I found that the telephone in my home sometimes worked. I began to make telephone calls to each of my homeroom students. How many times did I push the buttons, only to receive no answer, even no connection?

"Gradually, I got to know that more than half of my students had left their homes, which were seriously damaged , and that they were staying in evacuation centers or had evacuated to relative's homes in other parts of Japan. I could not go to school because there was no public transportation system, but every day I made a telephone call to Fukiai High School and talked to the gakunen-shunin (head homeroom teacher) or other gakunen (homeroom family) teachers to get to know what I should do for the students. I made a second call to each of my homeroom students to tell them that the school would begin a week after the earthquake at 10 o'clock on January 25th.

"From the day of the earthquake, about one-fourth of the teachers including gakunen-shunins and teachers who lived near school or lived in safer areas could come to school and look after the 300 evacuees staying there. One homeroom teacher who lived quite far from school took two hours to come to school by bicycle. Homeroom teachers also collected information about the students' safety as students began calling their condition in to the school. At this time some of the teachers got the news that three Fukiai students were killed in the earthquake. The homeroom teachers of these students and teachers from other gakunen went to see their dead bodies to say goodbye with flowers from the school's garden.

"It seemed that I played a role as a key station of information concerning students' safety. They talked a lot about what happened to each other and how they escaped from their houses and also exchanged information about where we could get food and water. Homeroom teachers gathered much information about students' conditions after the earthquake, for example, how their houses were damaged, where they had temporarily moved, whether they had the possibility of moving back to where they used to live, whether there were injured or dead in their families, whether their parents had lost their jobs or not, and os forth. As homeroom teachers we also talked with students after school, encouraging them depending on their special needs in this chaos."

- Ms Takako Chamoto, English Teacher,
11th Grade Homeroom Teacher.

Students Helping Each Other, Students Helping Us

"At the moment the earthquake occurred, I couldn't understand what was happening. About thirty minutes later, I managed to get out of my house. I wondered whether I should go to school under this kind of situation, however I soon found out that it was impossible - no electricity, no gas, no transportation.

"The first thing I did was to try to contact my parents and my school, but in vain. It did not take long to realize that what was happening around my house was also happening all over Kobe - and to all my students. My eyes were nailed to the TV. Watching Kobe red with fire, I sat still, speechless. A few days later I was informed that six of my students had died while many others had lost their parents.

"The power of nature had given the students too many lessons to digest, and I was afraid that there was nothing I could teach. In such chaos, I thought, classrooms should be the place for students to express themselves, not simply being a place to learn and study something. My role as a teacher was not to teach but to listen to my students and share our experiences.

"On my way to school, I was shocked to learn that the situation was far worse than I had expected. I passed by the junior high school where I had taught before. Half of the school was damaged by fire. Around the school were my former students' homes. Some had fallen down while others were burnt-out shells.

"In class I talked about what I had experienced and how I had felt. Then I let my students have time to write about their experience in English because I believed they needed an outlet for their fears. To my surprise, however, one boy hesitated to do so. He said that he was too shocked to write about the earthquake. I learned that, for some of them, the classroom should be a place where they could completely forget about the disaster. I regretted not being sensitive enough to identify myself with him. 'Teacher', 'educator', 'instructor' were not words to describe me at that time. It seemed that the word 'student' had little meaning in the midst of such chaos, too. We were just fighting against something unseen together."

-Ms Satoko Endo, High School English teacher and former homeroom teacher of a Kobe junior high school.

"On Saturday, January 21, I went to school for the first time after the earthquake. I found about twenty teachers working hard, answering the phones in the staff room. Thanks to the staff who had been coming to school almost every day, we could know the safety (or loss) of nearly all the students in our grade.

"On Tuesday, almost half of all the students gathered on the tennis court. Some students seemed very tired after a long walk because transportation facilities were still cut off. We had a moment of silent prayer for the victims and then went to our classrooms. I knew that more than half of the students in my class came from homes that were destroyed or heavily damaged. Over the days to come, more and more students came to school and we began getting back to our normal life.

"Teachers decided to stay overnight at school by turns and patrol the grounds after midnight together with the guard and some of the refugees. It was a precious experience for us to share time together with the refugees, talking with and comforting them. During those times, there were no troubles between the refugees and the students at school. On the contrary, they seemed to have learned to care about one another, to have learned the importance of coexistence."

- Mr Tadashi Imamichi, Homeroom Teacher and High School English Teacher

Remembering My Student Nozomi

"My beloved student Nozomi was one of those who died. Nozomi means 'hope' in Japanese, making this tragedy even sadder and more cynical. I had been in charge of Nozomi's homeroom for two years during her 11th and 12th grades at Kobe Commercial High School. Nozomi was crushed under her collapsed building. Several hours later, Nozomi was carried out from the crushed apartment. She had been dead for some time, yet it was impossible to bury her. Her body lay in the school for two days together with those of many other victims.

" I can't forget the swelling feeling of mourning when my friend came to tell me he tragic news of Nozomi. My heart was torn with sorrow and unspeakable anguish. At that time, I was taking refuge at a school gymnasium near my house.

"I first met Nozomi's family during the ceremony that was held 49 days after her death. We held each other without uttering a single word. In the Japanese educational system, it is not too much to say that a student's parents and home room teacher are more concerned with the student's happiness and proper development than any other persons. Yet I couldn't find any words to console them. All I could do then was to share my sadness and sorrow with them.

- Ms Kyoko Sugino, High School Japanese Language Teacher and former Homeroom Teacher of Commercial High School.

LESSONS FROM EDUCATORS

The psychological scars of those who lost their parents, relatives, and houses have not entirely disappeared. Many people in Kobe are still struggling against despair without enough support from the government. What matters most is an urgent and shared concern for the weak, the elderly, and minorities. We should, therefore, pay much more attention to mental care as well as financial support of those who are suffering. This is a lesson, not only when a disaster strikes, but for all those who lack basic human rights and needs. Suffering and death from isolation, loneliness, inattention, and identity crisis among aging refugees have become a cruel fact of life in Kobe today. Suicide rates have climbed; divorces have tripled. The unstable life of the 20,000 - 30,000 refugees still in make-shift prefabricated housing units all over the city holds little future. Tens of thousands of people lost their jobs and livelihoods. These symptoms call into question the status of fundamental human rights in our society in terms of the quality of human life and the pursuit of happiness.

We have learned many lessons for the future from this tragedy, especially mistakes we should not repeat as citizens, as public servants, as a community, and as government officials. The cost to the victims in this natural and man-made disaster was too high for those who lost their loved ones , their property, their jobs, their professional dreams, and their future. It may take many years to truly foster an urgent common concern for human crises and an independent, swift, decision-making process in crisis management in the many vertically structured, bureaucratic societies around the world, however, we have to do this as human beings concerned with the welfare of all humanity. The first of all human rights is physical, social, and mental security. It is a duty for those of us who are better off. In return, a real sense of citizenship and democracy will flower, benefitting all of us.

CONCLUSION

Citizenship, democracy, and social welfare are symbiotic. As teachers, particularly, we should have a clear sense of crisis management as citizens, as democrats, and as social activists. The positive lessons of the aftermath of January 17, 1995 are great indeed.

When we face a new reality we cannot look away. Catastrophes teach us that in the next century we will need to focus even more on citizenship and community. School zones include all of us in this community. The earthquake taught us as educators, as parents, as students, and as community members that we have strong responsibilities.

Action became the focus of our efforts in schools clear through this experience, action locally, with the school as the center of the community. We also learned that we have behind us a strong momentum, an active, positive urge as teachers for the betterment of our community and its members. As witnessed by the voices in this essay, we discovered that our duties as educators include our orientation to a larger community, a human community, in a spontaneous spirit of commitment to our students and communities.

During this experience, while the authorities and the governments floundered, the solidarity of citizens in the schools that had become community centers coalesced. Empowered by the efforts of volunteers who came from outside the area, even from neighboring countries, by those others in Japan such as north and south Korean residents of Kobe, and by the efforts of the teachers, many of whom spent countless nights in the evacuation centers, a trans-cultural orientation appeared among those of us who work in schools. As educators, we realized how we need to cross the borders between people when we are in the midst of crisis and disaster. After the terrible disasters of this past century, the challenges of a new human century are dawning. Beyond what we learned in the particular catastrophe of Kobe are the lessons for all of us as educators, lessons in awareness, in strength, and in the possibilities within the human community.

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NOTES

1. Masayuki Suzuki is Professor of Comparative and International Education in the Faculty of Human Development of Kobe University. He is widely regarded in Japan as a leader in human rights education and education for diversity. Much of this paper is based on his book on the Kobe earthquake, *Sono Toki Gakko Wa* (At That Time, The Roles of Schools...), which the Kobe PTA asked him to compile for parents, students, and teachers. David Willis is adjunct professor of Cultural Studies at Kobe University. He also holds a position at Soai University, a Buddhist women's university in Osaka. He has lived in Kobe for over 15 years. He has taught in an international high school and public elementary school in Kobe. He raised two sons who went to Kobe elementary and junior high schools and he was vice-chairman of the PTA of a Japanese middle school. Yukari Takimoto received her MA in American Studies from Doshisha University, Kyoto, specializing in multicultural education. She has worked as a teacher of elementary students in Singapore and Kobe, and is a doctoral student in multicultural education, human rights, and human development education at both Kobe University and the University of Washington (USA) with the support of a Rotary Foundation Scholarship. Kokji Nakamura, Takako Chamoto, Tadashi Imamichi, Kyoko Sugino, and Satoko Endo are home-room teachers in Kobe high schools.

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2. Naming of the earthquake has been sensitive and controversial. The term Great Kobe Earthquake has been used here because of Kobe's familiarity to people outside Japan and because the destruction was greatest there. Official documents use two terms: The Great Hanshin Earthquake for the area between Han (Osaka) and Shin (Kobe) and The Great South Hyogo Awaji Earthquake which recognizes other communities in Hyogo Prefecture that were badly affected. Osaka, however, had little damage and Hyogo doesn't include Kobe, where most deaths and the greatest destruction occurred.

3. Many people, including the media, have tried to simplify (in this case) the Richter Scale for popular consumption by saying that an increase of one on the scale indicates a ten-fold increase in energy released (magnitude). In fact, each unit on the Richter Scale represents approximately 32 times more energy released at the source than the next lower unit. Going from 4 to 8, the result happens to be about the same. The Mercalli scale measures damage (intensity) on a scale of I to XII but is subject to many variables. The author's point is well taken; both systems are too complex for the average individual. /ed

POPULATIONS AT RISK

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Are you finding your Emergency Management program filled with more questions than you have answers. . . or more expenses than you have financial resources, more paperwork than you have time, more places to go and people to see than you have days left before you retire. . . or, as I most often perceive in others as well as in myself, a combination of "all of the above"? There certainly won't be anything in this paper that will help alleviate any of your concerns about any of these areas and, unfortunately, I will probably add more concerns to the pile of the essential elements of your emergency plan. It's not that I necessarily *want* to add anything more to your plan, but this concern keeps popping right out in front of me every time I think I have a handle on this whirlwind of a career choice I made. The real concerns are about those members of our communities who often seem to slip through the planning cracks.

To identify the populations at particular risk, I first had to examine what my community looks like. We have a good mixture of ages, abilities, and needs. Because we are so often viewed as a "retirement" community now that our industrial base has nearly evaporated, we do find ourselves with a good share of "senior citizens". Our young families still believe in the "Great American Dream" and when they start families, they get ready to send their youngsters off to school. Our special needs individuals have proven to be valuable members of our community and several self-supporting industries have helped them live full, meaningful, and productive lives. For these segments of society, however, everyday activities often present challenges that can be overlooked n disaster planning. Since daily existence is often a challenge, a disaster increases the challenges. This is a problem that can bring your program to its knees.

SENIOR CITIZENS

One reason the senior citizen is a concern is that they come in so many different varieties. The myriad of experiences that have lead them to their particular position, whether it be in family or community, result in differences in culture, conditioning, health related challenges, and financial considerations. While they helped start the expansion of modern technology, few are prepared for what the world has become. They now find themselves refugees from their own creation. My grandmother recently passed away at the age of 105. Imagine what she saw develop in her lifetime! She remembered seeing her first automobile. It scared her horse who then threw her and her sister into the mud! She rode to her 100th birthday celebration in a climate controlled Lincoln Town Car. She would not fly even with my flight attendant sister at her side. She had been a telephone operator who handled *all* the phone calls for her community, prioritizing calls for party lines and yet, before she died, she saw the advent of the cellular phone. Her mind was as sharp as a tack but she would comment just before she died that she was tired - and no wonder! It was increasingly difficult for her to keep up with the changes that were impacting her daily life.

What changes do you think will affect the senior citizens in your community? As you and I stumble through the latest computer upgrade or the most current trend in sophisticated communications equipment, we need to remember that not everyone is at the cutting edge of modern technology. Yet, it influences what happens to them. Technology has kept many senior citizens alive, but it has created a totally different environment in which to live. While financial stability often dictates many conditions for them, even more frequently health care concerns and illness will play a greater role in determining what the "sunset" years will hold, even greater than the changing technology. An ever increasing number of seniors find it necessary to live in extended care facilities, to have daily contact with medical or nursing professionals, or to spend a larger percentage of their income on prescription services. Imagine what it would be like then, not having even a small portion of your income to spend on the latest CD, but rather having to spend the last of it on the new drug that your doctor thinks will cure the problem she has never seen before, but had information flashed to her office over a datalink with a pharmaceutical company. A bowl of chicken soup would feel good right now - but that had better be low-fat, vitamin enriched, free-range raised chicken with no preservatives or artificial coloring.

So, can you categorize them, place them in a pigeonhole, or call any of them a typical senior citizen? Try it and they will break your mold! What happens when you must evaluate the needs of this group, our elderly population at risk, without the time, energy, or resources to emphasize their preparedness on an individual basis? Get help! Because they are *so* different, I have found this is not easy at all. When I pointed out the necessity of a 72-hour kit to one community group, several members laughed and pointed out the window to their motor homes, their $200,000 emergency kit on wheels. One was concerned that a 72-hour kit might get lost in their relative's nursing home room among all the machines and supplies that were needed to keep her alive. Still another wondered who they could get to carry the "steamer chest" necessary to hold everything grandfather would need for 72 hours because he certainly couldn't carry it himself. Among others were those who wanted to know if anyone offered a "senior discount" on disaster supplies, those who needed assistance with pets (they weren't about to go to any shelter that wouldn't let "fluffy" in with them), and those ever present skeptics who doubted that any of this was really necessary because it hadn't happened to them in over 70 years and this wasn't the time to start being concerned about it - and since I was a good twenty or thirty years younger than they were, why should they listen to me anyway? Also in the ranks of the senior citizens , of course, are those who contribute an absolutely incredible wealth of information, experience, and insight into the history of the community, remembering how high the flood waters came back in '06 and every winter since. Many others, though, expressed genuine concern and paid close attention to everything that was discussed.

Although they come in many varieties, ages, and physical conditions, senior citizens are very good at appreciating their appreciation for the assistance they receive. Maybe it's because that's another thing they remember from their earlier years when courtesy and helping one another were more the rule than the exception. The best way I have found to handle senior citizens is to honor them and their contributions and to build more opportunities for them to assist in developing goals into emergency plans, especially in the area of human services management. If you need to know what concerns senior citizens have about disaster planning, just ask them - I recommend a tape recorder with lots of tape! Convincing them to try something new without their involvement is often fruitless. Remember, most of them have seen many attempts to achieve what you are proposing. Why should they look at your attempts any differently than those of your predecessors.

THE PRE-SCHOOLER AND THE PARENT

Unlike the senior citizen who has seen most of what could go wrong in a lifetime, the younger members of our community stand in absolute awe when anything out of the ordinary occurs before them. This curiosity and fearlessness in children will require special consideration. While they do not always understand precisely what they are expected to do or the urgency with which it must be done, pre-schoolers do follow instructions of those in authority when faced with a crisis. If somehow they miss the instructions, you can generally find them where you left them, crying because they feel abandoned.

Caregivers need to know precisely how many children they have under their care *at all times*. It works for firemen going into burning buildings, it works for SWAT teams beginning an assault, and it will work for preschoolers, too. One item I would add to a youngster's 72-hour kit would be a brightly colored vest, large enough to go on top of whatever else he or she might be wearing with his or her name embroidered in very large letters, front and back.

You have probably already heard that a soft, cuddly toy should be included in a child's 72-hour kit, but you probably don't have one yourself. I highly recommend it. Maybe it's because my affiliation is now "law enforcement," but I have a pig. He sits on my desk, overlooking everything I do, and reminds me not to be overburdensome and demanding. He also greets kids when they visit. The high school kids roll their eyes but the little kids love him. The good news is how can anything ever go too wrong with a fuzzy pig in your office?

When you try to plan for pre-schoolers, it really pays to try to get inside their minds and figure out what it is they are feeling when a disaster strikes. Everything comfortable may have just disappeared before them. Thrust into a totally unknown world, they seek guidance and a quick return to something that is familiar. Whether it is at home, a day care facility, or grandma's, it is necessary for a caregiver to immediately reassure them that things will be OK. (That can be difficult if the caregiver is not doing well and everyone around them knows it.) An essential part of our planning must be training our caregivers to provide this reassurance to our pre-schoolers quickly when disaster strikes.

Once we get them beyond the initial phase of the calamity, kids are very resilient. They show the strengths of youth, being very excitable and fearless. They want to help. They can comfort and care for one another, especially using a buddy system. As long as their basic needs are met, they don't require much more than comfort and protection. Whatever is in their 72-hour kits can sustain them until their parents arrive.

Parents are the other part of this equation and could be an additional problem for planning. You have undoubtedly heard the stories and the cautions about separating a mother bear from her cubs. Think what it's going to be like when a disaster hits your community and you have parents separated from their children. We have three rivers in Josephine County with bridges over each of them. I wouldn't want to be the public works superintendent who tries to tell a mother she can't cross a bridge until it's proven safe when she needs to get to where her children are located. During one earthquake evacuation drill, I asked office workers where their assembly point was and one lady remarked, "I don't care. You better get my name as I run by you because the first thing I'm going to do is check on my kids. The Hell with everything else!" When planning for the initial steps in the event of a disaster, you will do much better if you cross out anyone who has small children. They are worthless to you until they are able to *personally* verify that their children are safe and sound. Parents will need to spend quality time with their kids following a disaster to quickly reassure them. This may be the single most important human service need in your emergency plan.

Caregivers need to establish specific rules regarding the release of kids during emergency situations. Sometimes these will be different from normal, everyday release procedures. Maybe it means finding a place to just sit and spend a moment with a child before running off to the next duty. To minimize the panic (it won't completely disappear) from parents, child care facilities should prepare disaster plans and review them with parents, reassuring them that in the event of a disaster, their children will remain safe - someone will stay with their child until the parent can personally make contact with them. Each facility should place emphasis on becoming a safe and secure place for the children under their care regardless of the circumstances.

Take some of the mystery out of disasters for kids. Caregivers at day care facilities can practice emergency procedures (fire drills, too), carry out duck-and-cover drills for earthquakes, and involve children in safety checks around the facility and the outdoor play areas. (Maybe if we train them young enough, they will carry these skills into their grown-up years.) Day care facilities should be involved in community disaster drills in an environment where children - even the youngest - actively participate.

SPECIAL NEEDS

Probably no greater misunderstandings exist in communities today than those about the contributions that the special needs population can provide. I'm not saying they are without their own assortment of problems but they have many abilities that they don't receive credit for having. The potential risks to the special needs population can be minimized by blending the concerns for the younger set of the community with the dignity and understanding of the elderly. Their care just needs to be metered at a rate they can assimilate. Patience is not a characteristic of most emergency responders, nor is it often expected, but here is the opportunity to practice it.

Whether they work at facilities like Goodwill Industries or at the local fast food restaurant or live on their own or in a communal home, the special needs community has always picked up the gauntlet when challenges present themselves. Of all the population groups who are at risk in the event of an emergency, the special needs population is the one that can benefit the most from the planning process.

Look to the special needs community for help in deciding what their needs are and how much they are capable of handling on their own. I think you will find that with just a little bit of assistance and prior planning they will not be a greater concern than any other segment of your community. In fact, I am willing to go one step further. I am willing to bet they will be one of the best prepared segments of your community and may even provide assistance to others in event of an emergency.
Develop goals and set tasks for them with their caregivers and facilitators, create opportunities in the mainstream community for them to participate, and be ready for the assistance that they can provide. Do you have materials that need to go out to the community and that you rely on volunteers to distribute? Here is an area where the special needs community can assist. You might even be able to secure a grant to help defray the expense of the program and contribute to the self esteem of the special needs community members.

Mobility may provide challenges for some. Others may have difficulties following directions, but certainly not beyond the scope that those who assist them are able to control. Give them a chance.

CONCLUSION

Planning is a patient activity. We try to get plans and programs on-line as quickly as we can and then wait for something to happen? I'm afraid I am so patient I don't care if they never happen! I have learned three things about planning:

> You can never do too much planning or do it too soon.
>
> Your plan is never as important as the planning that has gone into it.
>
> The only thing more difficult than planning for an emergency is trying to explain why you didn't.

This has given you some insights into concerns about particular populations at risk in southern Oregon. I could probably turn your attention to still other groups that can use the same attention, preparing them for the next disaster, and I hope that when you discover another portion of *your* population, you approach them with the same urgency, care, and respect. Once you have them identified and have their immediate needs met, all most groups need is to feel protected and secure.

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NOTES

1. Deputy Robert E Grist, CEM, ORCEMS has been working for the Josephine County Sheriff's Office in Grants Pass, Oregon for the last five years. Deputy Grist has an MA in Education from San Jose State University and an extensive list of course from FEMA. He was one of the first six to complete the course work for the Master Trainer Program at the Emergency Management Institute. He has been selected as the "Outstanding Emergency Program Manager" for Oregon's rural counties (1995) and is a recipient of the 1997 Law Enforcement Commendation Medal from the Oregon Chapter of the Sons of the American Revolution for leadership during Oregon's New Years Day floods. He is currently President of the Oregon Emergency Management Association and a member of the Higher Education Task Force, developing degree programs in emergency management in Oregon.

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AN ASSESSMENT OF THE TRANSPORTATION OF EXTREMELY HAZARDOUS SUBSTANCES FOR THE SOUTHERN MISSISSIPPI RIVER CORRIDOR

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The Mississippi River corridor between Baton Rouge and the Gulf of Mexico supports more than 100 chemical processing plants and refineries, requiring the transport of chemicals and finished products along the highways, waterways, and railways. While most shipments pose no risk, some hazardous substances may pose a threat to the community in the event of a transportation accident. Emergency planners and responders need information about the nature of these shipments and the likely impact an accidental hazardous chemical release may have. No *one* state, federal, or industry data source provides information on which hazardous substances are transported, which transportation routes are used, or what health or safety problems an accident may cause.

The Louisiana State Police contracted Louisiana State University's Institute for Environmental Studies to conduct an analysis of Extremely Hazardous Substances (EHS) transported along the Southern Mississippi River Corridor in Louisiana. Surveys of Transportation Community Awareness and Emergency Response (TRANSCAER) members representing chemical facilities, railroads, motor carriers, and barge operators were carried out to provide data. The resulting study identifies EHS chemicals and the modes of transportation in the Mississippi River corridor. For each chemical, the study describes risk zones for different accident scenarios involving each mode of transportation during different weather conditions. The study team was, therefore, able to provide LEPCs with realistic emergency planning information for EHS chemicals.

This broad look at hazardous chemical transportation suggests that risk is not isolated but impacts a large region well beyond a single jurisdiction. By coordinating the efforts of manufacturers, transporters, and local officials, the study clarifies risks associated with Louisiana's hazardous chemical transportation systems. This analysis is not a probability study of likelihood of an accident at a specific site or involving specific chemicals. Neither number of shipments nor names of originators or recipients were a factor. Furthermore, this study does not address incidents at facilities. Vulnerability zones identified for each chemical represent only the general information and are dependent on weather conditions, type of container, and size of shipment.

The study involved several phases: 1) Collecting the information, 2) Analyzing the information and establishing scenarios for modes of transportation and weather conditions, and 3) Identifying the at risk populations for modes of transportation.

DATA COLLECTION AND SOURCES

Collecting potentially sensitive information required the cooperation and trust of facilities, and transporters, scientists and public officials. Therefore, we included all groups from the beginning of the project and clearly defined the goal of the project. The goal was simple: identify those Extremely Hazardous Substances transported in the study area and the mode of transportation for each chemical to assist local planners in preparing for a transportation incident. To accomplish this goal, we first identified the potential respondents and designed a simple survey form. Once EHS chemicals were identified, chemical characteristics were compiled to facilitate the model.

The Respondents

A two-prong data collection approach identified chemicals transported by the carriers and the facilities that were receiving or shipping EHS. Cooperation from transporters and chemical facilities made it possible to collect a significant amount of information about chemicals, container and shipment sizes, transportation modes and routes, and information about potential accident scenarios. Transporters represented only those companies transporting EHS in the state. A member of the barge industry provided a list of barge companies who transport approximately 75% of chemical cargoes in Louisiana. All railroad companies with lines in the state were surveyed although only two, Illinois Central and Union Pacific responded. The Louisiana Chemical Association provided a list of 70 chemical facilities.

The Survey Form

Meetings with representatives from carriers and facilities helped design a survey instrument that made reporting the information relatively easy for the respondents. One problem that immediately became apparent was that, although the list of EHS remained constant, facilities and carriers use different reference codes. The railroads use a different chemical code or number from barges, which are, in turn, different from motor carriers. Therefore, we cross-referenced the codes to provide accurate or consistent reporting and included the EHS by name of substances, Chemical Abstracts Service Registry (CAS) numbers, Department of Transportation (DOT) or UN identification numbers, and Standard Transportation Commodity Codes (STCC). Commodity codes (CRIS) used by the barge industry, were not available for most of the chemicals.

Four types of surveys were sent out, one designed for each mode of transportation (rail, truck, and barge) and one for the chemical facilities. The survey form listed the chemicals and the codes, and requested the transportation respondents to check the chemicals they transported by indicating only the container size used most often. Chemical facilities were asked to identify the mode of transportation for each chemical. All respondents were free to remain anonymous.

Chemical Data

ALOHA (Areal Locations of Hazardous Atmospheres, National Safety Council) was used to model the atmospheric dispersion of the chemicals. A different type of data collection involved the physical properties of various chemicals. Many chemicals in this study cannot be found in ALOHA's library. In some cases, the substances' names and molecular weights are listed, but other critical information is missing from the library. For the sake of consistency, we used DIPPR (Daubert et al, 1994), the chief source of ALOHA's chemical database, to amend or extend the existing the database when we found incomplete listings or unlisted chemicals.

DISPERSION MODELING

Substances released into the environment may behave differently depending on the physical properties of the chemical in relation to the existing meteorological parameters. Wind and atmospheric turbulence are the driving forces that move and dilute the plume. The concentration of the pollutant is high in the centerline of the plume in the direction of the wind. The concentration, however, rapidly decreases cross-wind.

Computer Models

Throughout this Study We Used ALOHA to model the Atmospheric Dispersion of the chemicals. There are a number of models that can address dense gas dispersion to estimate the hazard zones associated with the release conditions. ALOHA gives more conservative estimates of hazard zones than any of its counterparts, is easy to use, and has widespread application by emergency planners and responders in Louisiana.

In our analysis, most uncertainties occur in the application of meteorological data (due to fluctuations in wind speed, direction, and ambient temperature) and in the determination of the size and shape of the breach on the tank in which the chemical is stored. Therefore, both type and size of container was considered with various meteorological conditions for each chemical.

Selection of Meteorological Conditions

Accident scenarios were evaluated under five sets of representative meteorological conditions (Table 1). The first condition corresponds to a stable atmosphere with low wind and moderate temperature. It typically occurs on summer nights; however, there are many seasons and times in the diurnal cycle in Louisiana when this condition is conceivable. Intermediate meteorological conditions correspond to the months of March through May and from October through November. The values listed in the five meteorological scenarios in the table represent averages of observed data in Jackson, Mississippi and in Baton Rouge, Lake Charles, New Orleans, and Shreveport, Louisiana over the last decade. For instance, the temperature of 45°F is the average of recorded mean temperatures between 1981 and 1990 in the months December, January, and February in these cities. Data were obtained from the Louisiana Office of State Climatology at Louisiana State University.

It may appear that for emergency purposes it would be more desirable to limit the number of meteorological conditions to two. In this case, however, one would miss a relatively large number of dispersion conditions when the released chemical behaves completely differently than in any two selected atmospheric conditions. Differently phrased, there are no two meteorological conditions that would uniformly cover all dispersion scenarios for all chemicals.

Table 1

Selected Meteorological Conditions

Meteorological Scenario	Temp (°F)	Relative Humidity	Wind (mph)	Cloud Cover	Stability Class
Low wind, stable (summer)	74	93	3.6	0.5	F
Night, winter	45	85	7.4	0.6	D
Night, intermediate	57	89	6.3	0.6	E
Day, winter	58	57	10.8	0.7	C
Day, summer	88	58	8.6	0.6	C

Incident Scenarios

This study focuses on three methods of transportation: rail car, tank truck, and barge. It is inconceivable that all accidents would result in an immediate release of the entire contents of a container. Therefore, two incident scenarios were examined for rail cars and tank trucks: a large breach, and a relatively small hole. For barges, a seam rupture is the most likely type of breach.

A significant effort was made to develop realistic models for the accidents. Data pertaining to release scenarios, typical tank sizes used in transporting specific chemicals, and physical dimensions of containers were obtained from the chemical industry and from service and transportation companies operating in South Louisiana (Refs 1-5). Permitted fill-densities, cargo weights, and other regulatory information were acquired from other sources including the US Department of Transportation.

The scenarios assume that the accident will happen to the most typical railcar, truck, or barge used to transport particular chemicals, and that for temperature-sensitive cargo an insulated tank is used. In some cases, however, it is conceivable that the cargo temperature will increase by a few degrees due to high ambient temperature or intense solar radiation. In our calculations every substance was individually evaluated as to the size, dimensions, and fill density of the container in which the chemical is transported. These parameters are input values necessary to run ALOHA. Other accident situations, such as overfilling, are limited to the sending or receiving areas, and are not included in this analysis.

Rail Scenarios. Rail cars are equipped with various safety devices to limit or minimize the impact of an accident. Even with these safety devices, large breaches and small leaks may occur as the result of derailment. In scenario #l, there is a rectangular opening approximately 12 inches by 6 inches at 50% of the tank height as defined by its diameter. In scenario #2, one of the flanges shears off resulting in a leak at a rate equivalent to that of a 0.5-inch diameter hole.

Motor Scenarios. On average, the volume of the truck tankers that are most frequently used to transport chemicals is 7,000 gallons (Refs 1,2,5), however, the most typical tank size, as in case of rail cars, is chemical-specific. In scenario #1, a train collision creates a large rectangular shape breach of 3 feet by 3 feet at 50% of the tank height as defined by its diameter. In scenario #2, a traffic accident results in a four inch diameter opening at 50% of the tank height as defined by its diameter.

Barge Scenarios. Most barges that operate on the lower Mississippi are double-hulled, meaning that an accident resulting in a cargo release must be substantial. Because such accidents seldom occur, it is difficult to estimate the most typical size and shape of the rupture or hole in the tank. A series of consultations with the industry (Ref 4) and the US Coast Guard yielded that the most conceivable scenario is a 0.5-inch wide and 30-inch long vertical seam split with the bottom of the opening at 50% of the tank height.

VULNERABILITY ANALYSIS

Vulnerability Zones

A total of 60 EHS chemicals were reported being transported by railroad, motor carrier, and barge in the study area. A vulnerability zone was established for each chemical by mode of transport. Specific distances, measured in miles or yards, were calculated using ALOHA for each EHS based on the mode of transportation, the type of breach to the container or accident scenario, and five different weather conditions. The specific area impacted by these releases was examined to determine if they could be grouped. The following vulnerability zones provide a means of clarifying the off-site impact of a large number of EHS using multiple scenarios:

A = less than 1 mile
B = 1 mile to less than 3 miles
C = 3 miles to less than 6 miles
D = 6 miles and greater

The vulnerability zones are intended to provide information for emergency planners and responders, transporters, facilities, and the community. Grouping the specific distance calculations from ALOHA into vulnerability zones makes it possible to examine many EHS in different weather conditions but not be overwhelmed by the data. In addition, the calculations were based on specific weather conditions and accident scenarios. Altering the weather conditions or accident scenarios could have a significant affect on the area surrounding the release. Table 2, "Motor Carrier Vulnerability Zones - Mississippi River Corridor", indicates the differing affect of weather conditions on each chemical for a four-inch breach in a motor carrier.

Table 2. Motor Carrier Vulnerability Zones
Scenario #2: Four Inch Breach

Chemical	Low wind Atmosphere	Night time Winter	Night time Intermediate	Day time Winter	Day time Summer
Acrolein	D	C	B	B	C
Acrylonitrile	A	A*	A	A*	A
Acrylamide		No Data			
Adiponitrile		No Data			
Ammonia	C	B	B	B	B
Aniline	NOI	NOI	A*	A*	NOI
Bromine	B	B	B	A	B
Carbon Bisulfide	A*	A*	A*	A*	A*
Chlorine	C	C	C	C	C
Chloroform	A*	A*	A*	A*	A*
Cyclohexylamine	A*	A*	A*	A*	A*
Dimethylhydrazine	No Data				
Dinoseb	No Data				
Epichlorohydrin	A*	A*	A*	A*	A*
Ethylenediamine	A*	A*	A*	A*	A*
Formaldehyde		No Data			
Hydrazine	A	A*	A*	A*	A*
Hydrogen Chloride	C	B	C	C	C
Hydrogen Fluoride	D	B	C	A	C
Hydrazuinone	NOI (solid)	NOI	NOI	NOI	NOI
Lithium Hydride		No Data			
Methyl Ethyl Ketone	A*	A*	A*	A*	A*
Methyl Mercaptan	B	A	B	B	B
Methyl Methacrylate Monomer	A*	A*	A*	A*	A*
Methylcyclopentadiene	No Data				
Nitric Acid	A	A*	A	A*	A
Nitrobenzene	A*	A*	A*	A*	A*
Propylene Oxide	A	A*	A*	A*	A
Sulfur Dioxide	B	B	B	B	B
Sulfur Trioxide (**R**)	A	NOI	NOI	NOI	A
Sulfuric Acid	A*	A*	A*	A*	A*
Titanium Tetrachloride (**R**)	A	A	A	A	A
Vanadium Pentoxide	NOI				
Vinyl Acetatea	A	*	A*	A*	A
Xylene					

NOTE: NOI = No Off-site Impact
A* The footprint was less than 500 Yards
R Chemical reacts with water

<u>Weather Conditions</u>

#1 Low Wind Atmosphere: 74F, 93% Relative Humidity, Stability Class F
#2 Night Time, Winter: 45F, 85% Relative Humidity, Stability Class D
#3 Night Time, Intermediate: 57F, 89% Relative Humidity, Stability Class E
#4 Daytime, Winter: 58F, 57% Relative Humidity, Stability Class C
#5 Daytime, Summer: 88F, 58% Relative Humidity, Stability Class C

<u>Vulnerability Zones</u>

A= <1 mile
B= 1 mile to <3 miles
C= 3 miles to <6 miles
D= > 6 miles

Rail Carriers. Rail transportation was used for 46 of the 60 EHS reported. No off-site impact (NOI) was determined for a release of three substance. For fifteen EHS (33%), the vulnerability zone was less than one mile. Six (13%) substances, Acrylonitrile, Ethylene Oxide, Hydrazine, Methyl Mercaptan, Sulfur Dioxide, and Sulphur Trioxide, have a vulnerability zone of B or C. Five (11%) of the EHS had the largest vulnerability zone of D in at least one of the weather conditions used in this study.

The vulnerability zones calculated for these EHS including Ammonia, Chlorine, Hydrogen Chloride, Hydrogen Cyanide, and Hydrogen Fluoride were very sensitive to the different weather conditions used in the study. Each of these EHS had a D vulnerability zone in the calm atmosphere (low wind stability class F) but had zones of B, C, or D depending on the weather conditions and stability classes used in the calculations. These EHS show the variability of the zones that may occur when releases occur in different weather conditions. Other substances may also behave as these five EHS; however, since the vulnerability zones are not as great the affect may not be as obvious.

Motor Carriers. Motor carrier transport is the second most frequently used mode of transporting EHS. While there are numerous trucks on the highways, tanker construction and cargo are regulated. In addition, drivers are provided a book of contacts in the event of an accident.

It is impossible to know the exact route of trucks; therefore, this study used Interstate 10 as the center of highway transportation. The vulnerability zones for most EHS transported by motor carrier is less than 500 yards. Thirty-five EHS were identified as transported by motor carriers. Of these substances only 8 (23%) had a vulnerability zone of B or greater. Ammonia, Bromine, Methyl Mercaptan, and Sulfur Dioxide had vulnerability zones of B. Four EHS had a vulnerability zone of either C or D (Acrolein, Chlorine, Hydrogen Chloride, and Hydrogen Fluoride). For the remaining EHS, 46% had either no off-site impact (NOI) or a vulnerability zone less than one mile. Vulnerability zones could not be calculated for ten substances since not enough data required by ALOHA is available.

The four inch breach scenario indicates that two EHS (Ammonia and Hydrogen Fluoride) had larger vulnerability zones than those calculated in scenario #1. The remaining 27 EHS (49%) either had no off-site impact (NOI), a vulnerability zone of A, or sufficient data was not available for ALOHA to determine a vulnerability zone.

Barges. Barges were used to transport 13 EHS, the least number reported in our study. The most typical barge operated on the lower Mississippi River to transport chemicals has three separate tanks. The most conceivable accident scenario is a 0.5-inch wide and 30-inch long vertical seam split above the water line. For ten EHS shipped by barge, seven have either no off-site impact (NOI) or a vulnerability zone of A. Three EHS (Acrolein, Ammonia, and Chlorine) had vulnerability zones of either B, C, or D. Acrolein and Chlorine had the largest vulnerability zone, a value of D.

The Chlorine vulnerability zones calculated for each of the five weather conditions all resulted in a value of D. Barge Chlorine vulnerability zones have a different pattern from the Chlorine zones determined for rail cars and motor carriers. Chlorine had D vulnerability zones in some weather conditions in scenarios for motor carriers and rail cars but not for each of the five weather conditions used for each mode of transport.

Populations at Risk

Table 3, "Population Estimates by Vulnerability Zone and Mode of Transport", shows that the rail vulnerability zone affects the largest number of people in the Mississippi River Corridor. Using the population estimates from the 1990 Census Bureau for Block Groups, each vulnerability zone was examined by mode of transport. For the rail six mile zone, 1,559,924 people are within the vulnerability zone. This is much higher than the motor carrier six mile zone (1,366,452) or the barge six mile zone (1,324,487). For the One and Three Mile Zones, the rail vulnerability zones also affect the largest number of people. The larger population within the vulnerability zone for rail may result from the limitation of the analysis of motor carrier and barge traffic to one route for each mode along the river (I-10 and the Mississippi River). An examination of the data shows a greater geographic area within the vulnerability zones for rail in comparison to motor carrier and barge. Figure 1 shows the effect of vulnerability zones for motor carriers in the Southern Mississippi Corridor. The inner outlined area represents a 1-3 mile vulnerability zone and the larger outlined area indicates a vulnerability zone of 3-6.

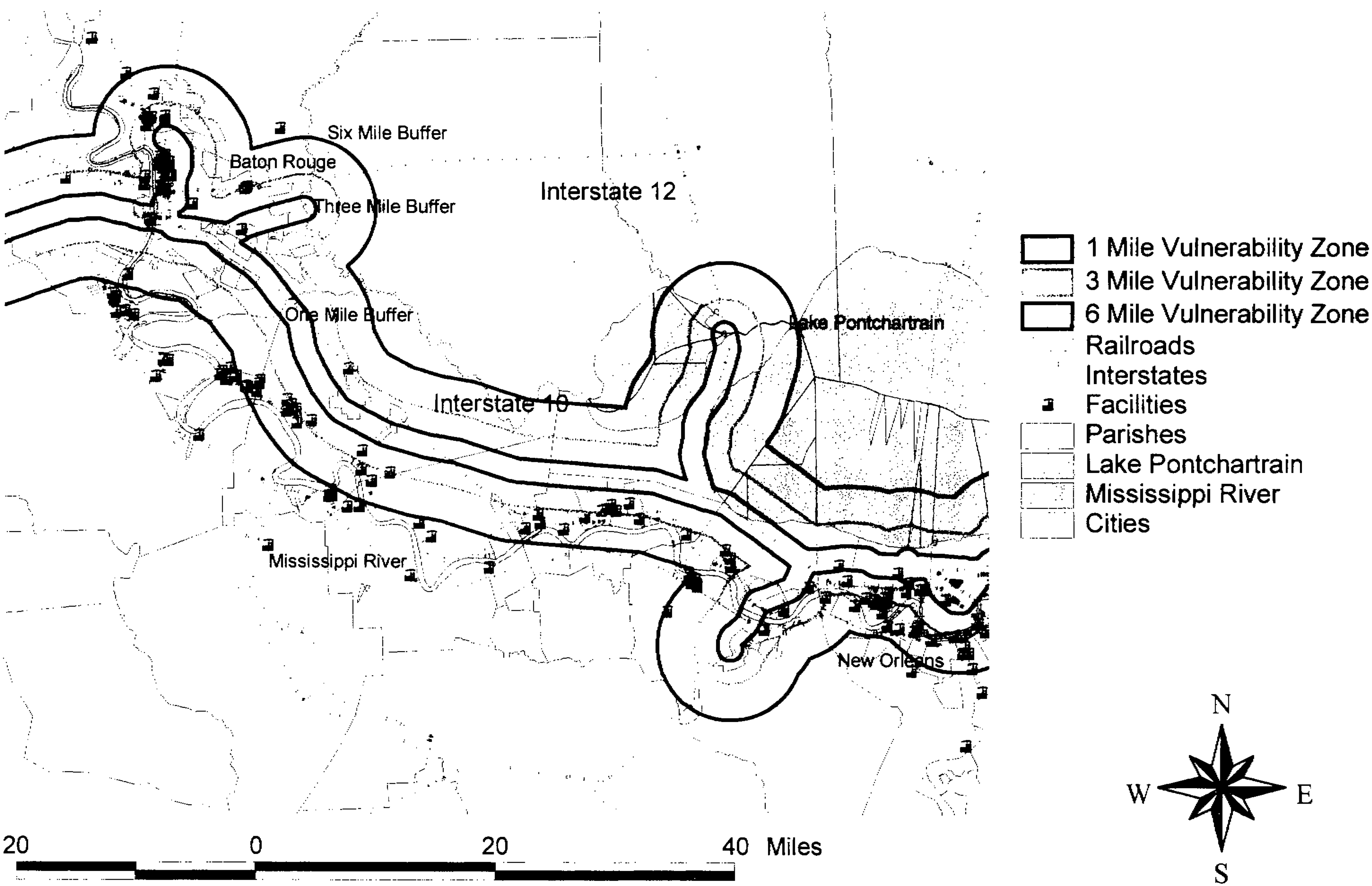
Table 3

Population Estimates by Vulnerability Zone and Mode of Transport
Mississippi River Corridor

Mode of Transport	Vulnerability Zone	Population	Families
Barge	Six mile zone	1,324,487	331,026
	Three mile zone	934,148	230,605
	One mile zone	351,286	163,527
Motor Carrier	Six mile zone	1,366,452	344,332
	Three mile zone	1,032,609	258,420
	One mile zone	514,168	129,653
Rail	Six mile zone	1,559,924	395,559
	Three mile zone	1,449,230	365,532
	One mile zone	986,874	245,103

The large population figures include both the New Orleans and Baton Rouge metropolitan areas. For the motor carrier vulnerability zone, some areas in Baton Rouge and along the western side of the river are not within the risk zone centered along Interstate 10. The Union Pacific rail line runs from the New Orleans area and follows the western side of the river. The Illinois Central and Kansas City Southern also run from the New Orleans area and follow the eastern side of the river to Baton Rouge, thereby including both cities in the vulnerability zone.

Figure 1: Motor Carrier Vulnerability Zones
Mississippi River Corridor



CONCLUSIONS

Characteristics of Extremely Hazardous Substances

Most of the transported chemicals are in a liquid state under ambient temperatures and pressures. On release they will form a spreading and evaporating puddle. Altogether, there are 28 such substances. Of the 60 EHS, seven EHS (including gases transported in a liquid state) present the greatest risk. Release of liquefied gas has higher potential to produce larger vulnerability zones (greater than six miles) due to the phenomena of flash boil and/or two-phase flow. Although the number of such chemicals is small, the risk to the population centers along the corridors is significant. Emergency plans should examine the areas that could be affected by an accidental release of an EHS in transport and should include procedures for notification of special population, traffic routing, and evacuation.

Weather Conditions

Weather conditions are a critical factor in chemical dispersion. It could be anticipated that the worst case meteorological condition is a nighttime low-wind atmosphere. This observation, however, is false and it may lead to the wrong decision if applied generally, without regard to the chemical involved in the accident. Depending on the release conditions, the substance may leak as a liquid and form an evaporating pool, may escape as a mixture of gas and liquid droplets to form an aerosol, or may flash-boil and enter the atmosphere as a gas. These conditions have a direct impact on how the substance will disperse in the atmosphere. Thus, it may be possible that the worst case scenario for a given substance is not when it is released into a calm nighttime atmosphere, or when released through a large hole on the tank. Careful analysis must be done on a case-by-case basis.

The Effects of Release Openings on Scenarios

The size of the opening alone does not always determine the degree of the environmental impact of the release. Depending on the release conditions, a smaller opening on the tank may result in a larger vulnerability zone than does a larger breach. The rate at which the chemical enters the atmosphere may be many times smaller in the case of an evaporating puddle than in case of a two-phase aerosol release of the same substance under the same ambient conditions. This is especially so if the released chemical has large heat capacity or large latent heat of evaporation, or small vapor pressure under the ambient conditions.

This effect is best illustrated by the release of hydrogen fluoride from a motor carrier tank. In low-wind stable atmosphere a large 3 foot by 3 foot breach will result in a C vulnerability zone (3 miles to less than 6 miles.) An opening of 4 inches in diameter, under the same ambient conditions, will generate a larger footprint, extending into zone D (greater than 6 miles). The reverse effect takes place in daytime winter weather conditions. The large breach yields concentrations reaching zone B while the smaller hole will generate a footprint contained within zone A. The conclusion that may be drawn is that the combined effects of release conditions are a highly determining factor.

Uncertainties

The vulnerability zones in this study are effected by uncertainties ranging from inherent model limitations to errors introduced by the input data. The latter includes uncertainties in the collected information pertaining to tank sizes, fill densities, storage temperatures, release scenarios, assumed ground roughness, and the standard deviation of the historic weather data collected over the last decade and used to calculate the five average meteorological conditions. Because of these uncertainties, the computed distances are not reported in exact terms, but are grouped into vulnerability zones.

A different category of uncertainty is introduced in ALOHA by the 60 minute limitation on the source term and /or the dispersion time. In cases when this limitation becomes important, a + sign is printed following the letter of the calculated vulnerability zone. This means that the footprint may exceed the indicated zone if the source and the given meteorological conditions persist for more than 60 minutes.

Throughout the calculations, the applied level of concern (LOC) was the Immediately Dangerous to Life and Health (IDLH) value, as listed in ALOHA's chemical library. Besides the IDLH, a variety of toxic thresholds have been established by several organizations that may be used as LOCs, such as the Threshold Limit Value - Time Weighted Average (TLV-TWA). The actual level of concern depends on the sensitivity of individuals; therefore, the IDLH concentration may not be applicable in all cases, or for all populations. In a actual release, the applied LOC should be the exposure limit that is best suited for the purpose of the emergency responder, and that will not result in unacceptable health effects in the affected population. In ALOHA, the IDLH concentration is the default LOC. Although the software allows setting a different concentration as the LOC for each incident scenario, in this study the IDLH value was found to be a consistent way to describe and compare the various hazards associated with the releases of different chemicals. Selection of TLV-TWA as LOC would have resulted in more conservative estimates for the vulnerability zones, but this value was often not available for the EHS chemicals considered in this study.

Value of Multiple Jurisdictional Analysis

This analysis examines two large geographic areas that are heavily involved in chemical processing. The two areas include large and small cities and parishes. Each parish (county) has independent local emergency planning committees and parish emergency management agencies. The data collected from this study shows chemicals in transit from and to fixed sites in a single jurisdiction; however, the routes to and from the sites will cross neighboring jurisdictions. The data collected from one jurisdiction is of vital importance other jurisdictions in the area. Data collected from each facility and from each transporter collectively provided a more accurate picture of chemicals transported in the whole Mississippi River corridor. The project team thus encourages other local jurisdictions to collaborate in studies examining transportation risks for their area. Data collected from manufacturing centers reflecting EHS in transit will be valuable information to neighboring jurisdictions. Since transportation studies require significant financial and human resources commitments, multiple jurisdictional studies may be an attractive approach. A regional assessment will encourage local governments to examine common transportation risks.

Value of Multiple Stakeholders in the Assessment of Transportation Risks

Many organizations and their representatives contributed to this analysis of transportation risks in the Mississippi River corridors. Louisiana TRANSCAER provided contact information on carriers and had parish TRANSCAER members follow up the surveys to obtain information on the transport of hazardous chemicals from member facilities. The Louisiana Chemical Association encouraged member facilities to collaborate and complete the facility transportation survey. Parish Local Emergency Planning Committees (LEPCs) encouraged facilities and carriers to provide data for the project. The Louisiana State Police, Right-to-Know Office provided funding for the project and met with carriers, facility representatives, and local emergency management officials to solicit support. The Institute for Environmental Studies at Louisiana State University also provided additional financial support to cover costs that were not included in funding from the State Police. The study team believes that future studies should include state and local emergency management agencies, chemical processors, transporters, and state associations. Their involvement in hazards analysis enhances awareness of transportation related risks and encourages discussion on strategies to improve planning, response, and the prevention of incidents. The study team will also be working with the parish local emergency planning committees in the study areas to discuss the findings and conclusions of this study. Local citizens, community groups and associations, the media, and public officials are represented on LEPCs and should have an opportunity to discuss the findings and conclusions of this study. The many stakeholders in this project made major contributions to the study and are in a position to use the results to enhance emergency planning and response efforts.

Study Limitations

This study clarified the nature of the risk of EHS transported in Louisiana. The study did not attempt to examine either the probability of an incident for EHS transported nor the number of shipments. The members of the research team believe that emergency planners at the state and local level need to know the number of shipments of EHS by rail, motor carrier, and barge. The study team did not examine the frequency of shipments of EHS to determine the probability of accidents involving hazardous chemicals. Future studies can be initiated to answer these questions. For the moment, it is a step in the direction of better planning to be able to identify those chemicals that are likely to be transported in each area.

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NOTES

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EMERGENCY PUBLIC INFORMATION
"Let Your Fingers Do the Walking Through the Emergency Pages"

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Winter storm - hurricane - major power outage over a wide area - hundreds of thousands of people without power - power is projected to be out for five to ten days. Now, what do you do, Emergency Manager?

Use the EAS, Quick! Whoops! The Emergency Alert System can broadcast on emergency power, but because of the power outage, no one can receive the information. Now, Emergency Manager, what are you going to do?

A PROBLEM

This scenario has been repeated numerous times in the past few years. Hurricanes and severe weather have disrupted power in the Southeast; winter storms have paralyzed the Northeast and Canada; El Niño has devastated parts of the west coast; and power surges have rippled through regional power grids. With all of these instances of major and extended power failures, we emergency managers still continue to rely heavily on electronic means to provide emergency public information. A great deal of time, money, and effort have been put into developing vital emergency information for the public. The problem is how to get this information to the public and in a form that will be readily available when it is needed.

Emergency managers provide many different type of emergency public information regarding threats to the local community. Some communities publish hurricane tracking maps and other emergency information as a newspaper supplement, however, this supplement, usually printed on newsprint paper will, on average, last only until the next house cleaning. A few nuclear power facilities publish calendars with all of the evacuation, sheltering, and other emergency information included. Even though they are professionally produced, they are not used in many homes as their primary kitchen calendar. Other industries, such as chemical producers, also use various methods like flyers, pamphlets, and posters to inform the public of their preparedness efforts. Much of this information is retained for only a short time because people are deluged with so much "junk mail".

Emergency managers use innovative ways to get emergency information out to the public in a timely fashion. Most rely on radio and television for the distribution of emergency and public service information. As electronic information technology matures, more ways become available to reach the public. Some use the new Emergency Alert System while others use programmed fax machines to quickly distribute information to various media sources. A few communities have extensive indoor warning capabilities using NOAA weather radios or commercial systems. In addition, more progressive emergency managers have mastered the Internet and the World Wide Web and have developed outstanding web sites.

After all this effort, however, emergency managers rely almost exclusively on the public's access to electrically powered receivers at the time of an event. The resulting problem is that without electric power, emergency managers are extremely limited as to how they can distribute the necessary information in a timely manner. Although many home or office radios can be battery powered, many of these are complex systems with radio, cassette, and compact disk players in one case. Because they use an inordinate number of batteries, the batteries are often not replaced after the first set decays or may never have them installed in the first place. Due to ecological concerns, many other people have gone to rechargeable batteries which, of course, cannot be recharged during a power failure. In addition, very few desktop personal computers have uninterruptable power supplies and even fresh batteries for laptops last for only a few hours. So there are problems during an extended power outage.

A SOLUTION

If you were to ask anyone where the telephone directory is located in their home or office, they could usually tell you where it is and could probably find it in the dark. Telephone books can be found in motels and hotels where travellers can find them and in offices, schools, and businesses. With the growing use of cellular phones, some people carry them in their cars.

Telephone books are usually kept through their valid dates, and many homes even have last years edition - just in case. Newcomers to a community, both residential and business, get at least one new telephone book as soon as they move in. If a community is a tourist location, that temporary population can find emergency instructions just as easily as the permanent residents. It would make sense to take full advantage of the telephone book to give a community's permanent and part-time population direct access to emergency information at all times.

It makes sense for a nationwide program supported by national emergency and disaster services agencies, such as FEMA and the American Red Cross, along with the telephone book publishers, to place local emergency management information in all telephone books as a public service. This information could be locally developed and approved, but placed in all telephone books, nationwide, in the same place in each companies' books. A telephone book can and should become the standardized location for general and specific local emergency information. No matter where a person lives or travels, they would know that in the event of an emergency, the information for evacuation, for shelter, and for emergency procedures would be found in any local telephone book in a standardized place.

During a disaster, basic emergency information is needed, quickly and succinctly. The public needs to know how and when to go to a shelter, how and when to evacuate. what to do when the electricity or gas is off, and some basic first aid reminders. Some communities have basic, generic information already provided by the telephone book publisher, however it is rarely specific to the local community unless it has been published separately. This information is usually found in different places throughout the various telephone books, if it is published at all.

The local emergency manager should determine what general and specific information is germane to their location. Information on hurricanes and storm surges would not be necessary in the Midwestern states, while earthquake information would not be necessary for communities with no earthquake risk. Flood information may not be needed where there are no rivers or major bodies of water and information on volcanos may only be needed on the west coast. Hazardous material information should address specific local hazards, as well as general information, for communities near interstate highways or major railroad lines. Utility information should fit the types of equipment in use in that community.

Telephone books provide the public with one more product to assist them during an emergency. Have you ever listened to the drone of repeated EAS messages? Have you ever tried to follow the instructions given for a wide area while trying to find road signs or blue hurricane evacuation route markers in a heavy wind with rain and flying debris? If your community attracts a large tourist or temporary population, they will not be as familiar with the transportation network or the risks in your area. If a person can listen to the general instructions and can follow the information in the telephone book, there is a greater probability that the information will be understood, retained, and followed during periods of high stress.

People should be able to use the information in the telephone book to supplement information that is routinely distributed during periods of severe weather, winter weather, wildfire, or flood. The telephone book information could supplement other information or be used when routine information systems are off-line, as in the case of a power failure. This information could be coordinated with local radio and television stations who can broadcast on emergency power to provide emergency information at specific times - on the hour, quarter hour, or half hour. The public could then use, say, their automobile radios at that specific time for more information. Telephone books should also show maps of county boundaries since the National Weather Service sends out alerts naming risk counties and may not associate the cities or municipalities within those risk counties. This is important for transient populations who know the city they are visiting but may not know the name of the county in which the city lies.

CONCLUSION

The telephone book is a valuable, readily available resource today. Telephone books are published en masse and are widely distributed to homes, businesses, and public facilities. Emergency public information needs to be placed, without cost, in all telephone books, nationwide. This is as much a public service as listing the various cultural activities, sporting events, and other local information currently found in many telephone books. The use of the telephone book for emergency information is one way to establish a national public safety standard that everyone could recognize, similar to the national use of 911, and can be a quality of life issue, especially during and after a major life-threatening disaster. If a life is saved and the community is served, it will be worth the effort to provide this service to the public.

NOTES

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DEVELOPMENT OF RADIOLOGICAL EMERGENCY PREPAREDNESS FOR COMMERCIAL NUCLEAR REACTORS IN THE UNITED STATES

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INTRODUCTION

Two federal agencies preside over emergency preparedness at commercial nuclear power plants in the United States. The US Nuclear Regulatory Commission (NRC), while overseeing the entire program, is primarily concerned with safety and preparedness at the generating plant (on-site). The Federal Emergency management Agency (FEMA) evaluates whether jurisdictions (off-site, near a generating plant) are ready to respond to power plant emergencies. This integrated, two-agency program is referred to as the Radiological Emergency Preparedness (REP) program. Other federal agencies are also involved, lending assistance in their areas of expertise, but the main responsibility for the program falls to the NRC and FEMA. This paper summarizes the background and history of the REP program, its development over the past 18 years, and some future directions.

Program Description

The REP program in its current form was established following the 1979 Three Mile Island accident. The purpose of the program was to improve the state of emergency preparedness among communities near nuclear power plants. Under the program, jurisdictions within about a ten-mile radius of a power plant are responsible for planning and preparation for a radiological emergency. State and local (county or municipal level) radiological emergency response plans have been developed and submitted to FEMA for review and approval.[2] Currently, most sites have approved plans, but FEMA continues to monitor the state of planning by reviewing periodic updates and major plan revisions.

In addition to planning, each site holds regular drills and exercises. Every two years a site holds a major "joint exercise" that includes both utility personnel and off-site authorities. FEMA and the NRC evaluate these exercises, and their findings become part of a regulatory process that affects the power plant's license (see "Evaluation Process and Guidance" below). Since 1981, more than 650 joint exercises have been held.

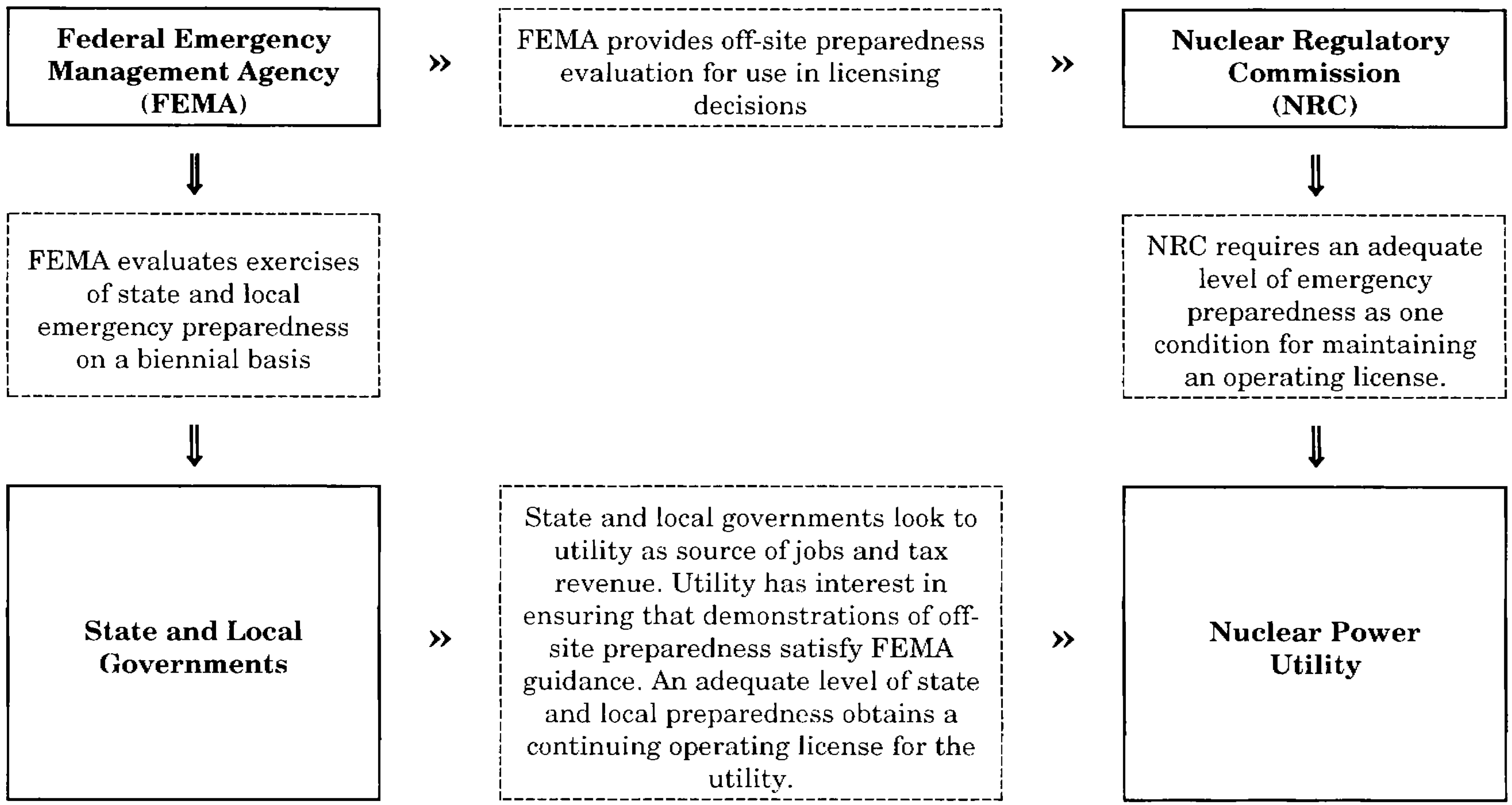
Legal Setting of Program

The roles of utilities and governmental agencies in the REP program must be understood in the context of the program's unique regulatory setting. FEMA's mission is to promote preparedness against disasters of all kinds, and the agency's numerous programs enhance the capabilities of state and local governments. In the REP program, however, FEMA does not have regulatory authority. The regulatory agency in the REP program is the NRC. While the NRC does not regulate state and local governments, it does regulate the utilities that operate nuclear power plants. The NRC requires an adequate level of community preparedness as a condition for licensing a plant to operate. If preparedness at a given site were to fall below acceptable levels, the power plant could lose its operating license and have to shut down. This has never happened, although initial operation at some power plants has been delayed, and one was eventually scrapped before operations began.[3]

The NRC is responsible for making licensing decisions for nuclear power plants; however, FEMA is the governmental agency with expertise in community emergency preparedness. The NRC, therefore, relies on FEMA for evaluations of community preparedness. An interagency Memorandum of Understanding between FEMA and the NRC governs the process by which FEMA conducts evaluations and furnishes results to the NRC.[4] This somewhat circuitous arrangement leads to a delicate four-way relationship among FEMA, the NRC, nuclear utilities, and state and local governments (Figure 1). To operate a nuclear power plant, the utility requires permission from the NRC. The NRC bases its permission in part on FEMA's assessment of whether local and state governments are adequately prepared to deal with an emergency at the plant, should one occur. If local preparedness is not up to par or, as has sometimes occurred, a governmental unit refuses to participate in the REP program, the utility is in danger of losing its operating license. This policy means that the utility must depend on local and state governments through the indirect means of federal regulation. On the other hand, a nuclear power plant provides electricity, employment, tax revenue, and other benefits to a community. In fact, utilities generally foot most of the bill for the REP program. They are required to cover the NRC's and FEMA's expenditures to enforce the program. In addition, their state and local taxes generally fund most (or all) of the REP-related expenses incurred on the part of state and local governments, including equipment and personnel. States and counties in which nuclear power plants are located tend to have larger and newer facilities, more up-to-date computer equipment, and other emergency management accoutrements than their non-nuclear counterparts. Few governments are willing to kill this golden goose. For those that are, the utilities have other options, including initiating their own private community-protection program, which was done at both the Seabrook and Shoreham plants on an interim basis. FEMA will evaluate such programs, and the NRC has been willing to acknowledge them as the basis for an operating permit.[5]

Another important factor for understanding the REP program is that volunteers perform many local activities. Nuclear power plants are usually located in rural areas where volunteer fire and disaster services departments are the norm. These volunteers have no concrete stake in the outcome of FEMA's evaluation; it will not affect their salary or chance of promotion. The only motivation that leads them to cooperate with FEMA guidance is the same spirit of cooperation and community that led them to be volunteer emergency responders in the first place.

In summary, FEMA evaluates local radiological emergency preparedness, but does not wield a regulatory club. What FEMA does is more like pushing on a raft that is loosely held together by ties of mutual benefit and good will. They can push, and everyone will



PARTNERS IN THE REP PROGRAM

Figure 1

go along; but if they push too hard and too fast, they risk having the whole structure fall apart.

EVALUATION PROCESS AND GUIDANCE

The primary guidance document associated with the REP program is *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants,* NUREG-0654, FEMA-REP- 1, Rev 1, 1980 (hereafter NUREG-0654). It contains standards for developing REP plans and describes capabilities and functions that should be included. It addresses a broad range of capabilities, including technical topics such as radiological monitoring and instrumentation, and more general aspects of response such as communications, public notification, and evacuation. Its provisions range from very general,

> "Each organization, where appropriate, shall provide for off-site radiological monitoring equipment in the vicinity of the nuclear facility." (NUREG-0654, Criterion H.7)

to fairly specific,

> "Each organization shall make provisions to inspect, inventory, and operationally check emergency equipment/instruments at least once each calendar quarter and after each use." (NUREG-0654, Criterion H. 10).

Soon after the publication of NUREG-0654, questions of interpretation began to arise. Over the past several years, FEMA has issued a series of guidance memoranda to address specific issues as they come up. These memoranda were then supplemented from time to time by letters from FEMA Headquarters to Regional Office personnel advising them on how to handle specific issues on a case-by-case basis. In 1991, FEMA consolidated the exercise-related portion of these memoranda and letters into the *REP Exercise Manual.* The manual addresses outstanding issues and establishes a more uniform and detailed set of evaluation standards. A similar effort was initiated for planning-related guidance, but was put on hold pending the resolution of other program issues (see "Current Trends in Program Development" below).

ANALYSIS OF PROGRAM DEVELOPMENT PROCESS

Community preparedness for radiological emergencies has improved at a gradual but steady rate. This improvement is based partly on experience gained during drills, exercises, and actual emergency responses (primarily non-radiological emergencies). It is also partly a function of improvements in training. Much of the improvement can be traced to two factors: improvements in technology and the sharing of "lessons learned" information among responders. Program guidance is both driven by, and in turn drives, these two factors.

Improvements in Technology

Improvements in technology have affected many aspects of the radiological response process including everything from instruments for detecting and measuring radiation to inexpensive computer programs that model evacuation traffic, map out evacuation routes, give time estimates, and identify traffic bottlenecks. Probably the broadest area for technological improvements has been communications. As new types of equipment have become available and less expensive, practices have shifted and guidance has followed, eventually solidifying a practice as the norm. For example, when the REP program in its current form began in 1980, relatively few jurisdictions used facsimile (fax) machines. They were relatively expensive, rare, and unreliable. In recent years, they have become cheaper and better and, consequently, more common. There is also a "network effect," ie, the more locations that have fax machines, the more useful they become. At first, the use of fax machines in the REP program was limited primarily to transmitting alert messages to emergency broadcast stations and sending news releases to and from public information centers. In both applications, exact reproductions of text and figures are of paramount importance. Somewhat later, they came into frequent use for transmission of emergency notifications from utilities to state and local governments. They are now used for all manner of message traffic among emergency operations centers (EOCs). Use of fax machines is now the norm and is expected at all fixed facilities.

Another example, perhaps not quite as far along the acceptance curve, is the use of cellular telephones by field monitoring teams. During a radiological emergency, monitoring teams with radiological instruments are sent out to determine the extent, location, and severity of the hazard. To fulfill that function and to ensure their own safety, it is important that they maintain communications with a base while in the field. They generally either carry radios or are accompanied by police or amateur radio volunteers to provide communications. The radio network is often imperfect, however. Many users may compete for one radio band, and hilly areas often have "dead spots" where the field team is unable to contact the base. A few years ago, some locations began to experiment with using cellular telephones instead of, or in addition to, radios. Now quite a few locations use them.[6]

Other examples of technological innovations include the following:

Portal Monitors. Until recently, the monitoring of potentially radiologically contaminated individuals has been 'a time-consuming process, relying on a substantial commitment of manpower, training, instrumentation, and equipment. The process can be streamlined by automating it with "portal" monitors. These instruments detect radioactive contamination as a person walks through them. Portal monitors look and operate somewhat like the metal detectors used at airports.

Radio-Controlled Monitoring Instruments. Primarily used as a training tool by field monitoring teams and as monitors at reception centers, radio-controlled survey meters increase realism in exercises. These instruments are identical to standard survey equipment, except that they are equipped with electronic components that provide meter responses and readings that simulate the presence of radiological materials. The meter responses are controlled remotely by a transmitting unit operated by an observer (ie, controller, training instructor).

Advances in Direct-reading Dosimetry Equipment. Direct-reading dosimeters (DRD) are one type of instrument used to measure external exposure to gamma radiation. They are generally issued to emergency workers who have response assignments in the field or in areas where they may come in contact with radioactive materials. Two basic types of DRDs are acceptable for use in an emergency response: an ion chamber electroscope (pencil) and an electronic dosimeter. Since the beginning of the REP program, the standard issue DRDs have been of the ion chamber electroscope design. They were distributed extensively for use in the Civil Defense Program and have been passed on to REP programs. The pencil DRD requires periodic attention by the user; the instrument must be "zeroed" before use and monitored frequently to determine if a gamma exposure has been received. The units tend to "drift" or display erroneous values and, therefore, require periodic inspection. In recent years, electronic dosimeters have been developed, and their use is becoming more and more widespread. They have several characteristics that make them more attractive for use by emergency workers than the pencil DRDs. The units have a light-emitting diode (LED) display that gives instantaneous readout of exposure and an alarm circuit that can be activated to trigger at predetermined exposure levels. Unlike the pencil DRDs, the LED displays are easily read, and the units are more accurate in the values they detect and display. Numerous pencil DRDs are needed to cover the sensitivity range of one electronic unit. In addition, the cost of the units are comparable to each other.

Communication Technology and Use of Pagers. Another technology improvement that is becoming more widely accepted among response organizations is the use of pagers for alerting response staff. Pagers are issued to those response staff essential to emergency operations. Pager systems can be activated to achieve several results: one call may be placed (or one button may be pushed) to activate all pagers that are part of a "network," or pagers can be selectively activated to alert specific groups (eg, county commissioners or key EOC staff). Most organizations without pager systems use commercial telephones to alert their staff. Doing so takes longer and often fails to reach some of the staff. More and more response organizations have adopted pager systems and this practice has become common, although it is not a requirement according to the current guidance.

Computerized Registration at Reception Centers. The use of computers for registration "evolved" from the systems that use an American Red Cross (ARC) registration form or, sometimes, a site-generated form that includes the same essential information as the ARC form. A data screen is designed so that crucial information can be captured as evacuees are interviewed upon arrival at the reception center. The electronic means of registration offers such benefits as (1) quickly processing evacuees (typed vs handwritten forms), (2) quickly interpreting data on the form (typed forms are easier to read than some handwritten forms), (3) generating reports (including general or specific reports), (4) transmitting data between the reception center and the EOC or other reception centers, and (5) querying the database to reunite families who have been separated. While the current guidance mentions electronic registration, it also includes the standard paper-based procedures.

Sharing of Information

Another significant factor in improving preparedness comes from the sharing of information among responders from different jurisdictions. Bad news may travel fast, but good ideas also seem to gain a certain amount of momentum. Over time they become standard practices and then are written into the guidance. For example, the regulatory standards for the program provide that response authorities should establish EOCs in an emergency.[7] Early in the program, it became apparent that in a power plant emergency, EOCs would require security arrangements to control access and keep out individuals that might disrupt the operations. These ranged from curious hangers-on, to protesters, terrorists, or possibly even reporters. The practice of providing EOC security spread rapidly and then was incorporated into the exercise evaluation standards.[8] The point is that the practice spread at first not through formal edict or requirements, but by word of mouth, since it was obviously a sensible precaution. Later, it was codified into the guidance.

Another example of sharing information is the use of predesignated protective action areas. Based on technical analyses, the usual practice in REP exercises is to order that protective actions (ie, evacuation or shelter-in-place)[9] be taken in a keyhole-shaped area, usually including a two-mile radius around the plant and a 90-degree wedge out to five or ten miles. For internal discussions among technical personnel and decision makers, the area is usually defined in terms of sectors and radius from the plant. For instructions to the public, however, this zone must be translated into familiar landmarks and boundaries. In the early years of the program, this would often be done *ad hoc* by drawing in the keyhole shape on a map and then looking for nearby roads, rivers, and political boundaries to approximate it. This process was slow and prone to error. The current practice, initiated in a few locations and later adopted essentially everywhere, is to subdivide the emergency planning zone (EPZ) ahead of time into appropriate blocks of area that follow familiar landmarks and boundaries. These areas are drawn on special maps in the EOC and are depicted in brochures mailed to the public. A protective action order can then simply indicate to evacuate, for example, "areas A1, B1, and B2 on the map." (This order is always followed by a recitation of the landmarks and boundaries that make up the areas for persons who do not have their brochures or who have trouble interpreting maps.) Adoption of this practice has sped up production of public instructions and reduced errors during exercises.

The process of spreading good ideas and practical innovations is becoming easier and faster. FEMA has sponsored electronic bulletin boards, virtual conferences, packaged training programs, and newsletters, as well as a series of national and regional conferences and workshops for program participants.

CURRENT TRENDS IN PROGRAM DEVELOPMENT

The history of the REP program has been one of change, that is, implementing modifications to improve and enhance preparedness. Many of these changes have been the result of internal reviews and self-assessments. More recently, FEMA has looked to other participants in the emergency response community for their opinions and suggestions. In July 1996, FEMA publicly announced that it was initiating a strategic review of the REP program and requested formal comments from outside factions. A series of public and private meetings was conducted across the country, bringing together the many different factions involved in radiological emergency planning. Utilities, licensees, states, local governments, and interested members of the public were given the platform to speak their minds and present proposals for change. On the basis of comments made at these meetings and others received in written form, FEMA developed a set of concepts for streamlining the program which it presented in March 1998.

Streamlining the Process

Concepts for streamlining the process focus on the exercise evaluation program. Some of the essential elements are:

Concentrate on aspects of the program that are unique to radiological Hazards. As FEMA points out, to conduct an effective response exercise, it is necessary to include various activities that are common to all types of hazards (eg, emergency communications, public notification), however, FEMA's evaluation could be limited to the radiological aspects of the exercise.

Break Large-scale Integrated Exercises into a Series of Smaller Scale Drills. Rather than concentrating all of the preparation and review functions into a one or two-day exercise every two years, the workload could be spread out by segmenting the exercise into a series of functional drills.

Give Credit, in a Structured Fashion, for Functions Demonstrated During Actual Emergency Responses. In many jurisdictions, the interval between radiological exercises typically includes actual responses to hazardous material or weather emergencies that demonstrate the effectiveness of response organizations.

Increase Flexibility in Exercise Scenarios. Currently, scenarios must be crafted to "drive" a fixed set of exercise objectives. This constraint leads to scenarios that are repetitive and predictable. Changing the evaluation requirements would allow more variation in the scenarios, making them more realistic and keeping the spark of interest alive in the exercises.

These proposals are still under review by FEMA, and it is not yet clear exactly what changes will be made. Further analysis may reveal, for example, that a single large exercise is in fact more cost effective than a series of smaller ones. It is likely, however, that at least some of the ideas outlined above will be implemented. There is a widespread feeling among those associated with the REP program that changes have been needed for some time. Most of the concepts could be implemented simply and easily by changes in guidance; others might require changes in regulations or statutes that would involve a more formal legal process.

CONCLUSION

In the current political climate, which emphasizes state's rights and local rule, the process by which the REP program and its guidance have developed provides an interesting model. It contrasts with other "technology-forcing" regulations and programs where a standard is set that may be ahead of currently demonstrated capabilities. In REP, the voluntary nature of the program has prohibited such a "big stick" approach. Rather, the program has developed through an incremental, gradual process which avoids major disruptions and confrontations. Progress has occurred over time as a result of sharing information, growth of collective expertise, and the natural tendency of people to want to do better at whatever they are doing.

Whatever changes FEMA decides to make to the program, the underlying purpose to protect the public's health and safety must not be altered. It is critical that any new approach maintain program integrity while preserving the many good things that have been developed and learned through the years.

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NOTES

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2. Most, but not all, affected jurisdictions have submitted plans for approval. Some jurisdictions have developed plans, and regularly exercise them, but have elected not to submit them to FEMA for approval.

3. Seabrook and Shoreham are examples of such power plants. In both cases, the emergency preparedness programs served as a conduit for local opposition, although they did pose somewhat greater than usual challenges from a preparedness standpoint.

Seabrook, located in coastal New Hampshire, was met with much local opposition and a unique challenge in terms of emergency preparedness. The beaches in the area attract thousands of people in the summer season, complicating evacuation planning. Another complication is that three states are involved in the emergency planning; in one of them there was heavy political opposition to the plant. That state, together with local opposition groups, formally asked that construction of the plant be suspended until emergency plans had been submitted and approved. Several years of debate ensued over emergency planning issues, including estimated evacuation times, provisions for transport-dependent individuals, provisions for the evacuation of school children and the handicapped, and designation of emergency treatment centers for treating radiation cases. Finally, in March 1990, after more than 15 years of debate and delay, the commissioners of the NRC voted to grant an operating license to the Seabrook Station.

In the case of the Shoreham plant on Long Island, New York, years of local opposition focusing on emergency preparedness programs culminated in the decision not to operate the plant. Because of Long Island's size and shape, its seasonal increase in population, and its congested road system, the county concluded that evacuation would be infeasible. In the county's view, an EPZ of less than 20 miles around the site would be inadequate to protect the public. Another concern focused on emergency workers and the distinct possibility that they would experience "role conflict" in the event of an evacuation and wish to aid their families first before assisting with a general evacuation. The utility countered by developing its own emergency plan, to be implemented by utility employees. FEMA evaluated an exercise based on this plan; however, opposition to the plant did not cease. Another source of opposition was the plant's high cost- local ratepayers were unhappy about the prospect of adding the $6 billion plant to the local rate base. Eventually, the utility agreed to give up trying to operate the plant and transferred ownership to a state-created power authority for decommissioning.

4. The latest version of the Memorandum of Understanding (MOU), dated September 14, 1993 can be found as Appendix A to 44 CFR 353. The MOU provides that FEMA is primarily responsible for evaluating offsite (community) emergency preparedness. The NRC weighs FEMA's evaluations heavily, but in the end, the commissioners reach their own judgment as to whether community preparedness is adequate. On at least one occasion, the NRC voted to allow power plant operations to continue despite a FEMA finding that the public was not adequately protected. (See the General Accounting Office report, 1984.)

5. The NRC and FEMA produced criteria for evaluating private, utility-funded community protection programs. These criteria are contained in NUREG-0654.

6. Some controversy exists over the wisdom of this practice. While pagers appear to work well during exercises, an actual emergency would create large amounts of message traffic, possibly overloading the available cell frequencies.

7. See NUREG-0654, FEMA-REP-1, Rev 1, Criterion H.3.

8. *Radiological Emergency Preparedness Exercise Manual*, FEMA-REP-14, September 1991, Criterion H.2, "Access to the facility is controlled."

9. "Protective actions" are those actions recommended to protect the public from harm in an area threatened, or potentially threatened, by a radioactive plume. They include "shelter-in-place" which means to go indoors, close all windows, doors, and exterior vents, and turn off heating and air-conditioning equipment that uses outside air and "evacuation" which means to leave the threatened area.

GOVERNMENT - INDUSTRY PARTNERSHIPS

Improving the Delivery of Disaster Recovery Services for Local Governments in Large-Scale Events

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In recent years, the federal government has identified a number of problems with the traditional disaster recovery model (Federal Emergency Management Agency, 1995, hereafter FEMA). The traditional disaster recovery model is one where the government performs the administrative, management, and accounting functions. Private industry is brought in only to provide the final product. This model is based on bureaucratic processes, on established administrative practices and procedures, on standard management structures and relationships, and on traditional relationships between the federal, state, and local governments. The priorities of the traditional model are focused on the process rather than the product of disaster recovery services to affected victims and impacted jurisdictions.

To this day, the federal government continues to implement only incremental changes in response to the problems which have been identified (44 CFR 1997). This situation requires a more in-depth assessment of its causes and an evaluation of long term solutions to endemic problems within the traditional government disaster recovery model. In the interim, however, alternative disaster recovery management strategies exist for local governments who experience large-scale or catastrophic events which exceed their existing resources or traditional management infrastructures - strategies based on government-industry, or government-business, partnerships.

In the government-industry model, the private industry partner is brought into, or is contracted to provide, some or all of the administrative, management, and accounting functions and is integrated into the process. The private sector partner possesses a vested interest to get in, do the job, get out, and move on to other opportunities. Government has neither this incentive nor this sense of urgency. As long as the disaster remains open, the contemporary administrative process justifies the traditional system and the indispensability of the administrative-accounting practitioners.

Economists don't agree on much , but most economists agree that monopolies don't function very efficiently. It doesn't matter whether it is a private or public monopoly, customers are often neglected. Government processes that focus on legitimizing themselves and emphasizing their own indispensable functions, often deliver poor service to people who deserve better (Eggers and O'Leary, 1995), especially victims in time of disaster.

After Hurricane Andrew in 1992, the state of Florida used a limited application of the partnership concept by hiring a consulting firm to provide technical and administrative assistance to local governments. The consulting firm assisted in developing and processing project applications and in organizing administrative records so that they tracked expenditures in compliance with state and federal disaster recovery policies and procedures. After the Northridge earthquake of 1994, California also implemented a limited application of the partnership strategy when CalTrans brought in a private contractor to repair damaged freeways. Under the traditional disaster recovery model, the time estimated to be required for repairs and reconstruction was as long as two years. Neither the Governor nor the public would accept a recovery period of this length. The national average for disaster recovery is seven years using traditional disaster management models, and one case exceeded 20 years.

In 1994, a devastating flood in Alaska rendered several local governments incapable of performing their traditional disaster recovery functions. Federal disaster management officials estimated that, with traditional recovery methods, the displaced victims would be unable to return to their effected communities for two to three years. Based on previous mental health studies of disaster victims (Meyer et al, 1980; Green et al, 1982), neither the victims, the effected local government jurisdictions, nor state disaster managers could accept the extended length of the forced relocation. In addition, the State knew, from its experience with the 1989 *Exxon Valdez* oil spill that it could not afford to interrupt its routine administrative programs for such a long period by throwing its limited disaster management agency staff into the recovery coordination function. Utilizing the government-industry partnership approach and contracting with industry to manage the disaster recovery, the state managed the disaster with only four full-time professional staff. The victims were returned to their rebuilt communities within eight months, and the physical recovery of the damaged communities was virtually complete within 18 months.

The Alaska experience was that private sector participants in the administrative, management, and accounting functions were as well or better qualified, more flexible, and more adaptable to the challenging and changing disaster recovery environment than tenured government administrative, management, and accounting personnel. Private sector practitioners exhibited greater diligence in the administrative processing functions which were less directly linked to job security than those within the bureaucratic environment of the government.

The government- industry partnership strategy is not without opposition. Bureaucracy, by its nature, is resistant to change (Crozier, 1964; Abrahamsson, 1997; Meiners and Miller, 1992), and such was the experience in the Alaska case. Two years of audits were undertaken into the government-industry partnership for the disaster management and recovery. The result was the validation of the new disaster management methodology through the out-come based recovery and the satisfaction of the disaster victims.

The new disaster recovery methodology may not be appropriate for routine, garden-variety events which only require an infusion of federal disaster funds to reimburse state and local recovery expenses. Based on past large scale disasters, however, such as the Mexico City earthquake (1985), Hurricane Andrew (1992), the Kobe earthquake (1995) and on the forecasted increase and magnitude of catastrophic events yet to come

(Quarantelli, 1993; Engi, 1995; Rosenthal and Kouzmin, 1997), disaster recovery managers in both the public and private sectors will be required to re-assess the current strategies. In order to ensure the restoration of critical life-line services and the recovery of severely impacted segments of the public as efficiently and as effectively as possible, a cooperative strategy of combining resources for the mutual reinforcement of capabilities is required. The joint government-industry partnership model for disaster recovery is inevitable.

The business community remains an indispensable partner in disaster recovery with and undeniable role. Public sector disaster managers must recognize and integrate the resources available from, and provided by, the private sector in disaster recovery operations in order to maximize the benefits of both parties in joint operations in the interests of the victims.

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NOTES

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