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PARTNERSHIP FOR PUBLIC WARNING

Developing A Unified All-Hazard Public Warning System

A Report by
The Workshop on Effective Hazard Warnings

Emmitsburg, Maryland

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The Partnership for Public Warning (PPW) was incorporated in January 2002 as a 501(c)3 public/private non-profit institute as recommended in 2000 in the report *Effective Disaster Warnings* authored under the National Science and Technology Council at the White House (www.nnic.noaa.gov/CENR/NDIS_rev_Oct27.pdf).

Our mission is to promote and enhance efficient, effective, and integrated dissemination of public warnings and related information so as to save lives, reduce disaster losses and speed recovery.

We anticipate being chartered as a Utilized Federal Advisory Committee, providing a formal basis for Federal employees to work with representatives of all other stakeholders of warning systems.

Our goal is to work together towards a full range of national standards, protocols and priorities related to public warning systems.

Our vision of the future is that most people at immediate risk from natural or manmade disasters will obtain timely and accurate information about what is highly likely to happen or is happening via a wide variety of dissemination systems so that they can respond in ways that reduce their losses.

We anticipate that private industry will develop most dissemination systems as successful business ventures and that warning receivers will be included in many different types of consumer electronics devices that might even self-activate in times of crisis.

Developing A Unified All-Hazard Public Warning System

Executive Summary

The purpose of this report is to propose a national all-hazard public warning architecture and to outline some of the issues that will need to be addressed in creating such an architecture.

A warning is information provided to people at risk in advance of (alert) or during (notify) a hazardous event, with the objective of inducing those at risk to take appropriate action to reduce losses. The goal of warning is to prevent hazards from becoming disasters. The success of a warning is measured by the timely and appropriate actions taken to mitigate hazards and secure personal safety.

Warnings are primarily the responsibility of local jurisdictions with assistance from state and Federal governments. Warnings are also issued by critical industries such as nuclear power plants or oil refineries, typically as a requirement of their license to operate. Most warnings are issued from any one of thousands of government sources, but most systems to deliver warnings rely on industry for receivers and typically for the many aspects of warning distribution. Today many different warning systems exist that are quite heterogeneous, are not interoperable, and do not reach most of the people at risk. The many government agencies issuing such warnings are inconsistent in their terminology leading to confusion and inadequate response.

Bringing diverse warning resources together and focusing on a unified all-hazard warning system will improve the effectiveness of all warnings significantly. More people at risk will be warned. Improved warning systems and procedures will clearly save significant numbers of lives every year, will reduce losses from natural and man-made disasters, and will speed recovery. Building and operating a unified all-hazard public warning system is beyond the capability of any local community, state, Federal agency, or industry. It requires the cooperation of all these groups to work effectively together in partnership. There is a need for Federal leadership, and while many Federal agencies are responsible for warnings, there is no single Federal agency that has clear responsibility to see that a national, all-hazard, public warning system is developed and utilized effectively. Primarily because of this, an industry capable of unifying and standardizing warnings has not developed. We believe that the new Department for Homeland Security should take responsibility for leading development of a national all-hazard public warning architecture in partnership with other Federal agencies, state and local governments, industry, universities, and other stakeholders.

The findings and recommendations contained in this report are the product of an ongoing dialogue among some of the nations leading experts in warning systems. A group of scholars, emergency managers, agency officials and consultants met in Emmitsburg, Maryland June 19-23 to both evaluate the Homeland Security Advisory System and to consider ways of improving the effectiveness of current public warning systems. There was a solid consensus at this meeting that improvement of existing diffuse warning efforts can be achieved most effectively and at the most reasonable cost by developing an all-hazards public warning system in the US. This consensus is quite notable in that significant change will be required

within many of the agencies represented to develop such a uniform system. Further, the willingness to embrace the work necessary to implement an all-hazards warning system is evidence that the need for such a system is considered extremely compelling.

The challenges ahead are significant but tractable. They include:

- Generating adequate real-time data and intelligence upon which to base a warning
- Determining the point at which data are indicative that a warning should be issued,
- Using standard warning terminology that is easily understood by message recipients
- Refining the message for a very diverse population with different levels of education and responsibility
- Providing the warning in a standard protocol that allows industry to implement interoperable systems,
- Delivering the warning to just the people at risk and emergency responders through multiple communications channels
- Educating and training people to act in appropriate ways
- Constantly evaluating and reevaluating the effectiveness of the overall system.

In developing an all-hazards warning system, we must acknowledge and incorporate insights derived from over 60 years of Federally funded social science research on how people respond to disaster warnings and how the warnings can be made more effective. This body of research challenges popular myths that still prevail among those who are hesitant about warning systems including the belief that warnings generate panic or that false warnings greatly diminish the propensity of people to heed future warnings. Research, based on extensive observation of many natural and technological disasters, reveals that mass panic is highly unlikely when accurate information is provided. Rare false warnings do not seem to lead to a “Cry Wolf” syndrome. People want accurate and reliable information, and if the official sources do not provide it they will seek it from less reliable sources. We summarize in this document many lessons learned from this research in evaluating the warning process.

Another challenge in designing a uniform all-hazards warning system involves knowing what people must know in order to interrupt their normal activities to heed a warning and take appropriate action. We must recognize that warning is a continuous process that peaks during rare crisis events. Warning requires education and training, it often involves moving from very sketchy information over time to increasingly specific information. People at risk must participate in this progression in order to understand the imminence, severity, and likelihood of experiencing a hazardous situation. People rarely respond effectively to a last minute, “out of the blue” alert to take action unless they can directly perceive the threat.

Given that warnings are issued for many types of hazards, warning recipients are far more likely to quickly assess what is happening and determine what to do if the same terminology to describe risk and suggested action is used in these very different situations. Thus, a unified, all-hazard, public warning system must adopt a standard terminology for hazard warnings.

We also recommend the implementation of a unified, all-hazard, public warning message protocol, so that industry can modify existing hardware and build new hardware to receive warnings. It appearse quite feasible to add such capabilities to objects such as telephones,

televisions, or radios that are purchased and used daily for other reasons. The rapid increase in use of Internet, Internet Protocol and wireless communication devices opens many powerful possibilities. With a standard message protocol and a reliable stream of messages, industry can evaluate the market potential and use its originality and competitiveness to produce all types of warning delivery systems.

In summary, we strongly recommend the implementation of an all-hazards public warning system that:

- Is cognizant of the social science research in the area of human response to warnings
- Incorporates training for populations at risk and the emergency managers who must mobilize a response
- Is based on a standard terminology for expressing risk and appropriate responses
- Utilizes a standard protocol for warning issuance.

We are confident that such a warning system is a major step toward enhanced public safety for a variety of natural and technological hazards in which timely response and appropriate action are critical.

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The views expressed by these participants are based on their professional experience and do not necessarily represent the views of their employers.

Introduction

On March 18, 2002, the Department of Justice published the Homeland Security Advisory System (HSAS) in the Federal Register and requested public comment on or before April 25, 2002. The Partnership for Public Warning, in its role of bringing together representatives of all the stakeholders in warning systems nationwide, submitted written comment reviewed widely by social scientists and other experts experienced in issuing warnings and in evaluating their effectiveness. It became clear, in this process, that convening a workshop of such experts would be of great value before the final version of the HSAS was presented to the President July 25, 2002. With financial assistance from the Federal Emergency Management Agency, the National Science Foundation, the National Weather Service and the U.S. Geological Survey, as well as private industry, 29 experts met at the National Emergency Training Center in Emmitsburg, MD, June 19-23. This group included experts from the social sciences, physical sciences, communications technologies, emergency management, and Federal law enforcement terrorism specialists. The results of this workshop, along with a detailed analysis of the HSAS, were many suggestions on how to improve warnings for a wide range of hazards and a decision to urge development of standardized all-hazard terminology and all-hazard protocol.

On July 4, 2002, a report, **Improving the Effectiveness of the Homeland Security Advisory System**, was issued and sent to Governor Tom Ridge, Director Office of Homeland Security (http://www.partnershipforpublicwarning.org/ppw/docs/hsas_report.pdf).

The major emphasis at the workshop was on the need and potential for an all-hazard standard terminology and protocol. This report summarizes the consensus reached on these issues together with lessons learned from past research and needs for future research.

Developing A Unified All-Hazard Public Warning System

1. An Overview Of Warning

Warnings Seek Action

The warning process consists of people with information communicating with people at risk, and others such as emergency responders, in advance of or during a hazardous event, with the intent that those at risk will take appropriate action to reduce casualties and losses. The goal of warning is to prevent hazards from becoming disasters. The success of a warning is measured by what actions people take. A warning might recommend immediate action or it might simply encourage people to seek more information.

Warnings about events days, weeks, or years away can and should be explained in detail through the print and broadcast media. In these cases there is ample time for those who have information about an event to inform people at risk and others such as emergency responders about the hazard. People at potential risk can be encouraged to seek additional information in order to make informed decisions about how to take appropriate action to reduce losses. However, warnings about events seconds, minutes, or hours away need to be disseminated rapidly through special warning systems using messages that have been designed during calmer times to encourage the desired behaviors. At 2:00 AM, traditional communications channels are simply ineffective. Such immediate warnings are the central focus of this report.

Warnings might be for natural disasters, technological accidents, or acts of terrorism. They could be for air quality or water quality. They may ask people to be on the lookout for a kidnapper or other criminal on the run. They may be for hazards that people can clearly perceive, such as a tornado, or they may be for hazards that cannot be perceived without specialized equipment or access to intelligence information. In these latter cases, it is critical that the warning system and its operators have a high level of credibility so that people feel compelled to take action based solely on the warning message.

The Success Of Warning Is Measured By What Actions People Take

A warning prompts people to take immediate actions that reduce losses. Natural and manmade hazards create disasters when they kill and injure people, destroy and damage property, and cause further economic and emotional problems by instilling a sense of unease and uncertainty into society. Such losses can and have been reduced when people receive an alert of what is likely to happen soon, or notification of what is happening and advice about what to do in response to the hazard. With such knowledge, people can take appropriate action to get out of harms way, to reduce losses, to reduce uncertainty, and to speed recovery. Thus a warning must provide the information and motivation for people to take informed action. The goal of a warning is to prevent hazards from becoming disasters. The success of a warning is measured by what actions people take.

Warnings Are Primarily A Local Government Responsibility

Disasters are local and local government has the primary responsibility to look after the welfare of its citizens. Thus local government has the primary responsibility to warn its citizens and to assist them to prepare, respond, and recover from disasters. However, it is beyond the capability or capacity of local governments to see that a unified, multi-channel, nationally standardized system is available to them for delivering warnings to their citizens.

When disasters overwhelm one or more communities, the state is responsible to assist. When a disaster leads to significant loss, then the President may declare a major disaster or emergency and the Federal government becomes responsible to assist. Such Presidential declarations have been occurring approximately 50 times a year in recent years. Under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Congress expresses its intent "to provide an orderly and continuing means of assistance by the Federal Government to state and local governments in carrying out their responsibilities to alleviate the suffering and damage which result from disasters."

Federal Responsibility For Warnings

US Code Title 42, Chapter 68, Subchapter II, Section 5132 states:

- The President shall insure that all appropriate Federal agencies are prepared to issue warnings of disasters to state and local officials.
- The President shall direct appropriate Federal agencies to provide technical assistance to state and local governments to insure that timely and effective disaster warning is provided.
- The President is authorized to utilize or to make available to Federal, state, and local agencies the facilities of the civil defense communications system …. or any other Federal communications system for the purpose of providing warning to governmental authorities and the civilian population in areas endangered by disasters.
- The President is authorized to enter into agreements with the officers or agents of any private or commercial communications systems who volunteer the use of their systems on a reimbursable or nonreimbursable basis for the purpose of providing warning to governmental authorities and the civilian population endangered by disasters.

More than a dozen Federal agencies have some responsibility related to warnings, but there is no Federal agency that has the clear responsibility to assure that a national all-hazard warning infrastructure exists and is properly utilized. We believe the new Department of Homeland Security should have this responsibility.

Most Warnings Originate From Government Organizations

When significant accidents occur along transportation corridors and especially when accidents involve hazardous substances, local emergency managers, police, or firemen often need to issue warnings to help people avoid the scene or to avoid materials being dispersed in the air or water.

Many critical facilities such a nuclear power plants, chemical plants, oil refineries, chemical stock piles and dams are required by Federal, state, or local government to provide warning systems and originate warnings to citizens living nearby when the facilities are in a dangerous condition.

Some state and many Federal agencies develop warnings through extensive research and instrument or intelligence networks. In these cases, warnings are often issued by Federal agencies, but usually in close cooperation with state and local emergency managers. For example:

- The National Weather Service issues warnings of severe weather and flooding focused on specific localities throughout the country and has done so for more than 130 years.
- The U.S. Geological Survey issues warnings of earthquakes, volcanic eruptions, and landslides.
- The Department of Justice issues warnings of criminal activities.
- The Environmental Protection Agency issues warnings concerning air or water quality.
- Legislation before Congress requires the proposed Department of Homeland Security to provide warnings of terrorist acts.

The national Emergency Alert System and its predecessors, the Emergency Broadcast System and CONELRAD, were designed to allow the President to warn the entire nation of major events such as an incoming enemy missile with a nuclear warhead. The President has never activated this system.

Most public disaster warnings are issued by government agencies because without the existence of clear standards of best practice, private organizations may incur significant liability. Many private organizations do issue warnings, for example for weather, but these are usually covered by contracts that limit liability. Media weathermen may refine local warnings for their community but must remain mindful of standards of best practice.

Warning Systems Require A National Partnership Between Government And Industry
Mass warning devices such as sirens are typically owned and operated by local government or managers of critical facilities. The national warning system, however, the Emergency Alert System, is operated under an unfunded government mandate by unpaid volunteers at television and radio stations and cable systems throughout the country. NOAA Weather Radio provides government transmission, but the receivers are built by industry and owned and operated by individuals or organizations. Warnings can be issued through telephones, pagers, computers, and many other personal communications devices, wired and unwired. The media play an important role in distributing warnings. Thus most warning delivery systems need government input, but are manufactured, owned, and operated by private industry and by individuals. The government cannot afford to provide the devices that reach every person at risk. Industry can and will provide such devices or include this capability in all types of devices sold primarily for other purposes if there are clear national standards that create a national market. There must be an effective public/private partnership between government and industry to deliver warnings.

Many People Are Involved In The Warning Process
Warnings must be received by a complex target audience including the general public, institutional decision makers (in business, state and local government, and non-governmental agencies), and emergency responders. Emergency responders, a term we will use in the rest of this report includes firefighters, law enforcement officers, paramedics, public health workers, and emergency managers.

The news media and the emergency management community frequently act as intermediaries between those issuing warnings and households (or other information end-users). These

intermediaries—together with independent experts in university research institutes, national laboratories, and other agencies—critically evaluate the information disseminated by the technical experts to determine if it is accurate, internally consistent, consistent with other sources' messages, complete, specific, timely, relevant, and important. If a warning is judged to be inadequate in any of these respects, it will be challenged, supplemented with additional information, or ignored. Moreover, end-users evaluate the warnings they receive from all sources in terms of their prior knowledge about the hazard and the recommended response actions. Finally, end-users also evaluate the warnings they receive about any given hazard in terms of their knowledge about other safety and health hazards and recommended actions for those other hazards.

Eleven Important Elements Of The Warning Process

A warning system is a complex mix of many critical elements from original data to action:

1. **Data collection, analysis, and decision making to issue a warning**: development of evidence of a hazard through collection of data and information, their analysis, and the process by which a decision is made to issue a warning
2. **Framing a warning**: specifying a verbal and digitally coded warning message using standards for terminology and format based on knowledge of how to communicate warnings that will lead to an appropriate response
3. **Reliable input of warnings from authorized sources to one or more local and national communication backbones**: secure collection of warnings from thousands of authorized sources into systems that can deliver the warnings to a wide variety of distribution systems
4. **Transmission to a wide variety of warning distribution systems**: Redundant and robust transmission along local and national backbones for input to a wide variety of distribution systems
5. **Distribution to user receivers**: Redundant distribution by wire and wireless to a wide variety of end-user devices
6. **Reception by end-user devices**: Reception of the signals primarily only by the people at risk through local mass warning devices, through intelligent networks or through intelligent receivers that know where people are and what their interests and affinity groups are
7. **Announcement of appropriate warnings to end-users**: Announcement of the warnings in an appropriate language and physical means by activation of devices that can deliver the warning to people no matter what they are doing or whether they have a disability
8. **Decision by the end-user to take appropriate action:** The processes by which the end-user decides to take action and indeed takes that action.

In addition many continuing processes are required to improve the effectiveness:

9. **Public education:** Education of the public on warning terminology and appropriate response
10. **Ongoing evaluation and improvement**: A system for evaluating effectiveness and introducing improvements
11. **Emergency planning**: Planning related to all aspects of framing, delivery and utilizing warnings

Technology is the easiest element. All types of appropriate technology already exist. Standards, procedures, training, and experience are critical.

2. Lessons Learned About The Fundamental Principles Of Effective Warning Systems

Beginning in World War II, the government has supported research on how people respond to disaster warnings. Since 1963, when the Disaster Research Center was funded at Ohio State University, hundreds of millions of dollars have supported research at universities, national laboratories, and institutes to determine how people respond to disaster and how warnings can be used to improve that response. There have been many lessons learned from this research and from operational experience.

A warning system is an organized process for detecting a hazard and rapidly disseminating information about the threat and about appropriate protective actions. An effective warning system is one that causes the maximum appropriate protective actions to be taken for a given commitment of resources because it has been designed to be compatible with the context in which it operates. Understanding this context requires knowledge of the other participants in the warning system for a given hazard, the other types of hazards faced by those participants, and the warning systems that are currently in use for those other hazards.

Warning System Context

Federal authorities who are responsible for warning frequently think only of disseminating threat information to the "general public", but it is important to recognize that the target audience is much more complex than this. There are independent experts, news media, institutional decision makers (in business, state and local government, and non-governmental agencies), as well as households. The news media and some institutional decision makers (especially emergency managers and public health officials at state and local levels) frequently act as intermediaries between Federal authorities and households (or other information end-users). These intermediaries—together with independent experts in university research institutes, national laboratories, and other agencies—critically evaluate the information disseminated by Federal authorities to determine if it is accurate, internally consistent, consistent with other sources' messages, complete, specific, timely, relevant, and important. If a warning is judged to be inadequate in any of these respects, it will be challenged, supplemented with additional information, or ignored. Moreover, end-users evaluate the warnings they receive from all sources in terms of their prior knowledge about the hazard and the recommended response actions. Finally, end-users also evaluate the warnings they receive about any given hazard in terms of their knowledge about other safety and health hazards and recommended actions for those other hazards.

It is also important to remember that "the general public" is really "publics" since it involves:

- Decision makers at all levels in the community
- People with many different levels of education
- People with many different levels of financial ability and responsibility
- People of all races and beliefs

- People with many different primary languages
- People with widely varying experience with the hazard
- People with disabilities

Warning System Design
Warning sources often seem to implicitly assume that there will be immediate reception of the warning, unlimited attention to the warning message, perfect comprehension of message content based upon accurate prior knowledge about the threat, and perfect compliance with the recommended actions. None of these conditions will occur, even though reception, attention, comprehension, and personalization increase when there is an imminent threat. Consequently, warning systems and warning strategies must be carefully designed to make it more likely that warnings will be as effective as possible.

The first step in warning system design is to define the desired message effects, especially the behavioral objectives of the system—what actions do authorities want the end-users to take? The second step is to identify any distinctively different segments of the target population—how do people differ in terms of their abilities to receive a warning, attend to it, comprehend its content, personalize the threat, choose an appropriate protective action, and implement that protective action? The third step is to identify the channels through which warning messages will be transmitted—what technologies and what intermediate sources are needed? Finally, warning system designers must define who the initial message sources will be and develop their perceived credibility by taking steps to ensure their expertise and trustworthiness.

The Mass Panic Warning Myth
It is extremely important to note that "mass panic" is commonly expected by civil authorities but is almost never found, even in cases such as the 1993 and 2001 World Trade Center bombings. People usually engage in rational adaptive action even when they are very frightened. When people take inappropriate actions, it usually is because they had inadequate information about the situation or were not provided instructions on what actions to take. That is, they received an inadequate warning or no warning at all.

The Cry Wolf Warning Myth
It is also commonly assumed that warnings not followed by the anticipated hazard will cause people to ignore future warnings. If false warnings were a regular occurrence, this is a problem, but there is no solid research that shows relatively rare false warnings have such an effect. The issue is educating the publics about uncertainty so that they can comprehend that false warnings arise from inherent uncertainty rather than from poor professional practice.

As we develop improved ways to wake people up and otherwise interrupt their lives with warnings when they are at risk, it will be important to limit the number of interruptions to those situations that are directly hazardous to them.

The Over Information Myth
You cannot give the public too much accurate information that applies directly to their safety. Warning, especially of uncertain events, is a dialog for the purpose of helping people deal constructively with that uncertainty. Fear of the known is better than fear of the unknown. An

abundance of accurate information can cut down on speculation. The issues are to be direct, clear and relevant. In our free and information-rich society, people are used to processing information; they have demonstrated a desire for information. They often assume someone is trying to hide information if it is not available.

Withholding Information Is Typically Not In The Public Interest

Officials who have information that might lead to significant public protective action often consider withholding that information. They reason that they should wait until the situation becomes more clear, not wanting to give out information that could make things worse. This natural human tendency is more likely to happen when information is incomplete or tenuous. Experience as well as research shows that when there is a credible threat, it is better to get information to people who can do something about it rather than to withhold it. Opening up an ongoing information flow as the story of the incident unfolds, literally telling the story of the emergency as new facts disclose themselves, allows initial directives to be modified as circumstances change. No one would expect directives for protective action to remain static when the emergency itself does not remain static. The public will listen to the emergency story unfold and will modify their actions as facts become clear and situations change. In many after action reviews of major emergencies, the economic, political and moral costs and liabilities of not providing information when it could have been released are often assessed as being very high.

Lessons About The Effects Of Warning Messages

1. Identify the appropriate actions that those at risk *should* take, as well as inappropriate actions that they *might* take based upon their experience with similar hazards. This is especially difficult but nonetheless vital when information is incomplete or there are conflicting recommendations.
2. Identify and plan for in advance the incentives and disincentives for taking the alternative actions, as well as the constraints that prevent people from taking appropriate actions (e.g. people typically want to look out for their children or pets before they take action for themselves).
3. Develop programs for overcoming any constraints to taking recommended actions (e.g. providing buses so those without personal vehicles can evacuate) and provide mechanisms for communicating the availability of these programs to those who need them.

Lessons About Warning Receivers

4. Recognize that “the public” is not a homogeneous entity. Households, businesses, government agencies, and non-governmental organizations vary in size, demographic composition, geographic location, and economic resources.
5. Identify the ways in which population segments differ in their perceptions of the credibility of different sources, their access to different warning channels, their reactions to warning message content, and the incentives, disincentives, and constraints they are likely to experience in attempting to take protective actions.
6. Receivers must be used on a daily basis, or they will be put away. Ideally warning capabilities will be found in commonly used appliances, such as radios, cell phones, telephones, etc.

7. Receivers must take into account the fact that many persons cannot and or will not program the clock on their VCR. Not all of us are at home with technology.
8. Warning alerts must be distinct, attention grabbing, and not appear to be another common occurrence. Ideally the alert will provide an indication of the hazard threat level.
9. Provide individuals with the opportunity to test the system themselves. For example: Call a 1-800 number and have an alert message sent to their receiver only.

Lessons About Warning Message Content

10. Be as specific as possible about the nature of the threat (e.g. explosive, chemical, nuclear/radiological, or biological), the anticipated impact location, and the expected time of impact). Decision makers in business, government, and non-governmental organizations need to have as much information as possible so they can weigh the consequences of alternative actions (including inaction) before expending significant resources on protective measures.
11. Recommend one or more specific protective actions. One of the major incentives is protection of persons and property from the hazard. Determine how to describe the hazard so that the message generates a high level of protection motivation.
12. Explain to those who are *not* at risk why they are not believed to be at risk and why they do not need to take protective action.
13. Recognize that actions are triggered by *changes* in threat condition. Develop a plan and systematic procedures for evaluating the need to change the threat condition. The longer a given threat condition is maintained, the less effect the classification system will be.
14. Use terminology in warning messages that is consistent across time for a given hazard and, to the greatest extent possible, compatible with the terminology that is used for other hazards (e.g. Code Blue is used by some school districts, but blue means something quite different in the Homeland Security Advisory System).
15. Let people know when the threat has ended so they can resume normal activities as soon as possible.

Lessons About Warning Message Timing

16. Be prepared to disseminate specific warnings even if there is a high level of uncertainty about the threat because the information needed to reduce that uncertainty might arrive only shortly before the incident occurs. In such cases, casualties could occur because an official warning could not be received and acted upon in time by all of those at risk.
17. Do not withhold information because of concerns about "panic" (which is commonly anticipated by authorities but almost never occurs). If authorities do not provide information, people will seek it from other—usually less reliable—sources.
18. Repeat warning messages at regular intervals so those who missed an earlier warning will have another chance to receive it and those who ignored an earlier warning will have another opportunity to pay attention to it. Repetition also will give those who did not understand an earlier warning another opportunity to comprehend it and those who did not believe an earlier warning another opportunity to personalize it.
19. Update information when conditions change significantly so that people can adapt their responses to the new situation.

Lessons About Warning Channels

20. Identify all the communications channels to which different segments of the population have access. It is especially important to identify the channels that people monitor routinely, as well as those that can reach people rapidly during emergencies.
21. Use multiple methods and channels to disseminate messages. These include print and electronic media, the Internet, and even face-to-face presentations from credible original and intermediate sources.
22. Encourage people to tune to reliable sources of local broadcast news.

Lessons About Warning Sources

23. Recognize that no single source has complete credibility regarding all aspects of the threat and protective actions. Federal, state, and local government agencies vary in their credibility, as do news media, business, and nongovernmental organizations.
24. Identify in advance which organizations (and individuals within those organizations) will be responsible for communicating with those at risk, as well as with other population segments that are not at risk.
25. Identify procedures by which information from different sources can be combined to ensure that each individual source's messages are consistent with all other sources' messages and that, together, all official sources' messages are accurate, complete, specific, internally consistent, timely, novel, and relevant.
26. Recognize that source credibility can be established initially by credentials such as agency mission and educational degrees, but is enhanced by preparing objective ("transparent") procedures in advance rather than improvising during an incident, by obtaining endorsement by external experts ("peer review"), and establishing a satisfactory record of performance over time.
27. Build credibility and understanding that the warnings are based on the best available professional practice. Develop credible, articulate authorities to use consistently. Develop and utilize trusted personalities who the public know and respect. This is especially important for warnings of terrorism. Politicians are not credible authorities

Lessons About Warning System Reliability

28. Even the most carefully designed warning system requires continual maintenance to ensure that it will be effective. Critical phases of maintenance include training, evaluation, and development. Core elements must be used every day.
29. Publics need to be regularly trained, and therefore a regular test of the system by individuals should be possible.

Lessons About Training

30. Provide training about the hazard and protective actions if those at risk must respond to unfamiliar situations. Be aware that few people will spend very much time and effort learning about a hazard before an incident occurs. Nonetheless, those who learn about the hazard and protective actions will have the necessary information to pass on to friends, relatives, neighbors, and coworkers, and serve as leaders within their local communities.
31. Adapt the scope of the training effort to the training motivation and capabilities of each target audience—personnel within emergency-relevant organizations, personnel within

hazardous facilities (e.g. chemical plants), critical facilities (e.g. hospitals), critical infrastructure (e.g. ports), news media, and households.

32. Recognize that pre-incident planning and training will reduce uncertainties in actual emergencies, but improvisation will be necessary because events will differ in many ways from practice scenarios. Thus, training must be designed to promote adaptation and creativity rather than just rote response.
33. Make basic training about the hazard and appropriate response actions readily accessible to end-users, especially small business and households that cannot afford to hire specialized assistance in preparing for the threat.
34. Emphasize the common elements of emergency preparedness for all hazards. Emphasizing these common elements will enhance the transfer of training from one hazard to another. Moreover, significant expenditures of money, time, and effort will be more acceptable if the knowledge, skills, tools, and equipment can be used in response to multiple threats.

Lessons About Technology Development

35. Actively promote continued evolution of warning system design to accommodate changes in hazard risk assessment, our understanding of the hazard and all its risks, communication technologies, and constantly changing demographic characteristics of populations at risk.
36. Recognize that one method will not reach all, and that an infrastructure is needed to support all channels.

Lessons About Evaluation

37. Conduct careful pre-implementation evaluations to ensure that all new emergency response technologies meet user needs and are compatible with other systems in use.
38. Conduct post-incident and post-exercise assessments of all plans, procedures, staffing, training, facilities, and equipment so revisions can be made to improve response to future incidents.

3. Design Of An Effective All-Hazards Warning System

What Motivates People To Take Action?

In the military, when a command is ignored or leads to an inappropriate action, the result is discipline. In a free society, a command may merit attention, consideration, evaluation, but we most often leave it up to people to decide how they will respond. Life is making choices and decisions. We regularly evaluate what deserves our attention, what our priorities are, what our options are, and what we will spend time and money on. We do this as individuals and we do it as leaders of families, businesses, or government bodies. Such choices are based on upbringing, education, personalities, our past experiences, our responsibilities, our means, and our overall knowledge. When we feel the need, we may seek information. We are used to the concept that most actions have costs and that managing insufficient resources is a major part of our personal and professional lives. We often must choose between reasonable choices. We must weigh the liabilities of action versus inaction.

Thus the first issue in warning is getting peoples' attention, getting them to realize that this may be important enough to be worthy of some of their time and thought. This is easiest when

there is a clear, perceivable threat: a tornado nearby, a hurricane with predicted landfall nearby. When the threat is less perceptible, such as a toxic cloud or a potential terrorist attack, sufficient information must be provided even simply to get peoples' attention.

Once you have peoples' attention, they will seek information in order to decide whether to continue giving their attention and to decide whether to take action. If official information is not available, they will get it from less authoritative sources. What they want are specifics upon which to base decisions. The more detailed the specifics, the better the chance that they will continue to be aware and to consider options. We are talking about literally intruding into people's lives, seizing their attention, and getting them to modify deeply embedded behaviors. It may be as simple as asking people to postpone planned travel or something as complicated as asking them to evacuate their home or office.

People typically would like to know the following data, the quality of these data, and the likelihood that they may change with time:

Hazard information
- What type
- When
- Intensity
- Duration
- Where

Vulnerability/Resilience
- Demographic characteristics (static and dynamic)
- Population density
- Population profile
- Access to escape routes
- Environmental characteristics
- Infrastructure
- Ways of responding to reduce hazards

Risk
- Projected numbers of individuals affected
- Types of impacts

Note that while specific information needs differ, there is increasing convergence of information needs, especially as the "public" is increasingly a very active participant in crisis management. Many actions require lengthy descriptions and therefore pre-event education and training is needed. For instance, the following actions can be used for a variety of hazards and an educated public can then implement them rapidly in response to a warning.

- Shelter in-place: Turn off air conditioner or heater, retreat to interior room, tape doors
- Board up windows and otherwise protect your belongings from the hazard
- Evacuate: arrange means of transportation, route of travel, destination and lodging
- Seek more information
- Plan and exercise your plan
- Stockpile supplies

An example of the kinds of threat information needed by a homeowner and the recommended actions when a hurricane is approaching:

Warning Information For Households

Threat information

Type of event	Hurricane
Type of threats	Storm surge, wind, inland flooding, tornadoes
Target location	What are the threats at their location
Impact area	Where else are there threats, should they change locations Width of threatened coastline; Inland extent of surge, wind, and flooding
Magnitude (intensity)	What is the impact to them Saffir-Simpson scale; Depth of surge/flooding and wind speed at critical locations
Time of onset	Estimated arrival time of Tropical Storm winds and surge
Duration	Duration of Tropical Storm winds and surge
Likelihood	Of landfall location, radius of hurricane winds, storm category, arrival time, duration
How vulnerability varies by structure and location	For single family structures, multi-family structures, mobile homes

Recommended actions

Information seeking	Contact point for further information (EAS station, NOAA Weather Radio) Contact point for assistance in protective response Environmental cues Social sources/conditions
Protection for persons	Evacuation Sheltering in-place Access controls
Protection for property	Strengthen building envelope (install shutters) Secure contents (bookcases, refrigerators) Turn off utilities (gas, electric power, water)

Clearly, the warning process for a hurricane, or any other hazard, requires communicating a great deal of information quickly and concisely. This is best achieved when the population has been given previous training and education. See Appendix 1 for more discussion on actions to be taken.

Warning Is A Continuous Process

Warning is not a single instantaneous action. It is an ongoing process that peaks every once in a while.

For the scientists, intelligence experts and emergency managers who will issue a warning, there is continuous collection of data and information that is either analyzed routinely by computer or by experts. Ultimately the experts either make an interpretation of what is likely

to happen or observe what is happening and decide to issue a warning perhaps with recommended actions based on scenarios previously agreed to by emergency managers.

For emergency managers, business continuity experts, and others there is the need to develop plans for reacting to any likely disaster. These plans based on assessments lead to scenarios that can be used for education, training, and procedures used during actual events. Training exercises are ideal times to network with the people developing the warnings and with others preparing to respond so that when the real warning comes, there is personal knowledge of all the different people involved. While the real event will never be just like an anticipated scenario and originality in response will be necessary, during an actual emergency people fall back to their level of training. With planning, training, and exercising comes analysis of recommended actions that might be given to the publics and a chance to pretest message content. Development of such recommended actions can be very useful when a technical warning must be issued immediately. Events that disrupt infrastructure may require special preplanning and information systems. For example it may be necessary to assure that doctors can get to the hospital.

For various groups that respond to warnings, education and training are very important so that they are better prepared for what is likely to occur. This is also the time when family and community plans can be developed and integrated with overall planning. It is the time to create networks among and between business leaders, community leaders, first responders, and people who issue warnings. The media play a key role here, providing relevant news and in-depth stories. Dramatization on entertainment channels may provide appropriate education. Such activities should take advantage of an increase in public interest because of major events elsewhere or recovery from an event at home. This is the time to communicate alternatives, potential resources, possible actions and likely consequences.

When a warning is being developed, there may be a significant range of specific information available over a significant period of time. In this case, communication with the publics may take place over an extended period of time. There may be some “trigger event” that leads to a preliminary warning: a hurricane moving into the Caribbean, the first case of smallpox or anthrax, the type of weather that usually leads to tornadoes, and such. As the threat is assessed, we begin to understand the hazard. As the specificity of the hazard increases, we begin to understand our vulnerabilities and ultimately understand the risk. Involvement of the publics in this learning experience is key if they are to take informed action. It gives them time to think about options and alternatives.

When a disaster is ongoing, continued warning can be very effective. Studies after the Northridge earthquake showed very favorable responses to:

1. Context-sensitive reminders
2. Realistic reassurance
3. Specific messages from emergency managers for the public to do or not do certain things.

Diversity Creates Many Challenges For Successful Warning

While a warning system's success can be judged against the simple principle of whether or not losses are reduced through appropriate actions, there are many challenges that must be overcome in order to provide society with a successful warning system. Most of these challenges are due to diversity: diversity of hazards, diversity of appropriate actions, diversity of types of responders, and diversity of ethnic groups.

The U.S. is a large country that faces a wide variety of natural and manmade hazards including hurricanes, blizzards, tornadoes, earthquakes, volcanic eruptions, landslides, floods, explosions, toxic chemical releases, epidemics, and acts of terrorism. Some hazards may be either natural or manmade such as fires, floods, and epidemics and some disasters will include a variety of hazards such as when an earthquake or explosion causes secondary fires and toxic chemical releases. The manmade hazards include both accidents and intentional acts such as terrorism. Not only does the country as a whole face a wide variety of hazards, but each individual citizen is likely to face a wide variety of hazards because we are a mobile society. For instance, we may move from earthquake prone areas to hurricane prone areas both on short trips and as part of major moves during our lives. Thus, each of us must be able to receive and act on a wide variety of warnings.

The appropriate actions to take in response to these hazards are similarly diverse. In response to a flood, one may need to evacuate while in response to a toxic cloud or hurricane one might need to shelter in place. There may even be a range of recommended actions in response to a single hazard; an evacuation might be an appropriate response to a hurricane in areas of high storm surge while at higher elevations it might be better to shelter in place. These actions might also vary as a storm grows closer and one moves from a period of preparation to the actual impact of the storm. For instance, during an earthquake it is best to duck, cover, and hold inside a building. But, after an earthquake it is best to evacuate until it is determined that a building will be safe during the aftershocks.

How we respond to a warning also depends on the different roles we have in society. While all of us have responsibilities to ourselves and to our families as private citizens, some of us also have responsibilities to organizations such as companies, and some of us are emergency responders. Thus, each warning must provide a wide array of people with adequate information to prompt actions based on their role in society.

America is also the great melting pot, proud of its very broad ethnic diversity. Warning systems need to deal effectively with many languages and cultural differences. These cultural differences may affect the credibility different people will give to various sources of warnings. Some may look to local government as the most credible source for information while others may place a higher value on the Federal government or on schools or religious institutions. Many Americans strongly value their right to privacy and resist cooperating with a warning system that requires centralized databases of personal information, especially those managed by government. Similarly, warning systems need to address the needs of people with a wide variety of disabilities. Warnings must take into account all of these differences if they are going to be broadly effective.

We must have a system that works for all groups because we are all tied together through our reliance on the same emergency response systems that must allocate limited resources during disasters. If a warning is ineffective in any group, it will stress the emergency response system and affect all segments of society. This is true if an ethnic group does not receive compelling communications or if a large company fails to heed a warning and places a large group of people at risk.

Heterogeneity In Current Warning Systems

Information starts flowing from the source and for this reason most warning systems are hazard-specific and were principally developed by the technical community that has the greatest knowledge about a specific hazard. For instance, multiple warning systems are operated both by the National Weather Service for warnings of severe weather such as hurricanes and tornadoes and by the US Geological Survey for warnings about geologic hazards such as earthquakes and landslides. The unfortunate result of this situation is that the emergency responders, who are primarily affiliated with local governments, are required to receive and understand a wide range of warnings via a wide range of communications channels. Also, each technical community does not have the expertise to design messages suitable for warning the diverse U.S. population. And finally, a successful warning system requires a significant education program in order to educate people about the warnings they are receiving or may receive in the future. Despite some success stories, adequate educational efforts are beyond the scope of the technical organizations that currently manage warning systems. The result, as documented in the White House report *Effective Disaster Warnings*, is a poorly organized system that may successfully communicate information on specific hazards to some populations but which fails for many other hazards and many other populations. Improving each hazard specific system to the point where it serves all populations well would require a great deal of wasteful redundant development work.

While information may largely be flowing from Federal agencies, the recipients of this information are largely local whether they are emergency responders, companies or schools that concentrate population during the days, or private individuals. While a small minority of these groups may have the resources to build ties to the agencies with the most knowledge of their local hazards, relying on those with the need for the information to build their own warning systems will fail for most of the groups facing these hazards.

Given the diverse nature of the hazards we face and the diverse population that must receive this information, it will be most effective and efficient to implement a uniform all-hazards warning system that makes the link between the technical groups that have knowledge about a hazard and those that need the information. Such a system can help the technical groups take advantage of the current ideas about how best to convey warnings to the entire population. And a unified warning system will provide the public, companies, and emergency responders with a single source of information on all hazards.

The many warning systems in place are also reflected by a variety of communications channels used to provide warnings. Currently the Federal government broadcasts warnings throughout the nation using both the Emergency Alert System operated by radio and television broadcasters and NOAA Weather Radio. There are many other localized systems

such as earthquake and volcanic warning systems operated by the USGS in regions at risk. Other warnings are carried by private warning systems and many warnings are retransmitted through the media. While a variety of communications channels can contribute to a reliable warning system by providing redundancy, the same variety can also be a problem when a user is required to monitor many systems in order to receive a variety of warnings. In the latter case, which describes current practice, the multiple systems place a burden on the users and do not support each other to provide redundant, reliable communications. A uniform all-hazards public warning system can utilize a variety of communication channels so that each user can choose the technology they want to monitor but are assured of receiving all pertinent warnings by monitoring any one channel at any one time.

Who Should Be Involved In A Unified Warning System?

Disaster mitigation, readiness, response, and recovery are primarily local issues. Local government, business, and citizens are the groups at risk, will be the first to respond, and will need to rebuild their community. The state provides help for large disasters and the Federal government provides help for major disasters. For disaster warning, however, the Federal government needs to assure there will be effective delivery of warnings both to satisfy its own requirements and because only it can coordinate a unified national system. Such a system is needed because:

- The President may need to warn the Nation as a whole
- Most warnings originate with the government or government contractors
- Warnings cross many jurisdictional boundaries for cities, counties, and states
- Municipalities do not have the resources or clout to solve issues larger than their own borders
- Warning systems should be compatible and interoperable among jurisdictions because warnings, and notifications of ongoing hazards, need to be input and received by first responders and the operators of critical facilities from thousands of locations throughout the nation
- Warnings will be most effective when devices for receiving warnings are readily available throughout our society

Not only is this role well established in law, but for more than 50 years, the Federal government has assumed primary responsibility to provide a national infrastructure for early warning.

Warnings come from agencies such as the National Weather Service, the U.S. Geological Survey, and the Justice Department. And the legislation before Congress to form the proposed Department of Homeland Security requires it to provide warnings of terrorist acts. The first national warning system, CONELRAD, was established in 1951 to provide emergency alert to the public. The Emergency Broadcast System and then the Emergency Alert System operated by radio and television broadcasters throughout the country followed it. Then NOAA Weather Radio was introduced.

While many warnings do originate from the Federal government, others come from state and local governments and private industry. For instance, when significant accidents occur, such as along highways and railways and especially when they involve hazardous substances, local emergency managers, police, or firemen often need to issue warnings. Also, many critical

facilities such a nuclear power plants, chemical plants, oil refineries, and chemical stockpiles are required by Federal, state, or local governments to develop warning systems in order to alert citizens living nearby when the facilities are in a dangerous condition. Many companies involved have shown interest and an investment to support actions that may reduce their liability. But, without clear standards of best practice with respect to hazards warnings, private organizations may instead incur liability when they release warnings. Thus, most disaster warnings are issued by government agencies.

Critical Components Of A Unified All-Hazard Public Warning System

- One single Federal agency needs to be responsible for assuring that national systems and procedures exist, are effective, and are properly utilized for the distribution of warnings and information for all types of hazards to state and local government personnel, agencies, and authorities and to the public.
- Federal, state, and local government need to agree that a unified all-hazard public warning system will best meet their needs and the needs of the American people.
- Standards must be developed for:
    - Professional standards for how warnings are developed and which warnings will be disseminated.
    - A unified, all-hazard terminology for communicating risk and appropriate action
    - A standard message protocol that will provide for interoperability among all types of warning delivery systems
    - Procedures for how warnings will be input into dissemination systems
    - Methods for distributing warnings nationally to be input into delivery systems
    - Standards for training, exercising, testing, and improving warning systems and procedures
- A clear statement by government of national needs and expectations and of the standards that will exist for many years.
- Ability of industry to assess market potential and thereby develop creative and competitive ways to meet these national needs.
- An understanding by all people at risk and the emergency responders that they depend on of the importance of as national system and the importance of planning, training, and preparing for response to disasters.

4. Developing A Unified All-Hazard Terminology

One aspect of a uniform warning system must be the use of uniform terminology for all hazards. Disasters have many similarities whether from natural causes, accidents or acts of terrorism. This is true because the mechanisms that harm people and property such as fire, building collapse, toxic chemical release, or floods are the same regardless of how these mechanisms are triggered. Alerting people at risk to impending disasters or notifying them about ongoing disasters involve the same kinds of activities no matter what the cause of the disaster. The goals in each case are to get peoples' attention, to advise them about what is happening, and to get them to take appropriate action. Effective warnings must be communicated clearly and succinctly. Currently the terminology used to communicate warnings varies by each type of disaster and by each agency issuing the warning (Appendix

3). People at risk would understand all the warnings much better if the terminology were standard for all types of hazards.

The only significant difference between warnings of terrorism and other warnings is that the terrorists may adapt their actions in response to warnings or might try to use the warning system to their advantage. This issue, however, does not affect our choice of terminology.

The ideal standard terminology should use:

- Easily understandable "trigger words"
- Words that are simple, memorable, to the great majority of people
- Words that are transferable across different hazards
- Words that translate into other languages with similar meanings
- Words that can be used in many different mediums such as a 10-character pager, a 12-character cell phone, a 60-character short messaging appliance, a newspaper article, a half-hour television documentary.

By using standard words, training can be standard, and people would get used to them. This would then alleviate problems associated with scales that people rarely hear about. For instance, on September 10, 2002 Robert Siegel of National Public Radio interviewed tourists at the Washington Monument about that day's increase in the Homeland Security Advisory Scale to level "Orange." Few of them knew that the level had changed and none could identify what it meant. One man stated, "No, I'm not [aware of the HSAS change or level]. I mean, I barely get the pollution and the heat colors. Last week the kids were talking about purple. Like, I've never heard of purple." Another commented, "I'd rather see it high, low, medium, you know? It'd be easier to understand." The first quote shows that using different terminologies for each warning system makes it difficult for the end user to remember how each system uses the terms and prevents them from transferring knowledge of one system to another. The second quote shows that it is important to carefully choose the terminology so that it is easily understood.

Beyond standardizing all alert systems on a single set of terms, there is the question of how to make these terms mean the same thing for all hazards when some warnings are based on the time to a hazard occurring (e.g. hurricane warnings), some are based on expected severity, and some are based on probability (e.g. earthquake warnings). We suggest that a unified warning terminology can be devised by focusing on a proposal to unify hazard advisory scales based on who needs to take action and what level of action will mitigate the hazard.

The actual type of response to a specific hazard depends, obviously, on the hazard. For this reason, a unified advisory scale will fail if it includes the specific actions that should be taken (e.g. shelter-in-place versus evacuation). Also, threat scales that measure how probable a hazard is will also need to be hazard specific. For instance, earthquake hazard is usually measured in probabilistic terms while hurricane threats are estimated in time to the arrival of the storm. However, a unified advisory scale is possible if it takes into account only who needs to respond and at what level they need to respond. It is important to remember that the goal is an advisory scale that is separate from the threat scales.

Below is an example of a five-level advisory scale for technical and emergency management and response communities that appears as a simpler three level scale for the general public. The numeric levels are aimed at the technical and emergency response community while the terms normal, medium, and high are aimed at the general public. However, the structure of the system is the main point and not the choice of language used to illustrate it in this document. Similarly, the actual actions suggested in each box are examples to show an increase of activity with advisory level and the specific activities are open to debate. Also note that this table leaves out some important groups such as private industry. These would be additional columns in the table and are left out here only for brevity.

The appropriate response to threat-level will depend on the particular audience and their responsibilities. The following table suggests how emergency management and response personnel might respond to every change in threat-level, while the general publics may not really get significantly involved beyond basic planning and preparedness until there is a clear and imminent danger. The advantage of this system is that at a given level a particular community knows if they are expected to take action and what level of action will be expected. For instance, the general publics may simply ignore the first two level of advisory regardless of the type of hazard. Thus, they gain information and can transfer this knowledge from one hazard to another.

Unified Advisory Scale

Level	Technical Community (Physical Scientists, Criminal Investigators)	Emergency Management & Response Community	Public Response
1- Normal	Long-term monitoring	Long-term planning, education, & mitigation	Long-term planning, education, & mitigation
2- Normal	Increased monitoring or investigation, communication with emergency management and response community.	Review response plans, ensure that emergency supplies are up-to-date, increase public education on this particular hazard, also lower level activities	
3- Normal	See level 2	Short-term improvements in response capabilities by staffing increases at emergency management centers, move from education to training on this hazard, encourage publics to review their personal response plans and supplies, also lower level activities	Review response plans and supplies as inspired by training given by emergency management community, also lower level activities
4- Elevated	See level 2	See level 3, further increased staffing at emergency management centers, possibly increase deployment and staffing of emergency responders, increase public training, possible disruption or particularly high-risk activities such as large gatherings or high-risk industries, also lower level activities	Ensure that emergency plans and supplies are up-to-date, expect disruption of gatherings or other high-risk activities, also lower level activities
5- High	See level 2	See level 4, increase all efforts, further increased staffing at emergency management centers, increase deployment and staffing of emergency responders, activate plans for general publics protection activities (e.g. evacuations or shelter-in-place) or other disruptive activities	Expect disruption of daily life, e.g. closed work places and schools, engage in recommended protective actions (e.g. evacuation or shelter-in-place)

For any given hazard the advisory level should be set to correspond to the level of activity that is appropriate to mitigate the current level of threat. Thus, the connection from technically based threat scales to the advisory scale needs to take into account the type of hazard and what mitigation steps will be effective. This process connects the hazard-specific event based threat level scales to the unified advisory scale system. In addition to connecting the event based threat level scale to the advisory scale levels, it is also necessary to modify the generic levels of action in the advisory scale table to specific actions based on mitigating each hazard. This process is structured as shown in the table below. Only two hazards are shown here as an example. The first is for a hazard where the technical community can estimate the probability of occurrence while the second is for a hazard where the technical community can estimate the severity of occurrence. There will be other types of threat scales such as ones that estimate the time to the hazard and ones that combine probability, severity, and time. For terrorism a threat scale may range from normal daily conditions, to detection of an unusual threat, to more specific information on a threat, to knowledge of imminent danger, and finally to an event in progress. Two one-dimensional scales are shown below only to provide a simple example.

Hazard 1: Threat Scale– Increasing Probability of Occurrence	Connection	Advisory Scale Level	Connection	Hazard 2: Threat Scale – Increasing Severity of Occurrence
Low Probability		**1**		Low Severity
		2		
		3		
		4		
		5		
High Probability				High Severity

Under this system the users of the advisory scale only need to understand the advisory scale levels and seek information on the specific actions if the advisory scale reaches the level that involves them. They do not need to understand the technically based threat scales in order to know when they need to take action and what type of action to take.

5. Developing A Unified Message Protocol

In the previous sections we have argued that a unified all-hazards warning system is both advantageous and possible from a logical perspective. The next question is whether or not such a system is technologically feasible. Clearly we should always utilize a wide variety of communications channels both to properly serve various situations and to provide a robust system that is not vulnerable to failures of a single component. The question then is not whether there is a single technology that can be used for all warnings, but can a backbone

warning system be developed that provides uniform information through a wide variety of communications systems.

Recent developments in digital communications make it possible to transfer a great quantity of information over landlines, wireless links, and satellite relays. Thus, we do not believe there are any physical impediments to developing a variety of parallel information backbones. Similarly, personal wireless electronic devices ranging from cell phones to personal digital assistants provide a variety of receivers for individuals. In fact, recent advances in integrated circuits that merge GPS locating, radio reception, and processing power onto a single chip will make it easy to include warning receivers into devices such as watches or "Walkman"-style portable audio players. And, efforts related to Phase II 911 to locate wireless phones, and current 911 addressing for landline telephones, make it possible to identify and then alert only persons in the area affected.

The technological challenge then is to develop a single standard protocol for issuing alerts, notifications, and warnings for all types of hazards so that the President, public safety, and emergency management agencies can take advantage of current and future communications and information technologies to communicate vital emergency-related information. This protocol should involve a standard set of terms and a way of grouping terms to communicate all appropriate information in human-readable and machine-readable manners. The exact nature of the machines must be thought of in a very inclusive way. A machine may be a general-purpose computer. It may be a specialized chip embedded in any variety of devices. It might be a digital messaging device such as a pager or cellular phone. It may simply be a display capable of displaying only a few characters or capable of paging through volumes of information. For instance, the AMBER system was originally implemented using electronic roadside signs that stimulated people to turn on their radios, but is now being distributed via email and to pagers by the AOL Internet service provider. The messages might simply be displayed or they might lead to specific actions such as triggering an EAS alert, turning on a radio or television, generating and scrolling a message, verbalizing a message, translation of the message into any language, sounding an alarm, opening fire-house doors, shutting off utilities, turning off air conditioners, etc. The goal is to include all appropriate ideas and concepts even though they may not all be used all the time. The challenge in defining the protocol is to think broadly enough that reasonable possibilities are not limited and yet not to make the protocol so inclusive that it becomes unwieldy.

A protocol is the result of merging content with technical requirements. The content should be inclusive of all the ideas, issues, concepts, and experience developed by people who have issued warnings, people who have studied the effectiveness of warnings, emergency managers, and others involved in composing, issuing, and utilizing warnings. The technical requirements must be set by technical experts who understand how the very wide variety of devices work that might be used to transmit and report warnings. There will need to be much iteration between these groups to converge on an effective protocol. For example, it may be technically necessary to specify short forms of words in order to scale to certain devices. These short forms need to be reviewed by the content specialists.

The protocol might be implemented in any number of ways. For general computing, use of a standard markup language such as eXtensible Markup Language (XML) appears very desirable. The protocol might also be expressed in a compact digital code, very small in volume and easily utilized by a wide-variety of devices. A message might be generated from a handbook or ideally from a series of menus or drop-down lists in a computer program. Computers processing routine data might also generate a message automatically.

A major benefit of a standard protocol is that it could be translated into any language. Implementation in different languages should be explored in detail. Some words do not translate literally. For example, a direct translation of the word evacuate into Spanish has more to do with bodily functions than leaving an area.

Any standard protocol needs to be backward compatible with EAS and the RSAME encoding used the National Weather Service (NWS) and the codes used by the AMBER system. Compatibility could mean using the same codes or simply being able to translate from one to the other. It should also be compatible with the VTEC (Valid Time & Event Code) currently being implemented by NWS.

In the rest of this section we will detail the important elements of a warning message protocol. The point of these details is that they highlight that this critical element of a unified warning system is quite complex and needs a great deal of forethought by a wide variety of users. Our workshop involved a good cross-section of the warning community but the actual development of a successful protocol will require broader representation and a longer process.

One issue is the need to differentiate among the forecast of an event, notification of event impacts, and ongoing information or updates. There is a fundamental need for a scale of terms that specify the general nature of this message. For example, messages that express:

1. A notification of a hazardous event that is happening
2. An alert that a significant hazard is highly likely in the near future
3. An alert that conditions are right for some type of event to happen, but no specific event is currently anticipated
4. A heads-up that there is some not so well established evidence for an event in the future

These are the types of issues addressed by the NWS terminology warning, advisory, watch, and outlook (See Appendix 4). While these words have been widely used, they are still not generally understood. This issue needs to be revisited in the framework of all all-hazards system as discussed earlier.

Some general requirements include:

1. A unique identification number must be assigned to every message and must never be allowed to change
2. An incident identification number must be assigned to every message
3. A way to communicate post-event messages that provide reassurance, give an all-clear signal, correct previous errors, etc.
4. Very general ways to specify the specific region of the hazard

5. A way to specify multiple regions with differing hazard. For example, within 3 miles (or blocks) high hazard, from 3 miles to 5 miles medium hazard
6. A way to allow for more than one action. For example, within 3 miles (or blocks) evacuate, from 3 miles to 5 miles shelter in place
7. A status field
8. Provision for encrypted validation of sender's authority
9. A field that indicates which person reviewed or validated the message
10. Fields should be included for computer-automated action based on measurement of event criteria. For example, earthquake magnitude so that tools receiving could respond to specific magnitudes with such actions as stop elevators, open garage doors at fire houses, turn traffic light at bridge to red and drop the barriers
11. Many events are compound events including accidents that may cause both a fire and a toxic release. The protocol must allow for such compound events with a field that identifies if the specific message is tied to a greater event, or other messages
12. A field to instruct the EAS system to be used with this message
13. A field for archiving that would allow for a collator to relate messages to one another without having to make a change to what was actually transmitted
14. A field that is used to issue messages to field equipment about programming changes, and perhaps the program update itself
15. Syntax for text to speech devices must be included in the content of the message.

Field descriptions and requirements instructions in the instructional document need to be comprehensive and use common terminology.

As our discussions turned from the general to the specific, we found it useful to use the *Common Alerting Protocol(CAP) (v.0.5) – Alert Message Format* (www.incident.com/cap/index.html) as a "straw man." We found that a lot of good thinking has gone into CAP and expanding and adapting it might be the most productive way to proceed. Our specific comments are listed in Appendix 2 to serve as a possible starting point for further discussions.

6. Research Needs

While considerable research informed public warning in the 1970's and 1980's, sponsors have not prioritized this area of inquiry for funding more recently. This trend in funding contrasts with emergent research needs due to major shifts in thinking among the professional warning community together with major societal change. The public warning professional community increasingly embraces an all-hazards approach to public warning consistent with best practices in disaster management. However, most existing early warning systems are still stove-piped. For this reason considerable research will be required to ensure the delivery of effective public warning. Specific research questions relate to similarities and differences of information needs across hazards, comparison of behavioral response to warnings across hazards that are perceptible and not perceptible, and formative research associated with the implementation of pilot systems.

The increased significance of terrorism as a disaster threat underscores the urgency of new research as well. Terrorism can result in disasters that are yet in uncharted territory for most Americans. In addition, the fact that terrorism results from a deliberate act may set up an important dynamic between warnings and actual terrorist acts where public warnings become part of a highly interactive system with the actual disaster threat. Research needs here are broad, covering a spectrum from basic research on the nature of terrorism to applied monitoring of the "publics'" response to various warning signals with widely varying degrees of specificity. Specific research needs include the following:

- Basic research on terrorist behavior
- Basic research on public response to terrorism and the threat of terrorism
- Research on the social and economic costs of terrorism warnings

- Research related to public warning signals:
  - ✓ The efficacy of warnings, given the inherent ambiguities of warnings/advisories
  - ✓ Use of existing geophysical monitoring systems for terrorism threat warning
  - ✓ Use of the publics as an information source
  - ✓ Determinants of specific terrorism warnings/advisories
  - ✓ Integration of existing special data bases to improve warning integrity
  - ✓ The effects of false negatives and positives on public responsiveness to warning and the long term effects of high rates of false positives
  - ✓ The effects of warnings on psychosocial stress
  - ✓ Formative research on the effectiveness of warning messages and their delivery systems

Terrorism and the threat of weapons of mass destruction raise important issues about how large populations will understand and respond to alerts of major nuclear or biological attacks and notifications of attacks in progress. Most people at risk from natural hazards have experienced several disasters and have some understanding of what to do and why.

At the same time, the past twenty years have witnessed dramatic societal change that may change the fundamental dynamics of public warnings. The revolution in information/communications technologies has had considerable effects on human behavior towards warning systems, begging research that challenges traditional behavioral paradigms guiding early warning and risk communications. The United States also has become far more diverse in terms of ethnic composition and socioeconomic stratification. Research questions include the following:

- Has there been a paradigm shift (drawing from social change models) in information consumption/use related to vulnerability/risk reduction/early warning systems? How does this vary by ethnic, socioeconomic, geographic and demographic characteristics?
- Can adaptive and interactive public warning models that are better integrated with training and decision-support tools result in improved public risk reduction?
- What renders information/signals credible to the publics and how does this vary by characteristics of the publics?
- What impact do advisories have on the behavior of publics? And on civil/uncivil behavior?

Given the formative nature of the Homeland Security Advisory System (HSAS), formative and summative research is essential. It is imperative that a monitoring system be put in to place to measure and evaluate warnings, public response, unanticipated effects, and the economic effects of HSAS. Given that a number of countries have a longer history in dealing with a more limited terrorist threat, comparative research synthesis of warning best practices is desirable. Finally, public warning research requires problem-focused and interdisciplinary approaches. A number of professional disciplines and sectors must come together, including communications/behavior change, risk communications, social persuasion, signal theory, the intelligence community, natural hazards community, game theory, etc.

A number of agencies may sponsor needed research including: NSF, DOJ, FEMA, DOT, HHS/CDC, DOD, NIH, USGS, USDA, DOT, EPA, NOAA, DOC, state agencies, foundations and industry. The need for research has never been as compelling as now. At no time in history has the time been ripe for an effective and efficient multi-hazard public warning system that includes the emergent threat of terrorism.

7. Recommendations

There was a solid consensus at this meeting that a uniform all-hazards public warning system must be developed if the United States is to have truly successful warning for any hazard. This consensus is quite notable because each of the attendees will need to change how they currently work in order to contribute to or use such a uniform system. Thus, our willingness to embrace the necessary work is evidence that we find the need for such a system extremely compelling.

Development and delivery of warnings is a complex process that requires national standardization of systems and procedures. Development of these systems and procedures must be done with the close assistance of the many different stakeholders in warning systems if they are to meet the need and be accepted and whole-heartedly supported nation-wide. The Partnership for Public Warning can provide leadership in bringing Federal, state, and local government together to the table with industry, research centers, and the many other key players.

A standard terminology needs to be developed. There is particularly the need for terms that distinguish different levels of available information such as warning, advisory, watch, outlook, and something equivalent to a hot tip. The definitions in Appendix 4 are a start towards such standard terminology. Definitions should be developed in a certified open standards process to assure they can be designated a standard.

The Common Alerting Protocol (CAP) (Appendix 2) needs to be developed similarly in an open standards process. It should be tested under many different conditions to prove the concepts.

One Federal agency needs to be identified to be responsible for assuring that national systems and procedures exist, are effective, and are properly utilized for the distribution of warnings and information for all types of hazards to state and local government personnel, agencies,

and authorities and to the publics. Until that changes, the current ineffective, heterogeneous situation will remain unchanged. The new Department of Homeland Security is a logical choice.

The Partnership for Public Warning and its members look forward to working with the lead agency, other agencies, private industry, universities, and other organizations to improve the effectiveness of warnings throughout the country.

Appendix 1: What Are The Actions That Should Be Taken?

The actions to be taken can often be divided into three categories: before, during, and after the event. However, for compound events it is sometimes not clear when an event is over. For instance, consider an earthquake followed by fires, chemical releases caused by the fires, and an ongoing aftershock sequence. While it may be easy to define when such an event begins, it is harder to differentiate between the "during" and "after" periods. However, this classification scheme can be useful for this discussion. Specific actions may depend on how imminent the event is, how certain it is, and the particular circumstances of the person. For the general publics, the intent is to empower them to take specific actions that include:

Before the event (Preparedness)

1. Heads up! Be aware. Something serious may be about to happen. This is what to expect.
2. Prepare
    a. Determine vulnerabilities/risks
    b. Develop a plan if you do not have one already
    c. Review the plan with family, business, etc.
    d. Get or supplement emergency supplies
3. Note suspicious activities (primarily for anticipated terrorism)
4. Seek more information from these sources
5. Consider modifying your daily routine
    a. Keep close to family or area of responsibility
    b. Consider protective actions for people or property (boarding up windows, moving to higher ground, …)
    c. Consider sheltering in place or evacuation
6. Be reassured

During the event (What is happening?)

1. Seek a safe location and position
2. Observe what is happening to prepare for response

Post event (Response and recovery)

1. Be aware, be vigilant, be civil
2. Here are the details of what happened or is happening
3. Seek more information from these sources
4. Government and other sources of help
5. Consider protective actions (Shelter in place, evacuate, avoid certain locations, close windows to reduce exposure to hazardous gases, do not drink the water)
6. Connect up with and help family and friends
7. Be reassured
8. Cautions (bogus donation agents)

The professional, technical community (scientists, security and law enforcement personnel) who define the threat and frame warnings need to consider other issues:

Before the event (Preparedness)

1. Analyze agency data, separate evidence and intelligence

2. Be aware of other agency actions
3. Advise partners and publics on what we know
4. Identify what we do not know
5. Share information on past events
6. Help partners and publics understand hazards and how to prepare
7. Stay within expertise but appreciate consequences
8. Coordinate with partners to insure consistent message
9. Be aware of public information already distributed by media and others
10. Get information on availability of local resources

During the event (What is happening?)

1. Tell what you know
2. Stay involved
3. Qualify statements with uncertainties
4. Provide authorities with needed information for local decisions

Post event (Response and recovery)

1. Analyze agency data, separate evidence and intelligence
2. Be aware of other Agency actions
3. Provide necessary information for response recovery
4. Evaluate performance for continuous improvement
5. Conduct rapid post event data collection supporting refined hazard analysis
6. Gut reaction
7. Support uniform terminology due to mobile society
8. Community development
9. Look for evidence of secondary hazards
10. Be aware of public information already distributed by media and others
11. Get information on availability of local resources
12. Determine scope of the crime scene

Emergency managers, first responders, business continuity experts (Groups with plans, that ramp up early and may be part of official warning source) need to consider other issues:

Before the event (Preparedness)

1. Event specific intelligence/information
2. Public information already out there (media)
3. Knowledge of other agency actions

During the event (What is happening?)

Post event (Response and recovery)

1. Event specific intelligence/information
2. Public information already out there (media)
3. Knowledge/coordination of other agency actions
4. Response
5. Recovery
6. Available resources

7. Reassuring messages
8. Event details
9. Government functions
10. Cautions (bogus donation agents)
11. Information on new resources
12. Scene management

The media play a major role in providing information, educating people, and interpreting events. In many areas there are media personalities whom segments of the population believe and trust. It is important to educate and engage the media. They are important partners in any warning process. It is also important to promote accountability of the media from the start. People alerted with more effective alerting methods will nearly always turn to the media for information.

Appendix 2: Comments On The Common Alerting Protocol

As our discussions turned from the general to the specific, we found it useful to use the *Common Alerting Protocol (v.0.5) – Alert Message Format* (www.incident.com/cap/index.html) as a "straw man." We found that a lot of good thinking has gone into CAP and expanding and adapting it might be the most productive way to proceed. We were only able to review some of the protocol's categories. Our comments are listed below to serve as a possible starting point for further discussions.

TAG NAME	COMMENTS	FURTHER ACTION
Nature of this notice	Alert, warning, automatic real-time information, notification, call to action, stand down, rumor control	
Source		
Sent		
Intended audience of this message	Ability to establish groups such as emergency managers, first responders, elected officials, …	
Urgency Priority	Descriptors are not general public friendly. Ability to reprioritize as multiple events unfold	Social science review and recommendations. Urgency different from timing. Just happened. Replace immediate with ongoing (update). Change recap to past or history. Use number of seconds, minutes, hours, and days.
Alarm	Is a tone alert required	
Severity intensity of the hazard	Appears OK.	Social science review and recommendations. Change unknown to uncertainty. Add catastrophic
Risk, the impact		
Probability	Word required for certain or occurring. Definitions need further work. Should not include % probability.	Social science and physical science review and recommendations. Might need second set of probability terms for law enforcement. Change unknown to uncertainty.
Change in probability	Is it now higher or lower, what is the trend?	
Intent	Criminal, accident, act of God	
Confidence level		
Event	Must allow for a compound event. Must allow for adjectives. Incomplete list (ex. terrorist related	Review by entire PPW community. Review by health services professionals.

	events, agricultural events, frost, hard freeze, plague, etc.). Duplication within list. May be too many options. Need to be looked at with technical field limitations considerations (ex. 15 character display limitation of screen).	
Event_desc	See above. Add additional fields: Criminal, Infrastructure, Chemical/Radiological, Biological, Environmental Change Health and descriptors to fall into the Bio/Chem/Rad. categories	See above. Add: **Under geo**: Avalanche, mud flow, eruption, ash fall, Lighting **Under Met**: Tropical Storm, seiche, smoke, depressions, Mud flow, Sub-tropical, **Under Criminal**: Bomb, Hijack, Civil disturbance, abduction, crime, **Under Safety**: Mass gatherings **Under Biological**: Pestilence, **Under Utility**: Water Outage, **Electrical Outage**: Natural Gas, etc. **Under Transport**: Traffic Restriction… Remove: Special Restriction, Special Provision **Under Environmental**: Water Quality, Air Quality **Under Safety** Remove; Civil disturbance, Abduction, Crime, Flooding **Under Infrastructure:** Combine items listed in Telecom and Utility, ADD: Structural failure
Cap: Response		
Affects	Was to accommodate Federal Information Processing Codes. Need an additional field with a description of the specific location, e.g. 3 mile radius with a center point at 5th Avenue and Main Street	Technical review.
Source_desc		
Status	Field title should be type, not status; however, a status (pending, current, suspended, cancelled, complete) field is required. Attributes appear good for field	Technical review. Add: Issued in error: Recall of previous message: Informational Change "Actual" to "Actionable"

	labeled type.	
Status_desc	Assumed to be type_desc. Why? would there not be a field for actual message as well?	
Event_id	May need to be rules associated with naming and renaming, however, not likely to be an issue at start of event but probably post-event. May want to use as a sort field once data archived.	
Incident_id	May need to be rules associated with naming and renaming, however, not likely to be an issue at start of event but probably post-event. May want to use as a sort field once data archived. Strike the word “larger” and note that incident is child to event parent.	Discuss parent/child relationship Is incident a child of event parent?
Effective		
Onset		
Expires		
Headline	Replace “slug” with common terminology.	Identify if this is the message title for news, pager? Is this the message?
Audience	Needs to include more detailed description so that audience is clearly defined; there are many publics, e.g. Latin community.	
Action	Suggest the need for two Action fields, with one action field being common terminology to choose from and the other an optional or an alternative field to be used where the common terminology does not meet the need.	Need: "if/then" field
Info_url		
Image_url		
Audio_url		
Parameter		
Contact		
Contact_role		
Contact_name		
Contact_title		
Contact_org		
Contact_tel		
Contact_email		
Contact_other		

The type of event should be listed first so the attribute codes can be made conditional on the event. This would allow the urgency scale for a toxic release to differ from that of an earthquake.

cap:urgency	Hours until event occurrence is expected = + X.X Hours since event occurred = –X.X Unknown = ?
cap:probability	Very likely ($p \geq .90$) Likely ($.90 > p \geq .65$) Even odds ($.65 \geq p > .35$) Unlikely ($.35 \geq p > .10$) Very unlikely ($.10 \geq p$)

cap:event	"Flooding is listed as "met" and "safety" events. Some "safety events" are actions, not events. These include "water rescue", "search and rescue", "evacuation", "access control", "curfew", "emergency relief" (which probably should be "disaster recovery". "Quarantine" is an action (see "cap:other_action), not an event. "Animals", is listed under safety, but "Animal" is listed under "health". What is the threat and why is it duplicated? "Hazardous material" should be broken down into "nuclear/radiological", "toxic chemical", "flammable", "explosive", "corrosive", "oxidizer", and "biohazard" (see DOT placarding chart). It is unclear what is a "distribution" event and why it is a "health" threat. Combine "telecom" and "utility" into "infrastructure" and make the categories "gas outage", ("flammable gas leak" should be in safety), "electric outage", "water outage", "water leak", "telecom outage", "telecom restriction",
cap:affects	Should be cap:effects or cap:impacts
cap:evacuation	Should be formatted just as cap:impacts to provide for "poly", "loc", or desc" attributes
cap:shelter_inplace	Should be formatted just as cap:impacts to provide for "poly", "loc", or desc" attributes
cap:action	Should be cap:other_action and should include "isolation", and "bottled/boiled/purified water"

Appendix 3: Examples Of Threat-Level Scales In Current Use

1. Air Quality Index (http://www.epa.gov/airnow/aqibroch/aqi.html#2)
2. Asteroids: The Torino Scale (http://explorezone.com/space/sub/torino_scale.htm)
3. Computer Virus Threat Severity Scales
    a. Panda Software Risk Assessment Criteria (RAC) (http://www.pandasoftware.com/library/indice_en.htm)
    b. Symantec Security Response Threat Severity Assessment (http://securityresponse.symantec.com/avcenter/threat.severity.html#category)
4. Earthquake Richter scale (http://www.seismo.unr.edu/ftp/pub/louie/class/100/magnitude.html)
5. Earthquake Parkfield Alert Scale (http://quake.usgs.gov/research/parkfield/statuspolicy.html)
6. Fire-danger Classes (http://www.fs.fed.us/fire/planning/nist/wims_ug/appe.pdf)
7. Graphical Techniques For Depicting Threat Levels for Hazardous Weather (http://www.srh.noaa.gov/mlb/ghwopres00.htm)
8. National Defense Scales
    c. DEFCON: The DEFense CONdition threat scale determines the posture of the military to prepare for the likelihood of war (http://www.fas.org/nuke/guide/usa/c3i/defcon.htm)
    d. THREATCON: condition for defense of the United States homeland and assets abroad (http://www.stuffiveheard.com/tac/tacalerts.html)
9. Nuclear Reactor Event Threat-scales
    e. US Nuclear Regulatory Commission classification of events (http://www.nucleartourist.com/operation/e-plan.htm)
    f. International Nuclear Event Scale (INES) (http://www-news.iaea.org/news/inesmanual/ines2001.pdf)
10. Technical Surveillance Threat Levels (http://www.tscm.com/threatlvls.html)
11. Terrorism Threat Level for Natural Gas Facilities (http://www.texasgas.com/Security%20Measures.htm)
12. Tsunami Threat Scales (http://www.wsspc.org/tsunami/OR/Tsuanami_Procedures_Oregon-2001.pdf)
13. Volcano Threat scale
    g. Response Plan for Volcano Hazards in the Long Valley Caldera and Mono Craters Region, California (http://geopubs.wr.usgs.gov/bulletin/b2185/)
14. Weapons of Mass Destruction
    h. U.S. Customs Service Alert Levels (http://www.customs.ustreas.gov/news/sept11/alertstatus.htm)
    i. 4 level CONPLAN (http://www.fbi.gov/publications/conplan/conplan.pdf)
15. Wind Threat Scale (http://www.srh.noaa.gov/mlb/tcworkshop_2001/slide14.html)

Appendix 4: Definition Of Terms Used

Here are sample definitions for several of the terms used in warning. A tool has been created on the PPW website (www.PartnershipForPublicWarning.org) for members to discuss and debate these and other terms as a way of developing a standard terminology. A committee within PPW will be actively expanding and improving this list.

Advisory: An event, which is occurring or is imminent, is less severe than for a warning. It may cause inconvenience, but is not expected to be life threatening or property threatening, if normal precautions are taken.

Alert: Information about an imminent hazard.

Factual statement: Report on current conditions; does not anticipate future events. Such statements are revised when warranted by new developments.

Forecast: (Weather) A prediction of what events are expected to occur. The range of predictability for hydro meteorological hazards extends from the short-term forecasts for one to two hours out to climatological forecasts for trends up to a year in advance. (Volcanoes) Comparatively nonspecific statement about volcanic activity to occur, weeks to decades in advance. A forecast is based on projections of past eruptive activity or is used when monitoring data are not well understood. This kind of statement is particularly useful for land use planning and development of emergency response plans.

Hazard: An event likely to cause injury or loss.

Notification: Providing information about typically an ongoing hazardous event.

Outlook: The potential for a hazard exists, though the exact timing and severity is uncertain.

Prediction: Comparatively specific statement giving place, time, nature, and, ideally, size of an impending eruption.

Probability: The likelihood that a given event will occur. A way to express uncertainty.

Risk: The possibility of suffering harm or loss. Exposure to injury or loss.

Statement: Detailed follow-up information to warnings, advisories, watches, and outlooks is provided.

Warning: Information provided to people at risk in advance of (alert) or during (notify) a hazardous event, with the objective of inducing those at risk to take appropriate action to reduce losses. The goal of warning is to prevent hazards from becoming disasters. The success of a warning is measured by the timely and appropriate actions taken to mitigate hazards and secure personal safety. Warnings about events days, weeks, years away can be explained in detail through the print and broadcast media. Warnings about events seconds,

minutes, hours away need to be disseminated rapidly through special warning systems. Warnings may be for hazards that people can clearly perceive or for hazards that cannot be perceived without specialized equipment or access to intelligence information. Such "warnings" need to specify

1. **What** type of event (why, how)
2. **Where** the event is likely to happen
3. **When** the even is likely to occur
4. **Severity** of the event that is likely
5. **Certainty** (probability) of each of these pieces of information
6. **Action** recommended
7. **Duration** of time warning is effective.

Watch: Conditions are favorable for occurrence (development or movement) of the hazard. The public should stay alert.