DISASTER BASICS

A training course for REACT Teams and members

This is a new REACT course designed to give every REACT member a basic understanding of major emergencies and disasters. This knowledge will help you plan for bad events that may impact your community as well as better prepare you to react in a disaster.

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I. WHAT IS A DISASTER?

The answer to this question is not simple. Let's start with the end of the problem with which most people are familiar and work up through disaster to catastrophe. There are many versions of the following set of criteria, but the following is a reasonable starting point in understanding the key concepts:

Routine Emergency – something that requires an emergency response to protect life, property, or the environment, but that can typically be managed by only a partial commitment of the resources of the jurisdiction in which it is occurring. For example, a house fire requires an emergency response by the fire department. It may even require mutual aid from a neighboring department to get resources to the scene quickly enough. Vehicles may use emergency driving privileges. The emergency medical services may dispatch ambulances in support and law enforcement may respond for a variety of reasons. Even though the house fire may be catastrophic for the family whose residence is destroyed, it is very much a routine event for a typical town or city. Routine emergencies are typically resolved in hours. Voluntary agency response is typically limited to assistance to the victims.

Major Emergency – an emergency that requires commitment of resources from a full range of government departments, adding agencies such as Public Health, Highway, Public Works, Social Services, and even the Sanitation Department, and that stresses the jurisdictions capabilities. Mutual aid may be a necessity to meet the full impact. Major emergencies typically are controlled within a day or two. Voluntary agency response is more extensive, but typically is managed by local resources.

Disaster – an event that exceeds the capability of the jurisdiction to manage it, and that requires assistance from higher levels of government. Typically purchasing and contracting rules are suspended, employees can be tasked to work outside their normal job description, and the normal budgetary allocation of funds can be modified to allow government to spend the sum sufficient to deal with the impact. Other rules and regulations may be suspended, evacuations ordered, shelters opened, mass feeding started, the National Guard mobilized, etc. Voluntary agency response will typically mobilize regional or national resources to deal with the event. Disaster response and initial recovery may be completed in weeks to months, but rebuilding from the event may take years to decades.

Catastrophe – a disaster event that severely stresses or exceeds available all national level resources and that involves extreme impacts over large areas, including massive destruction and large numbers of casualties. Assistance from other

countries, especially by specialized teams, may be required. Although rescue efforts may be completed in days and key infrastructure stabilized in weeks to months, a return to a semblance of normalcy may take years, and in some cases recovery may never be complete.

COMPLICATING THE DEFINITION

The above definitions do not have hard boundaries, and are relative to who is looking at the problem. For example, the destruction in Puerto Rico in 2017 was catastrophic for Puerto Rico, but the United States government response suggested that it was a routine disaster (committing fewer resources that the hurricane impacts in Florida and Texas during the same year).

The picture is further complicated by the variety of authorities government agencies have in the law. In some states in the United States the senior fire officer on scene has the authority to declare a mass casualty incident, a type of medical emergency, which may provide legal authority to do certain medical procedures that otherwise would not be permitted. Some agencies of both state and federal government have the authority to declare emergencies related to their agency mission, for example, public health emergencies. Other agencies do not declare emergencies or disasters but perform disaster work under their normal authority.

And finally, there are specific legal meanings to the terms emergency and disaster and requirements for their use. State governors in many cases declare States of Emergency for their state, which is a disaster declaration. On the Federal level the President may declare either an Emergency or a Disaster, with fewer authorities under an Emergency and more in a Disaster.

None of this directly impacts how you respond as a REACT member or as a Team. But it is important to understand what the terms mean in your jurisdiction and who has the power to declare them, because …

THE BOTTOM LINE

A disaster is a disaster when someone who is authorized by law to declare a disaster to be a disaster in fact does so.

II. THE TYPES OF DISASTERS

CATEGORIES

There are three generally accepted categories of major emergencies and disasters. Note that the names of the categories themselves vary, the assignment of types of events to categories vary, and that the lists of individual disasters is by no means comprehensive. Almost anything that can go wrong, and many things we think cannot go wrong can go wrong also.

Natural Disasters - these include a wide range of geologic, hydrologic, atmospheric, oceanic, and other events. An additional category that does not receive much attention, but that can significant impacts is space weather.

Geologic	earthquakes, landslides, avalanches, volcanic eruptions, volcanic collapse, sinkholes, cave-ins, and poisonous gas releases
Hydrologic	riverine flooding, flash flooding, urban runoff flooding, seiches, and droughts
Atmospheric	thunderstorms, tornadoes, hail, blizzards, ice storms, hurricanes, downbursts, nor'easter, other severe weather, heat waves, increasing impacts of climate change
Oceanic	severe storms, tsunami, coastal flooding, and rogue waves
Other	wildland fires, insect infestations, a wide variety of diseases, crop failures,

Man-Made or Technological Disasters – virtually anything in the built environment can and does fail.

Structures	bridge, dam, and building collapses, and tunnel cave-ins
Transportation	highway accidents, aircraft crashes, ship collisions and sinkings, railway accidents, mass casualty incidents, pipeline ruptures and fires and explosions
Processes	hazardous materials spills and releases, nuclear power plant accidents, other radiological exposures, industrial and residential fires, sewage releases, electrical power outages, pollution from industrial processes, earthquakes from waste product injection, potable water supply failures, poverty, starvation

Communications	Telephone, radio, television, Internet, and navigation systems outages

Conflict or National Security Events – we live in a period in which internal strife has become a major source of concern in many nations, including the United States, and in which the potential for nuclear war is increasing after a period of relative safety following the collapse of the Soviet Union.

Internal Unrest	large demonstrations, riots, targeted assassinations
Terrorism	targeted attacks on people, government officials, and facilities to achieve political purposes
Insurgency	medium scale, organized, internal armed conflict using unconventional warfare tactics and strategies
Civil War	full scale internal conflict between government forces and an opposing body that uses combat to seize and hold territory
War	state to state conflict which may result in widespread destruction of both military and civil targets, invasions, and the eventual devastation of the losing nation
War with weapons of mass destruction	Wars with widespread use of chemical, biological, or nuclear weapons resulting in catastrophic fatalities

ONE, TWO, OR MANY

It is tempting to view this large collection of bad things as separate, individual events. But very often they are not. For example:

- A hurricane dumps enough rain on flat agricultural land in southeast Virginia to cause a flood impacting the town of Franklin along the Blackwater River, covering much of the town in water with badly polluted with chemicals used routinely in farming. One event involves impacts from one atmospheric event (the hurricane), one hydrologic (riverine flooding), and one process related event (pollution).

- An earthquake (geologic event) off Indonesia generates a tsunami (oceanic event) that devastates the coast lines of Indian Ocean countries, including derailing and flooding (oceanic event) a railway locomotive and passenger cars (railway accident) and killing all aboard (mass casualty incident).

- A terrorist group (terrorism) uses a radiological dispersion device (weapon of mass destruction) in southern Russia to shut down rail travel on a main passenger route.

And the list goes on … Any initial single disaster event may well create multiple, related, secondary disaster events.

ONSET

Disasters occur in two basic scenarios based on the speed and time period of their onset from a normal state to impact:

Chronic Onset Disasters

- Slow onset, often over years or decades.
- Requires vision to identify them because the rate of change is slow and other problems may appear far more pressing.
- Often are recognized, but the political will does not exist to resolve them.
- Progressively worsen over time, until conditions force a solution which is often less effective than an earlier response would have been.

The United States provides three absolutely excellent examples: (1) the developing water crisis in the southwest and southern California, (2) the increasing vulnerability of New Orleans to catastrophic destruction due to the ongoing destruction of Mississippi delta wetlands, (3) the growing vulnerability of the Atlantic coastline of the United States resulting from overbuilding along the beaches.

Acute Onset Disasters

- Rapid onset, in weeks, days, hours, or minutes.
- Usually easy to forecast, recognize, and react to the threat.
- Time to react effectively may not exist, however.
- Outcomes are influenced by the behavior of people in the impact zone.
- Typically create the greatest potential for injury and death (although the development of effective warning systems for many threats have significantly reduced actual losses).

Outcomes in acute onset disasters are influenced significantly by the experience of the people at risk. For example, people who live in an area where hurricanes have

been reasonably frequent, but their impact relatively weak, may not take a major hurricane that will make landfall in their vicinity seriously. People who know that they live at the foot of a volcano, but the volcano has not recently erupted, may not take the threat of a pyroclastic flow seriously.

AREA COVERED

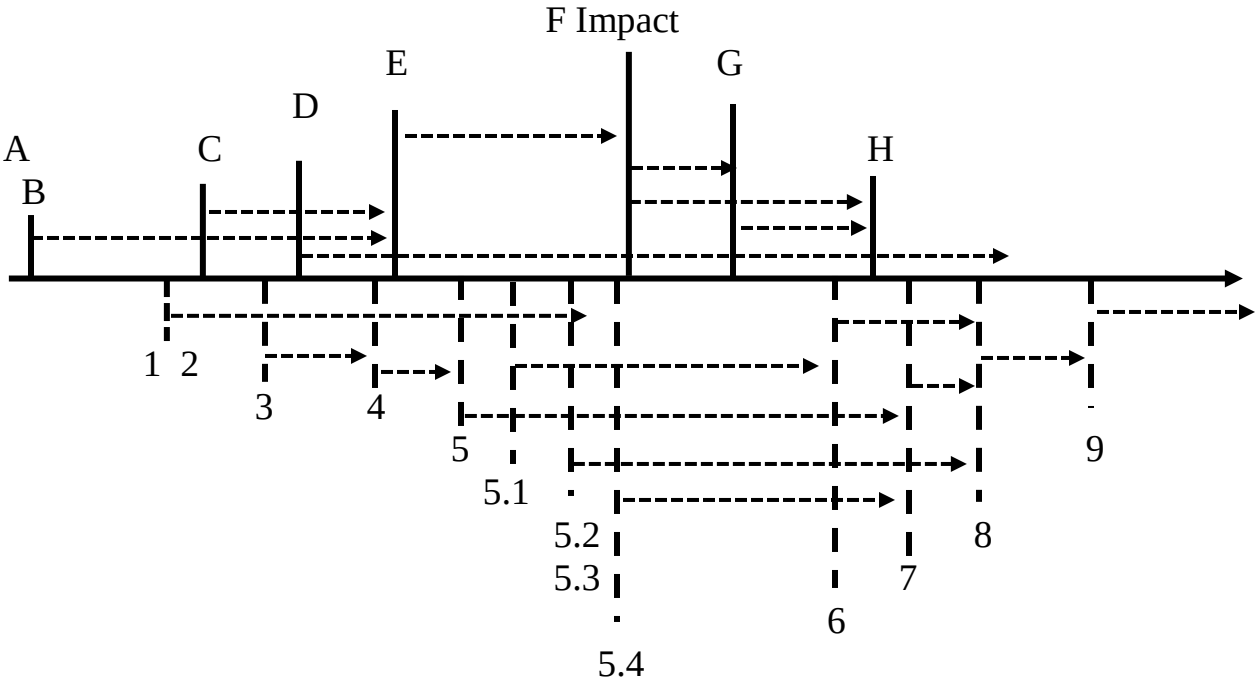
The area covered by the impact of a disaster plays a significant role in how it is managed. The following chart provides an approximate depiction of how area covered interacts with how the response is managed and resourced. There is significant variations to this based on state laws, the level of authority of local government, the current political view of disaster response, and the characteristics of the individual event.

Area	Lead Jurisdiction	Resources	Volunteers
Single town, city, or county	The impact town, city, or county	Local, mutual aid, state for technical assistance, federal for funding is there is a presidential declaration	Local voluntary organizations, local area voluntary organization mutual aid, state voluntary organization assistance
Region within a state	Each impact city or county – state government in a resource coordinating role	Local, state, intrastate mutual aid, federal for technical assistance and funding	State and regional voluntary organization response
State	Each impact city or county – state government manages allocation of its resources	Local, state, intrastate mutual aid, federal resources and funding	National voluntary organization response
National	Each impact city or county – state and federal government	Local, state, intrastate mutual aid, federal resources and	National voluntary organization response, international

	manages allocation of its resources – federal government manages use of international resources	funding, international teams	voluntary organization mutual aid

TIMELINE

For years emergency management training has been centered around the programmatic phases of disasters. You may have learned four phases – mitigation, preparedness, response, and recovery. If you search for disaster phases online, you will see a wide variety of other phases described in differing ways. The problem is that, because the focus is on how an emergency management program is managed, this is a significant underrepresentation of how complex the disaster event actually is. That complexity defines how we, as emergency communicators, react to the event.



The above diagram illustrates the complexity of the relationship between the disaster occurrence (items labeled A through H) and the overall response to the event (items labelled 1 through 9). A number of response actions have to happen simultaneously, or almost so, and a number of the steps in the disaster's time line also overlap. The

chart does not depict the exact time relationships between items in any specific type of disaster. However, the general curve above and below the lines is consistent with the intensity of the impact of the event (above the line) and the stress level on the response system below the line.

A. Pre-Existing Threats include anything in the area of concern that pose a hazard that can become active as a threat. One of the most important activities your Team can undertake is to identify the hazards that potentially can become threats to your community, state, and region. Hazards can be natural (a volcano, even apparently dormant poses a natural hazard of eruption), man-made (a dam and a large reservoir upstream poses a dam collapse and flooding threat to a downstream community), or reflect threats to national security (the increasing vulnerability of Guam and Hawaii to attack by nuclear weapons from North Korea is an example).

B. Environmental Changes include anything that changes the natural or built environment to increase the potential for disaster impacts. For example, extensive wildland fires in mountainous areas significantly increase the potential for flash flooding and mud flows. Failure to maintain a high hazard dam (one with a significant population at risk downstream) increases the possibility of failure, rapid release flooding, and downstream destruction.

1. Disaster prevention activities work to actually prevent the occurrence of disaster events. A good example are the avalanche control activities taken in heavy snow environments to trigger small snow slides to prevent the development of large unstable snow masses that could slide, block roads, destroy villages, etc.

2. Mitigation activities accept that events that can cause disasters will happen, but work to reduce those impacts to a level that they become manageable. For example, restrictions on building in flood plains recognizes that floods will happen but restricts the damage that they will do by minimizing the number and types of exposed structures.

C. Prodromes are signs of the potential for a developing disaster. To take a very simple example, a hot spot that you feel on your foot while wearing a new pair of shoes is a prodrome for the development of a blister. Prodromes may extend over many years or be short and specific to one event.

3. Preparedness activities include planning, training, equipping, recruiting volunteers, budgeting, exercising, etc. to get ready to respond to the development and onset of the disaster.

D. Seasons play a role in disaster timelines as specific times of the year show a greater concentration of specific types of events. For example, hurricane season, tornado season, and wildland fire season are not exact time periods, varying with the weather patterns, but they serve as a consistent annual prodrome of when to expect those events.

E. Development is the phase during which the forces which will eventually be released in the disaster grow to the point that impact is imminent.

4. Watches and Warnings are immediate preparedness tools to communicate that a disaster is possible or is developing.

5. Response actions are actions taken before the onset of the disaster impacts, during the height of the impacts, and immediately after the impact to rescue and protect people, property, and the environment.

5.1. Mobilization is the activation of response resources and prepositioning these resources and supplies in anticipation of the impact or in its aftermath.

5.2. Evacuation is a population protection measure to move residents and tourists out of the danger area of the natural or man made effects of a disaster event. It may be required post-impact if the failure of lifeline services makes an otherwise undamaged or minimally damaged area uninhabitable.

5.3. Sheltering is a population protection measure to house evacuees or those with special needs in a safe environment in preparation for the arrival of disaster impacts, during the impacts, and until reentry or other housing actions are possible.

F. Impact is the period during which the disaster's force is fully felt as a clear threat to life, including human, animal, and plant, property, and the environment. The wider impacts of this force is damage or destruction to the social structure of the impact area, the economic impacts, and the impacts to confidence of the citizens in their government's ability to protect them.

5.4. Rescue and other emergency operations to protect life and absolutely critical infrastructure may start during the development prior to the most serious impacts of the disaster being felt. They may be suspended for safety to resume after the worst of the impact starts to dissipate. Typically rescue operations to safe human life will

end and transition to body recovery once survival time for the conditions is exceeded.

G. Secondary Disaster Events include a wide variety of events that, had they happened on a normal day, would have been emergencies, major emergencies, or disasters in their own right. They are caused or facilitated by the primary disaster event and serve to significantly increase its impact.

H. Dissipation is the phase after impact during which the ongoing force of the disaster lessens and eventually ends.

6. Emergency Recovery actions are those taken to restore lifeline services (potable water, sewage, electric power, transportation routes, etc.) to allow reentry to occur.

7. Reentry is the process of the residents of the impact area returning to their homes and businesses to assess damage and take immediate actions to preserve and start to reoccupy their property.

8. Recovery is the process of restoring some degree of normalcy to the impact area and its population. This is typically thought of as restoring conditions such that businesses can reopen, people can go to work, and schools can resume instruction. Recovery is only a partial fix; it does not restore conditions to the way they were before the impact.

9. Long Term Recovery and Rebuilding are actions stretching from months to decades to restore the physical, social, and economic status of the impact area to something resembling its status before the disaster.

Note that this timeline has a number of events that may be described differently, placed in a different sequence, or omitted from other disaster timelines. This sequence is based on both United States and international practice and experience and on disaster research.

As you do emergency planning for your team, it is important to look at the types of disasters your community may face, how rapid their onset is, and in which portions of the event can you make a contribution with your communications capabilities.

III. WHAT DO DISASTERS DO?

The simple answer is that you should always expect that a disaster will make a mess of anything that it can. It is not that disasters are some evil entity, it is that disrupting and destroying is just what they do, and do well. To look at the big picture, disasters impact the following areas:

Deaths and injuries – disasters have the potential to injure and kill people, either from the initial forces involved or from subsequent secondary events. Sometimes the causes of death or injury are not the obvious ones. For example, in hurricanes in the United States in general, evacuations have reduced the mortality from wind and storm surge (the movement of ocean water onto the land with widespread flooding in coastal areas), but inland flooding from heavy rain remains a significant potential source of deaths. Fortunately, the trend in developed nations has been that while economic losses from disasters have increased, deaths and injuries have steadily decreased.

Psychological impacts on both those impacted and the responders – disaster events and the response and recovery period afterwards are periods of high stress for both those impacted by disasters and the responders. Although commonly described, panic is not one of the typical outcomes in most cases. Those impacted do move quickly to seek shelter and avoid the impacts of the event, but do so rationally based on their training and experience, and purposefully. Panic is only likely if escape is impossible.

In the aftermath survivors may develop survivor guilt, the unreasoning questioning of why they survived and others did not. Responders may show all of the normal reactions to stress, including short temper and difficult relations with others. Members of the impact area's emergency services may refuse to be relieved and work themselves into exhaustion, driven by the need to serve their community and their perceptions of expectations of others.

Both survivors and responders may suffer from posttraumatic shock disorder (PTSD).

Disruption of, damage to, or destruction of lifeline services – lifeline services are those required to allow people to live and work in the impact area with some reasonable degree of safety and functionality. They include electric power, waste water, potable water, communications, clear transportation routes, access to food

and some degree of shelter, and basic financial services. In a significant disaster you can expect all of these will be damaged or disrupted. This means that responders must be as self-sufficient as possible for as long as possible.

Damage to or destruction of infrastructure – in addition to lifeline services, virtually any part of the built environment may be damaged or destroyed in a disaster. Port facilities, schools, warehouses and industrial facilities, governmental buildings, etc., all are vulnerable to disaster impacts.

Damage to or destruction of property – agricultural land may be made unusable by inundation by sea water. High winds may blow down forests, losing valuable timber and creating an increased wildland fire threat in coming months. The destruction of residences may render large numbers of people essentially homeless and spur migrations out of the disaster area. New Orleans lost a large part of its population after Hurricane Katrina and a significant portion of Puerto Rico's population has or is leaving in the aftermath of Hurricane Maria.

Impact on the economy – loss of infrastructure, loss of property, loss of people through migration, all mean that the cost of rebuilding will be high, high enough that some businesses will close or move away. Employment options for those who remain will be limited. Those who have surviving or salvageable homes, but no employment, may lose their homes. The tax base and sales tax revenue will decline severely limiting what local government can do.

Economic cost – the cost of the 2017 Mexico City earthquake may be as high as 2 billion US dollars. The cost of Hurricane Harvey is estimated at $90 billion or approximately $3000 per individual in Texas. The cost of Hurricane Maria in Puerto Rico is estimated as approximately $35 billion, approximately $10,000 per individual in a much poorer economy.

Impacts on the trust people have in their government – if disaster response and recovery efforts are seen as mismanaged, unfair, or corrupt, trust in government will erode. At the simple end of this problem, the result may be a revolt at the ballot box. However, government may see it as an even more dangerous possibility for actual revolt. Mismanagement and corruption in the aftermath of the 1972 Managua earthquake in Nicaragua led to the overthrow of the Somoza regime. The People's Republic of China for many years never reported disasters because of the fear that a disaster questioned the infallibility of the Chinese Communist Party.

Criminal activity – crime does not take a holiday during a disaster. Looting can be widespread in civil unrest. In natural disasters, looting does also occur, but a substantial part of this is people who lack basic supplies such as food and water and lack any way to access what they need for survival.

Impact on relations with others based on economic status, race, and ethnicity - in disasters it is not uncommon for there to be a search for scapegoats and racial, religious, etc. communities within a community to be blamed for political reasons. The oft repeated and false statement of one presidential candidate that he saw thousands of Muslims cheering in New Jersey as the World Trade Center towers fell in the 11 September attacks is an example. It is also not uncommon for the disaster to be used as a justification for people who are not part of the dominant economic, racial, or ethnic group in the community to be subject to discrimination in allocation of disaster relief funds and benefits.

IV. SPECIFIC IMPACTS OF EVENTS

The following table summarizes typical causes and impacts of natural emergencies and disasters.

Event	What Is It?	Impacts
Avalanche	Rapid flow of snow down a slope	Buildings, roads, and railroads buried, towns cut off, persons buried in the snow
Blizzard	Snow event with high winds and lowered temperatures	Transportation halted, power and phone outages, impacts to animal populations; towns, villages, settlements cut off
Cave-in	Collapse of tunnels or mine shafts or other excavations.	Transportation routes or access blocked, deaths
Climate change	Gradual warming of the Earth's climate	Sea level rise and flooding, vegetation changes, desertification, changes in weather patterns
Coastal flooding	Inundation of low lying coastal areas as a result of prolonged winds, unusually	Transportation routes closed, roads and bridges damaged, structures damaged or destroyed, animal and human

	high tides, hurricanes, nor'easters, and tsunamis	deaths, changes in the coast line
Crop failures	Loss of crops in the field due to weather, climate, drought, insect infestation, or disease	Food shortages leading to starvation, economic impacts to agricultural sector
Disease, epidemic and pandemic, human, animal, or plant	Typically infection by bacteria, viruses, fungi, protozoa, or multicellular organisms or through exposure to hazardous materials	Mass sickness, mass deaths, loss of productivity, in animals and plants food shortages leading to starvation, economic impacts to agricultural sector
Downburst	A strong downdraft with damaging winds on or near the ground.	Locally high winds reaching as much as 168 miles per hour
Drought	Water shortage resulting from a period of abnormally low rainfall or snow melt	Impacts on human, animal, and plant populations, crop failures, food shortages leading to starvation, economic impacts to agricultural sector
Earthquake	Rapid shifting of the earth's surface, typically along fault lines	Damage to transportation, power, and communications systems; building, bridge, and dam collapses; fires; mass casualties with people trapped; tsunamis
Flash flooding	Rapid onset flooding of low lying areas caused by heavy rain or rapid melting of snow	Transportation routes closed, roads and bridges damaged, structures damaged or destroyed, animal and human deaths
Hail	Solid ice precipitation in varying sizes of balls or irregular lumps	Structural damage to buildings and vehicles, mass animal fatalities, crop destruction
Heat waves	Sustained abnormally high temperatures	Human and animal deaths, failure of electrical power systems

Hurricanes and other tropical cyclones	rapidly rotating storm system with a low-pressure center, low-level atmospheric circulation, strong winds, thunderstorms that produce heavy rain, and tornadoes.	Coastal erosion and flooding, inland flooding from heavy rain, human, animal, and plant deaths, coastal settlements damaged or destroyed, communications outages, vessels sinking
Ice storm	Freezing rain landing on cold surfaces	Blockages of transportation systems, power and communications outages
Insect infestations	Abnormally large numbers of insects in an area or location	Transmission of human, animal, and plant diseases, crop devastation
Landslide	A sliding mass of earth or rock including rockfalls, slope failures, and shallow debris flows.	Destruction of buildings, transportation and communications infrastructure, towns buried, fatalities
Mudflow	A rapidly moving mass of fluid soil associated with rain or melting snow	Destruction of buildings and vehicles and even complete towns, fatalities, extensive debris fields
Nor'Easter	US east coast winter storm with relatively slow movement and high winds	Sustained beach erosion over multiple tide cycles, coastal flooding, high wind, heavy snow, vessel sinkings
Poisonous gas release	Rare phenomenon with release of a buildup of carbon dioxide gas in a lake	Mass casualties by asphyxiation
Riverine Flooding	Outflow of water into normally dry land from watercourses ranging from creeks to major rivers	Transportation routes closed, roads and bridges damaged, structures damaged or destroyed, animal and human deaths, water supply contamination
Rogue waves	Unpredictable ocean waves of great height	Ships, even large ones, badly damaged or sunk
Sieche	Wave oscillation in a confined body of water	Dams overtopped, flooding, destruction of buildings, mass fatalities

	caused by wind, earthquake, or landslide	
Sink hole	Collapse of the surface of the land caused by the dissolving of underlying rock by groundwater	Building and vehicle destruction, transportation route blockage
Thunderstorm	A storm with lightning, thunder, typically high winds, heavy rain, and sometimes hail	Aircraft crashes, localized flash and urban runoff flooding, damage to trees, lightning damage including structural damage to buildings and fires, downbursts
Tornado	Violently rotating column of air in contact with the surface and a cumulonimbus cloud	Building and vehicle destruction, transportation route blockage, communication outage, fatalities
Tsunami	Series of ocean waves resulting from earthquakes or land collapses or slides (including underwater)	Intense, rapid onset, wave trains leading to severe coastal flooding, destruction of built environment, and mass fatalities
Urban runoff flooding	Flooding resulting from urban runoff of rainwater in areas where the built environment has reduced the ability of the soil and vegetation to absorb rainfall	Rapid flooding closing transportation routes, flooding vehicles and residential and business property, and resulting in water pollution
Volcanic collapse	Lateral collapse of the flank of a volcano	Release of magma flows, tsunamis, volcanic explosions
Volcanic eruption	Discharge of lava, ash, and gas from the vent of a volcano	Lava flows burn and destroy everything in their path, rapidly moving gas and rock clouds (pyroclastic flows) result in fatalities, mud and debris flows (lahars) result in widespread destruction
Wildland fires	Grass, brush, and forest fires from a variety of causes, including lightning,	Highways closed, extensive loss of forest resources, destruction of towns and

	improper cooking at camp sites, and arson	buildings, animal and human deaths

The following table summarizes typical impacts of failures in man-made systems.

Event	Impacts
Bridge collapses	Transportation routes blocked
Dam collapses	Severe flooding downstream of the dam with significant destruction and loss of life (if warning inadequate)
Building collapses	Possible mass casualty/mass fatality incident with victims trapped
Tunnel cave-in	Transportation route blocked, vehicles and people crushed or trapped by the cave-in
Highway accidents	Vehicles damaged or destroyed, large incidents involve mass casualties, hazardous materials releases, pollution
Aircraft collisions and crashes	Aircraft destroyed, fire, mass casualties, mass fatalities, destruction on the ground, if at airport transportation facility closed
Ship fires, collisions, and sinkings	Vessel damaged or destroyed and cargo lost, injuries and fatalities, in some cases vessel simply disappears and is not located
Railway accidents	Transportation routes blocked, mass casualties, hazardous materials explosions, fires, or releases
Pipeline ruptures	Spills of hazardous materials, pollution, explosions, fires
Mass casualty and mass fatality incidents	Large numbers of injured (mass casualty, with the potential for significant mortality) or deceased (mass fatality) victims requiring special procedures for their management
Hazardous materials spills and releases	Exposure leading to illness, injury, or death for humans, animals, and plants, pollution, long term contamination of land, airborne inhalation hazards to life
Nuclear power plant accidents	Possible serious facility damage with impacts extending downwind outside the facility to cause radiation sickness, evacuations, sheltering, and long-term monitoring

Other radiological exposures	A wide variety of exposures ranging from limited in number of people impacted to relatively large numbers and with considerable variability in the physical effects of the exposures ranging from mild to death
Industrial fires	Destruction of property, release of hazardous materials, potential exposure of many people to dangerous fumes
Residential fires	Building destruction or damage, in apartments and residential facilities mass casualty incident
Sewage releases	Pollution, contamination of potable water sources
Electrical power outages	Loss of power and communications, loss of environmental controls for buildings and exposure of occupants to heat or cold, inability to run pumps and equipment
Industrial process pollution	Long term contamination of the ground and water sources, diseases related to the type of exposure, debilitation, increased mortality, loss of property values
Waste product injection earthquakes	Swarms of low intensity earthquakes in the vicinity of the injection site with frequent minor damage and falling property values
Potable water supply failures	Drinking and cooking water unavailable, boil water orders may allow water use if supply is working but contaminated, typically requires large bottled water delivery operation
Poverty	Increased vulnerability to disease, death in heat waves or cold weather, residential fires, and starvation
Starvation	Debilitation and mass fatalities among poor human populations and animal populations

V. DISASTER SCALES AND OTHER MEASURES

A wide variety of scales are used to describe the danger posed by a disaster event. Some are not widely used, some are used primarily by disaster scientists, but you may encounter the following when dealing with major emergencies and disasters.

Watches and Warnings – although these are not a measurement of disaster size or intensity, they are a measure of how concerned you should be about a developing natural event. In general establishment of a Watch indicates that conditions are favorable for the development of a particular type of event. Thus a tornado watch indicates that atmospheric conditions allow the development of tornadoes. A Warning means that the event type is expected or is in progress now – a funnel cloud on the ground or observation of rotation radar signatures would trigger a tornado warning. There is a refinement for hurricane and tropical storm warnings; they are issued 36 hours prior to the expected arrival of hurricane conditions.

Wildland fire Warnings – for wildland fires a Fire Weather Watch and a Red Flag Warning are used to convey the scale of the danger. A Fire Weather Watch is issued 12 to 24 hours before there is the relatively low probability of the development of severe fire weather. The fire danger level is typically high to extreme. A Red Flag Warning is issued when there is imminent danger of severe fire weather conditions, including when there is a high probability of dry lightning. The national Fire Danger Rating System classifies wildfire danger as (this description is provided by the National Park Service):

- **Low (Green)**—Fire starts are unlikely. Weather and fuel conditions will lead to slow fire spread, low intensity and relatively easy control with light mop-up. Controlled burns can usually be executed with reasonable safety.

- **Moderate (Blue)**—Some wildfires may be expected. Expect moderate flame length and rate of spread. Control is usually not difficult and light to moderate mop-up can be expected. Although controlled burning can be done without creating a hazard, routine caution should be taken.

- **High (Yellow)**—Wildfires are likely. Fires in heavy, continuous fuel such as mature grassland, weed fields and forest litter, will be difficult to control under windy conditions. Control through direct attack may be difficult but possible and mop-up will be required. Outdoor burning should be restricted to early morning and late evening hours.

- **Very High (Orange)**—Fires start easily from all causes and may spread faster than suppression resources can travel. Flame lengths will be long with high intensity, making control very difficult. Both suppression and mop-up will require an extended and very thorough effort. Outdoor burning is not recommended.

- **Extreme (Red)**—Fires will start and spread rapidly. Every fire start has the potential to become large. Expect extreme, erratic fire behavior.

100-500 Year Events – the use of 100 year or 500 year (or any other number of years) criteria for floods is common for emergency management and land use planning, and as a tool to describe the magnitude of a flooding event. A 100 year flood is a flood that you could expect to have happen once in a 100 year period. However, if you had a 100 year flood last year, it does not mean that it will be 99 years before you have another. It also does not mean that the chances of having a 100 year flood increases with each passing year. You might have 100 year flood this year as well. For a number of reasons, there is a growing sense of unease that 100 year floods are now more accurately cast as some smaller number, perhaps 50 year or 25 year floods.

Injuries and Fatalities – in events where a number of individuals have suffered injuries or been killed the following three terms are commonly used to characterize the extent of the event. Note that these terms are elastic; what is a mass casualty incident for a small rural jurisdiction might be a normal Saturday night for a major city.

- **Multiple Casualty Incident** – an incident with multiple injured individuals which can be managed using normal emergency medical protocols.

- **Mass Casualty Incident** – an event that generates sufficient numbers of injured individuals to stress the emergency medical services system's ability to respond and to require the use of special mass casualty procedures.

- **Mass Fatality Incident** – an event that results in more human remains can be handled using local resources. In at least one state 25 deceased has been considered the criteria for declaration of a mass fatality incident.

Moment Magnitude – although news media routinely report earthquakes in terms of numbers on the Richter Scale, there are a number of different measures of earthquake magnitude. Magnitude refers to the relative size of an earthquake based on the maximum motion as measured by a seismograph. The larger the number the more extreme the motion. In the United States the current earthquake magnitude measure is Moment Magnitude. The following two tables from UPSeis at Michigan Technological University) is a general guide to the effects and classes of various magnitudes.

Magnitude	Effects	Estimated Annual Number
2.5 or less	Usually not felt	900,000
2.5 to 5.4	Often felt but causes only minor damage	30,000
5.5 to 6.0	Slight damage to buildings and other structures	500
6.1 to 6.9	Extensive damage in very populated areas	100
7.0 to 7.9	Major earthquake with serious damage	20
8.0 or greater	Great earthquake able to completely destroy communities near the epicenter	One every 5 to 10 years

Earthquakes are also assigned to classifications by their magnitude. Note that these classes differ from the damage descriptions.

Class	Magnitude
Minor	3.0 to 3.9
Light	4.0 to 4.9
Moderate	5.0 to 5.9
Strong	6.0 to 6.9
Major	7.0 to 7.9
Great	8.0 or more

Modified Mercalli Scale – this scale measures the perceived intensity of earthquake shaking at the observer's location (this description is provided by the United States Geological Survey). This is a good example of a scale which provides a cue as to the extent of the problem for a given measure of intensity.

Intensity	Shaking	Description and Damage	Moment Magnitude
I	Not felt	Not felt except by a very few under especially favorable conditions	1.0 to 3.0
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings	3.0 to 3.9
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an	

		earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.	
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.	4.0 to 4.9
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	5.0 to 5.9
VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	6.0 to 6.9
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	7.0 and Higher
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	

Enhanced Fujita Scale – The Fjuita Scale has been widely used to classify the impact of tornadoes. One of its limitations was the focus on wind speed as the determinant of damage. In 2007 a revised scale was developed, the Enhanced Fujita Scale which estimates wind speed based on the damage suffered. The following (data from the Weather Channel) is the simplified form of the actual scale used which assesses specific damage to 28 different types of buildings and objects.

Rating	Damage	Description	Wind Speed
EF 0	Light	Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.	65-85 mph
EF 1	Moderate	Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.	86-110 mph
EF 2	Considerable	Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.	111-135 mph
EF 3	Severe	Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.	136-165 mph
EF 4	Devastating	Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.	166-200 mph
EF 5	Incredible	Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd); high-rise buildings have significant structural deformation; incredible phenomena will occur.	Over 200 mph

TOR:CON – TOR:CON is a 0 (lowest) to 10 (highest) rating of the potential for the development of a tornado in a given 12 hour day or night period within 50 miles of a specific area. TOR:CON is used by the Weather Channel in tornado season; it is not used by the national Weather Service. TOR:CON values are:

- 8+ Very high probability of a tornado
- 6 - High probability of a tornado
- 4 - Moderate chance of a tornado nearby, but hail and/or high wind gusts possible
- 2 - Low chance of a tornado, but hail and/or high wind gusts possible
- 0 - Near-zero chance of a tornado or a severe thunderstorm

Multiplying the TOR:CON value by 10 gives you an easily communicated percentage probability of the development of a tornado in the area.

Saffir-Simpson Hurricane Scale – The Saffir-Simpson Scale is the commonly accepted scale for characterizing hurricanes by their wind speed (table from the National Hurricane Center).

Category	Sustained Wind Speed	Summary	Description
1	74-95 mph 64-82 knots 119-153 km/h	Very dangerous winds will produce some damage	Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph 83-95 knots 154-177 km/h	Extremely dangerous winds will cause extensive damage	Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.

3	111-129 mph 96-112 knots 178-208 km/h	Devastating damage will occur	Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130-156 mph 113-136 knots 209-251 km/h	Catastrophic damage will occur	Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	157 mph or higher 137 knots or higher 252 km/h or higher	Catastrophic damage will occur	A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Volcanic Eruptions – Volcanic eruptions are described in several ways. The Volcanic Explosivity Index (or VEI) table below (from multiple sources) combines several of the key elements. The ejecta volume is important because it provides a measure of how much material is likely to come out of the vent of the volcano. The larger the quantity the wider the ash fall and other types of destruction. The classifications are named after specific volcanic eruptions that have what have become standard characteristics. For example, a Plinian eruption named after the Roman writer who described it, Pliny the Younger, is the type of eruption that destroyed Pompei. Plume height has become increasingly important because of the damage that virtually invisible ash particles will do to aircraft engines at altitude.

VEI	Ejecta Volume in cubic kilometers	Classification	Description	Plume Height	Frequency
0	Less than 0.00001	Hawaiian	Effusive	Less than 100 m	continuous
1	More than 0.00001	Hawaiian Strombolian	Gentle	100 m – 1 km	daily
2	0.001+	Strombolian Vulcanian	Explosive	1-5 km	every 2 weeks
3	0.01+	Vulcanian Pelean Sub-Plinian	Catastrophic	3-15 km	3 months
4	0.1+	Pelean Sub-Plinian Plinian	Cataclysmic	10 km +	18 months
5	1+	Pelean Plinian	Paroxysmic	10 km +	12 years
6	10+	Plinian Ultra-Plinian	Colossal	20 km +	50-100 years
7	100+	Ultra-Plinian	Super-Colossal	20 km +	500-1000 years
8	1000+	Ultra-Plinian	Mega-Colossal	20 km +	50,000 years

Nuclear Power Station Accident - The Nuclear Regulatory Commission has standard criteria for emergencies within a nuclear power station. If your Team is in the vicinity of a nuclear power station you should be familiar with these classifications.

- **Unusual Event** – a small problem onsite with no release of radioactive material expected.

- **Alert** – an actual or potential substantial degradation of the level of safety of the plant. Any release of radioactive materials is expected to be a small fraction of that specified in the Environmental Protection Agency (EPA) Protective Action Guide (PAG) for Nuclear Incidents.

- **Site Area Emergency** - events are in process or have occurred that result in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material are not expected to exceed the levels established by the EPA PAGs except near the site boundary.

- **General Emergency** - a serious problem involving actual or imminent substantial core damage or melting of reactor fuel with the potential for loss of containment integrity. Emergency sirens will be sounded. Radioactive releases can reasonably be expected to exceed the EPA PAGs for more than the immediate site area.

THE OTHER BOTTOM LINE

The importance of all these scales lies in what they tell you about the probability that the disaster will occur and the disaster environment in which you will be working.

For example, do you have to worry about an Ultra-Plinian Mega-Colossal volcanic eruption from the dormant to extinct San Juan volcanic fields dumping 1000+ cubic kilometers of ash and rocks on your Team if you live in Denver? At once every 50,000 years probably not this week. On the other hand if today's TOR:CON forecast is 9 for the Denver area, it is probably a sensible idea to alert your Team members, make sure someone is assigned to monitor the weather, and be ready to respond if tornadic activity develops.

And if there is a major earthquake in the Yellowstone area and you have been asked to deploy to assist, Modified Mercalli scale reports of VII in the area to which you are assigned should alert you to expect:

> Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.