NATIONAL PLANNING SCENARIOS

Created for Use in National, Federal, State,
and Local Homeland Security Preparedness Activities

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Contents

Introduction

The Federal interagency community has developed 15 all-hazards planning scenarios (the National Planning Scenarios or Scenarios) for use in national, Federal, State, and local homeland security preparedness activities. The Scenarios are planning tools and are representative of the range of potential terrorist attacks and natural disasters and the related impacts that face our nation. The objective was to develop a *minimum number* of *credible* scenarios in order to establish the *range of response requirements* to facilitate preparedness planning.

Since these Scenarios were compiled to be the minimum number necessary to develop the range of response capabilities and resources, other hazards were inevitably omitted. Examples of other potentially high-impact events include nuclear power plant incidents[1], industrial and transportation accidents, and frequently occurring natural disasters. Entities at all levels of government can use the National Planning Scenarios as a reference to help them identify the potential scope, magnitude, and complexity of potential major events. Entities are not precluded from developing their own scenarios to supplement the National Planning Scenarios.

These Scenarios reflect a rigorous analytical effort by Federal homeland security experts, with reviews by State and local homeland security representatives. However, it is recognized that refinement and revision over time will be necessary to ensure the Scenarios remain accurate, represent the evolving all-hazards threat picture, and embody the capabilities necessary to respond to domestic incidents.

How to Use the National Planning Scenarios:

Capabilities-Based Planning –

In seeking to prepare the Nation for terrorist attacks, major disasters, and other emergencies, it is impossible to maintain the highest level of preparedness for all possibilities all of the time. Given limited resources, managing the risk posed by major events is imperative. In an atmosphere of changing and evolving threat, it is vital to build flexible capabilities that will enable the Nation, as a whole, to prevent, respond to, and recover from a range of major events. To address this challenge, the Department of Homeland Security (DHS) employs a capabilities-based planning process that occurs under uncertainty to identify capabilities suitable for a wide range of challenges and circumstances, while working within an economic framework that necessitates prioritization and choice. As a first step in the capabilities-based planning process, the Scenarios, while not exhaustive, provide an illustration of the potential threats for which

[1] A severe incident at a nuclear power plant, whether or not it is terrorist-initiated, could result in a release of radioactive materials to the environment with adverse consequences to public health. Scenarios for such severe incidents have not been included in this scenario set because: (1) current Federal regulations from the Nuclear Regulatory Commission and the DHS Federal Emergency Management Agency (FEMA) mandate robust emergency planning and preparedness for each nuclear plant to include the full range of response organizations; and (2) scenarios for nuclear plants cannot be generically extrapolated to other types of facilities (e.g., chemical plants).

we must be prepared. The Scenarios were designed to be broadly applicable; they generally do not specify a geographic location, and the impacts are meant to be scalable for a variety of population and geographic considerations.

HSPD-8 Implementation –

The Scenarios will be used in the implementation of the Homeland Security Presidential Directive (HSPD)-8, "National Preparedness," including the development of the National Preparedness Goal and the National Exercise Program. In helping to develop the National Preparedness Goal, the Scenarios provide the foundation for identifying the capabilities across all mission areas and the target levels of those capabilities needed for effective prevention, response, and recovery to major events, such as those outlined in the Scenarios. Examination of the Scenarios leads to certain common functions that must be accomplished. The need for response organizations to move quickly and in a coordinated manner and the requirements to quickly treat mass casualties and to assist displaced residents are examples. This commonality implies flexible, adaptive, and robust capabilities to cope with diverse events and hazards.

In addition, the Scenarios will be used as the design basis for exercises in the National Exercise Program. As a common foundation for exercise development, the Scenarios reduce the possibility that agencies exercising the same basic type of event will exercise greatly different consequences which may lead to vastly different capability requirements and preparedness expectations. While not meant to be all-inclusive, the Scenarios provide a basic set of common homeland security events and their related impacts that can be employed at the national level or by States and localities. Although certain areas have special concerns—for example, continuity of Government in Washington, DC; viability of financial markets in New York; and trade and commerce in other major cities—the Scenarios have been developed in a way that allows them to be adapted to local conditions. Agencies will not be limited to this set of Scenarios, and they will continue to be able to exercise scenarios that are not specifically included in the planning set. However, when exercising the basic events included in the Scenario set, the Scenarios provide a mutual starting point.

General Considerations for the Scenarios:

Future Development of Prequels –

The goal of the Part I of the Scenarios is to flesh out response capabilities and needs, not threat-based prevention activities. For the terrorist attack Scenarios, DHS, in coordination with the Federal interagency community, has developed detailed prequels to the scenarios, including information on the perpetrator, the "Universal Adversary" (UA), to help further prevention related planning and preparedness efforts. The UA prequels are published as Part II and Part III of the Scenario set.

Scenario Outline –

Each scenario in the National Planning Scenarios follows the same general outline, which is as follows:

- Scenario Overview
  - General Description
  - Detailed Attack Scenario (or Detailed Scenario when a UA is not present)
- Planning Considerations
  - Geographical Considerations/Description
  - Timeline/Event Dynamics
  - Meteorological Conditions (where applicable)
  - Assumptions
  - Mission Areas Activated
- Implications
  - Secondary Hazards/Events
  - Fatalities/Injuries
  - Property Damage
  - Service Disruption
  - Economic Impact
  - Long-Term Health Issues

Intelligence Disclaimer –

While the scenarios developed generally reflect possible terrorist capabilities and known tradecraft, neither the Intelligence Community nor the law enforcement community is aware of any credible specific intelligence that indicates that such an attack is being planned, or that the agents or devices in question are in possession of any known terrorist group.

Relative Grouping of Scenarios –

Depending on the ultimate use, various schemes have been used in the past to rank scenarios based on probability, number of casualties, extent of property damage, economic impact, and social disruption. Because the scenarios represent a range in casualty numbers and property damage, the scenarios do not include all events that would produce high morbidity and mortality.

Multiple Events –

As there is a possibility that multiple incidents will occur simultaneously or sequentially, organizations should always consider the need to respond to multiple incidents of the same type and multiple incidents of different types, at either the same or other geographic locations, in preparedness planning efforts. These incidents will invariably require the coordination and cooperation of homeland security response organizations across multiple regional, State, and local jurisdictions.

Economic Impacts –

Any decision in response to one of the disaster/terrorist scenarios to close the U.S. border with Canada or Mexico would have potentially enormous economic consequences. Thus any key decision to close a border must take into account those costs in assessing economic loss associated with the incident. Such a calculation might determine that the costs of closing the border would outstrip whatever would be gained by closing the border, especially in those cases (pandemic influenza, plague) where closing the border would not effectively stop the spread of disease but perhaps only impede its advance for a limited period of time.

Mission Areas:

The following Mission Areas were used to assist in scoping the response requirements generated by the scenarios.

Prevention/Deterrence – The ability to detect, prevent, preempt, and deter terrorist attacks and other manmade emergencies

Infrastructure Protection – The ability to protect critical infrastructure from all threats and hazards

Preparedness – The ability to plan, organize, equip, train, and exercise homeland security personnel to perform their assigned missions to nationally accepted standards—this mission area includes public education and awareness

Emergency Assessment/Diagnosis – The ability to achieve and maintain a common operating picture, including the ability to detect an incident, determine its impact, determine its likely evolution and course, classify the incident, and make government notifications

Emergency Management/Response – The ability to direct, control, and coordinate a response; manage resources; and provide emergency public information—this outcome includes direction and control through the Incident Command System (ICS), Multiagency Coordination Systems, and Public Information Systems

Hazard Mitigation – The ability to control, collect, and contain a hazard; lesson its effects; and conduct environmental monitoring—mitigation efforts may be implemented before, during, or after an incident

Evacuation/Shelter – The ability to provide initial warnings to the population at large and at risk; notify people to shelter-in-place or evacuate; provide evacuation and shelter support; and manage traffic flow and ingress and egress to and from the affected area

Victim Care – The ability to treat victims at the scene; transport patients; treat patients at a medical treatment facility; track patients; handle, track, and secure human remains; provide tracking and security of patients' possessions and evidence; and manage the worried well

Investigation/Apprehension – The ability to investigate the cause and source of the incident and identify, apprehend, and prosecute those responsible for terrorist attacks and other manmade emergencies

Recovery/Remediation – The ability to restore essential services, businesses, and commerce; cleanup the environment and render the affected area safe; compensate victims; provide long-term mental health and other services to victims and the public; and restore a sense of well-being in the community

Scenario 1: Nuclear Detonation –
10-kiloton Improvised Nuclear Device

Casualties	Hundreds of thousands
Infrastructure Damage	Total within radius of 0.5 to 3 miles
Evacuations/Displaced Persons	100,000 in affected area seek shelter in safe areas (decontamination required for all before entering shelters) 250,000 instructed to shelter in place as plume moves across region(s) 1 million+ self-evacuate from major urban areas
Contamination	Various levels up to approximately 3,000 square miles
Economic Impact	Hundreds of billions of dollars
Potential for Multiple Events	No
Recovery Timeline	Years

Scenario Overview:

General Description –

In this scenario, terrorist members of the Universal Adversary (UA) group—represented by two radical Sunni groups: the core group El-Zahir (EZ) and the affiliated group Al Munsha'a Al Islamia (AMAI)—plan to assemble a gun-type nuclear device using Highly Enriched Uranium (HEU) stolen from a nuclear facility located in Pakistan. The nuclear device components will be smuggled into the United States. The device will be assembled near a major metropolitan center. Using a delivery van, terrorists plan to transport the device to the business district of a large city and detonate it.

Detailed Attack Scenario –

Current intelligence suggests that EZ may be working with AMAI to develop an Improvised Nuclear Device (IND). It is suspected that special training camps in the Middle East have been established for IND training. Some IND manuals have also been confiscated from suspected EZ operatives. The volume of communications between EZ and AMAI operatives has increased significantly in past two weeks.

EZ operatives have spent 10 years acquiring small amounts of HEU. Operatives acquired the material by posing as legitimate businessmen and by using ties to ideologically sympathetic Pakistani nuclear scientists. EZ plans to construct a simple gun-type nuclear device and detonate the weapon at a symbolic American location.

EZ Central Command initiates the operation. To preserve operational effectiveness at all levels, compartmentalization and secrecy are required. Due to fears of penetration, EZ has become increasingly discreet in its decision-making process, with few operatives informed of the next target. Target selection, preparation, and acquisition are confined to a small number of terrorist operatives.

Planning Considerations:

Geographical Considerations/Description –

This scenario postulates a 10-kiloton nuclear detonation in a large metropolitan area. The effects of the damage from the blast, thermal radiation, prompt radiation, and the subsequent radioactive fallout have been calculated (based on a detonation in Washington, DC), and the details are presented in Appendix 1-A. However, the calculation is general enough that most major cities in the United States can be substituted in a relatively straightforward manner. Enough information is presented in the appendix to allow for this kind of extrapolation [1]. The radioactive plume track depends strongly on the local wind patterns and other weather conditions. In a situation where the wind direction cycles on a regular basis or other wind anomalies are present, caution should be exercised in directly using the fallout contours presented in the appendix.

If the incident happened near the U.S. border, there would be a need for cooperation between the two border governments. Additionally, the IND attack may warrant the closure of U.S. borders for some period of time. If the detonation occurs in a coastal city, the fallout plume may be carried out over the water, causing a subsequent reduction in casualties. On the other hand, the surrounding water will likely restrict the zones that are suitable for evacuation. Bridges and tunnels that generally accompany coastal cities will restrict the evacuation, causing delay and an increase in the radioactive dose that evacuees receive. This delay may be substantial, and the resulting dose increase may drive a decision to shelter-in-place or evacuate-in-stages. This assumes that the authorities have an effective communication channel with the public.

Timeline/Event Dynamics –

The response timeline will begin the instant the detonation occurs. Initially, only survivors in the immediate area will conduct rescue and lifesaving activities. Later (minutes to hours), rescue teams will begin to arrive and provide assistance. These initial efforts are likely to be uncoordinated. With the current state of education, training, and equipment, it is likely that many of these responders will subject themselves to very large (perhaps incapacitating or fatal) doses of radiation. As various command posts are set up (which may take hours to days), the response will become more coordinated. The productivity of rescue and direct lifesaving activities will decrease significantly as a function of time and will be very low within a couple of days.

For a nuclear detonation, the actual occurrence of injuries does not stop when the immediate blast effects have subsided. The most critical components of the post-detonation response may not be the lifesaving efforts that assist the victims directly injured by the detonation. Instead, it is likely that the most effective lifesaving activities will be those that address the evacuation or shelter-in-place decisions for the potential victims in the immediate fallout path, the effective communication of instructions to the affected population, and the efficient decontamination of the evacuated population. As soon as possible following the explosion, screening and decontamination efforts need to

[1] Consequence Report for a 10-kiloton Nuclear Detonation in Washington, DC, February 10, 2004.

be established. Timely decontamination of highly contaminated individuals is expected to drastically reduce casualties. Starting almost immediately, and continuing for the first few days, self-directed evacuation will occur and is likely to be the most prevalent protective action taken. Decontamination of people will be most important early in the incident but will continue throughout the entire process, including site cleanup and remediation. Long-term activities associated with environmental decontamination, monitoring, and sampling will last many years. Decontamination will be by far the most expensive economic impact of the IND attack.

Within the first few hours to days, monitoring must be performed to delineate fallout boundaries, normalize and verify predictive models, and provide assurances that populated areas are safe. After public contamination and initial evacuation issues have been addressed, incident management resources will shift to supporting ground surveys, conducting sampling efforts, and managing the disposition of human remains.

Medical follow-up activities will need to be conducted on those people exposed to the radiation or fallout and on those that may receive drugs to reduce exposure to internal contamination. (These drugs are in extremely short supply and are not effective on most radioactive isotopes.) Documentation of these cases will provide significant challenges but will be required for long-term health reasons and to address legal issues.

The exposure to large doses of radiation will produce an increased long-term risk of cancer for the exposed people (see Appendix 1-A and Appendix 1-B). These cases will need to be monitored and treated for many years.

Assumptions –

- The explosion produces a nuclear yield of 10 kilotons from a device that uses HEU as the fissile material.
- The prompt effects of the detonation cover an approximately circular area of devastation and the degree of destruction tapers off with increasing distance from ground zero.
- The device is detonated at ground level.
- The computer code used for calculating casualty projections assumes that the population exposed to the fallout radiation is not evacuated or sheltered for the first 96 hours. This is because the code is not able to track the complexities that would otherwise arise. This is certainly not a recommended protective action.
- Immediate protective actions will greatly reduce fatalities and injuries from the exposure to the radiation.
- The weather is clear—there is a light haze and a light breeze, with no snow or cloud cover.
- Casualties are calculated without considering the sheltering/shielding effects of buildings. This is true for both the blast and radiation effects.
- Casualties are calculated without considering the hazards of secondary effects, such as building collapses or secondary fires.

- Panic and the lack of traffic control signals may contribute to traffic fatalities/injuries in either a directed or self-directed evacuation.
- Workers may be reluctant to perform their jobs due to fears of radiation or contamination.
- Electricity and other services are disrupted across much of the affected area. Service will be restored to all but the immediate detonation area within 10 to 20 days following the explosion. Services in the immediate area of the explosion will not be available for a significantly longer time due to radioactive contamination of the area and the extent of the damage.
- There will be disruption of communications, making it difficult to provide safety information to the public in a timely manner.
- The largest radiation concerns following an IND incident will be the "prompt" radiation (gamma and neutron) and the gamma dose received from the "ground shine" (radioactive particles deposited on the ground) as people are evacuated from the fallout areas.

Mission Areas Activated –

Prevention/Deterrence:

Law enforcement will attempt to prevent the importation of nuclear device components as well as the assembly, delivery, and detonation of the device. After the detonation, officers will provide reconnaissance, protection, and deterrence measures at the boundaries of the site. Perimeters will need to be established to prevent entry into the contaminated zone. This will require trained personnel and specialized equipment. Officers will respond to reports of potential threats, provide increased surveillance at vulnerable sites/events, investigate threats, enforce curfews and exclusion boundaries, and manage other law enforcement issues (e.g., looting, theft of private property). It is likely that the National Guard and perhaps the military will be involved directly in these areas. A declaration of martial law may be considered.

Emergency Assessment/Diagnosis:

The detonation will be instantly recognized as a nuclear blast by both local observers and National Assets. This will initiate several response and contingency plans and bring Federal assistance. Due to its location, it is likely that the local Emergency Operations Center (EOC) will be significantly affected by the detonation. Should it survive intact and operational, it will be stressed to its limits. Actions of incident command and EOC personnel should include dispatching response units; making incident scene reports; detecting and identifying the source; establishing a perimeter; collecting information; making hazard assessments and predictions; coordinating hospital and urgent care facilities; coordinating county and State response requests; and coordinating monitoring, surveying, and sampling operations. Demand for these assets will be great. It is likely that State and other local EOCs in surrounding areas will be needed to support response efforts.

Emergency Management/Response:

One of the most critical factors that may reduce subsequent fatalities and injuries following a detonation will be the speed and appropriateness of the evacuation/shelter-in-place decisions that are made and the effectiveness of the dissemination of this information. This is a large-scale incident with many casualties and radiation exposures in the downwind hazard area. Actions of incident-site. EOC, and JIC personnel should include alerting, activating and notifying, providing traffic and access control, protecting at-risk and special populations, supporting requests for assistance, directing and controlling critical infrastructure assets, and directing public information activities.

There will be radiological emergency response teams from Federal and various State and local governments that will converge on the area to provide general assistance, support rescue and recovery efforts, help delineate and survey the areas for contamination, assist in decontamination activities, and provide radiological information to local decision makers. The location and removal of injured and disabled people will be a significant undertaking that will be greatly complicated by the need to keep the radiation dose of the individual workers As Low as Reasonably Achievable (ALARA). Certainly, rescue operations will quickly reach the point of diminishing returns. Victims will continue to absorb radiation doses while waiting on rescue, and this will result in an increased likelihood of fatality. In a limited manpower situation, where the total integrated dose that can be absorbed by the finite number of trained and equipped response workers is fixed—as it is likely to be during the first few hours after the incident—the value of these rescue activities will need to be weighed against the value of preventing or reducing future exposure of people in the high-dose fallout regions downwind.

It is essential that emergency response workers be educated, trained, and equipped to deal with this situation. Emergency workers entering high-radiation areas in the first few days after the detonation are likely to receive lethal doses of radiation. Personal Protective Equipment (PPE) is used to control contamination but does not protect workers from external radiation doses. If workers are exposed to contaminated particles in the air (i.e., re-suspension), then a device to protect them from breathing this contamination is required (e.g., a respirator or a Self-Contained Breathing Apparatus). Personal electronic dosimetery and turn-back levels (i.e., dose levels that have been calculated to account for the time it takes the worker to evacuate the radiation zone while still not exposing the worker to doses that exceed a safe value) are essential for all workers entering the contaminated area.

Hazard Mitigation:

The extent of radioactive fallout contamination will present a major challenge. One of the biggest factors that may reduce the subsequent fatalities and injuries will be the speed and appropriateness of evacuation /shelter-in-place protective action decisions that are made and the effectiveness of the dissemination of this information. Close to the site of detonation, there will be little time to institute any protection for the population from the fallout radiation. As the distance increases, there will be more time to get instructions disseminated on evacuation or shelter-in-place guidelines. However, information distribution will be greatly hampered by power outages and damaged electronic equipment. Since information dissemination will be difficult, it is likely that self-evacuation will be the dominant protective action taken in the short term (~ 24 hours) after detonation. Authorities may resort to loudspeakers mounted on vehicles to help disseminate information. As the distance from the detonation increases, the time to react increases, the total possible dose from the fallout decreases, the population density decreases, and the likelihood of the infrastructure remaining intact increases. All these factors imply that protective actions will have a greater effect in reducing injuries as the distance from the detonation increases. **However, by far, the greatest factor impacting the reduction of the effects of the detonation on the general population will remain the speed and appropriateness of the decisions that are made and the effectiveness of the dissemination of this information.**

Another critical mitigation activity will be the prompt decontamination of people being evacuated. Local fire departments may be best equipped to deal with personnel decontamination, which will consist of the removal of contaminated clothes and washing in water; however, the water supply may be limited. Unfortunately, fire departments will be taxed dealing with essential firefighting and rescue duties. Clean clothes and/or blankets will be needed for modesty and, in cold weather, exposure reasons. It should also be noted that the public will strongly resist leaving personal items (e.g., wallets, keys, purses, pictures, jewelry) behind in the contaminated zone.

Actions of incident-site personnel should include isolating the incident scene and defining the hazard areas, establishing incident command, preserving the scene, providing mitigation efforts, fighting fires, decontaminating responders and equipment, and conducting site remediation and monitoring.

Evacuation/Shelter:

Evacuation and/or sheltering of downwind populations will be required. Actions of the incident-site, local-area, and EOC personnel should include monitoring and decontaminating evacuees, protecting schools and day care facilities, and providing shelter/reception facilities.

Victim Care:

Tens of thousands will require decontamination and both short-term and long-term treatment. In addition, the evacuated population will require shelter and food for the indefinite future. Health care facilities and emergency workers in the affected area will be overwhelmed. To adequately address the care and treatment of victims, trained medical health care workers from outside the affected area will be needed. Actions of incident-site, EOC, and local-area hospital personnel should include the following:

- Making and communicating protective action decisions
- Providing Emergency Medical Services (EMS)
- Implementing medical triage, treatment, and stabilization of casualties
- Performing search and rescue (fire, police, and EMS)
- Performing patient screening and decontamination

- Implementing decisions to administer prophylaxis to the affected populations
- Transporting injured patients
- Reporting patient status
- Treating walk-in radiation victims
- Collecting and identifying human remains (coroner and morgue functions, including the potential for remains to be residually radioactive)
- Providing next-of-kin notifications

The level of care that can be expected may be significantly lower than would normally be expected. This may well contribute to a larger-than-expected number of casualties. Officials and care providers should discuss these issues before any such incident takes place.

Triage will be a major issue for care providers. Among other things, this will require the determination of which victims may benefit from medical attention and which have received radiation doses that make it unlikely that they will survive. While there are post-exposure methods to measure dose levels, these methods are unlikely to be widely available during an incident of this nature. This is due to the extremely limited national capability for these tests and to the complexity of the laboratory procedures required. In this situation, it is likely that the best that can be done is to note the delay between the exposure and the onset of visible symptoms (e.g., vomiting). As a rule of thumb, the sooner the onset of the symptoms, the higher the dose received and the less likely the victim is to survive.

Investigation/Apprehension:

There will be national political pressure on Government officials to expedite the attribution process and for the subsequent response. For a nuclear detonation, attribution activities at the detonation site will rely largely on scientific forensic techniques and will be provided by specialized national teams. In addition, the intelligence community will be pressured for information relating to the incident. Actions of incident-site personnel will include site control and criminal investigation. Federal authorities, including the military, will probably conduct “apprehension” activities.

Recovery/Remediation:

Decontamination/Cleanup: Approximately 8,000 square kilometers (~ 3,000 square miles) may be contaminated to some level, including urban, suburban, rural, recreational, industrial, and agricultural areas. Expected radiation levels will limit the total time workers can spend in the affected area, quickly leading to a shortage of willing, qualified, and trained workers. When a worker reaches this limit, he/she must be rotated to a job where no dose is received, or sent home. The volume of contaminated material that will be removed will overwhelm the national hazardous waste disposal facilities and will severely challenge the Nation’s ability to transport the material. This effort will be the most expensive and time-consuming part of recovery and will likely cost many billions of dollars and take many years.

Site Restoration: A large area centered on ground zero will be destroyed. There will be varying degrees of damage in an approximately 100-square-kilometer (~ 40-square-mile) area. Some degree of decontamination will be required in a very large area that will have to be determined by the authorities. They will have to weigh the costs of the cleanup against the political realities of the situation.

Implications:

It is extremely difficult to estimate the true implications of terrorist use of a nuclear device on a U.S. city. The personal loss of loved ones would be immeasurable. The health consequences to the population directly impacted would be severe. The physical damage to the community would be extreme. The costs of the decontamination and rebuilding would be staggering. But these losses do not begin to address the true implications of this type of an incident The detonation of an IND in a U.S. city would forever change the American psyche, as well as its politics and worldview. The real implications may only be addressable by historians many years after the incident.

Secondary Hazards/Events –

The detonation will cause many secondary hazards. The intense heat of the nuclear explosion and other subsequent causes will produce numerous fires located throughout the immediate blast zone. Damaged buildings, downed power and phone lines, leaking gas lines, broken water mains, and weakened bridges and tunnels are just some of the hazardous conditions that will need to be assessed. Depending on the type of industries present (such as chemical or petroleum production, industrial storage facilities, and manufacturing operations), there could be significant releases of hazardous materials.

Another secondary effect of a nuclear explosion is the Electro-Magnetic Pulse (EMP) that will be produced by the ionization and subsequent acceleration of electrons from the air and other materials by the intense radiation of the detonation. This EMP is a sharp, high-voltage spike that radiates out from the detonation site. It has the potential to disrupt the communication network, other electronic equipment, and associated systems within approximately a 5-kilometer (~ 3-mile) range from the 10-kiloton ground blast. The range of these effects is highly dependent on the details of the detonation and the type of electronics involved. However, the duration of the EMP is very short, and there are no residual effects. Standalone equipment that is undamaged from the pulse will continue to function afterward. However, most electronic devices depend on external infrastructures (e.g., the electrical power grid, cell towers, broadcasting stations, computer networks, switching stations) in order to function. These infrastructures are far more vulnerable to EMP than most standalone electronic devices. It is possible that these infrastructure systems will be damaged at significantly larger distances than isolated electrical equipment.

There likely will be significant damage to the general public support infrastructure with potentially cascading effects. These systems include transportation lines and nodes (e.g., air, water, rail, highway), power generation and distribution systems, communications systems, food distribution, and fuel storage and distribution. There will be concerns about the safety and reliability of many structures (e.g., dams, levees, nuclear power plants, hazardous material storage facilities). Structures may be damaged that are used to provide essential services (e.g., hospitals, schools).

In addition to the direct physical health effects caused by the nuclear detonation, the subsequent trauma may have a significant psychological impact on survivors. This may impede the ability of local officials to mount an initial response to the incident. There will certainly be economic, political, law enforcement, civil liberty, and military consequences that will likely change the very nature of the Country.

Fatalities/Injuries –

A full description of the fatalities and injuries for a nuclear detonation is difficult and complicated. There will be casualties directly associated with the blast, which will cause "translation/tumbling" (the human body being thrown) and subsequent impacts of people and other objects. A nuclear detonation will also produce a great deal of thermal (heat) energy that will cause burns to exposed skin (and eyes). Under certain circumstances, these burns may occur over large distances. There are two general "categories" of nuclear radiation produced in a detonation. First is the so-called "prompt" nuclear radiation, arbitrarily defined as being emitted within the first minute—it is actually produced as the device detonates or shortly thereafter. For a 10-kiloton blast, this radiation may expose unprotected people within a distance of a few kilometers (a couple of miles) to extremely large gamma ray and/or neutron doses. In addition, a detonation of a nuclear device near the surface of the ground will result in a great deal of fallout (in the form of dirt particles) that is radioactively contaminated. This fallout will settle out of the radioactive cloud over a period of time, mostly in the first weeks. By far, the most dangerously radioactive fallout will be deposited near the detonation site and will happen within the first couple of hours after detonation. Fallout will exponentially decay with time, but may expose many people to large doses and will certainly contaminate large areas of land for years. Many fatalities and injuries will result from a combination of these various effects.

Historically, early emergency response efforts have been focused on the lifesaving needs close to the emergency site. However, for a nuclear detonation, other actions need to be taken downwind where the plume will deposit radioactive fallout. Perhaps the greatest potential impact on saving lives will be activities immediately following the detonation that address the reduction of the future radiation dose that will be received by the population in the fallout zone immediately downwind of ground zero. Decision makers may have to weigh the benefits of focusing on this problem versus that of the direct lifesaving activities in the blast area. It must be noted that all people, including the emergency response workers, entering the high radiation areas near the blast site have a significant probability of receiving large (likely fatal) radiation doses. Authorities will be faced with making these real-time decisions, as well as many other decisions, with insufficient and often contradictory information.

The largest radiation concerns following an IND incident will be the "prompt" radiation (gamma ray and neutron) and the gamma dose received from the "ground shine" (radioactive particles deposited on the ground) as people are evacuated from the fallout areas. These effects are likely to have significantly larger impacts on the population than internal doses. Internal doses tend to expose the body to relatively small radiation doses over a long period of time, which produces different effects than large radiation doses received during a short period of time (see Appendix 1-A). The figures used for casualties in the appendix are based on acute external radiation doses, but are conservative (i.e., high). The conservative nature of the calculation will tend to compensate for not explicitly including the internal radiation dose effects.

As the distance from ground zero increases past 20 kilometers (~ 12 miles), the injuries due to acute radiation exposure (i.e., from prompt radiation and the subsequent fallout) will decrease, and lower-level contamination, evacuation, and sheltering issues will become the major concern. In general, at distances greater than 250 kilometers (~ 150 miles) from ground zero of a 10-kiloton nuclear detonation, acute health concerns will not be a significant issue. However, contamination of people and the environment will still be a concern.

Years later, there will still be health consequences in the form of increased probabilities of cancers in the exposed population. The number of these cancers will likely run into the thousands and will extract a large human, social, and financial cost.

For more information, see Appendix 1-A and Appendix 1-B.

Property Damage –

It is likely that the blast and subsequent fires will destroy all buildings in the immediate area of the detonation. Historically, decontamination of sites involves the removal of all affected material. Often, this includes the surface of the ground to a depth of several inches over the entire area that has been contaminated. Therefore, most buildings in the immediate downwind fallout path will likely have to be destroyed in the decontamination effort. As the distance from the detonation site increases, the contamination level will decrease. At some distance, the buildings will not have to be destroyed and removed but will still require decontamination of all affected surfaces. This decontamination process will take years and will be extremely expensive. The decontamination will produce a far greater challenge and cost much more than the actual rebuilding of the destroyed structures. Approximately 8,000 square kilometers (~ 3,000 square miles) of land will have to undergo varying degrees of decontamination. This effort will last for many years and will cost many billions of dollars to complete.

For more information, see Appendix 1-A and Appendix 1-B.

Service Disruption –

Service disruption will be extensive in the area near ground zero and in the fallout path for several miles downwind. Services in these areas will not be restored for years because the land affected will not be returned to use until the decontamination is complete and the structures rebuilt. Service disruption will be much less dramatic in areas that are less severely contaminated or not contaminated at all.

The electrical power grid is likely to be damaged by transients produced by the destruction of substations, as well as other power production and distribution installations, and perhaps by the EMP of the detonation. It is likely that the grid damage may cause power outages over wide areas, perhaps over several States, but these outages should be repaired within several days to a couple of weeks. The communication systems in the area will suffer similar damage and will likely be repaired within similar timeframes.

City water mains will likely survive without major damage. This is because they are largely underground and, therefore, somewhat protected. It is possible that some lines will be broken directly by the detonation and also some damage sustained in subsequent building collapse. However, this damage should be relatively minor and localized. The city water supply is unlikely to become substantially contaminated with radiation via water main breaks, but it is possible that some small amount of radioactive and non-radioactive contamination may enter the lines. Contamination of the water supply by radioactive impurities in the water (neutron activation) will not be a significant issue. It is possible that radioactive fallout may be deposited into the watershed used by the city. This will have to be measured before the water can be used.

All government services will be impacted over some geographical area. These services may include (but are not limited to) education, mail, law enforcement, justice system, fire departments, social welfare, and trash collection.

For more information, see Appendix 1-A and Appendix 1-B.

Economic Impact –

Locally there will be economic impacts from many factors, including business and personal bankruptcies, banking service disruptions, loss of jobs, destruction of employment locations, collapse of insurance companies, as well as the drastic increases in Government spending and debt and the effects on the stock market. The national economy will be significantly impacted. Decontamination, disposal, and replacement of lost infrastructure will cost many billions of dollars. Replacement of lost private property and goods could add billions more to the cost. Additionally, an overall national economic downturn, if not recession, is probable in the wake of the attack.

Long-Term Health Issues –

There will be fatalities and injuries resulting from the effects of the detonation and resulting radiation for many years after the attack. The fatalities resulting from physical trauma and acute radiation injuries will tend to taper off over a period of several months to a year or so. The most significant long-term health impact will likely be due to the increase in the number of cancers that result from radiation exposures from the incident and subsequent activities.

For more information, see Appendix 1-A and Appendix 1-B.

Appendix 1-A: Exemplar – Consequence Report for a 10-kiloton Nuclear Detonation in Washington, DC

Prepared by the Department of Energy (DOE)/National Nuclear Security Administration (NNSA) Office of Emergency Response and Sandia National Laboratory

Summary:

This appendix describes a set of **possible** consequences calculated for a 10-kiloton nuclear blast including its prompt effects (occurring within the first minute) and fallout. It should be emphasized that the **results of this calculation are strongly dependent on the initial assumptions**. This report is intended to assist in preparing to address the consequences of a terrorist attack, so the assumptions used in this calculation are conservative and produce an upper limit on the number of fatalities and casualties that might be expected.

The results of the calculation reported in this appendix are from the detonation in the central business district of Washington, DC, of a 10-kiloton uranium-235, gun-type nuclear device. Table 1-1 summarizes selected input parameters for the calculation. The actual meteorological data used in the calculation consisted of wind speed, direction, and temperature as a function of altitude. These data were determined as typical by examining both surface wind and upper air measurements recorded at the city's airport over the course of a year. The detonation is assumed to take place during working hours (10:00 a.m.) on a weekday. The population distribution is based on U.S. Census (nighttime) data, with two additional population densities added in order to represent the workday influx into the center of the city. Specifically, 481,000 people were added inside a 5-kilometer (~ 3- mile) radius of the detonation site, and 220,000 additional people were added inside an 11-kilometer (~ 7-mile) annulus with an inner radius of 5-kilometers (~ 3 miles).

Summary of Calculation Parameters	
Release location (latitude, longitude)	North 38.90, West 77.0392
Nuclear yield	10-kilotons
Height of burst	0
Height of cloud top above ground	8,110 meters (26,607 feet)
Mean wind direction	From the west-southwest
Wind speed at cloud top	33.3 meters per second (~74.5 miles per hour)
Population	Census data plus estimate of daytime influx

Table 1-1. *Summary of calculation input parameters for a set of possible consequences for a 10-kiloton nuclear blast*

The effects of a nuclear detonation can broadly be categorized into casualties and property damage. The mechanisms producing these effects can be categorized as blast, radiation, and thermal energy. Figures 1-1 through 1-4 and Tables 1-1 through 1-3 summarize the effects of the 10-kiloton nuclear detonation. The rings in Figure 1-1 represent blast overpressure contours from the explosion. Blast fatalities and injuries result from "translation/tumbling" (the human body being thrown), "translation/impact" (items impacting the human body), lung damage, and eardrum rupture. The calculations assume that people are exposed to the blast wave in the most hazardous orientation, and therefore the number of casualties reported is an upper limit. Table 1-2 tabulates the casualty estimates for the population within the contour rings of Figure 1-1.

Additional fatalities and casualties are likely to occur from thermal burns, which have not been calculated. The relative contributions of the casualties due to blast and thermal injuries strongly depend on the details of the local environment and cannot easily be modeled or incorporated into the calculations. To a first approximation, it is a reasonable assumption that the overestimation of blast injuries provides a reasonable estimate of the likely numbers of blast and thermal injuries combined.

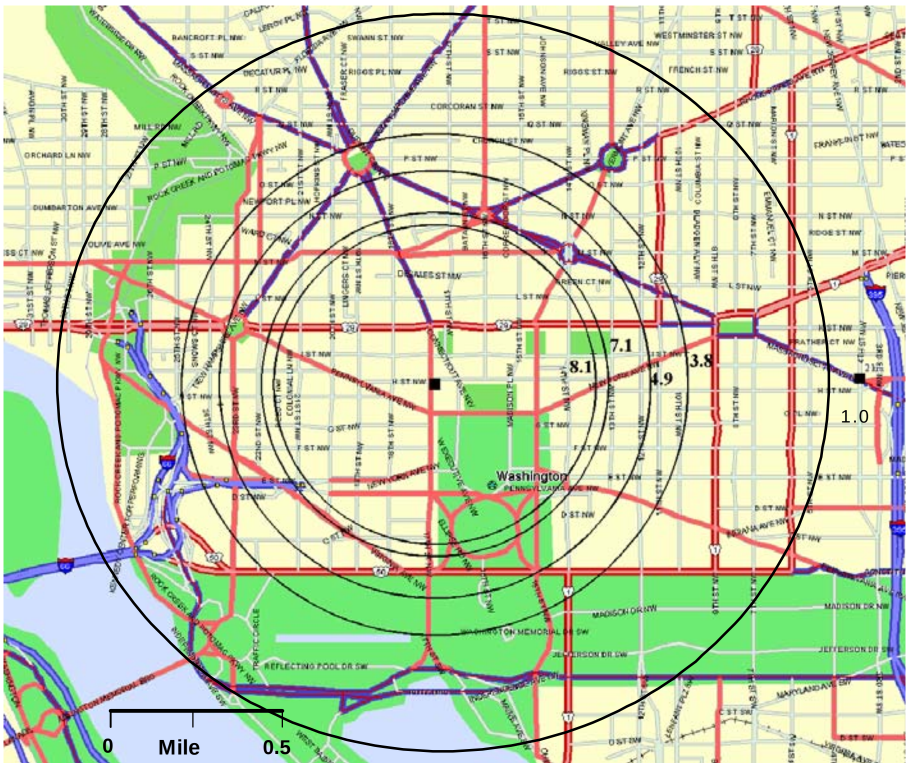
Figure 1-2 shows selected prompt effects of the detonation as a function of distance from ground zero. These include the peak overpressure, thermal fluence, and both moderate and severe building damage. "Severe damage" means the building either collapsed or cannot be further used without essentially reconstructing it. "Moderate damage" means that unless major repairs are made, the structure cannot be used for its intended purpose.

There are two main sources of the ionizing radiation that cause radiation-induced injuries and fatalities. The first is the prompt radiation produced by the detonation itself and which, by arbitrary definition, occurs within the first minute after the detonation. The second is the radiation emitted by the radioactive fallout. Both of these, taken together, will hereafter be referred to simply as "radiation exposure." The contours in Figures 1-3 and 1-4 represent the dose equivalent in Roentgen Equivalent Man (REM) that would be received by unprotected individuals who remain in the radiation area for 24 hours (acute effects) and 96 hours (chronic effects), respectively, following a 10-kiloton nuclear detonation. Results used to define the contours in the figures are tabulated in Tables 1-2 and 1-3. For casualties due to radiation exposure, both acute and chronic health effects are considered. A chronic health effect that leads to a fatality will be counted as a fatality, even though that individual may survive for weeks, months, or even years before succumbing.

Results shown in Figures 1-3 and 1-4 are cumulative within contours, meaning that the casualty and fatality counts of the outer contours include the number of casualties and fatalities reported for the inner contours, respectively. Also, the casualty values include the fatalities numbers. Many of the injured will suffer from multiple effects (e.g., blast, radiation exposure, thermal burns). The combination of effects is not considered or integrated into this report. However, a comparison of Tables 1-1 and 1-2 shows that the majority of the casualties are due to radiation exposure and not blast effects.

The assumption that people will remain unprotected and in the area where they will continue to receive a radiation dose is **VERY** conservative and will result in higher calculated values for the casualties and fatalities than might actually be expected.

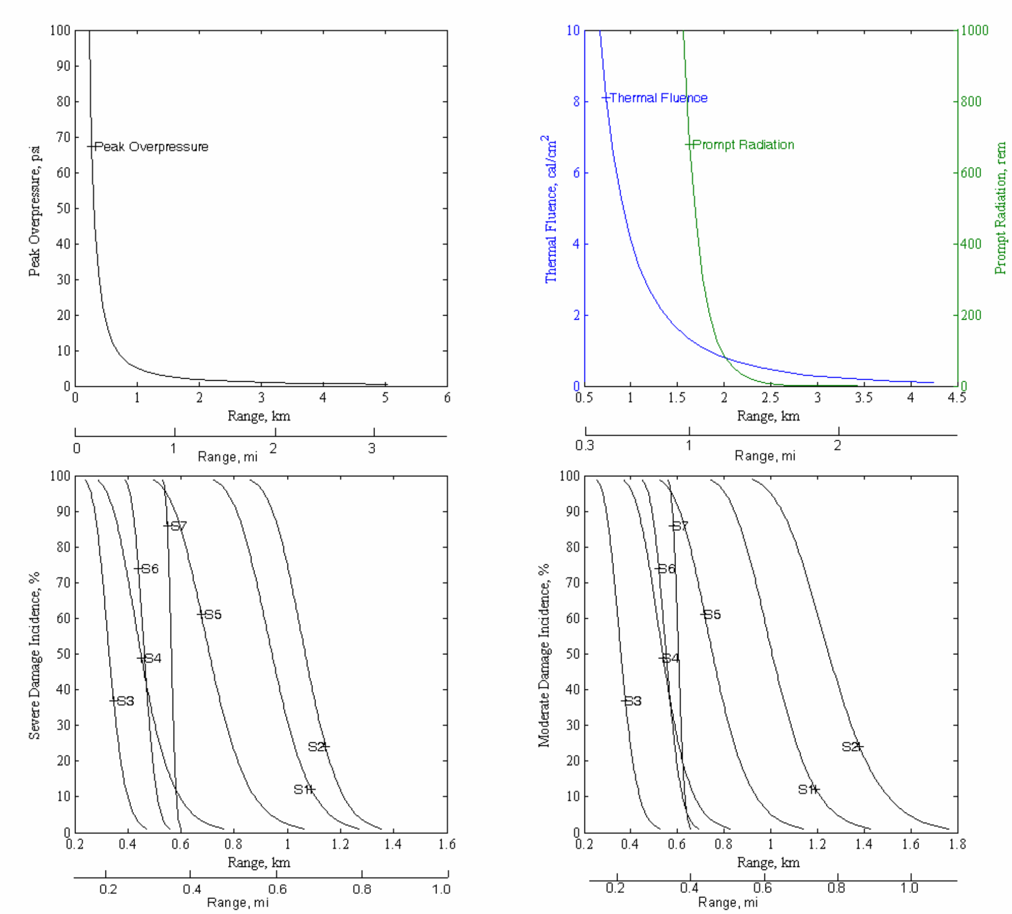
Figure 1-1. *Contours for 8.1, 7.1, 4.9, 3.8, and 1.0 Pounds per Square Inch (psi) overpressure from a 10-kiloton nuclear detonation superimposed on the central business district of Washington, DC*



Casualties Due to Blast Effects								
Pressure (psi)	**Description**	**Range**		**Area**		**Population Exposed**	**Fatalities**	**Casualties**
		km	**mi**	**km^2**	**mi^2**			
>3.8	10% Casualties	1.2	.74	4.5	1.73	46,612	14,623	31,430
>4.9	50% Casualties	1	.62	3.3	1.27	31,673	14,623	27,590
>7.1	10% Fatalities	.82	.51	2.1	0.81	16,903	14,479	16,818
>8.1	50% Fatalities	.76	.47	1.8	0.69	14,642	13,850	14,606

Notes: Fatality numbers are included in the number of casualties. The "Description" column provides information on the results of the overpressure shown in the "Pressure" column and does not imply an average result for all people enclosed within the ring.

Table 1-2. *Exposure, fatalities, and casualties based on the size of the inner blast contours in Figure 1-1 for a 10-kiloton nuclear detonation*



Structures:

S1: Multi-story (MS), wall-bearing building; brick apartment; 1-3 stories

S2: Wood frame house; 1-2 stories

S3: MS offi ce building; 3 -10 s tories; l ightweight, L ow-Strength, Q uickly Fai ling Wa lls (LSQF W); Earthquake-Resistant Designs (ERDs)

S4: MS office building; 3-10 stories; lightweight LSQFW; non-ERD

S5: Light-frame industrial building; 1 story; 5-ton crane; LSQFW

S6: Highway girder bridge; 2-4 lanes; deck/through; 75-200 feet span

S7: Railroad Girder Bridge; open floor; 1-2 tracks; 75–200 feet span

Figure 1-2. *Prompt effects for a 10-kiloton nuclear detonation as a function of distance from the detonation (effects include overpressure, thermal fluence, prompt radiation, and damage to various building and structures)*

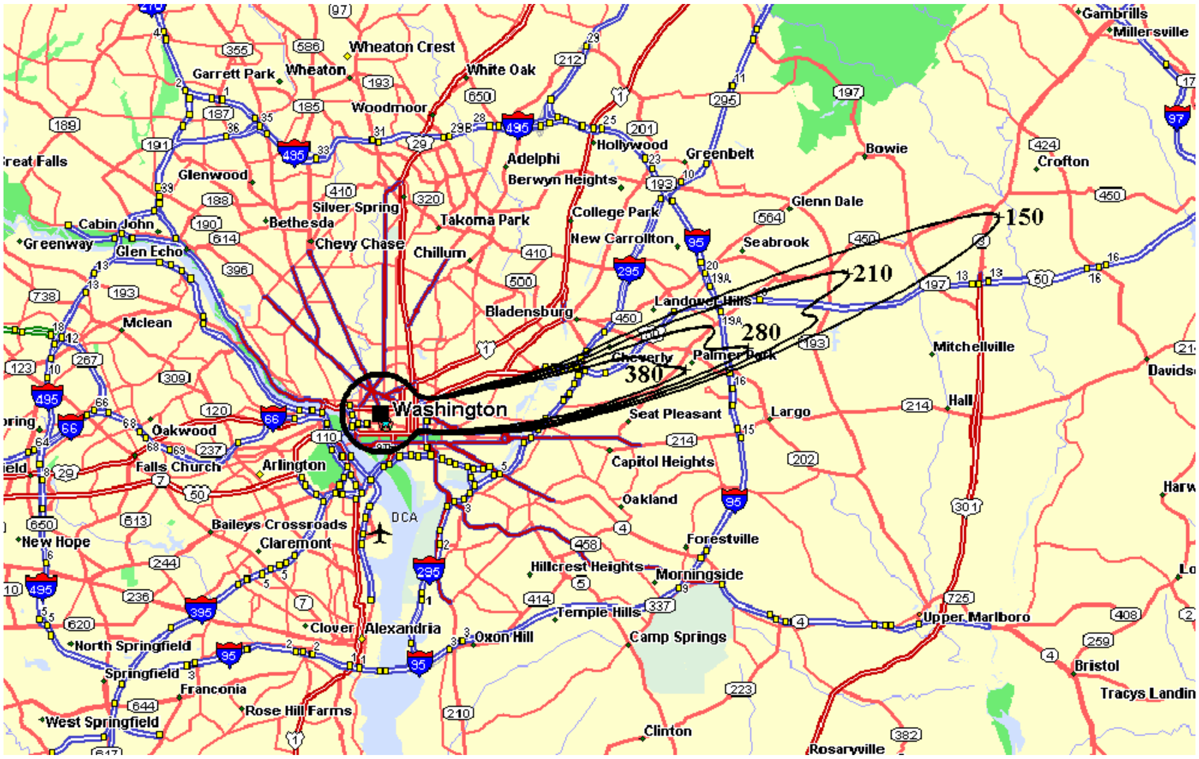


Figure 1-3. *Contours for acute (24-hour) exposure dose equivalent in REM for a 10-kiloton nuclear detonation*

Casualties Due to Acute Radiation Exposure								
Equivalent Dose (REM)	**Description**	**Distance**		**Area**		**Population Exposed**	**Fatalities**	**Casualties**
		km	**mi**	**km^2**	**mi^2**			
>150	10% Casualties	30	19	89	34	303,071	190,167	264,486
>210	50% Casualties	23	14	59	23	270,242	190,139	256,542
>280	10% Fatalities	17	11	40	15	235,762	189,089	232,786
>380	50% Fatalities	14	9	30	12	203,375	180,389	202,133

Notes: The equivalent dose levels were chosen to represent the 10% and 50% values for both casualties and fatalities. The casualty figures are cumulative—the figures for the 150-REM contour line include those of all interior contours. The “Description” column provides information on the results of the dose shown and does not imply an average result for all people enclosed within the contour.

Table 1-3. *Exposure, fatalities, and casualties based on the size of the acute (24-hour) radiation equivalent dose level contours in Figure 1-3 for a 10-kiloton nuclear detonation*

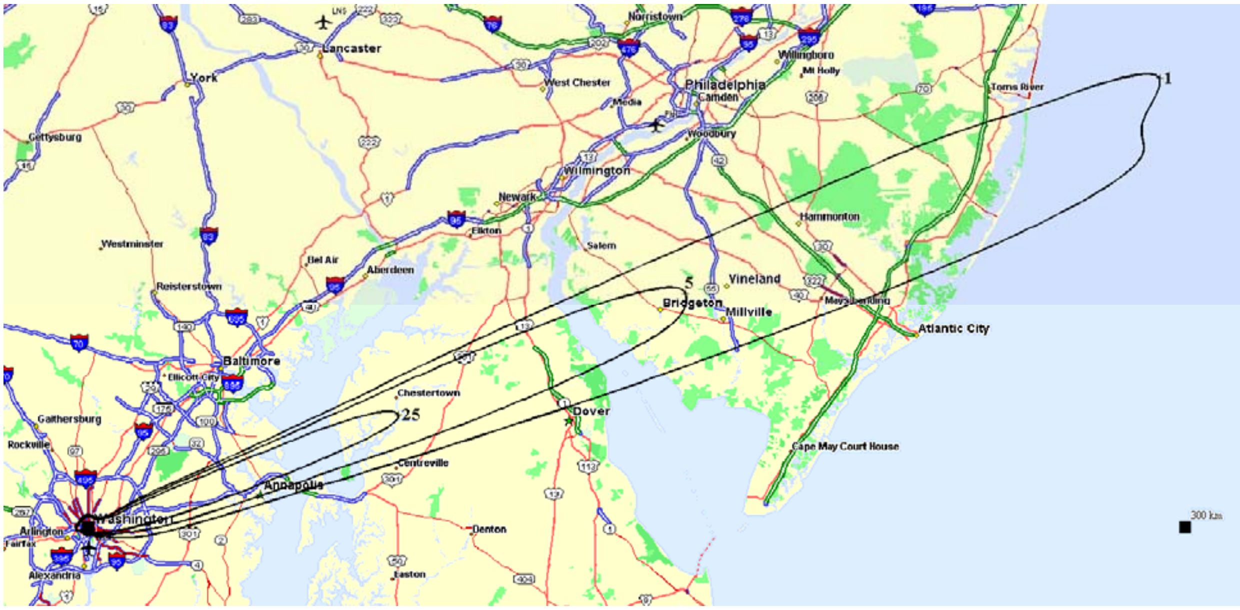


Figure 1-4. *Contours for chronic (96-hour) exposure dose equivalent in REM for a 10-kiloton nuclear detonation*

Casualties Due to Chronic Radiation Exposure								
Equivalent Dose (REM)	**Description**	**Distance**		**Area**		**Population Exposed**	**Fatal Cancers**	**All Cancers**
		km	**mi**	**km^2**	**mi^2**			
>1	Evacuation/Sheltering PAG (Lower)	320	198	7,800	4,836	1,358,718	24,580	49,160
>5	Evacuation/Sheltering PAG (Upper)	170	105	2,300	1,426	827,506	23,916	47,833
>25	EPA Emergency Personnel Limit	90	56	600	372	572,891	22,482	44,964

Notes: The exposure equivalent dose levels were chosen to represent the various Protective Action Guides (PAGs) shown. The casualty figures are cumulative—the figures for the 1-REM contour line include those of all interior contours, and the figures under "All Cancers" include those under "Fatal Cancers." The "Description" column provides information on the results of the dose shown and does not imply an average result for all people enclosed within the contour.

Table 1-4. *Exposure, cancer fatalities, and cancer casualties based on the various chronic (96-hour) radiation exposure equivalent dose level contours in Figure 1-4 for a 10-kiloton nuclear detonation*

Discussion:

The remainder of this appendix discusses in greater detail the input parameters and the results of the calculation. A deeper understanding of some of the details of the calculation will allow the extension of many of these results to other cities.

Meteorology –

An upper air "sounding" (atmospheric measurement), downloaded from the University of Wyoming archives, was chosen to represent a set of typical meteorological values for the entire city area. The sounding provides wind speed, direction, and temperature as a function of altitude. A set of typical surface (10-meter elevation) wind speeds and wind directions, as measured at the city's main airport, were also used. Average wind data were determined from the Natural Resources Conservation Service (NRCS) at the U.S. Department of Agriculture for years 1961 through 1990. The calculation assumes no cloud or snow cover and assumes a 10-kilometer (~ 6-mile) visibility with light haze.

Population –

U.S. Census data for the city area were used as the primary database to draw conclusions about the exposed population and the subsequent fatalities and casualties. Census data reflects the nighttime population, which for Washington, DC, is about 571,000. In addition, the workday influx of people from suburbs into the downtown area was considered, since detonation of a nuclear device would most likely occur during business hours so as to inflict a greater number of casualties. For this calculation, 481,000 people were uniformly distributed within a 5-kilometer (~ 3-mile) radius of the detonation. Additionally, 220,000 people were uniformly distributed within an 11-kilometer (~ 7-mile) wide annular area (see Figure 1-5). These values were determined from several city government and business sources.

The Oak Ridge National Laboratory (ORNL) Geographic Information Science and Technology Group has developed a daytime/nighttime population database for Washington, DC, using county-to-county workflow numbers from census data. ORNL estimates the nighttime (census data) and daytime population to be 571,476 and 1,066,666, respectively, so that there is an influx of 495,190 people during the day. These results are in excellent agreement with the additional population distribution assumed in this calculation.

The population densities for the top 20 U.S. cities as of 1990 are shown in Table 1-6. This information can be used to approximate the prompt casualties (resulting from the energy released within the first minute after the detonation) for these cities for a 10-kiloton nuclear detonation at ground level. The present results are versatile enough that they may be extended to any major city in the United States with only a few relatively straightforward changes. To a first approximation, the prompt casualties can be scaled by ratio of the population densities. For example, the expected casualties in a new city from a 10-kiloton nuclear detonation would be those in this city times the ratio of the population density of the new city to that of this city. The results retain most of the relevant features for emergency response training and preparation purposes.

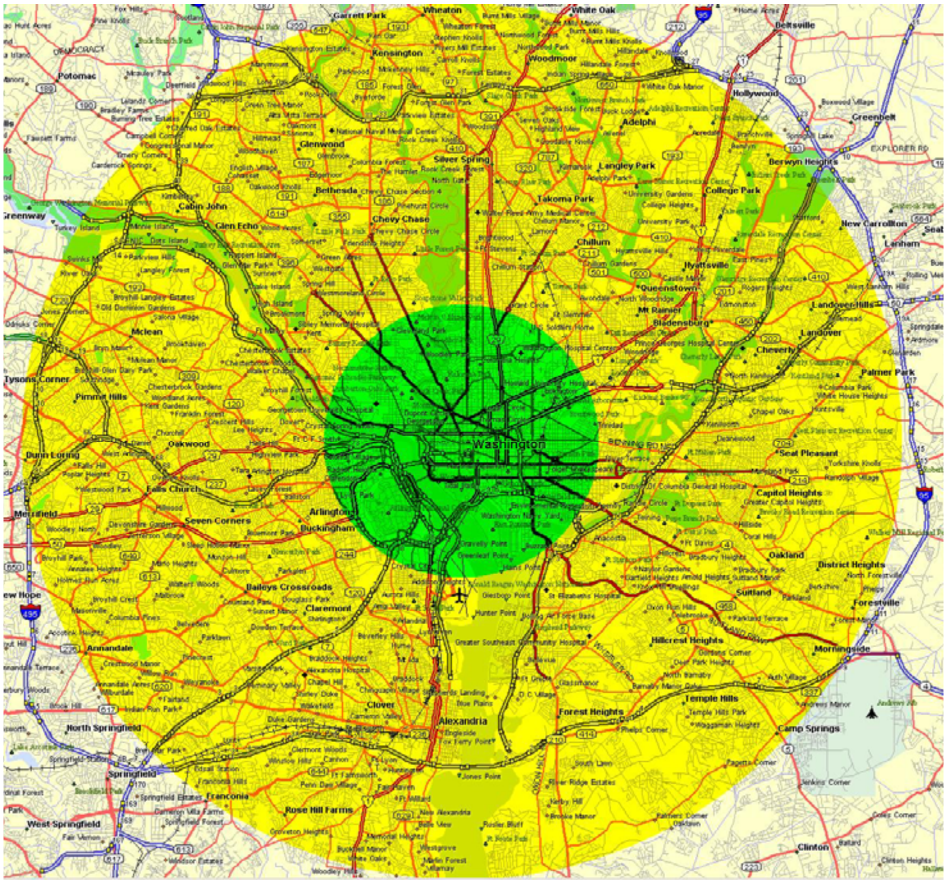


Figure 1-5. *Map of the additional population added to the Washington, DC, (nighttime) populations to account for workday commuters—the 5-kilometer (~ 3-mile) inner (green) region includes 481,000 additional people, and the outer annulus (yellow) includes 220,000 additional people.*

Additional Daytime Population Influx for Washington, DC		
	This Paper	**Oak Ridge National Laboratory**
Washington, DC	481,000	495,190
Surrounding area	220,000	Not Available

Table 1-5. *Additional daytime population for Washington, DC, and the surrounding area*

Top 20 Most Populous U.S. Cities						
Total Population Rank	**City Examples**	**Population (× 1,000)**	**Area (km^2)**	**Area (mi^2)**	**Persons per km^2**	**Persons per mi^2**
1	New York, NY	7,323	800	308	9,154	23,813
14	San Francisco, CA	724	122	47	5,934	15,438
3	Chicago, IL	2,784	588	226	4,735	12,317
20	Boston, MA	574	124	48	4,629	12,042
5	Philadelphia, PA	1,586	350	135	4,531	11,788
19	**Washington, DC**	**607**	**158**	**61**	**3,842**	**9,994**
	(Density used in calculation)				**9,946**	**25,461**
12	Baltimore, MD	736	210	81	3,505	9,117
2	Los Angeles, CA	3,485	1,215	467	2,868	7,462
7	Detroit, MI	1,028	360	138	2,856	7,429
17	Milwaukee, WI	628	249	96	2,522	6,561
6	San Diego, CA	1,111	839	323	1,324	3,445
16	Columbus, OH	633	495	190	1,279	3,327
11	San Jose, CA	782	443	170	1,765	4,592
4	Houston, TX	1,631	1,399	538	1,166	3,033
8	Dallas, TX	1,007	886	341	1,137	2,957
10	San Antonio, TX	936	862	331	1,086	2,825
18	Memphis, TN	610	663	255	920	2,393
9	Phoenix, AZ	983	1,088	418	903	2,350
13	Indianapolis, IN	731	938	361	779	2,027
15	Jacksonville, FL	635	1,966	756	323	840

Factors used in the calculation of the daytime population density of Washington, DC:	
Surface area in which workday population was added	78.5 km^2 (30.7 mi^2)
Density of additional (daytime influx) population	6,124/km^2 (15,700/mi^2)
Total population density used (census data plus influx)	9,946/km^2 (25,400/mi^2)

Table 1-6. *Populations of the top 20 cities in the United States as of the 1990 census listed in order of population (nighttime) density*

Software –

These calculations were made using the Sandia National Laboratory (SNL) Automated Consequence Report for Insidious Dispersal (ACRID) software and a Graphical User Interface (GUI) that calls the AIRborne RADiation (AIRRAD) and NUKE physics models and performs the various post-processing tasks. AIRRAD [2] is used to predict fallout from nuclear devices. Based on the Department of Defense Land Fallout Interpretive Code/SIMplified Fallout Interpretive Code (DELFIC/SIMFIC) [3,4] "disk tossing" models, AIRRAD uses an empirically stabilized cloud height formula. It breaks the stabilized cloud into several disks with numerous particle size bins defined from Nevada Test Site (NTS) nuclear test data. The code then tracks the top and bottom of each disk as they undergo gravitational settling through the various upper air wind fields before final deposition on the ground. The code NUKE models prompt nuclear device effects such as blast, prompt radiation, ground shock, and EMP. NUKE was developed at SNL based on other references.[5,6,7]

Nuclear Detonation –

Persons exposed to a nuclear explosion may be killed or suffer injuries of various types. Direct and indirect blast effects, thermal radiation, and ionizing radiation are the primary causes of injuries. The distribution and severity of these injuries depends on many factors, including (but not limited to) the device yield, height of burst, atmospheric conditions, body orientation, protection afforded by shelter, and the general nature of the terrain.

At altitudes of less than 40,000 feet, the energy of a fission device is roughly distributed as follows:

- 50% blast wave in air and ground shock
- 50% in all forms of radiation, including nuclear radiation, thermal (heat) radiation, and light radiation
  - 5% prompt ionizing radiation
  - 10% residual ionizing radiation (from fission daughter products in the radioactive fallout)
  - 35% thermal (heat) radiation, including visible light

Regardless of the height of burst in the atmosphere, roughly 85% of a nuclear device's energy is divided between blast, shock, and thermal radiation.[5]

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[2] F.L. Wasmer and W.E. Dunn. *AIRRAD Fallout Prediction System Users Manual*. The University of Illinois, 1988.

[3] H.G. Norment. *SIMFIC: A Simple Efficient Fallout Prediction Model*. Atmospheric Science Associates, DNA 5193F, December 31, 1979.

[4] H.G. Norment. DELFIC: Department of Defense Fallout Prediction System. *Volume I –Fundamentals*. Atmospheric Science Associates, DNA 5159-1, October 26, 1979.

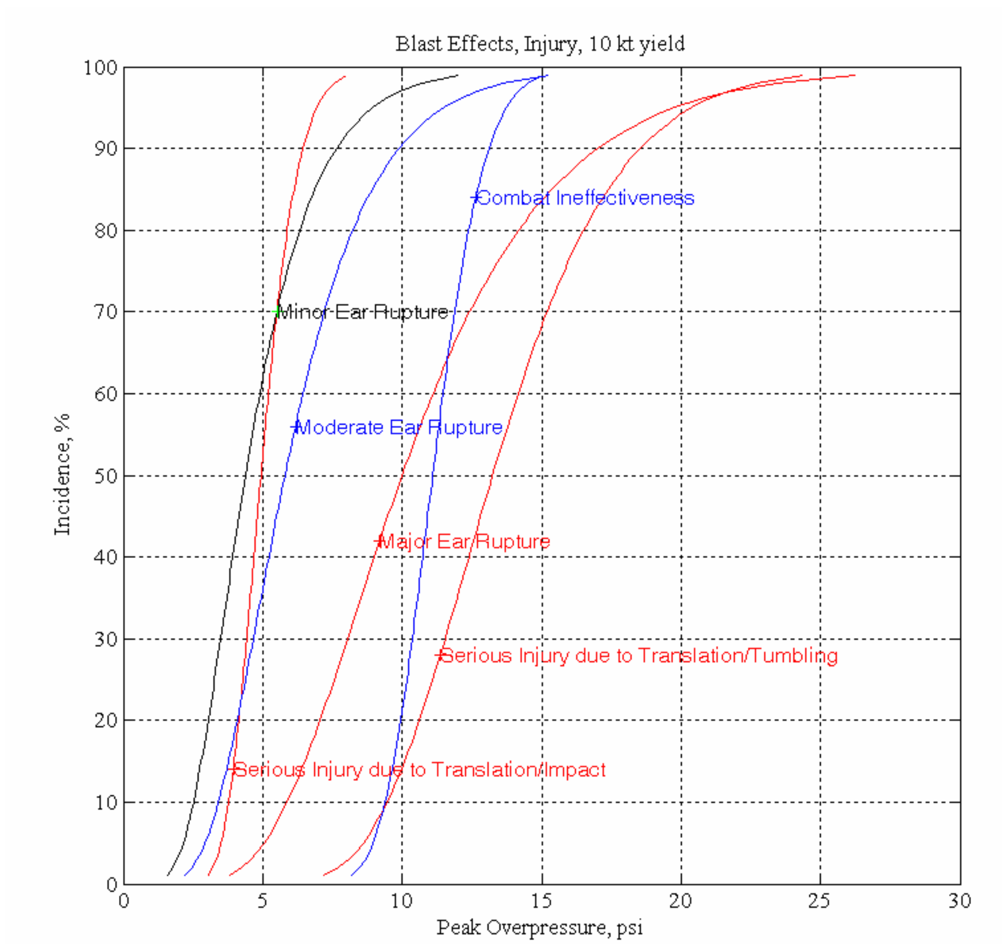
[5] O. J. Messerschmimdt, *Medical Procedures in a Nuclear Disaster*. Veralg Karl Thiemig, Munich, FRG, 1979.

[6] S. J. Glasstone and P. J. Dolan, *The Effects of Nuclear Weapons*. U.S. Department of Defense and U.S. Department of Energy, 1977 (3rd edition).

[7] DNA EM-1 (Effects Manual 1), *Capabilities of Nuclear Weapons*, Chapter 10, July 1, 1972.

Blast –

Blast casualties occur from the direct action of the pressure wave, impact of projectiles and fragments (including glass) created from explosion-energized materials, and whole body translation and impact. The destructiveness of the blast is a function of its peak overpressure and duration of the positive pressure wave (or impulse). Fatalities are expected for the more serious cases of translation resulting in displacement or impact. Casualties are expected for the following severely injuring categories: translation/tumbling, translation/impact, and major ear rupture. Minor, moderate, and major ear rupture and combat ineffectiveness (for this case, these are people who require some assistance) are also calculated but not discussed in this report (see Figure 1-6). The figure shows all the calculated injury categories for a 10-kiloton nuclear device but does not show fatality categories.



Notes: For this calculation, translation/tumbling, translation/impact, and major ear rupture are defined as causing "severe" injuries. Minor and moderate ear rupture and combat ineffectiveness are defined as producing "moderate" injuries and are not considered for calculating blast casualties. For a 10-kiloton nuclear device, serious injury due to translation/impact is the most serious of the "severely injuring" categories, and the "casualty" numbers used elsewhere in this report are determined for this effect.

Figure 1-6. *Calculated injury categories for 10-kiloton nuclear blast effects*

Thermal –

Burn casualties may result from the absorption of thermal radiation energy by the skin, heating, ignition of clothing caused by thermal radiation, and structural fires started by the thermal pulse or as side effects of the air blast or the ground shock. Exposed eyes are at risk of incurring damaging retinal burns, which may cause permanent blindness or flash-blindness even at relatively large distances, especially at night. If an exposed person is looking in the direction of the blast, eye damage is possible even at large distances. Table 1-7 includes information on the distances from the detonation that various levels of thermal injuries are expected. The last item is included to provide a sense of scale. It shows the maximum distance from the detonation where glass, broken by the blast, is expected to cause injuries.

Thermal Effects		
	Range	
Effect	**km**	**mi**
Threshold of pain (1.4 cal/cm^2)	1.6	1.00
1st-degree burn (2.3 cal/cm^2)	1.3	0.81
2nd-degree burn (4.6 cal/cm^2)	0.9	0.56
3rd-degree burn (7.0 cal/cm^2)	0.8	0.50
Retinal burns, day	23	14.3
Retinal burns, night	41	25.4
Flash-blindness, day	22	13.7
Flash-blindness, night	73	45.3
Window glass injury threshold (0.6 psi)	4	2.8

Table 1-7. *Distances from a 10-kiloton nuclear detonation from which various prompt thermal effects are expected*

Structural Damage –

Direct damage to structures in the area surrounding a nuclear detonation occurs due to air blast, ground shock, and thermal radiation. Ionizing radiation does not damage structures, although the presence of radioactive fallout may make buildings uninhabitable unless decontamination takes place. The interaction geometry between the blast wave and the various surfaces of the structure plays an important role in blast damage. Damage to structures is broadly categorized according to whether the damage is a result of the maximum pressure of the shock wave or the duration of the pressure wave. Both effects are included in the calculations of the damage to structures. Various types of structures are considered, including wood frame houses, Multi-Story (MS) buildings with LSQFW and ERD, railroad girder bridges, and highway girder bridges. See Figure 1-2 for the results of these calculations.

The construction practices and building designs of a given local area are extremely difficult to account for in a calculation of this type and vary greatly from one location to the next. If these factors were accounted for, they would produce a result that is site specific and less generally applicable to other locations. Figure 1-2 provides a general description of the effects of a nuclear detonation on various building types. The reader may use these figures to determine the damage to a particular building of interest. For example, the lower left graph in Figure 1-2 shows that at a distance of 1.1 kilometers (0.7 miles) from ground zero, approximately 40% of wood frame houses (S2) are severely damaged, while at a distance of 1.3 kilometers (0.8 miles), only approximately 5% of wood frame houses receive similar damage.

Prompt Radiation and Fallout –

Radiation casualties following a nuclear detonation may be caused by prompt nuclear radiation, radiation from the radioactive fallout, or both. Prompt-effect calculations are based on empirical relationships and are taken from “Capabilities of Nuclear Weapons” (EM-1)[7]. In this calculation, prompt radiation is defined as that occurring within the first minute after detonation and includes neutrons, x-rays, and gamma rays originating from the nuclear reactions producing the yield in the nuclear device and the radioactive decay that the resulting fission “daughter” produces during this time.

A nuclear surface burst will produce significant downwind radioactive fallout, up to about 160 kilometers (100 miles). This fallout is due to the large quantity of material (e.g., dirt, asphalt, concrete, steel) close to the device when it detonates. Much of this material is vaporized in the detonation and is carried up by the rising fireball. The fireball mixes the radioactive fission products and this vaporized material. The fireball cools as it rises, and the vaporized material and the fission products coalesce to form particles. These particles are carried off and dispersed downwind where the larger, heavier particles fall to the ground first. This dispersal is a complicated process that depends on many factors, including the amount of heat energy in the fireball, the amount and composition of the vaporized material, and the size of the particles formed, as well as the weather conditions. The radioactive fission products in the fallout may emit alpha, beta, or gamma rays or combinations of these. Neutron radiation is predominately produced in the prompt phase and is not a significant component of the fallout radioactivity.

Less local fallout is produced by a nuclear detonation where the fireball does not touch the ground. The yield of a device, and thus the quantity of fission products produced, is unaffected by the height of detonation. However, since there is much less surrounding material to be vaporized, there is less material with which the fission products can coalesce. Therefore, smaller particles are formed and carried much further (essentially around the world) by the air currents. Since this radiation is dispersed over a much larger area, it poses much less danger in the local area (tens to hundreds of miles) immediately downwind from the detonation.

Health Physics –

The output from the AIRRAD program is in the form of a system of grids reporting the dose at equally spaced time intervals between the time of first and last fallout deposition. Thus, a time history of ground-shine (surface exposure to the gamma radiation) at each grid point is obtained. Additionally, NUKE determines the dose received from both prompt gamma and neutron radiation within the first minute after detonation. The sum of the prompt and ground shine radiation doses is then applied to the lethality and injury criteria for each population grid point to determine the total number of fatalities and casualties. The criteria for lethality and injury for acute exposure to nuclear device radiation are shown in Table 1-8 and come from EM-1 [7]. These numbers give the threshold dose equivalent in REM for a given incidence level of casualty or fatality. EM-1 similarly summarizes the associated levels for prodromal effects (i.e., those symptoms forewarning of more serious effects—such as nausea; diarrhea; dehydration; and, in more serious cases involving neuromuscular symptoms, fatigue, apathy, sweating, fever, and the like). These effects are summarized in Table 1-9.

Injury and Lethality Criteria		
Incidence (%)	**Injury (REM)**	**Lethality (REM)**
10	150	265
50	215	385
90	280	500

Table 1-8. *Equivalent dose thresholds for injury and lethality for different levels of incidence*[8]

The Roentgen (R) is a unit of radiation exposure and is a measure of the ionizing action of the radiation on air. The radiation dose to a person is measured in terms of the energy of the ionizing radiation absorbed in tissue. Absorbed dose is measured in units of Radiation Absorbed Dose (rad). Even when different types of radiation deposit the same energy in tissue (i.e., same absorbed dose), the biological effect may be different. The biological effect is measured in "dose equivalent in man," which has units of REM. For the gamma rays and x-rays produced by nuclear detonations, a REM is approximately numerically equivalent to a rad. Neutrons and alpha particles may do much more damage to human tissue than a similar dose of gamma rays. For these types of radiation, 1 rad may produce several REM.

[8] Young, EM-1 Table 14IV3, 1987.

Exposure Related Pathophysiological Effects			
Free-in-Air Tissue Dose Range (rad)	**Prodromal Effects**	**Manifest Illness Effects**	**Survival**
75-150	Mild	Slight decrease in blood cell count	Virtually certain
150-300	Mild to moderate	Beginning symptoms of bone marrow damage	Probable (> 90%)
300-530	Moderate	Moderate to severe bone marrow damage	Possible Lower third: $LD_{5/60}$ Middle third: $LD_{10/60}$ Top third: $LD_{50/60}$
530-830	Severe	Severe bone marrow damage	Fatality within 3½ to 6 weeks Bottom half: $LD_{90/60}$ Top half: $LD_{99/60}$
830-1,000	Severe	Bone marrow pancytopenia and moderate intestinal damage	Fatality within 2 to 3 weeks
1,000-1,500	Severe	Combined gastrointestinal and bone marrow damage: hypotension	Fatality within 1 to 2½ weeks
1,500-3,000	Severe	Severe gastrointestinal damage, early transient incapacitation, gastrointestinal fatality	Fatality within 5 to 12 days
3,000-4,500	Severe	Gastrointestinal and cardiovascular damage	Fatality within 2 to 5 days

Notes: The dose levels used in the calculation for $LD_{10/60}$ (minimum Lethal Dose that causes 10% of the population to die within 60 days) and $LD_{90/60}$ are appropriate for a generally healthy population that receives good medical treatment. Successful bone marrow transplant could raise the $LD_{50/60}$ dose from perhaps 500 REM to as high as 900 REM, with corresponding increases in the values of $LD_{10/60}$ and $LD_{90/60}$.[7] However, medical facilities are likely to be highly stressed after a nuclear detonation, and this level of "heroic" care is unlikely to be maintained. This limited care may well produce more fatalities at lower levels of exposure. It is also true that the "average" victim of a nuclear detonation in a major downtown area during working hours may not accurately reflect the demographics of the population at large. This may also affect the casualties.

Table 1-9. *Dose ranges and associated pathophysiological effects for acute radiation exposure*[9]

[9] Baum et al., 1984, EM-1, February 1988.

General Health Physics Rules

- After the prompt radiation has subsided, the external gamma radiation from fission products deposited on the ground is the most significant health hazard and is expressed as whole-body dose. There will be some beta radiation skin exposure, but in most cases this is not biologically significant.
- The dose from the detonation-produced airborne debris cloud as it passes by is negligible.
- Radioactive decay can be characterized by a simple function of time. The approximate rule is that for every sevenfold increase in time after the explosion, the dose rate decreases by a factor of 10. For example, one week (seven days) after the detonation, the dose rate from the fallout on the ground will be 1/10th its value on the day of the detonation; seven weeks later, it will be 1/100th.
- By multiplying the collective dose in person-REM to the population that survives beyond 60 days by 5×10^{-4}, one can estimate the number of excess Latent Cancer Fatalities (LCFs)[10] by referring to the expected cancer rate among Americans.

Radiation Protection Factors –

In order to calculate the health effects to the population from the numerous effects of a 10-kiloton nuclear device, certain assumptions were made about where people are located and oriented with respect to the blast. In most cases, these assumptions were intentionally set conservatively. Therefore, the number of casualties and fatalities reported here is an upper limit. Blast fatality and casualty data are based on the assumption that people are facing in the most hazardous orientation and do not account for any protection provided by buildings or other structures. Similarly, the benefit of shielding by buildings or structures from the prompt neutron and gamma radiation, or from the subsequent radioactive fallout, was not considered. However, this overestimation of casualties that results from not including the beneficial effects of buildings as shielding is somewhat offset by not including the detrimental effects of buildings, such as casualties resulting from building or structure collapse.

In reality, a large fraction of the population will be indoors. Typically, only 15% of the population is outside at any given time during the workday, except in the case of special events. Estimates for radiation protection factors of buildings vary widely. Table 1-10 provides some insight into the radiation shielding effects that various types of structures provide for gamma and neutron radiation. A transmission factor is defined as the ratio of the dose received while in a structure to that which would have been received outside, and can be thought of in terms indicating how much radiation passes through the structure. It gives a measure of how much being indoors protects people from radiation. For example, if a person with no protection received 100 rad of gamma rays, a person in a concrete blockhouse shelter with 9-inch walls would receive only 10 to 20 rad. Values of the transmission factor vary from 1 (where no protection is offered) to 0 (where the radiation is completely shielded). Protection factors vary for numerous reasons, including uncertainties in the gamma source (prompt and/or fallout), radioactive source

[10] National Council on Radiation Protection and Measurements, *Limitation of Exposure to Ionizing Radiation*. NCRP Report No. 116, March 31, 1993.

distributions, geometries assumed in the calculation, etc. In areas with numerous buildings, a person may receive only 20% to 70% of the full dose he or she would have received if no buildings were present.

Transmission Factors of Buildings and Structures			
Structure	**Gamma**		**Prompt Neutrons**
	Prompt	**Fallout**	
3-Feet Underground	0.002-0.004	0.0002	0.002-0.01
Frame House	0.8-1.0	0.3-0.6	0.3-0.8
Basement	0.1-0.6	0.05-0.1	0.1-0.8
Vehicle		0.5-0.7	
MS Buildings	0.1-0.6		0.1-0.8
Apartment			
Upper stories	0.8-0.9	0.01	0.9-1.0
Lower stories	0.3-0.6	0.1	0.3-0.89
Concrete Blockhouse Shelter			
9-inch walls	0.1-0.2	0.007-0.09	0.3-0.5
12-inch walls	0.05-0.1	0.001-0.03	0.2-0.4
24-inch walls	0.007-0.02	0.0001-0.002	0.1-0.2

Table 1-10. *Transmission factors for various structures (Glasstone[5])*

Table 1-11 provides data on when a dose is received. An unprotected person leaving the fallout zone after the first hour of a detonation receives 55% of the dose that a person who remains unprotected in the blast zone for an infinite amount of time receives. Together with information on shelter shielding factors, Table 1-11 can be used to show that remaining sheltered-in-place for the first few hours after a detonation and then evacuating may greatly reduce a person's radiation exposure compared to a person who evacuates immediately.

For example, suppose sheltered people stay in place for a period of 72 hours and then evacuate. If the shelter provides a protection factor of 10 (transmission factor of 0.1), the sheltered group will receive only 8.6% of the total possible long-term dose up to the time at which that group evacuates. (Unsheltered people would have received 86% of the total dose in that same interval.) According to Table 1-11, there is only an additional 2% of dose potentially delivered from 72 to 100 hours after detonation. Assuming evacuation can be achieved in less than 28 hours, individuals who shelter and then evacuate receive 8.6% plus 2%, or about 10% of the maximum possible dose. Meanwhile, individuals who evacuate in the first 24 hours receive 55% of the maximum possible dose. Of course, if only high transmission factor sheltering is available, evacuation should take place immediately.

Table 1-11 can also be used to estimate the dose received by first responders working in areas between the delineated contours of Figures 1-3 and 1-4. For example, an evacuation worker remaining in the zone between 280 and 380 REM between 24 and 48 hours after the detonation will receive 83% minus 80%, or 3% of the total possible long-term dose. This, together with the information in Tables 1-2 and 1-3, can be used to estimate the doses responders may receive. Of course, in a real event, actual measurements of radiation exposure should be used. Emergency workers responding near the blast zone **MUST have real-time dosimetery and be trained to use it for their own personnel protection. In the early period following a ground-level nuclear detonation, it will simply be impossible for responders to approach ground zero or the high-radiation areas of the fallout footprint without absorbing a lethal dose of radiation.**

Time Dependence of Accumulated Dose	
Time (hours)	**Percentage of Infinite-Time Dose**
1	55
2	62
4	68
6	71
12	75
24	80
48	83
72	86
100	88
200	90
500	93
1,000	95
2,000	97
10,000	99

Note: The radiation received before 1 minute is not included here but is accounted for elsewhere in the prompt radiation numbers.

Table 1-11. *Percentages of the "Infinite Time" residual radiation dose received from a nuclear detonation (fission products) between 1 minute and the various times listed after the explosion (Glasstone[5])*

Although gamma emissions are of primary concern, inhalation-shielding factors have been included in Table 1-12 for completeness. Alpha and beta radiations generally do not penetrate the skin and cannot do internal damage, unless the material (i.e., the fallout) that emits these particles is internalized. Internalization can occur via ingestion, inhalation, direct absorption through the skin, or open wounds. Although the radioactive fallout particles generated by the explosion are an inhalation concern, the data in Table 1-12 show that **buildings typically do not provide significant filtration of (or protection**

from) radioactive particles in the 1- to 10-micron range, which is the size range that is the greatest health threat.

First responders may don PPE to prevent internalization of fallout, but **PPE does not reduce the gamma or neutron dose from external sources of radiation.** The effects on the health of the population that internalizes fallout after the detonation are not considered in this appendix. This has been done because the total number of impacted persons in this category will be relatively small compared to the numbers of people exposed to large acute external doses. Therefore, the effects of accounting for these internal contamination cases on the numbers of external cases presented here is smaller than the uncertainty in those numbers.

Timeline of Fallout Dimensions and Population Statistics –

Figure 1-3 shows the acute dose contours for those exposed for 24 hours following the detonation. Instead of producing such a figure for several different times after detonation, graphs have been created that can aid in determining the extent of the fallout and the dose received for other times. Figure 1-7 shows the maximum distance for a fallout contour as a function of time. Comparing this to the data shown in Figure 1-3, the 150-REM dose equivalent contour extends out to 30 kilometers (~ 19 miles) downwind from ground zero, which corresponds to the range of the 150-REM dose equivalent as shown in Figure 1-7.

If one were interested in knowing the range of the 150-REM dose equivalent contour after 60 hours, Figure 1-7 shows it to be 33 kilometers (~ 21 miles). Then returning to Figure 1-3, one can scale (i.e., expand or shrink) the contour lines accordingly. Thus, by using Figures 1-7 and 1-3 together, one can obtain estimates of the affected regions for arbitrary times after the detonation. Another way to look at this is that unsheltered persons remaining in place for 40 hours after the detonation will receive a dose equivalent to *at least* 150 REM if they are downwind of the detonation and are within 32 kilometers (~ 20 miles) of ground zero, and a dose equivalent to at least 210 REM if they are within 24 kilometers (~ 15 miles) of ground zero. Figure 1-8 is similar to Figure 1-7, except it shows the total area enclosed within the contour rather than the maximum downwind distance.

Summary of Penetration Factors	
Penetration Factor	**Reference**
Penetration factors ranged from about 1 to 0.3 as particles increased in diameter from 0.1 to 10 microns (or micrometers, μm).	Thatcher, et al., 2003
Indoor concentrations of particles of outdoor origin were estimated to be on the same order as outdoor concentrations.	Wallace, 1996 Ott, et al., 2000 Riley, et al., 2001
Penetration factors near 1 were found for particles with diameters larger than 1 micron for the single residence studied.	Thatcher and Layton, 1995
Penetration factors were calculated to be very close to 1 for Particulate Matter (PM) with diameter of 2.5 microns or less (PM 2.5).	Wallace, 1996
Penetration factors between 0.4 and 0.9 were reported for ambient particles with diameters between 0.01 and 2.5 microns.	Vette, et al., 2001
Penetration factors between 0.9 and 0.3 for particles between 0.02 and 6 microns were reported for nine homes.	Long, et al., 2001
As particles increase in diameter from 1 to 6 microns, penetration efficiencies drop precipitously (P = 0.9, 0.82, 0.74, 0.69, and 0.53 for particle diameter bins 1-2, 2-3, 3-4, 4-5, and 5-6).	Long, et al., 2001
Penetration factors of 1 were found for two radioactive isotopes (^{131}I and ^{7}Be) and 0.53 for a third (^{137}Cs).	Roed and Cannell, 1987
Penetration factors of 0.85 were reported based on measurements of PM 2.5 in five homes.	Chao and Tung, 2001
The older home had high penetration factors (near 1 for most particle sizes), while the newer home showed significant filtration by the building shell (penetration factors near 0.3 for particles larger than 5 microns)	Thatcher, et al., 2003

Table 1-12. *Selected literature penetration factors summary for particulate materials into buildings*[11]

The lungs tend to trap and retain particles in the 1- to 10-micron range, increasing the long-term dose that is expected from radioactive particles in this range. The conclusion for Table 1-12 is that buildings do not provide significant protection from radio active particles in the size range of concern (1 to 10 microns) for a nuclear incident.

[11] F.T. Harper and W.B. Wente. *Guidance for First Responders in the Very Early Phase of a Release from a Radiological Dispersal Device*. Draft SAND report, January 2004.

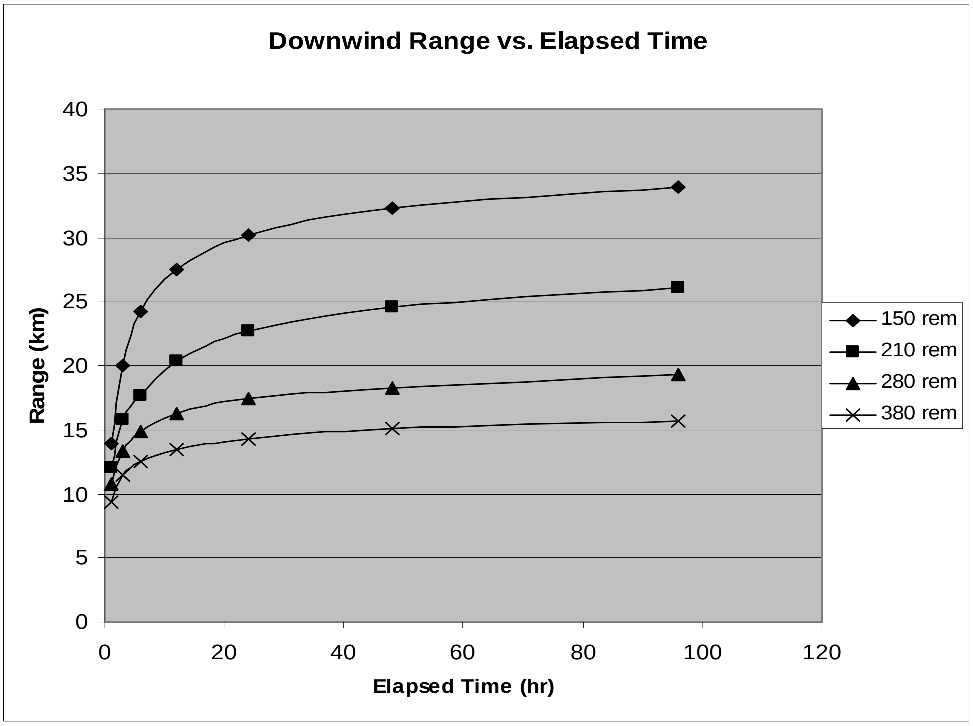


Figure 1-7. *Downwind maximum fallout distance (1 mile = 1.6 kilometers) as a function of elapsed time*

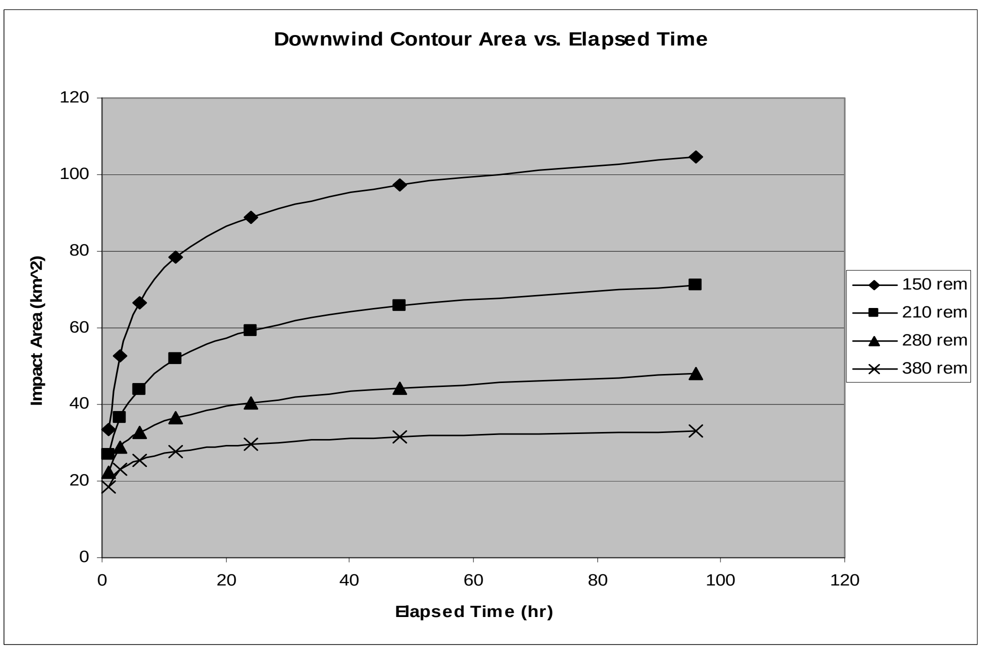


Figure 1-8. *Fallout footprint area (1 square mile = 2.56 square kilometers) as a function of elapsed time*

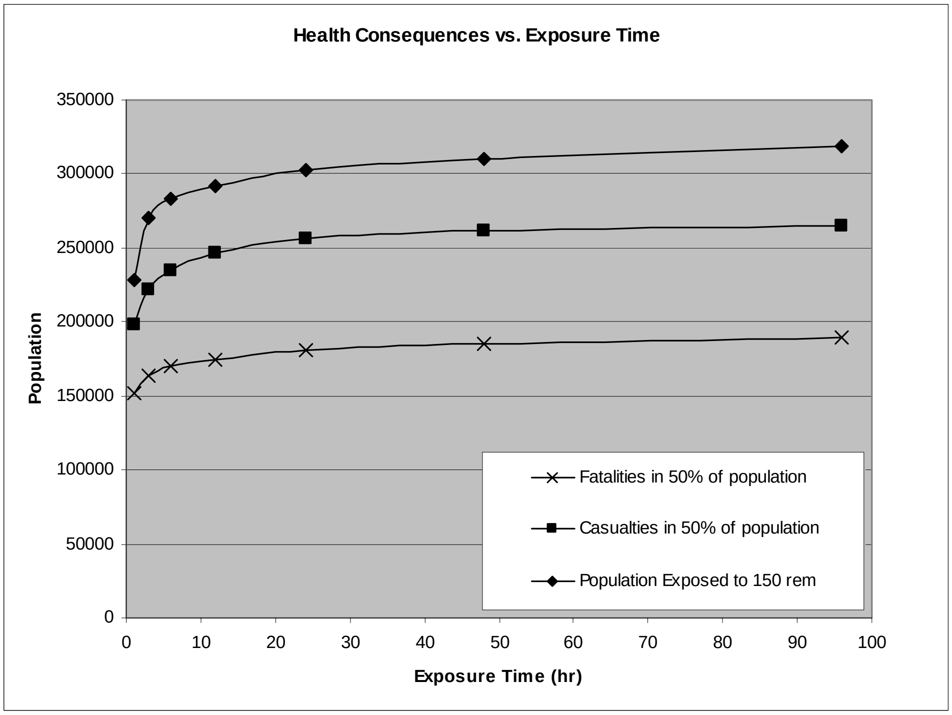


Figure 1-9. *Estimated fatalities, casualties, and total number of exposed people as a function of exposure time*

Figure 1-9 shows the casualty and fatality estimates, as well as the total population exposed to 150 REM, as a function of time. It can be seen that most of the casualties occur within the first 10 hours or so. This is to be expected, since the radiation levels decrease with time, approximately by a factor of 10 for each seven-fold increase in time. The number of fatalities is a measure of the number of those receiving lethal doses, although individuals receiving these doses may survive weeks, months, or even years after receiving the dose, depending on the level of medical treatment received.

Timeline of Accumulated Dose –

Figure 1-10 is an estimate of the expected number of people exposed to a given absorbed dose as a function of time subsequent to a 10-kiloton ground burst of a nuclear device. Table 1-13 tabulates the numerical results used to generate the figure. As before, these numbers assume that the entire exposed population is not evacuated and remains unsheltered for the duration shown. **This assumption will produce a large overestimation of the total dose** but should still be useful in establishing the worst-case scenario. Together with Table 1-8, these results can be used to estimate radiation-induced casualties and fatalities for different exposure durations.

In a real situation, where the shelter-in-place or evacuation decision is made soon after the detonation and is effectively communicated to the population, these numbers should be significantly reduced. If the city has an efficient, functional transportation infrastructure that is not bottlenecked by bridges, tunnels, or other major obstructions—

and a high percentage of the population has access to the system—it is certain that these dose values will be drastically reduced. Conversely, if the decision to evacuate or shelter is slow, the communication is limited, or the mobility of the population is restricted, then these calculations may come closer to what might actually occur.

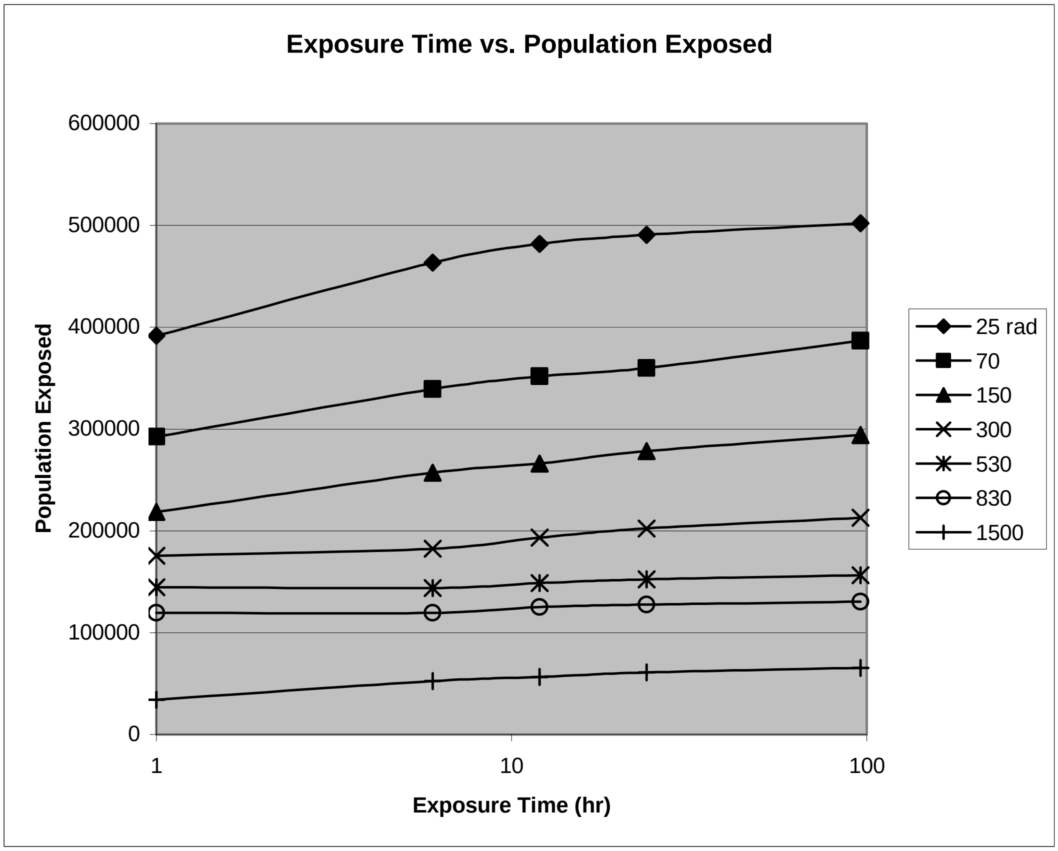


Figure 1-10. *Projected number of people exposed to a given dose as a function of time*

Population Receiving Dose as a Function of Time						
Exposure Time (hours)	Contour Level (rad)	Downwind Range		Area		Population Exposed
		km	mi	km^2	mi^2	
1	1,500	4.9	3.038	3.67	1.410748	33,993
1	830	6.2	3.844	12.09	4.647396	119,380
1	530	7.8	4.836	15.12	5.812128	144,710
1	300	10.5	6.51	21.28	8.180032	175,294
1	150	13.9	8.618	33.57	12.904308	218,629
1	70	22.1	13.702	64.79	24.905276	292,365
1	25	35.1	21.762	134.56	51.724864	391,438
6	1,500	5.9	3.658	4.79	1.841276	52,222
6	830	8.2	5.084	11.77	4.524388	119,274
6	530	10.6	6.572	16.97	6.523268	143,738
6	300	14.3	8.866	27.67	10.636348	182,462
6	150	24.2	15.004	63.53	24.420932	257,125
6	70	39.8	24.676	138.32	53.170208	339,269
6	25	67.5	41.85	347.44	133.555936	463,532
12	1,500	6.2	3.844	5.19	1.995036	56,356
12	830	8.8	5.456	12.66	4.866504	125,132
12	530	11.3	7.006	18.56	7.134464	148,501
12	300	15.6	9.672	31.21	11.997124	193,434
12	150	27.5	17.05	75.65	29.07986	266,115
12	70	44.5	27.59	163.2	62.73408	351,839
12	25	75.8	46.996	423.67	162.858748	481,984
24	1,500	6.4	3.968	5.52	2.121888	60,960
24	830	9.2	5.704	13.35	5.13174	127,483
24	530	11.8	7.316	19.79	7.607276	152,176
24	300	16.6	10.292	34.37	13.211828	202,325
24	150	30.2	18.724	88.82	34.142408	293,159
24	70	48.3	29.946	185.32	71.237008	359,927
24	25	81.9	50.778	490.73	188.636612	490,849
96	1,500	6.9	4.278	6.03	2.317932	65,330
96	830	9.9	6.138	14.53	5.585332	130,495
96	530	12.7	7.874	21.84	8.395296	156,492
96	300	18.1	11.222	40.62	15.614328	212,911
96	150	34	21.08	102.02	39.216488	294,050
96	70	54.9	34.038	222.58	85.559752	386,566
96	25	89.8	55.6	600.79	230.94	565,234

Table 1-13. *Population receiving a given absorbed dose versus time*

Electromagnetic Pulse –

An enormous amount of specificity is required to determine the EMP effects. An EMP is generated by massive electrical currents in the air caused by ionization of the air in a region known as the "source region." The ionization is caused by the intense radiation immediately following a nuclear explosion. Significant EMP effects may extend out to the 2-psi contour but are generally localized in this region. Outside the source region, the emitted energy is small, and susceptible equipment—such as electrical equipment that is connected to long runs of cable, piping, overhead power, and telephone lines, etc.—is primarily at risk. Small, isolated equipment outside the immediate source region should have a higher survival rate.

The effects of an EMP include large induced voltages in electrical equipment, which can damage the equipment if unprotected. When considering the extent of EMP effects, detonations that occur at an altitude below several kilometers are considered surface bursts. This definition is important to note, because whereas the source region for a surface burst of 10 kilotons is on the order of 4.4 kilometers (~ 2.6 miles), a high-altitude burst with the same yield could cause disruptions over several States.

Although the EMP is a short-duration event, lasting a few nano-seconds (10^{-9} seconds), unprotected electrical equipment subjected to this pulse has a high probability of being permanently damaged. Standalone, or self-contained, communications systems that are brought in from outside the impacted area will be unaffected by the EMP. However, the blast and EMP may impact cell towers and other communications or repeater systems and, thus, may indirectly affect the systems brought into the area after the detonation. This may make it difficult for first responders to communicate with each other or for officials to communicate with the public.

Cratering –

The depth and diameter of the crater created by a 10-kiloton nuclear device surface burst are shown in Table 1-14.

Cratering				
Effect (10 kiloton)	**Dry, Hard Rock meters (ft)**	**Dry, Soft Rock meters (ft)**	**Wet, Soft Rock meters (ft)**	**Wet Soil meters (ft)**
Crater Diameter	23 (~ 70)	27 (~ 87)	37 (~ 120)	47 (~ 150)
Crater Depth	10 (~ 32)	11 (~ 36)	16 m (~ 52)	20 (~ 64)

Table 1-14. *Cratering effects for various ground characteristics created by a 10-kiloton nuclear device surface burst*

Uncertainties and Disclaimer –

Virtually every parameter used in these calculations is subject to some uncertainty, as are the models themselves. Therefore, the estimates made here should not be regarded as absolute numbers but rather used only as guidelines.

Appendix 1-B: Estimated "Realistic" Results

This appendix reflects a set of **possible** results from the 10-kiloton nuclear detonation described in the scenario above. The assumptions used in Appendix 1-A are very conservative and produce results that can, with a high degree of confidence, be expected to set the upper limit for what can be expected. In this section, the assumptions are less conservative and produce results that are, arguably, more "realistic." Unfortunately, these results are not directly supported by a computer code or any other calculation. Instead, they result from extrapolations, interpolations, and estimations based on the conservative calculation of Appendix 1-A; on the results of actual nuclear detonations over population centers (e.g., Hiroshima and Nagasaki); and on the results of the U.S. nuclear weapons testing program.

The estimates presented here strongly depend on the assumptions used and how those assumptions are applied. The various numbers presented in this section do not directly correlate with those shown in the appendix and should not be directly compared. For instance, in the appendix, no attempt has been made to separate the number of burn victims from those of blunt trauma or to account for the blast and radiation shielding effects of buildings. These changes would require a very complicated calculation that is beyond the capabilities of the computer codes used. However, in this section, educated estimations have been used in an attempt to address these types of issues.

The following results will be tabulated in zones corresponding to areas delineated in Appendix 1-A. Zones 1, 2, 3, and 4 correspond to the rings of radius 0.76 kilometers (0.47 miles), 0.82 kilometers (0.51 miles), 1.0 kilometer (0.62 miles), and 1.2 kilometers (0.74 miles), respectively, of Figure 1-1 in Appendix 1-A. For the purposes of this section, people in these zones would not necessarily experience the same physical effects from the blast that are described in the appendix. For example, the effects of the blast wave will be reduced by a shielding factor and the attenuation (e.g., drag, reflection) due to the buildings and structures. So the physical effect shown in Appendix 1-A of 7.1 psi overpressure for the outer edge of Zone 2 will not be assumed here. Instead, the outer edge of Zone 2 will have a fixed radius of 0.82 kilometers (~ 0.5 miles) but will be subjected to a lower pressure. Similarly, this will be true for the other zones.

Equivalent dose, measured in REM in Zones 5, 6, 7, and 8, correspond to the areas defined by the 380-REM, 280-REM, 210-REM, and 150-REM contours of Figure 1-3. Again, in this section, people inside these areas will not be assumed to have been subjected to these dose levels. These zones are used only to delineate specific geographical locations and a given number of people initially located inside each zone. Zone 9 corresponds to the area delineated by the 1-REM contour in Figure 1-4.

A Possible Set of "Realistic" Estimated Results for a 10-kiloton Nuclear Device									
	Numbers of People in Thousands (k)								
	Zone 1 (0.76 km)	**Zone 2** (0.82 km)	**Zone 3** (1.0 km)	**Zone 4** (1.2 km)	**Zone 5** (380 REM)	**Zone 6** (280 REM)	**Zone 7** (210 REM)	**Zone 8** (150 REM)	**Zone 9** (1 REM)
Total Population	14.6	16.9	31.7	46.6	203	236	270	303	439
Total fatalities*	13	17	19	21	82	91	94	97	99
Instant (within minutes)	7.7	8.5	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Within 24 hours	9.8	11	13	15	45	45	45	45	45
Within 96 hours	10	13	15	16	61	62	62	62	62
Within 8 weeks	11	14	15	17	66	71	79	83	85
Injuries (initially alive)**	4.1	7.9	9.1	18.7	**106**	**123**	**128**	**136**	**138**
Blunt trauma plus other effects	.6	.9	1.0	1.1	1.1	1.1	1.1	1.1	1.1
Burns	.8	1.4	1.6	1.7	1.7	1.7	1.7	1.7	1.7
Prompt radiation	.5	.6	.7	.7	.7	.7	.7	.7	.7
Multiple (excluding fallout)	2.3	2.6	2.9	3.2	3.2	3.2	3.2	3.2	3.2
Able to walk	1.5	4	7	15	101	123	128	136	138
Requiring special care	3.9	7.5	8.5	17	80	84	89	91	95
Injuries from Fallout	.1	.3	3.6	12	99	116	121	129	131
Eye Damage***									
Flash Blindness	.2	.7	1.6	1.8	2.2	2.3	2.4	2.4	2.5
Retinal Burns	.1	.3	.5	.7	.9	.9	1.0	1.0	1.1
Evacuation needed****	6.9	8.4	23.1	38	**194**	**227**	**261**	**294**	**430**
Critical to evacuate	Extreme?	Extreme?	Extreme	Extreme	Very	Yes	Yes	Yes	Less so
Needing shelter	6.9	8.3	17	28	150	170	200	225	310
Requiring decontamination	6.9	8	20	32	75	82	91	101	110
Major fires (not in thousands)*****	200	220	235	245	247	250	250	250	250
Infrastructure									
Electrical Power									
Out for more than 1 week	Yes	Yes	Yes	Yes	Yes	Likely	Maybe	Maybe	Maybe
Out for more than 4 weeks	Yes	Yes	Yes	Likely	Maybe	No	No	No	No
City Water System									
Contamination with radiation	Unlikely	No	No	No	No	No	No	No	No
Contaminated with "dirt"	Yes	Maybe	No	No	No	No	No	No	No
Telecommunication									
Out for more than 1 week	Yes	Yes	Yes	Yes	Yes	Yes	Likely	Likely	Likely
Out for more than 4 weeks	Yes	Yes	Yes	Yes	Likely	Maybe	Maybe	No	No
EMP damage	Yes	Yes	Likely	Maybe	No	No	No	No	No
This table indicates a **possible** set of consequences for people in a given zone at the time of the detonation. The numbers are accumulative with respect to the zones (e.g., Zone 2 includes the values for Zone 1). **Note that these results depend strongly on the assumptions used and the methods used to apply those assumptions. The values are estimates and are not supported by computer calculations.**									

Table 1-15. *A possible set of realistic estimated results for individuals in a given zone at the time of detonation of a 10-kiloton nuclear device*

* The number of fatalities in each zone has been separated into large time segments (immediate, less than 1 day, less than 4 days, and less than 8 weeks). The numbers given for total fatalities include the immediate fatalities and subsequent fatalities, up to and including projected cancers that may occur many years after the incident.

** For the purposes of estimating the "immediate fatalities" and immediate injuries ("Blunt trauma plus other effects," "burns," and "prompt radiation"), it is assumed that buildings located at a reasonable distance (> 0.5 kilometers, or 0.3 miles) from the blast provide substantial protection from both the blast and prompt radiation effects. Closer to the detonation, the mitigation is minimal, while it contributes significantly as the distance from the detonation increases. The assumption was made that the average shielding benefit from the blast and prompt radiation is 30% on the outer edge of Zone 1 and increases to 90% by the outer edge of Zone 4.

Note that this table uses the term "injuries" and not "casualties" as in the appendix. The "injuries" category excludes fatalities while "casualties" includes them. These injured people may die later (and will then be included in delayed fatalities categories) or may recuperate. The delineated injuries category does not include eye or fallout injuries, which are tabulated separately. An attempt has been made to separate the injuries from "blunt trauma plus other effects" (defined as including puncture wounds, glass cuts, etc.) from those sustained from burning and radiation. Obviously, many victims will have multiple categories of injuries, but the dominant category is listed. There is also a category for "multiple" injuries that is used for situations where the health effects of two or more types of injury classes are of roughly the same magnitude.

The "fallout" injury estimates presented here exclude emergency response workers who may enter these zones after the detonation. It is essential that emergency response workers are educated, trained, and equipped to deal with this situation. Workers entering the very high radiation areas (much of Zones 1 through 4 and the areas of Zone 5 within a few miles of ground zero) in the first few days after the detonation are very likely to receive large doses of radiation. PPE is used to control the spread of contamination and does not protect workers from external radiation doses. If the workers are exposed to contaminated particles in the air (i.e., re-suspension), then devices to protect them from breathing this contamination are required. Personal dosimetery and turn-back levels are essential for all workers entering the entire area affected by the fallout. Without these precautions, a large fraction of emergency response workers will be exposed to large (in Zones 1 through 5, likely lethal) doses. These estimations assume that it takes 24 hours to evacuate 90 % of the population is in Zones 1 through 8, and one-fourth of the population is evacuated in each of the four, 6-hour time periods.

*** The effects of flash blindness will decrease with time (hours to a few days), but retinal burns will cause permanent damage. The detonation occurred at approximately 10:00 a.m. in the morning on a workday. It is a ground blast, which will tend to shield the direct line-of-sight of the device from most observers. Therefore, a lower level of eye damage will occur and will be caused largely by reflections. On average, pedestrians tend to walk in random directions with respect to the detonation site and tend to be looking down as they walk. To estimate eye damage, it is assumed that buildings and other structures will shield many of these pedestrians. Most pedestrians in Zones 1 through 4 will suffer severe injuries or fatalities from other causes and are, therefore, not counted here. It is assumed that most commuters (90%) will already be at work. Of those that are not at work, about half will drive into the city. Of those that drive, approximately half will not be moving toward the city (perhaps on a beltway). Of those that are moving toward the city, approximately 75% will be shielded by buildings, trees, retaining walls, etc. Eye damage that occurs while driving creates the possibility for an increased number of fatalities and injuries due to accidents.

**** Evacuation will be required for the vast majority of people in all delineated zones. For people in Zones 1 through 5, this evacuation (or sheltering-in-place, if those instructions can be disseminated and an appropriate shelter can be located) is absolutely essential and must take place immediately or it will have a significant impact on the number of lives that will be lost. The "?" in Zones 1 and 2 indicates that the assisted evacuation of these people will cost the lives of many emergency responders. In the initial couple of days, perhaps the best solution would be to help those able to self-evacuate from these zones. In zones that will be subjected to lower levels of fallout, the timescale of the evacuations are somewhat less critical (but still must take place as soon as possible) because the fallout will take longer to reach these areas and the total radioactive activity in these areas is expected to be less. It is expected that many evacuated people will need shelter, food, and medical attention for months after the detonation. Those that are not able to adjust may require care for years. Of those that are evacuated, all will need to be checked for contamination. For most, a bath and change of clothes will provide sufficient decontamination, but many will require fast, efficient, expert decontamination and subsequent verification.

***** The assumptions used in this section (for example, ground blast and buildings shielding the effects of the detonation) will serve to restrict most fires caused directly by the heat of the detonation to a region that has largely already been destroyed by the blast wave. Much of this region will burn in subsequent fires. The exception will be fires caused by highly flammable materials that are exposed to the direct thermal emissions from the detonation, and secondary fires that are caused from traffic accidents, ruptured gas lines, etc. It is suggested that fires in Zones 1 and 2 simply be contained at a suitable outer boundary and not directly fought because fighting these fires will likely subject fire fighters to unacceptable radiation doses.

Scenario 2: Biological Attack – Aerosol Anthrax

Casualties	Approximately 13,000 fatalities and injuries
Infrastructure Damage	Minimal, other than contamination
Evacuations/Displaced Persons	25,000 seek shelter (decontamination required) 10,000 instructed to shelter-in-place in each city 100,000+ self-evacuate out of affected cities
Contamination	Extensive
Economic Impact	Billions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Months

Scenario Overview:

General Description –

Anthrax is a disease caused by *Bacillus anthracis*. There are three types of this disease: cutaneous anthrax, gastrointestinal anthrax, and inhalational anthrax. Anthrax spores delivered by aerosol spray result in inhalational anthrax, which develops when the bacterial spores are inhaled into the lungs. A progressive infection follows. This scenario describes a single aerosol anthrax attack in one city, but does not exclude the possibility of multiple attacks in disparate cities or time-phased attacks (i.e., "reload").

This scenario is similar to one being used by the Anthrax Modeling Working Group convened by the Department of Health and Human Services (HHS). It is based on findings from the N-Process Project conducted under an interagency agreement between the Centers for Disease Control and Prevention (CDC) including the Strategic National Stockpile (SNS),; and Sandia National Laboratory (SNL), Albuquerque, New Mexico.

Detailed Attack Scenario –

On an autumn Monday morning, a specially fitted flat-bed truck turns onto a busy street and enters the late rush hour traffic that is exiting a large urban city; a significant percentage of the city's workforce consists of commuters from bordering States. As the truck drives north, the driver's companion turns on a concealed improvised spraying device with a conventional nozzle that rapidly aerosolizes approximately 100 liters of wet-fill *Bacillus anthracis* (anthrax) slurry, or 10^9 Colony-Forming Units per Milliliter (cfu/mL). The dissemination efficiency achieved in this operation (1%) is comparatively modest. Nonetheless, it is sufficient to result in the potential exposure of approximately 330,000 persons. Assuming that winds are southeasterly, these people will be in an area extending northwest over the city into the southern tip of the State in which the city is located and into the northern tip of another State. Among those exposed, more than 13,000 cases of inhalation anthrax would be expected.

Over the next 3 days, Emergency Rooms (ERs) and doctors' offices experience an increase in the number of individuals seeking evaluation and treatment for fever and respiratory complaints. Several ill patients are hospitalized with an initial diagnosis of pneumonia. Businesses in the affected area also experience an increase in the number of employees calling in sick. Two high schools and three elementary schools report an increase in absenteeism in both students and teachers. Initial reports of an increase in influenza cases in the area are found to be inaccurate because many of the rapid flu tests being done in the ERs are returning negative results. Through its surveillance and Influenza-Like Illness (ILI) sentinel physician reporting system, the city's health department has been alerted to an increase of respiratory illness and absenteeism, and health department officials are currently conducting an investigation. On the fifth day following the release, the health department is notified by two separate clinicians about patients admitted to different hospitals with severe respiratory symptoms (potential mediastinal widening on their admission chest x-rays) that are now growing gram-positive rods from blood cultures.

Planning Considerations:

Geographical Considerations/Description –

Dispersal of the anthrax takes place in a densely populated urban city with a significant commuter workforce. The exposed population will disperse widely before the incident is detected.

Timeline/Event Dynamics –

It is possible that a Bio-Watch signal would be received and processed, but this is not likely to occur until the day after the release. The first cases would begin to present to ERs approximately 36 hours post-release, with rapid progression of symptoms and fatalities in untreated (or inappropriately treated) patients. In the absence of Bio-Watch confirmation of the incident, the rapidly escalating number of previously healthy persons with severe respiratory symptoms would quickly trigger alarms within hospitals and at the Department of Public Health (DPH).

Observed incubation periods will vary significantly between individuals but will demonstrate a lognormal distribution with median and mean incubation times of approximately 10 and 14 days, respectively. Based on crude estimates developed for determining hospital capacities following September 11, 2001, it is thought that by expediting discharges and by canceling elective and semi-elective surgical procedures in the 100-plus hospitals around the city, rooms would be available to accommodate as many as 3,000 additional patients on fairly short notice. It is not precisely known how many patients requiring intensive care could be absorbed, but the number would be significantly less than 3,000, possibly on the order of a couple of hundred. Intensive care bed capacity could be increased fairly rapidly by temporarily lodging patients with inhalation anthrax in post-anesthesia care units.

The situation in the hospitals will be complicated by the following facts: The release has occurred at the beginning of an unusually early influenza season and the prodromal symptoms of inhalation anthrax are relatively non-specific. It should be expected that large numbers of worried patients, including many with fever and upper respiratory symptoms, would crowd ERs for evaluation and treatment. Discriminating patients with anthrax from those with more benign illnesses will require the promulgation of clear-case definitions and guidance. Physician uncertainty will result in low thresholds for admission and administration of available countermeasures (e.g., antibiotics), producing severe strains on commercially available supplies of such medications as ciprofloxacin and doxycycline, and exacerbating the surge capacity problem.

Assumptions –

• Wet-fill anthrax supply	100 liters of 10^9 cfu/mL
• Length of line source	1,000 meters
• Initial buoyancy of plume	None
• Meteorological conditions	Mid-range
• Dissemination efficiency	1%[1]
• Human ID_{50}/ID_1	10,000 cfu/530 cfu
• Untreated case-fatality rate	99%
• Protection factor of buildings	50%
• Percentage of population outside	15%

Mission Areas Activated –

Prevention/Deterrence:

The ability to prevent further releases of anthrax lies with Federal, State, and local law enforcement and may include: selection of agent registration and control; knowledge of persons with laboratory skills to grow and aerosolize anthrax; reconnaissance of purchase and shipment of critical laboratory and dispersion supplies; reconnaissance of mobile or temporary laboratories; and public health protection measures at the site before and during the attack.

Emergency Assessment/Diagnosis:

Depending on release area, wind conditions, and location of collectors, the incident may be detected by Bio-Watch. Clinical surveillance systems will be used to monitor the impact of the attack, determine resource needs, classify the type of incident, and determine whether additional events have taken place. Extensive environmental sampling, both inside and outside buildings, will be required in order to assess the risk for continued exposure from contaminated environments. ER physicians, local hospital personnel, infectious disease physicians, medical examiners, epidemiologists, and other public health officials should immediately recognize the seriousness of the incident. Laboratory methods to suspect preliminary diagnosis of anthrax are available at many local public and private laboratories; however, there may be delayed recognition of anthrax since most hospital ER and laboratory personnel in the city and elsewhere have limited or no experience in identifying and/or treating this disease. Supplemental testing

[1] The dissemination efficiency of 1% was chosen to match that of the scenario being modeled by the Anthrax Modeling Working Group. While machines with higher dissemination efficiency exist, this scenario is realistic for a device that could easily be procured from a hardware store.

and confirmation for anthrax is available through the CDC's Laboratory Response Network (LRN).

A rapid onset with large numbers of persons presenting at ERs with pneumonia should create high suspicion of a terrorist event utilizing anthrax or other agents of bioterrorism. Detection of anthrax also should initiate laboratory identification of the strain and a determination of any antimicrobial drug resistance. Actions of incident-site and EOC personnel tested during and after the attack include dispatch, agent detection, hazard assessment and prediction, monitoring and sampling, and tracing origin of the initial contamination back to its source.

Emergency Management/Response:

The National Incident Management System (NIMS), the EOC, and the Joint Information Center (JIC) will be used to manage and respond to the attack. This is a large-scale incident with thousands of potential exposures. Actions of incident-site EOC and JIC personnel tested after the attack include public alerts, mobilization of the SNS, activation of treatment sites, traffic and access control, protection of special populations, potential protective measures including shelter-in-place recommendations, requests for resources and assistance, and public information activities.

Hazard Mitigation:

Efforts to mitigate the impact of the attack include the provision of PEPs, environmental testing and decontamination, and care of ill persons. Persons with primary aerosol exposure to anthrax need to receive antibiotic therapy prior to the onset of symptoms in order to prevent inhalation anthrax—this is an illness with an exceptionally high mortality rate (approximately 40% to 50%), even when met with aggressive medical care. Person-to-person spread does not occur. Actions of incident-site personnel tested after the attack include hazard identification, site control, establishment and operation of the ICS, treatment of exposed victims, mitigation efforts, obtainment of PPE and prophylaxis for responders, site remediation and monitoring, notification of airlines and other transportation providers, provision of public information, and effective coordination with national and international public health and governmental agencies.

Evacuation/Shelter:

JIC will coordinate efforts to provide warnings to the population-at-large and the population-at-risk, and will notify people to shelter-in-place and/or evacuate. The ICS will be used to provide resources for managing traffic flow and accessing affected areas and PEP distribution centers. Evacuation and treatment of victims will be required, as will prompt antimicrobial prophylaxis of exposed persons, responders, and pertinent health care workers.

Victim Care:

Public health will take the lead in providing care to ill persons, disbursement of PEP, and vaccination, if indicated. Tens of thousands of persons will require treatment or prophylaxis with ventilators and antibiotics. Thousands of persons will seek care at hospitals, with many needing advanced critical care due to inhalation anthrax. Exposed persons also will need to be informed of the signs and symptoms suggestive of inhalation anthrax. Mobilization of the SNS for additional critical supplies and antibiotics will be necessary. Public information activities will be needed to promote awareness of potential signs and symptoms of anthrax exposure/inhalation. Actions of incident personnel tested after the attack include emergency response; protective action decisions and communication; recognition of the hazard and scope; victim treatment with additional ventilators at hospitals; non-hospital patient screening clinics; and establishment of treatment or drug distribution centers for prophylactic antibiotics, veterinary services, and mortuary considerations.

Investigation/Apprehension:

Law enforcement will take the lead in investigating the attack. It will be done in collaboration with the public health officials who will be working to identify populations at risk of disease. Epidemiological trace-back of victims and parallel criminal investigations to determine the location of point-source exposures will be needed. Laboratory analyses will be required in order to determine the implicated anthrax strain. Actions of incident-site personnel tested after the attack include dispatch, site containment and control, criminal investigation, tactical deployment, and apprehension.

Recovery/Remediation:

Decontamination/Cleanup: Decontamination/cleanup efforts will be coordinated by the EPA with input from the CDC. Anthrax in its spore form (the probable form for dissemination as a biological terrorism agent) would not be rapidly inactivated by environmental conditions (i.e., ultraviolet exposure or desiccation). Anthrax is hardy and resistant to environmental extremes—it is therefore long-lived in the environment. Extensive decontamination and cleanup likely will be necessary. Actions of incident-site personnel include environmental testing, identification and closure of highly contaminated areas, and provision of public information. The economic costs associated with the closure and decontamination of affected areas may run in the billions of dollars.

Site Restoration: The EPA will coordinate site restoration efforts with input from the CDC. Costs are scenario-dependent and therefore difficult to predict, but they will likely be enormous.

Implications:

Secondary Hazards/Events –

Social order questions will arise. The public will want to know very quickly if it is safe to remain in the affected city and surrounding regions. Many persons will flee regardless of the public health guidance that is provided—some fearing additional anthrax releases and some fearing perceived continued risk of exposure from the "contaminated" area. Pressure may be placed directly on pharmacies to dispense medical countermeasures directly, particularly if there are delays in setting up official points of distribution. It will be necessary to provide public health guidance in more than a dozen languages. The number of visitors and commuters working in the city on the morning of the attack will complicate the identification of patients and distribution of antibiotics, as cases will present over a wide geographic area, and many commuters will be reluctant to reenter the city because of perceived risk and their desire to remain in their city of residence for treatment.

As always with a bioterrorism event, the public health and law enforcement communities will be attempting to determine whether any other agents were released at the same time as the anthrax attack.

Deaths/Injuries/Illnesses (due to exposure)–

Exposures 328,484	
Untreated fatalities	13,208
Total casualties	13,342

Property Damage –

Property damage will be minimal.

Service Disruption –

City services will be hampered by concerns regarding the safety of remaining in the city, going outdoors, and returning to the city from surrounding States.

Economic Impact –

There is the potential for a sell-off in the economic markets; moreover, the stock exchange and large businesses may be directly affected by the attack. Depending on the success of the dissemination techniques and virulence of the biological agent, fatalities could be considerable. Therefore, the expected earnings during a victim's life will be lost, resulting in a decline in consumer spending and a loss of revenue for the metropolitan area. An overall national economic downturn is possible in the wake of the attack due to loss of consumer confidence. The costs of the closure of a large section of the city and the decrease in revenue from tourism for an indeterminate period would be enormous, as would the costs of remediation and decontamination.

Long-Term Health Issues –

The CDC will be involved in the assessment of the long-term health impacts of the attack, as well as the measures that will be taken to prevent disease (e.g., post-exposure prophylaxis and vaccinations). Many persons will be killed, permanently disabled, or sick due to anthrax. The long-term sequelae of inhalation anthrax in survivors are not well understood but may be significant. The long-term effects of longer duration antimicrobial prophylaxis regimens for large numbers of persons also will need follow-up study. The associated mental health issues relating to the attack will be significant.

Scenario 3: Biological Disease Outbreak – Pandemic Influenza

Casualties	30% illness attack rate; fatalities and hospitalizations vary with virulence of the pandemic virus: moderate scenario—209,000 fatalities range and 865,000 hospitalizations; severe scenario 1.9 million fatalities and 9.9 million hospitalizations
Infrastructure Damage	None, however sustainability of infrastructure is stressed
Evacuations/Displaced Persons	No evacuation required Shelter-in-place or quarantine used in some situations and communities
Contamination	Isolation of ill persons
Economic Impact	No estimate of the overall costs, including on economic activity and trade are available. An estimate of direct and indirect health-related costs, absent intervention, for a moderate pandemic is $181 billion.
Potential for Multiple Events	Yes, near simultaneous national and worldwide distribution; second wave of disease in first pandemic year
Recovery Timeline	Several months to over 1 year

Scenario Overview:

General Description –

Influenza pandemics occur unpredictably, with three occurring in the 20th century (1918-1919, 1957-1958, and 1968-1969). Influenza pandemics may occur when a new influenza A virus subtype emerges and causes infection in people (termed genetic shift). If this new virus subtype, for which there is little to no immunity in the population, spreads efficiently between people, it can cause a pandemic. While influenza A outbreaks occur annually, a pandemic is a unique event. Rates of influenza illness, as well as its severity, are likely to be high because most (or all) of the human population will be susceptible, having had no prior exposure to this new influenza subtype. In addition, persons not generally at high risk may develop severe or fatal disease.

Experience with influenza pandemics during the 20th century varied markedly: the 1918 pandemic caused over 500,000 deaths in the United States; the 1957 pandemic caused about 70,000 deaths; and the 1968 pandemic caused about 34,000 deaths. Pandemic impacts on health, society and economic functions, and pandemic response activities will differ quantitatively and qualitatively for moderate and severe pandemic scenarios. Therefore, to best guide planning and preparedness, two scenarios are presented based on experience with the 1918 pandemic (severe) and the 1957 and 1968 pandemics (moderate). No predictions can be made on the relative likelihood of each scenario or a pandemic intermediate to the two occurring.

Detailed Scenario –
The origin and initial spread of moderate and severe pandemic viruses may be similar and is presented as a single scenario. Once spread to the United States occurs, the scenarios are described separately as impacts on health care and on society will differ markedly between the two situations, requiring different response actions and capabilities.

Pandemic Scenario – Origin and Initial Spread
For the past two years, a highly pathogenic avian influenza strain has sporadically infected domestic poultry in several countries. Spread by wild and migratory bird populations which may be asymptomatically infected, the geographical distribution of infection has increased over time. Sporadic human infections have occurred among persons who have close contact with infected poultry. The World Health Organization (WHO) has declared a "pandemic alert." In response, the U.S. Government has begun to develop and evaluate a vaccine against the avian viral strain. Antiviral drugs have been included in the SNS, and several States and large urban areas also have established stockpiles.

In late February of the current year, an outbreak of severe respiratory illness is identified in a small village in a country known to have experienced recent avian influenza disease. At least twenty-five cases have occurred, affecting all age groups. Several household clusters with infection of multiple family members are identified. Twenty patients have required hospitalization at the local provincial hospital, five of whom have died from pneumonia and respiratory failure. Cases initially are investigated by national health authorities but in mid-March, after identification of new cases in neighboring villages and in the provincial capital, WHO assistance is requested. Specimens collected from several patients are sent to WHO Influenza Collaborating Center laboratories including at the CDC in Atlanta. CDC determines that the isolates are of the avian subtype that had previously been circulating in birds but that the viral genome had undergone changes consistent with an increased ability to spread between people.

The novel influenza virus begins to make headlines in every major newspaper and becomes the lead story on major news networks. Key U.S. Government officials are briefed on a daily basis, and surveillance is intensified throughout many countries, including the United States. State health departments enhance influenza surveillance systems and begin diagnostic testing for the new subtype. CDC, the FDA, and other laboratories begin to develop reference strains for vaccine production from isolates of the new strain; the National Institutes of Health (NIH) studies whether vaccine developed against the avian viral strain provides some protection against the pandemic virus; and influenza vaccine manufacturers are placed on alert. Laboratory studies suggest that the vaccine developed previously for the avian strain will only provide partial protection against the new virus.

Over the next two months, March and April, WHO with assistance from the U.S. and other governments, attempts to contain the outbreak, but new cases continue to occur and to spread to neighboring countries. Cases and small outbreaks also are identified in more distant countries that have extensive trade links with the affected area. Cases are reported in all age groups and case-fatality rates range from 2% to 15%, depending on the quality of medical care. Travel restrictions with affected areas and surveillance of arriving passengers for febrile illness are implemented at borders and quarantine stations. In early May, CDC reports that the virus has been isolated from ill airline passengers arriving in four major U.S. cities. State and local areas intensify influenza surveillance activities, and vaccine manufacturers are requested to shift vaccine production from annual to pandemic vaccine.

In June and July, small focal outbreaks begin to be reported throughout the United States. The first doses of a new pandemic vaccine become available in August. Despite full-scale production by manufacturers, supply remains very limited. All influenza antiviral drugs available in the private sector are purchased by sick or concerned individuals and by organizations; thus, the only supplies that remain available are national and State stockpiles, which are of limited size. Community-wide outbreaks begin to occur more frequently as children return to school and by late September, outbreaks are occurring simultaneously throughout the country.

Scenario Continued for Severe (1918-like) Pandemic –
Epidemiological investigation of initial outbreaks determines that rates of hospitalization and death are greatest among infants, adults, and the elderly. Overall, about 2% of Americans with influenza illness die. In communities, during the peak weeks of influenza outbreaks 6-8 weeks in length, about a quarter of workers are absent because of illness, the need to care for ill relatives, and fear of becoming infected in public or workplace settings. Hospitals are overwhelmed and staff shortages limit capacity at the height of the outbreak. Intensive care units at local hospitals are unable to provide care for all who need it, and there are shortages of mechanical ventilators for treatment of patients with severe pneumonia and respiratory failure. Makeshift hospitals established in schools and armories care for those who are unable to be treated in regular hospitals but are unable to care for those who are seriously ill due to insufficient trained staff, supplies, and equipment.

During the peak of disease activity in communities, police, fire, and transportation services are limited by personnel shortages, and absenteeism at utility companies leads to spot power outages. Supplies of food, fuel, and medical supplies are disrupted as truck drivers become ill or stay home from work. In some areas, grocery store shelves are empty, and social unrest occurs. Long lines form where food and gasoline are available. Elderly patients with chronic, unstable medical conditions hesitate to leave their homes for fear of becoming seriously ill with influenza. Riots occur at some vaccination clinics as people are turned away or supplies run out [1]. Several trucks transporting vaccine are hijacked, and a gray market develops for vaccine and antiviral drugs—many of which are counterfeit. Pig herds acquire infection with the pandemic virus and are decimated; large numbers of workers in those settings also become ill. Family members are distraught and

[1] Disclaimer: Disaster literature has established that people don't panic or act irrationally in a disaster as long as they have credible information and purposeful activities to undertake in response. While one must plan for the worst, this is not a prediction of violence and mass panic. There is no evidence that the public will respond in a lawless manner in a real influenza pandemic.

outraged when loved ones die within a matter of a few days. Public anxiety heightens mistrust of government, diminishing compliance with public health advisories. "Worried well" seek medical care despite their absence of influenza illness, further burdening the health care system. Mortuaries and funeral homes are overwhelmed. The peak of cases occurs in mid-October; by early December, virtually all communities have experienced outbreaks and sporadic cases continue to occur. A second influenza disease wave begins in late January and peaks about a month later. Although vaccine production and vaccination have been ongoing between disease waves, the majority of people still have not been vaccinated at the time of the second wave and antiviral drugs, for which stockpiles were exhausted during the first wave of disease, are available in very limited quantities.

Scenario Continued for Moderate (1957- or 1968- like) Pandemic –
Epidemiological investigation of initial outbreaks determines that rates of hospitalization and death are greatest among infants and the elderly. Overall, about three of every thousand (0.3%) Americans with influenza illness die. In communities, during the peak weeks of influenza outbreaks 6-8 weeks in length, about 10% of workers are absent because of illness or the need to care for ill relatives. Hospitals expand capacity by placing beds in hallways, and health care workers serve 12-hour shifts. Intensive care units at many local hospitals become overwhelmed, and there are shortages of mechanical ventilators for treatment of patients with severe pneumonia and respiratory failure.

As 1 in 10 workers is absent during the peak of disease activity in communities, remaining workers expand their hours, and supervisors work alongside frontline staff. Police, fire, transportation, and utility services generally are maintained, although there are several well publicized breakdowns in especially hard hit areas. Some elderly patients with chronic, unstable medical conditions hesitate to leave their homes for fear of becoming seriously ill with influenza. Demand for vaccine far exceeds supply, but public order is maintained. A gray market develops for vaccine and antiviral drugs—many of which are counterfeit. The peak of cases occurs in late October; by early December, virtually all communities have experienced outbreaks, and few sporadic cases still occur. With the cessation of widespread disease, demand for vaccine wanes, and vaccination clinics are poorly attended. Demand for vaccine surges as a second wave begins in late January and peaks about a month later, but again drops with a decline in disease.

Planning Considerations:

Geographical Considerations/Description –

The initial emergence of a new influenza subtype that spreads between people can occur in any country. The most recent pandemic strains have originated in Asia, and the H5N1 avian influenza in Asia represents the greatest current pandemic threat. However, the likely U.S. origin of the 1918 pandemic and recent outbreaks of other pathogenic avian influenza strains that caused human infections in Europe, Canada, and the United States illustrate the uncertain geographic origin of a pandemic.

If efforts to contain the initial outbreak fail, pandemic influenza disease will spread globally. Neighboring countries and those sharing extensive travel/trade links will be affected first. Extensive international travel will accelerate spread compared with past pandemics. Once community-based outbreaks begin to occur in the United States, national spread will be rapid given the large amount of travel within this country. Large urban areas will likely be affected earliest, but within one to two months, virtually all communities will experience outbreaks. Some remote communities may be able to prevent the introduction of disease by total restrictions on entry from outside the community, but such instances will be exceedingly rare. Because outbreaks will occur in all areas, few, if any, medical personnel, medical equipment, or similar resources will be available for redistribution—State, city and local governments, as well as health care systems, will have to cope using existing resources. Stockpiled medical supplies (ventilators, PPE), antiviral drugs, and stockpiled vaccine (if any) will be distributed to States and Indian tribes *pro rata*.

On an international level, countries with limited health care resources, no domestic influenza vaccine production, and little to no stockpiled antiviral drugs will likely request aid from the United States and other industrialized countries. However, current limitations in U.S. influenza vaccine manufacturing capacity, drug production and stockpiling, and limited stocks of relevant medical equipment will make it extremely difficult, if not impossible, to provide any materials in response to international requests. It is likely that there will be notable international political ramifications of this inability to meet even a portion of the requests from developing countries for relevant aid.

Timeline/Event Dynamics –

Appendix 3-A provides a timeline for spread of the 1957-1958 influenza pandemic to, and within, the United States. The amount of time between recognition of an initial outbreak caused by a new influenza subtype that is transmitted between people and the occurrence of large outbreaks in the United States is unclear and depends on several factors. These include where the initial outbreak occurs (e.g., a remote rural area or an urban transportation hub), how early it is detected, the impact of containment measures implemented around the initial cases and outbreaks, the effectiveness of travel restrictions and screening, and the season. Results of mathematical modeling suggest that travel restrictions and screening, even if they are 99% effective, are unlikely to delay introduction of pandemic disease into the United States by more than a month or two.

Large disease waves in the United States associated with prior pandemics occurred in the fall and winter. In 1957, for example, clusters of cases occurred in military camps and other closed settings during June and July. No community outbreaks occurred until children returned to school in August, and the first wave of disease peaked in mid-October. However, past experience is too limited to support confident predictions that a disease wave will not occur during the summer. Community pandemic influenza outbreaks generally will last about 6 to 8 weeks.

The speed at which the pandemic disease spreads to the United States is important, because it will take at least three months and up to six months before the first doses of a new pandemic vaccine are produced. Domestic vaccine surge production capability for 600 million doses (two per person) will be needed within 6 months of the onset of a pandemic. Nevertheless, because of limited current U.S.-based vaccine production capacity, the large majority of the population will not have access to vaccine before the pandemic arrives even if some doses are available. Thus, there must be a mechanism for allocating the vaccine among the population—for deciding who will be at the "head of the line."

Assumptions –

- Susceptibility to the pandemic influenza subtype will be universal.
- Clinical disease attack rate: 30% (highest rate among school aged children [~ 40%]; declining rates with age [~ 20% among working aged adults])
- Number seeking outpatient medical care: 50% of those who are ill.
- Number of hospitalizations: depends on the virulence of the pandemic virus. Because this cannot be predicted, two scenarios are presented based on past pandemic experience (Table 3-1 and 3-2).
- Untreated disease case-fatality rate: 0.2% to 2%.
- Incubation period: 1-4 days (average 2 days)
- Secondary transmission rate: two secondary infected persons per primary infected person
- Countermeasure availability:
    - Vaccine: several million doses of partially effective vaccine may be stockpiled and available before the pandemic. New pandemic vaccine will take 3-6 months to produce. At current production capacity, sufficient doses will be supplied to immunize between 0.25% and 1% of the population per month.
    - Antiviral drugs: influenza antiviral drugs are included in the SNS. A current target is 20 million treatment courses. Some States also are establishing stockpiles. Ongoing U.S.-based production will be about 1.2 million treatment courses per month.

Mission Areas Activated –

Prevention/Deterrence:

Most scientists consider influenza pandemics inevitable. Efforts to decrease the spread of influenza in animals, and to decrease the risk that human and animal influenza strains will co-infect a person or animal and form a new pandemic virus, may reduce the risk. This might extend the time period before the next pandemic occurs. Animal influenza surveillance and rapid implementation of control measures when infection is identified is important. Vaccination with annual influenza vaccine may decrease pandemic risk and will stimulate increased influenza vaccine production, improving pandemic response capacity.

When a new influenza A subtype emerges that is capable of efficient and sustained transmission between people, containment ("putting out the spark" and preventing a pandemic) will be extremely difficult. Mathematical models indicate that a combination of early detection and rapid response with effective case detection; antiviral treatment and prophylaxis of potential contacts and neighboring populations; measures to decrease contact between people; and vaccination, if available, could prevent a pandemic. The sensitivity of surveillance and the ability of poor countries to implement an effective response are barriers to successful containment[2]. No decisions have been made regarding the extent of U.S. participation in a WHO-lead containment effort or potential use of antiviral drugs and vaccines from U.S. stockpiles.

Preparedness:

Preparedness activities are critical across a range of areas. Improved global surveillance and earlier detection of new subtypes that infect and spread between people will facilitate containment and earlier development of pandemic vaccine. Vaccine preparedness includes expanding U.S.-based production capacity; developing new production methods; improving vaccine to enhance immune response; and shortening the time to production of new vaccine. Antiviral drugs are being stockpiled and stockpiles of other essential materials such as needles/syringes, PPE, and masks are currently being considered.

Targets for health care system preparedness, supported by a Health Resources and Services Administration (HRSA) cooperative agreement, include increasing staffed hospital bed capacity by 15%-20%, coordination between local hospitals and health care organizations, and education and training. Health care burden estimates for the peak weeks of pandemic outbreaks suggest that in a moderate pandemic about 25% of hospital beds and almost 40% of Intensive Care Unit (ICU) beds will be needed to care for patients with influenza. Estimates for a severe pandemic are about 10-fold greater, with demand for hospital and ICU care exceeding 100% of current staffed hospital bed capacity. Thus, preparedness for a more severe pandemic will need to be qualitatively different and include strategies to massively expand the ability to provide hospital-like care, for example, through the establishment of makeshift hospitals in schools and armories. Increased ability to provide intensive care also is important, particularly for persons in rural areas, which include about 20% of the U.S. population but only about 17% of adult and 9% of pediatric ICU beds.[3] The SNS maintains 5,000 ventilators. This is a quantity far less than the potential need in a more severe pandemic.

Research can lead to the development of new interventions and capabilities that will improve a pandemic response. For example, changing vaccine formulations by adding an adjuvant or administering vaccine intradermally may improve the immune response, decreasing the amount of vaccine antigen required for each dose and potentially

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[2]Models of pandemic containment supported by the NIH Models of Infectious Disease Agents Study (MIDAS) recently have been published: Longini IM Jr. Nizam A. Xu S. Ungchusak K. Hanshaoworakul W. Cummings DA. Halloran ME. Containing pandemic influenza at the source. *Science. 2005;309(5737):1083-7;* Ferguson NM, Cummings DAT, Cauchemez S, Fraser C, Riley S, Meeyai A, Iamsirithaworn S, Burke DS. Strategies for containing an emerging influenza pandemic in Southeast Asia. *Nature published online 3 Aug 2005 10.1038/nature04017.*

[3] Data on hospital bed capacity and intensive care bed capacity provided by J. Bentley, American Hospital Association, September 2005.

increasing several fold the number of doses that could be produced using available manufacturing capacity. Critical research activities also include the development of new antiviral drugs, developing improved diagnostic tests, and assessing optimal clinical management strategies. A more complete list of research and development activities for pandemic influenza preparedness is published elsewhere.[4] Improving vaccine uptake for annual influenza also would contribute to pandemic preparedness by encouraging manufacturers to increase production capacity and strengthening the vaccine delivery infrastructure and the acceptability of influenza vaccine to the public.

Emergency Assessment/Diagnosis:

Investigation of the earliest outbreaks of human disease caused by a new influenza virus subtype—whether such outbreaks occur in the United States or overseas—is important to provide information on risk groups, clinical course, transmission, and treatment. Laboratory investigation of the pandemic strain is critical for development of vaccine and diagnostic tests, and to assess antiviral drug susceptibility. Mathematical modelers are defining a set of critical data to collect early in a pandemic to facilitate real- time modeling of intervention strategies and their impacts.

Diagnosis of most influenza cases during a pandemic will be clinical. Rapid tests are insufficiently sensitive to be used as a basis for management decisions, and laboratory capacity for more definitive testing would quickly be overwhelmed. Current surveillance infrastructures include reporting of illness by sentinel physicians; reporting of hospitalizations in children in several geographic areas ; mortality surveillance using death certificate data; and State-based assessment of the intensity of influenza activity. These systems will be supplemented in a pandemic by morbidity and mortality reporting from hospitals. Work is needed to ensure that this occurs. Additional investigation will be conducted to define the epidemiology of who becomes infected, develops severe disease, and dies.

Emergency Management/Response:

The effectiveness of emergency management during a pandemic will depend on the degree of pre-pandemic planning and preparation and on the severity of the pandemic. The Federal government is completing a pandemic preparedness and response plan, and all States have completed draft plans. Many States also have conducted preparedness exercises. Planning has been hindered by a lack of specificity in national guidance, and uncertainty regarding the availability of antiviral drugs from a stockpile and the ownership and distribution of pandemic vaccine. Substantial work is needed on specific plans for implementing pandemic response activities at the State and community levels.

Pandemic impacts on critical infrastructure and societal functions will be markedly different for moderate and severe pandemics. No significant societal disruption occurred in 1957 or 1968, although the increased complexity and networking in society makes sole level of disruption in a moderate pandemic possible. A pandemic of the magnitude

[4] A publication of an Institute of Medicine report of a meeting on pandemic research priorities held in April 2005 is posted on the internet (http://www.nap.edu/books/0309097312/html/1.html). An annex to the HHS pandemic influenza preparedness and response plan on research is posted on the internet (http://www.pandemicflu.gov/research/).

experienced in 1918 would likely cause significant disruption of community services and business activities. In a severe pandemic, emergency management needs would include establishing makeshift hospitals, transporting patients, providing care and services for persons who are ill at home, handing disposition of corpses when existing capacity is overwhelmed, maintaining security in communities and at vaccination and medical care sites, and assuring the provision of utilities and other essential services. Because the pandemic will impact all areas, there will be no ability to concentrate emergency management personnel and resources (see *Geographic Considerations/Description*).

Hazard Mitigation:

The success of hazard mitigation will depend on the level of planning and preparedness, the availability of stockpiled resources, the duration of warning before widespread pandemic disease in the United States, and the severity of the pandemic. Because of the uncertain benefit of stockpiling vaccine for a potential pandemic strain and the limited production capacity for pandemic vaccine, most cases of disease will not be prevented. In a moderate pandemic, health care system quality and community services likely will be maintained, mitigating health and societal impacts. In a severe pandemic, demands for health care services and worker absenteeism in critical infrastructures may lead to breakdown. Planning for both moderate and severe pandemic scenarios is important to decrease this risk.

Implementation of public health measures, such as closing schools, canceling public gatherings, wearing masks in public, and encouraging hand washing, are of uncertain value in limiting the extent of pandemic disease within affected communities; nevertheless, many communities likely will implement these measures. "Snow days," when persons stay home from school and work, may limit disease transmission but would result in significant economic disruption. Restricting travel is unlikely to be beneficial, except perhaps to the most remote communities, and would have substantial economic impacts.

Effective communication of information to the public is an important component of hazard mitigation. Recent public health emergencies, such as the anthrax-letter attacks in October 2001 and the 2003 Severe Acute Respiratory Syndrome (SARS) epidemic, have demonstrated that the public's response depends, in part, on:

- The type of public health information provided;
- The perceived and actual reliability and scientific "soundness" of such information;
- The source of the information; and
- The timeliness of the information.

Evacuation/Shelter:

Evacuations will have no meaningful effect on the spread of disease and may be counter-productive by spreading infection to as yet unaffected areas and by overburdening services in a site that soon is likely to experience an outbreak of disease. Isolating ill persons at home, if hospital care is not needed, can decrease the transmission of infection but requires that health care and other services can be delivered, as needed. Quarantine of exposed persons is not likely to affect the spread of influenza because of the short incubation period (1-4 days) and the ability of asymptomatically persons to transmit disease.

Victim Care:

In both moderate and severe pandemics, most ill persons will be treated as outpatients with over-the-counter medications. Antiviral drugs will be used for treatment in defined target groups among both outpatients and those admitted to hospital. Because the effectiveness of antiviral treatment is greater when started earlier in the illness, drugs will need to be dispensed from outpatient clinics, ERs, and at other point-of-care sites.

In the moderate pandemic scenario, less than 1% of ill persons will require hospital care, whereas in the more severe scenario, almost 10% will require admission. Treatment will primarily be supportive. Patients with pneumonia may require supplemental oxygen, including mechanical ventilation. Shortages of ventilators in a severe pandemic may occur. Secondary bacterial pneumonias frequently complicate influenza and may be caused by resistant pathogens. Shortages of effective antibiotics (e.g., vancomycin) for highly resistant strains are possible. Patient care also may be compromised by shortages of other hospital supplies, particularly if transportation systems are disrupted in a more severe pandemic (note that hospitals stock limited inventory and rely on daily delivery of supplies). To prevent the spread of influenza in the hospital, infected patients will be kept in isolation or when isolation capacity is exceeded, will be cohorted in wards. Advance instructions will be needed for family members taking care of influenza patients at home.

There is also a need to plan to deal with the large number of fatalities that will occur in a relatively short period of time. Mortuary and burial services may become over-extended, causing delays in funeral services; this, in turn, will heighten the anguish of bereaved families.

Since a pandemic will be global in scope, the U.S. Department of State will provide appropriate assistance to U.S. citizens traveling or residing abroad, including the timely dissemination of information to allow citizens to make informed plans and decisions.

Investigation/Apprehension:

For pandemic influenza, investigation includes clinical and epidemiological studies and disease surveillance. The current influenza surveillance system, described in the *Emergency Assessment/Diagnosis* section, has distinct limitations.

Implications:

Secondary Hazards/Events –

The greatest secondary hazard will be the problems caused by shortages of medical supplies (e. g., vaccines and antiviral drugs), equipment (e.g., mechanical ventilators), hospital beds, and health care workers—potentially exacerbated by resulting disruptions in supply chains, and reduction in essential services such as transportation and telecommunications. Having a detailed system for allocating resources and maintaining provision of medical supplies potentially can reduce such difficulties. This system should be in place well before an influenza pandemic actually occurs.

Of particular concern is the likelihood that health care systems, particularly hospitals, will be overwhelmed. One method of mitigating such an impact is to have plans in place that effectively allocate scarce hospital-based resources among incoming patients. This will require incoming patients to be triaged according to need, availability of resources, and expected outcomes. In effect, hospital staff and patients will have to accept different standards of care during an influenza pandemic. For example, nurse-to-bed ratios will have to be decreased, meaning that each nurse will have to look after more occupied beds. Non-credentialed staff and volunteers will provide some care. Patients might not be given all of the treatment that they and their physicians would normally expect to be used, such as mechanical ventilation. Makeshift hospitals established in schools or other settings will be unlikely to provide the same level of care as in regular facilities.

In addition to the acute anxiety caused during the most severe phases of the pandemic, there will be other behavioral health concerns. Severe shortages in medical personnel and supplies mean that people will not be able to obtain psychotropic medications, methadone, or other needed medicines. Highly vulnerable populations, such as people with Human Immunodeficiency Virus (HIV), will be uniquely affected.

Another important secondary hazard is the disruption that might occur in society in a more severe pandemic. Institutions, such as schools and workplaces, may close because a large proportion of students or employees are ill or may close as a public health measure to decrease the spread of illness in these settings and in communities. Essential services may be limited because workers are absent from work due to illness, the need to care for sick family members, or fear of becoming infected at work. The complexity of networks, supply chains, and just-in-time inventories make it likely that absenteeism among some groups will have a ripple affect with much broader impacts. This risk may be decreased by critical industries developing continuity of business plans that include cross-training workers.

Travel between cities and countries may be sharply reduced, not only due to fewer staff personnel available to operate the transportation system, but because fewer people will want to, or be able to, travel.

Fatalities/Injuries –

Estimates of health impact are provided in Tables 3-1 and 3-2. Estimates for the impact of moderate and severe pandemics are derived by extrapolating data from 20th century pandemics (see Appendix 3-B for methods). Improved medical care, interventions such as antiviral drugs, and potentially more widespread vaccine availability may reduce health impacts below those shown. However, it is possible that a new subtype such as H5N1 could cause even more severe infections than occurred in 1918. Estimates in Table 3-1 are the total number of episodes that would occur during a single pandemic wave. Cases, hospitalizations, and deaths would occur over approximately three months, with each community experiencing a 6- to 8-week outbreak during that period. A better measure of pandemic impacts on communities and on health care services is to estimate demand for hospital beds, ICU beds, and ventilators based on the proportion of people who would require these services and the estimated durations that they would be needed. Table 3-2 shows the health care demands during the two peak weeks of pandemic outbreaks. Although these peaks would not occur simultaneously in all communities, the data are aggregated so that numbers can be compared with national totals for staffed hospital beds and ICU beds. Rates per 1000 persons also are presented so that communities can estimate impacts on their own health care system.

Characteristic	Moderate (1958/68-like)	Severe (1918-like)
Illness	90 million (30%)	90 million (30%)
Outpatient medical care	45 million (50%)	45 million (50%)
Hospitalization	719,000	8,520,000
ICU care	107,850	1,278,000
Mechanical ventilation	53,925	639,000
Deaths	209,000	1,903,000

Table 3-1. *Number of episodes of illness, health care use, and death associated with moderate and severe pandemic influenza scenarios. See Appendix 3-B for approach to calculation and assumptions*

Health care burden	Moderate (1958/68-like)		Severe (1918-like)	
	Aggregate	Per 1,000	Aggregate	Per 1,000
Hospital beds	154,594	0.516	1,710,531	5.70
ICU beds	39,772	0.133	440,066	1.47
Mechanical ventilation	19,886	0.066	220,033	0.73
Death	39,710	0.132	361,570	1.21

Table 3-2. *Aggregate health care burden and burden per 1,000 population during the peak week of a pandemic outbreak. See Appendix 3-B for approach to calculation and assumptions. Aggregate burden represents the number of hospital beds, ICU beds, and ventilators that will be needed during the peak week of a pandemic outbreak, if all communities experienced the peak at the same time. This allows the totals to be compared with total available hospital and ICU beds to calculate the proportion of each that would be needed for influenza patients. Hospital-bed and ICU-bed needs per 1,000 population can be used by communities to estimate their burden in a pandemic.*

Additional scenarios/estimates can be generated for virtually any population level using the CDC's Flu-Aid and Flu-Surge programs, which are free software programs designed to help State and local public health officials plan, prepare, and practice for the next influenza pandemic. The programs are available at http://www.hhs.gov/nvpo.

Risk groups for severe and fatal infections cannot be predicted with certainty. Most likely, they will include persons with chronic illnesses such as respiratory diseases including asthma, heart disease, and diabetes, and persons with conditions or treatments that compromise immunity (e.g., cancer, Acquired Immune Deficiency Syndrome [AIDS]). Infants, pregnant women, and the elderly also are likely to be at high risk. In the 1918 pandemic, most fatalities occurred in young, previously healthy adults. This pattern was not seen in the 1957 or 1968 pandemics. Whereas more than 90% of persons who die during annual influenza outbreaks are 65 years old or older, during past pandemics between 30% and 90% of excess deaths occurred among those younger than 65 years.

Property Damage –

Property damage is unlikely, except to the extent that pandemic influenza-related absence from work may cause maintenance-related failures and/or accidents.

Service Disruption –

Some service disruption is likely in a more severe pandemic, particularly during the peak weeks of disease outbreaks in communities. Disruption may be minimal in a moderate pandemic, although the complexity of systems and infrastructures make them vulnerable to disruption if certain critical functions are not performed. In a pandemic of any magnitude, the health care system will be severely stressed, if not overwhelmed.

The workloads of essential service personnel and first responders are also likely to be severely strained, due to large numbers of influenza-related emergency calls and the decreased numbers of available workers. Again, the extent of such disruptions will depend on the pattern of which persons become ill, when they become ill, and how severe is their illness.

Economic Impact –

For a moderate pandemic, the direct and indirect illness-associated costs, including lifetime lost productivity costs, in the absence of an effective intervention are about $181 billion (estimated in 2004 U.S. dollars). This estimate does not include costs associated with disruption of trade and other economic activity. For illustration purposes, if a 50% decrease in economic activity occurred during the two peak weeks in each of two pandemic waves, given a U.S. Gross Domestic Product (GDP) of about $11.7 trillion per year, the total economic loss would be $450 billion. The actual magnitude of economic disruption and its duration are unknown and will be related to pandemic severity.

Long-Term Health Issues –

Many people recovering from severe influenza-related illnesses may need care and convalescence for several months after the pandemic has ended. Long-term sequelae of infection are not common.

APPENDIX 3-A: Timeline of Events for the Influenza Pandemic of 1957-1958

February 1957	Outbreaks of ILI occur in Guizhou Province, China.
Early March 1957	Outbreaks of ILI occur in Yunan Province, China.
Mid-March 1957	Outbreaks of ILI are now widespread in China.
April 1957	Outbreaks of ILI occur in Hong Kong, Singapore, and Taiwan.
Mid-May 1957	Influenza virus associated with ILI is isolated in Japan.
Late May 1957	Six pharmaceutical companies begin vaccine production in the United States.
June-July 1957	The virus is isolated in the United States; outbreaks of influenza are reported in military facilities and other closed or "unique" settings.
Mid-August 1957	The first community outbreaks of pandemic disease occur in Louisiana when children return to school.
Late August 1957	Four million doses of pandemic influenza (single-strain) vaccine are released.
September 1957	Widespread occurrence of influenza begins in the United States. Nine million doses of single-strain influenza vaccine are released.
October 1957	The peak incidence of the disease occurs. At this stage of the pandemic, the highest rate of the disease is among school children and young adults. Seventeen million doses of the single-strain vaccine are released.
Late October 1957	The demand for influenza vaccine declines.
November 1957	The incidence of new cases declines. The first peak of pneumonia and influenza-related fatalities are observed. Seventeen million doses of the single-strain vaccine are released. Five million doses of three-strain vaccine are released.
Early December 1957	A cumulative total of 60 million doses of vaccine have been released, but much of the vaccine has gone unused.

January-February 1958	A second peak of pneumonia and influenza-related fatalities is observed, with a higher-than-usual proportion of fatalities among the elderly. Retrospectively, it was realized that there was a "second wave" of disease that occurred mainly among older adults and the elderly.

APPENDIX 3-B: Methods for Calculating Pandemic Health and Health Care System Impacts

The numbers of episodes of illness, hospitalization, and death that may occur in moderate and severe pandemics are estimated based on extrapolation from 20th century pandemics. Methods are published by Meltzer et al in *Emerging Infectious Diseases*, 1999[5]. In brief, for this publication, the authors abstracted data from the 1957 and 1968 pandemics and immediate post-pandemic years to identify the rates of various outcomes by age category and risk group. Data were extrapolated to the contemporary U.S. population within age and risk strata. Impact estimates were calculated for illness attack rates of 15% to 35%. Economic data were derived from various sources. Modeling was done with multiple simulations (Monte Carlo methods) using a pre-defined probability distribution of key input variables. Recently, the lead author updated these estimates to the current U.S. population and the economic impacts to 2004 U.S. dollars. In addition, estimates were calculated for a severe pandemic using data from the 1918-1919 pandemic.

Although Meltzer modeled illness attack rates in a pandemic wave ranging from 15% to 35%, analysis of rates of illness from 20th century pandemics indicates an attack rate of about 30% in each (chosen as the basis for estimates in the moderate and severe scenarios). Rates of hospitalization and death differed among those who became ill differed between pandemics. In addition, during the 1918 pandemic, young, previously healthy adults had a high risk of death, whereas this peak in mortality did not occur in 1957 or 1968. This difference is reflected in the moderate and severe scenarios presented here.

Converting episodes of illness and hospitalization to estimates of health care burden requires estimating the duration of hospitalization (in normal and ICU beds), the proportion who require intensive care, and, among these, the proportion who require mechanical ventilation. Few data are available specifically for pandemic influenza. Therefore, estimates were derived from community-acquired pneumonia. Modeling was done using FluSurge software (http://www.cdc.gov/flu/flusurge.htm). Assumptions used in the model include the following:

- Duration of hospital stay for influenza: 7 days
- Duration of ICU stay: 10 days
- Duration of mechanical ventilation: 10 days
- Proportion of hospitalized persons requiring ICU care: 15%
- Proportion of ICU patients requiring mechanical ventilation: 50%
- Pandemic outbreak duration within a community: 8 weeks

Using these parameters, the shape of the epidemic curve in a community (modeled by the change in rates of illness per day during the pandemic outbreak) was calibrated to data from the 1918 pandemic, which indicated an approximate 7-fold difference in mortality rates between the beginning and peak of the outbreak.

[5] Meltzer MI, Cox NJ, Fukuda K. The economic impact of pandemic influenza in the United States: priorities for intervention. *Emerging Infectious Diseases 1999;5:659-71.*

Data on hospital bed capacity and ICU bed capacity was obtained from the 2003 American Hospital Association Annual Survey of Hospitals. Estimates of total hospital beds in the United States take into account non-response. Extrapolations are not done for ICU beds; thus, these likely represent an underestimate of the total. Data are stratified for urban areas and rural areas as based on metropolitan statistical area designation by the U.S. Office of Management and Budget. No data are available from this survey or other existing data sources for the number of ventilators nationwide.

Scenario 4: Biological Attack – Plague

Casualties	9,553 fatalities; 28,383 illnesses; 37, 936 cumulative cases (fatalities and illnesses)
Infrastructure Damage	None
Evacuations/Displaced Persons	No evacuation required Shelter in place Quarantine given to certain highly affected areas Possible large-scale self-evacuation from affected communities
Contamination	Lasts for hours
Economic Impact	Millions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Weeks

Scenario Overview:

General Description –

Yersinia pestis (*Y. pestis*), the causative agent of plague, is a gram negative bacterium of the Enterobacteriacea family. The disease is enzootic in certain sylvatic reservoirs such as rats, squirrels and mice. In addition, cats, dogs and goats can serve as incidental hosts and be a source of infection to humans. The two most common forms of plague in humans are bubonic and pneumonic, but both can progress to a septicemic form similar to a gram negative sepsis. Bubonic plague occurs following the bite of an infected flea. Rapid onset of symptoms of fever, chills and headache occur within 1 to 7 days of exposure. Bubonic plague is not transmitted from human to human; however, about 5% of bubonic cases develop into pneumonic plague, which is transmittable human to human by droplets. The general fatality rate for untreated bubonic plague can be as high as 50% but with aggressive antibiotic treatment the case fatality rate is usually about 5%. Pneumonic plague occurs following the inhalation of *Y. pestis* organisms (as few as 100 to 500 organisms) and fulminant symptoms of fever, chills, cough, hemoptysis, and chest pain develops within 1 to 4 days. The case fatality rate may be as high as 100% if aggressive antibiotic therapy is not initiated within 24 hours of the onset of symptoms.

In this scenario, members of the Universal Adversary (UA) disseminate plague via an agricultural sprayer while driving through a major metropolitan city in the United States. As a result of foreign and domestic travel, rapid dissemination to distant locations occurs.

Detailed Attack Scenario –

In Karachi, Pakistan, a member of the UA receives *Y. pestis* seed stock from Europe and South America via airmail and begins production. Once the *Y. pestis* production is complete, the UA operative departs for Beirut , Lebanon. After a brief stay in Beirut, she departs for a major U.S. airport, via Beirut, Lebanon, and Madrid, Spain, using commercial air. Upon arrival at the international airport, she is met by another UA operative and is escorted to a safe house. Three days later, a UA messenger arrives at the international airport from Karachi, Pakistan, via Madrid, Spain, and delivers 50% of the *Y. pestis* seed stock concealed in the battery compartment of a cellular telephone. Approximately three weeks later, another UA messenger arrives at the international airport from Karachi, Pakistan, via Athens, Greece, and delivers the remaining 50% of the *Y. pestis* seed stock concealed in the battery compartment of a second cellular telephone. After the arrival of the remaining *Y. pestis*, the UA agent begins full-scale production of the agent. Two months later, the UA orders agricultural sprayers. The UA also uses cash to purchase three used Sport Utility Vehicles (SUVs) from private citizens at three different locations for use in the attacks. They are stored in a warehouse until the agent is ready. Less than 1 month after the purchase of the SUVs, *Y. pestis* production is complete, and the UA begins weaponization of the biological agent. Once this process is finished, the UA operatives load the *Y. pestis* agent into the sprayers and prepare for deployment as planned. The following day, three UA members drive the three SUVs outfitted with Biological Warfare (BW) dissemination devices toward the city and execute their mission.

D+1

The first victim of the biological attack, a 14-month-old girl, is admitted to a local hospital.

D+2

Three victims are admitted to area hospitals. One victim arrives by EMS and is coughing up blood.

One of the abandoned SUVs is discovered by local security in a local parking lot and is reported to police. The agricultural sprayer is still in the SUV.

A presumptive diagnosis of *Y. pestis* is established based on patient epidemiology, laboratory results, and a laboratory analysis of a swab taken from the abandoned SUV.

D+3

Investigation of the SUV leads to the discovery of the location of the biological weapons production facility used by the UA.

Investigation of the SUV leads to the discovery of the location of the UA safe house.

A second SUV is discovered abandoned near the local airport.

D+3 to D+6

The first cases arrive in ERs approximately 36 hours post-release, with rapid progression of symptoms and fatalities in untreated (or inappropriately treated) patients. The rapidly escalating number of previously healthy persons with severe respiratory symptoms quickly triggers alerts within hospitals and at the DPH. Observed incubation periods vary significantly between individuals and range from 1 to 6 days after exposure. It is estimated that the approximately 80 hospitals in the major metropolitan area (MMA) can make room for as many as 3,000 additional patients on fairly short notice, with total capacity in the State exceeding 8,000 beds. It is not precisely known how many patients requiring intensive care could be absorbed, but the number would be significantly less than 3,000, possibly on the order of around 200. ICU bed capacity could be increased fairly rapidly by temporarily lodging patients with pneumonic plague in post-anesthesia care units.

The situation in the hospitals will be complicated by the fact that the prodromal symptoms of pneumonic plague are relatively non-specific and by the necessity of initiating antimicrobial therapy rapidly once symptoms begin. It is expected that large numbers of worried patients, including many with fever and upper respiratory symptoms, will crowd ERs. Discriminating patients with pneumonic plague from those with more benign illnesses will require the promulgation of clear-case definitions and guidance. Physician uncertainty will result in low thresholds for admission and administration of available countermeasures, producing severe strains on commercially available supplies of Ciprofloxacin and Doxycycline (among other medications) and exacerbating the surge capacity problem.

Pneumonic plague is transmissible from person to person, and the public will want to know quickly if it is safe to remain in the city and surrounding regions. Given the large number of persons initially exposed and the escalating nature of the epidemic, it is likely that Federal, State and local public health officials will recommend a modified form of sheltering in place or voluntary "snow day" restrictions as a self-protective measure for the general public and as a way of facilitating the delivery of medical countermeasures and prophylaxis to those at risk of contracting pneumonic plague. Some people may flee regardless of the public health guidance provided. Support of critical infrastructure and the maintenance of supply chains during this period will pose significant logistical and human resource challenges. The public may place pressure on pharmacies to dispense medical countermeasures directly, particularly if there are delays in setting up official points of distribution. It will be necessary to provide public health guidance in several languages. The number of potentially exposed people will complicate the identification of patients and distribution of antibiotics, because cases will present over a wide geographic area and the timing of the attacks will not be known within a timeframe relevant to the provision of post-exposure prophylaxis.

Planning Considerations:

Geographical Considerations/Description –

Although the release will occur only in the major city, rapid dissemination to distant locations through foreign and domestic travel is included in this scenario. Countries with recognized plague outbreaks will be subject to international travel restrictions. Intense communication and cooperation between U.S. and Canadian foreign affairs entities will be required in order to address potential border restrictions as well as citizen and resident health issues.

Following a release in the environment, plague may become established within animal populations (e.g., rats), which then pose a risk of ongoing exposure to humans through bites of arthropod vectors. Rodents are found in large numbers in many metropolitan areas. In the United States, flea vectors, which can efficiently transmit plague from rodents to humans, are found in some cities but are not believed to be common in the major city.

Timeline/Event Dynamics –

D-Day:

Persons in the primary exposure group are becoming symptomatic. Some have become infectious and are sources for secondary exposure through coughing, which generates contagious respiratory droplets. By 8:00 p.m. there are 1,068 cases and 908 fatalities.

D+1 (Day plus one):

U.S. physicians become alarmed at the volume of patients with similar and increasingly severe symptoms. Hospital staff, medical examiner office personnel, and local officials recognize the scope of the current incident. Public health officials are faced with the task of defining and managing the crisis. By 8:00 p.m., there are 7,970 cases and 4,782 fatalities.

D+2:

The major city DPH and the State DPH (SDPH) continue to receive information that increasing numbers of persons are seeking medical attention at the major city's area hospitals for cough and fever. Laboratory reports on several patients are positive for plague. The Federal Bureau of Investigation (FBI) receives information about a possible release at the sports arena. Health Canada establishes appropriate contact with health organizations worldwide. The United Nations (UN) schedules a meeting of the General Assembly. By 8:00 p.m., there are 10,344 cases and 2,379 fatalities.

D+3:

The number of plague cases across Canada increases, and many are dying. The plague spreads across both the Pacific and Atlantic Oceans and encircles the globe. The WHO issues a warning for all persons who may have gone through the major city the previous weekend to seek medical attention. WHO mobilizes teams to assist countries with identification and treatment of plague cases. The FBI begins an operation against a suspected terrorist laboratory thought to be connected to the recent clandestine release of plague. By 8:00 p.m., there are 9,615 cases and 769 fatalities.

D+4:

New cases of plague continue to be reported, and the fatality toll is still on the rise. U.S. and Canadian authorities have exchanged liaison offices to further coordinate follow-on investigations. Health Canada and the CDC continue epidemiology investigation efforts. The FBI continues an operation against a suspected terrorist laboratory thought to be connected to the recent outbreak. The plague continues to spread and is confirmed in 11 countries other than the United States and Canada: Australia, Brazil, China, England, France, Germany, Japan, Kuwait, Mexico, Russia, and Saudi Arabia. WHO officials suspect that hundreds of victims have been exposed to the plague in these and other countries. By 8:00 p.m., there are 8,939 cases and 715 fatalities.

Assumptions –

- Sophisticated terrorist adversary with limited capacity to develop and deploy a weapon
- Line-source outdoor release (in multiple locations) through small-orifice, single-fluid nozzle
- *Y. pestis* supply: liquid slurry of 1 x 10^{10} organisms per milliliter; 25 gallons total
- Release size: agricultural sprayer nozzle configured to 5 µ; disseminating at a rate of 1 gallon per minute
- Dissemination efficiency: 0.01% in forming 1-micron to 5-micron aerosols
- Biological decay rate: 10% per minute at 75º Fahrenheit (F), 80% humidity
- Human infectious dose: 2,000 to 6,000 organisms (average: 3,000)
- Untreated case-fatality rate: > 90%
- Incubation period: lognormal distribution with a range of 1 to 6 days
- Secondary transmission rate: one secondary infected person per primary infected person

Mission Areas Activated –

Prevention/Deterrence:

Prevention and deterrence require select agent registration and control, knowledge of persons with laboratory skills to grow and aerosolize plague, reconnaissance of purchase and shipment of critical laboratory and dispersion supplies, reconnaissance of mobile or temporary laboratories, and public health protection measures at the site before and during the attack.

Emergency Assessment/Diagnosis:

ER physicians, local hospital staff, infectious disease physicians, medical examiners, epidemiologists, and other public health officials should rapidly recognize the seriousness of the incident. Although laboratory methods to suspect preliminary diagnosis of the plague are available at many local public and private laboratories, there may be delayed recognition of the plague, since most hospital ER and laboratory personnel in the United States and Canada have limited to no experience in identifying and/or treating plague.

Supplemental testing and confirmation for the plague is available through the CDC LRN. A rapid onset with large numbers of persons presenting at ERs with pneumonia should create high suspicion of a terrorist incident using the plague. Detection of the plague should also initiate laboratory identification of the plague strain and a determination of the potentiality of known antimicrobial drug resistance. Existing antibiotics may be ineffective against drug-resistant strains of the plague. Actions of incident-site and EOC personnel tested during and after the attack include dispatching personnel, performing agent detection, conducting hazard assessment and prediction, monitoring and sampling, and tracing the origin of the initial contamination back to the source.

Emergency Management/Response:

This is a large-scale incident with thousands of potential exposures and additional person-to-person, airborne spread through close contact. Identification of drug-resistant plague strains would require full use of PPE and quarantine measures. Actions of incident-site, EOC, and JIC personnel tested after the attack include provision of public alerts, mobilization of the SNS, activation of treatment sites, traffic and access control, protection of special populations, potential quarantine measures including shelter-in-place recommendations, requests for resources and assistance, and public information activities.

Hazard Mitigation:

Persons with primary aerosol exposure to plague need to receive antibiotic therapy within 24 hours in order to prevent near certain fatality. The prevention of potential secondary person-to-person spread by fleeing victims will be a challenge. Epidemiological assessments, including contact investigation and notification, will be needed. Actions of incident-site personnel tested after the attack include hazard identification and site control, establishment and operation of the ICS, isolation and treatment of exposed victims, mitigation efforts, obtainment of PPE and prophylaxis for responders, site remediation and monitoring, notification of airlines and other transportation providers, provision of public information, and effective coordination with national and international public health and governmental agencies.

Evacuation/Shelter:

Evacuation and treatment of some victims will be required. Self-quarantine through shelter-in-place may be instituted.

Victim Care:

Tens of thousands of people will require treatment or prophylaxis with ventilators and antibiotics. Plague prompts antimicrobial prophylaxis of exposed persons, responders, and pertinent health care workers. Thousands will seek care at hospitals with many needing advanced critical care due to pneumonia caused by plague. Exposed persons will also need to be informed of signs and symptoms suggestive of plague as well as measures to prevent person-to-person spread. PPE (e.g., masks) for responders and health care providers should be available. Mobilization of the SNS for additional critical supplies and antibiotics will be necessary. Public information activities will be needed to promote awareness of potential signs and symptoms of plague. Proper control measures will include the need for rapid treatment; contact tracing; and, potentially, self-quarantine through shelter-in-place or other least restrictive means.

Actions of incident-site personnel tested after the attack include protective action decisions, recognition of the hazard and scope, providing emergency response, communication, protection of special populations, treating victims with additional ventilators at hospitals, providing patient screening clinics, and providing treatment or drug distribution centers for prophylactic antibiotics. Mortuary requirements, animal-based surveillance to monitor potential spread of plague via natural methods, and veterinary services also will need to be considered. Since this is an international incident, the U.S. Department of State will provide appropriate assistance to U.S. citizens traveling or residing abroad, including the timely dissemination of information to allow citizens to make informed plans and decisions.

Investigation/Apprehension:

Epidemiological trace-back of victims and parallel criminal investigations to determine location of point-source exposures will be needed. Laboratory analyses will be required to determine the implicated plague strain. Actions of incident-site personnel tested after the attack include dispatch, site containment and control, criminal investigation, tactical deployment, and suspect apprehension.

Recovery/Remediation:

Decontamination/Cleanup: Typically, plague cannot live long in the environment and is not viable when exposed to heat and sunlight. Therefore, it is likely that extensive decontamination and cleanup will not be necessary but would be undertaken to support political, response-worker, and public confidence. Contact tracing or potential person-to-person spread of exposed individuals will be necessary to mitigate secondary or tertiary spread. Actions of incident-site personnel include closure of the site for at least 24 hours, environmental testing, and public information provision.

Implications:

Secondary Hazards/Events –

As the financial world in the major city and elsewhere begins to realize the likelihood of an epidemic, a sell-off occurs in the markets. There is a high absentee rate at banks, other financial institutions, and major corporations. Adding to these complications is the fact that bank and other financial customers may be staying home, afraid to venture into public places and trying instead to conduct business on the phone. As a result, the phone systems at financial institutions may become completely tied up, with far fewer transactions than normally occur. The fear of plague has raised memories of the anthrax incidents of 2001, which may cause many citizens to be afraid to open their mail.

Fatalities/Injuries –

The total number of illnesses at the end of the fifth day is approximately 28,383. The total number of fatalities is 9,553. Assumptions affecting these figures include length of incubation period following primary exposure, rate of secondary transmission, incubation period following secondary exposure, and timing and effectiveness of the intervention (e.g., respiratory precautions and antimicrobial treatment).

Property Damage –

Although the actual physical damage to property will be negligible, there will be an associated negative impact of buildings and areas that were or could have been contaminated by the primary exposure or by subsequent casualties. This may result in people shying away from or refusing to visit locations with a “negative reputation,” potentially constituting a significant economic loss.

Service Disruption –

The 911 system may be flooded with calls from both the sick and the "worried well." As worry spreads in the major city and other areas, calls to hospitals, doctors' offices, emergency call centers, and public health offices could increase drastically. Responding to the medical transport needs of casualties may overwhelm emergency service representatives. Hospital beds will fill rapidly, and staff will need to work longer hours. Persons who use medications for chronic health conditions may have difficulty obtaining refills because of demands on pharmacies.

Because the biological agent is known to be contagious and readily transmitted from one individual to another, closing or restricting modes of transportation, such as railroads, may be necessary to reduce the spread of the disease. Assuming that the major city is one of the major air transport nodes in the United States handling passenger volumes that exceeded 83 million in 2001 (73.5 million domestic and 9.5 million international) and handling nearly 1.5 million tons of cargo in 2001, the closure or restricted use of the airport would create large perturbations in the passenger and cargo aviation system worldwide. The major city area is also one of the key rail transportation centers in the United States, with approximately 60% of the Nation's rail traffic traveling through the area. Finally, the Major City Transit Authority (CTA), which operates mass transit rail and bus service throughout the city and its 38 suburbs, carries 1.5 million passengers on a typical business weekday.

Food prices in the major city area are likely to soar because of the threat of reduced supply. However, any transportation restrictions that might be implemented are not likely to cause serious shortages in the initial week following the incident. Moreover, many people may be afraid to venture out, thus averting (at least initially) any hoarding or panic shopping.

Economic Impact –

There is potential for a sell-off in the economic markets. Depending on the success of the dissemination techniques and the virulence of the biological agent, fatalities could be considerable. Therefore, the expected earnings during a victim's life will be lost, resulting in a decline in consumer spending and loss of revenue for the metropolitan area. Automatic Teller Machines (ATMs), especially drive-up machines, may run out of cash before they can be replenished. An overall national economic downturn is possible in the wake of the attack due to loss of consumer confidence.

Long-Term Health Issues –

Many people will be killed, permanently disabled, or sick as a result of the plague. The primary illness will be pneumonia, although the plague can also cause septicemia, circulatory complications, and other manifestations. The long-term effects of antimicrobial prophylaxis in large numbers will require follow-up study. The associated mental health issues relating to mass trauma and terrorism events will also require assessment.

Scenario 5: Chemical Attack – Blister Agent

Casualties	150 fatalities; 70,000 hospitalizations
Infrastructure Damage	Minimal
Evacuations/Displaced Persons	More than 100,000 evacuated 15,000 seek shelter in immediate area (decontamination required)
Contamination	Structures affected
Economic Impact	$500 million
Potential for Multiple Events	Yes
Recovery Timeline	Weeks; many long-term health effects

Scenario Overview:

General Description –

Agent Yellow, which is a mixture of the blister agents sulfur mustard and lewisite, is a liquid with a garlic-like odor. Individuals who breathe this mixture may experience damage to the respiratory system. Contact with the skin or eyes can result in serious burns. Lewisite or mustard-lewisite also can cause damage to bone marrow and blood vessels. Exposure to high levels may be fatal.

In this scenario, the Universal Adversary (UA) uses a light aircraft to spray chemical agent Yellow into a packed college football stadium. The agent directly contaminates the stadium and the immediate surrounding area and generates a downwind vapor hazard. The attack causes a large number of casualties that require urgent and long-term medical treatment, but few immediate fatalities occur.

Detailed Attack Scenario –

Agents of the UA acquire 55 gallons of agent Yellow (a 50/50 mixture of the blister agents mustard and lewisite) from overseas sources. UA Central Command has a trained chemical warfare specialist who puts the agent in a 55-gallon stainless steel drum. This drum is then overpacked into a 75-gallon drum partially filled with absorbent material. UA then uses contacts in the shipping industry to have the drum shipped to the United States in a sea-borne cargo container. As one of the more than 6,000 containers arriving in the United States daily, and shipped from a legitimate source, it passes through customs and is delivered to agents of a UA cell operating in the United States.

A separate UA cell is assigned to recruit a pilot and acquire a light aircraft. The cell does so and stores the airplane at a remote private airpark. While the container is in transit, the chemical warfare specialist travels overseas and is smuggled across the border into the United States where he joins the UA cell. After inspecting the aircraft, he buys and installs an aerial spray system that can be quickly and unobtrusively attached to the aircraft and deployed over the target. (Figure 5-1 depicts a plane equipped in this manner, with the spray booms attached to the wing struts and the tank and pump unit located in the cabin. The aircraft depicted belongs to the U.S. Government.)

Meanwhile, UA Central Command dispatches an attack planning and reconnaissance team to survey potential targets within 500 miles of the airpark. The team decides on a large college football stadium located 300 miles from the airpark. One of the largest stadiums in the country, it seats more than 100,000 fans. Team members attend several home games to assess security procedures, which are then incorporated into the attack plan.

The first UA cell receives instructions to transport the drum to a UA safe house near the airpark. The pilot is instructed to file a flight plan that will bring him within 10 miles of the stadium during the first half of the next home game. The cell members arrive very early in the morning at the airpark before anyone else is there; they install the spray system on the airplane and load the drum of agent Yellow aboard. The specialist makes the final connections; the cell members then cover the equipment with blankets.

The UA pilot and cell member take off approximately two hours before game time, and the rest of the UA cell members scatter. All have scheduled flights out of the country later in the day, as well as a backup ground plan.

At his closest approach to the stadium, the pilot veers directly toward the target. He cuts his speed and drops over the stadium, simultaneously hitting the spray release button. A coarse spray of agent Yellow is released over the eastern half of the crowd. He stops the spray, banks sharply, and dives over the western half of the crowd, again activating the spray. Once clear of the stadium, he heads away at maximum speed with the police helicopter in hot pursuit but losing ground. Less than 6 minutes have elapsed since the time the plane veered off course.

On the ground, surprise at the appearance of the aircraft turns to panic when the spray is observed coming out of the rear of the plane. In total, 70,000 people have been hit by the agent Yellow spray. Thousands are injured, and many are killed in the rush to exit the stadium. Only those hit in the eyes are feeling any immediate pain. The first people out of the stadium are trying to get away as soon and as far away as possible. Many motor vehicle accidents occur in the parking lot and access roads. Some people track contamination with them to nearby residences/dormitories or onto public transportation.

Alerted by law enforcement personnel, first responders begin to flow toward the stadium within minutes of the attack. Shortly after arrival, they identify the presence of a blister agent and begin to cordon off the area and control the panicky crowd. Due to traffic congestion, the fire department is unable to gain access to the facility with its heavy equipment, and it sets up several expedient mass-decontamination lines at the perimeter of the site and begins to process the crowd.

Meanwhile, police work with air traffic controllers to track the airplane as it continues to the northwest at maximum speed. Police forces are dispatched to every known airfield in the general direction that the airplane is headed. Two hours later and running low on fuel, the aircraft touches down on a small airstrip used by a crop dusting enterprise. Police make an arrest shortly thereafter.

Planning Considerations:

Geographical Consideration/Description –

For purposes of estimating Federal response requirements, the stadium is assumed to be a major college football stadium in an urban area. Examples include Ohio Stadium on the grounds of Ohio State University in Columbus, Ohio; and the Rose Bowl in Pasadena, California, each of which have a seating capacity of approximately 100,000 people. However, the size and location of the stadium and maximum occupancy can be adjusted to meet local conditions.

Timeline/Event Dynamics –

The total time of the attack, including the last mile of the plane's approach, is less than 5 minutes. The crowd will panic and immediately evacuate the stadium, which will require up to 30 minutes. First responders should begin arriving at the facility perimeter within 10 to 15 minutes of the attack.

Meteorological Conditions –

Wind speed, temperature, humidity, and precipitation determine the success or failure of a chemical attack.

- *Wind Speed:* Wind speed determines how fast a primary cloud moves. High winds can disperse vapors, aerosols, and liquids rapidly, thereby shrinking the target area and reducing the population's exposure to the agents. The best wind speed for an attack is between 4 and 6 knots.
- *Temperature:* Higher air temperatures may cause the evaporation of aerosol particles, thereby decreasing their size and increasing the chance that they will reach the lungs. The best air temperature for an attack is between 65ºF and 75º F.
- *Humidity:* High humidity may lead to the enlargement of aerosol particles, thereby reducing the quantity of aerosol inhaled. The combination of high temperature and high humidity causes increased perspiration in humans, intensifying the effects of mustard agent. The best low- range humidity for an attack is between 30% and 40%.
- *Precipitation:* The best condition for an attack is no precipitation.

Assumptions –

- Of the total stadium attendees (i.e., those in the stands), 70 % are exposed to the liquid at the time of the attack. The remaining 30% (i.e., those in the covered areas of the stadium), plus 10% of the total population in the vapor hazard area, are exposed to vapor contamination.
- The temperature is above the agent's freezing point, and the agent is efficiently disseminated as a coarse spray.
- Due to light winds, there is little liquid over-spray, but there is a downwind vapor hazard. The vapor hazard will decrease with time, but persist until the stadium is decontaminated.

- Fifty-five gallons of agent Yellow is disseminated, a 50/50 mixture of mustard and lewisite weighing approximately 722 pounds (within the capability of five or six Cessna Aircraft 2003 model year, single-engine, private airplanes [assuming two pilots, 50 pounds of spray gear, and proper load balancing]).
- Law enforcement and intelligence communities do not detect the importation of the agent, the acquisition and modification of the aircraft, or the training of the pilot. The aircraft is able to evade any security precautions long enough to conduct the attack. One-way range is estimated to be 700 to 800 miles.
- Current EPA and Department of Defense (DoD) rules regarding the release of material that has previously been contaminated with Chemical Warfare Material (CWM) for public use will be followed. Surface decontamination of the stadium with bleach will allow for reoccupation of the downwind area.
- Many people will be contaminated only on their clothing, not directly on their skin. Expedient decontamination (i.e., clothing removal, heavy water spray and washing with soap and compounds such as Fuller's Earth, before the agent can penetrate through to the skin) will reduce contamination below the injury threshold for half of those exposed. Since decontamination of skin and eyes must occur within 1 to 2 minutes in order to significantly reduce tissue damage, decontamination will not play a significant role in reducing injuries to those exposed on the skin or eyes.

Mission Areas Activated –

Prevention/Deterrence:

The ability to prevent the attack is contingent on the prevention of CWM importation, weapon assembly, plane and pilot acquisition, and site reconnaissance. Deterrence measures must be taken by visibly increasing security and apprehension likelihood at the site before and during the attack. Depleting overseas stockpiles of mustard and precursor agents would also aid in preventing such an attack.

Emergency Assessment/Diagnosis:

On-scene personnel should instantly recognize the attack. The components of agent Yellow are readily identifiable using M8 or M9 chemical agent identification paper typically carried by Hazardous Materials (HAZMAT) teams. Liquid contamination and a downwind vapor hazard will be components of the hazard. Actions of incident-site and EOC personnel tested during and after the attack include dispatch; agent detection; and hazard assessment, prediction, monitoring, and sampling.

Emergency Management/Response:

This is a large-scale incident with tens of thousands of potential exposures and a downwind plume. Actions of incident-site, EOC, and JIC personnel tested after the attack include alerts, activation and notification, traffic and access control, protection of special populations, resource support and requests for assistance, and public information activities.

Hazard Mitigation:

The spread of contamination by fleeing victims will be a major challenge. Actions of incident-site personnel tested after the attack include isolating and defining the hazard; establishing, planning, and operating incident command; preserving the scene; conducting mitigation efforts; decontaminating responders; and conducting site remediation and monitoring.

Evacuation/Shelter:

Since mustard and lewisite are persistent agents, evacuation and/or sheltering of downwind populations will be required until the stadium is decontaminated. Because this is expected to be a lengthy process (weeks to months) and the wind is not likely to remain constant, the evacuation will have to occur in a 360° arc around the stadium. Actions of incident-site, local-area, and EOC personnel tested after the attack include reception site and shelter operations and veterinary services.

Victim Care:

Tens of thousands of people will require decontamination and both short-term and long-term treatment. Actions of incident-site, local-area, hospital, and EOC personnel tested after the attack include protective action decisions and communication, emergency aid, search and rescue, triage, treatment and stabilization, patient screening and decontamination, patient transport, patient status reporting, hospital treatment, and next-of-kin notification.

Investigation/Apprehension:

Tracking of the aircraft and apprehension of the suspects will be included. Actions of incident-site personnel tested after the attack include dispatch, site control, criminal investigation, tactical deployment, and suspect apprehension.

Recovery/Remediation:

Decontamination/Cleanup: The stadium and adjacent facilities, such as a parking lot, will be contaminated with liquid agent Yellow. Fleeing victims, including private and public conveyances and residences, may spread spot contamination for a considerable distance. Actions of incident-site personnel include decontamination of the stadium and other contaminated areas, disposal of decontamination wastes (complicated by the presence of arsenic from the lewisite component), environmental testing, and public information provision.

Site Restoration: There will be little damage to the stadium as a direct result of the attack. However, decontamination of some materials may be difficult or impossible. Even if structures and property could be technically decontaminated, the psychological impact on future usability would be significant. In all likelihood, the entire site (approximately 15 acres) would have to be replaced. Likewise, any contaminated personal property and equipment would be incinerated as well.

Implications:

Secondary Hazards/Events –

Numerous injuries will occur as a result of crowd panic, including those that result from falling and crushing. Further injuries are likely to occur due to motor vehicle accidents in the parking lot and surrounding roadways.

Fatalities/Injuries –

In the case of a full, 100,000-seat stadium, 70,000 people (70%) may be contaminated in the attack. Of these, most will have only clothing and/or skin contamination, resulting in moderate-to-severe skin blisters that will appear in 2 to 12 hours. Expedient decontamination (i.e., clothing removal and heavy water spray) will avoid half of these injuries. Systemic arsenic poisoning will occur in highly contaminated individuals. However, many will inhale sufficient agent vapor to cause severe lung damage, and many more will sustain permanent damage to the eyes. Fatalities and major injuries will occur due to falling and crushing during the evacuation, and due to vehicle accidents.

The following problems and resultant fatalities/injuries occur:

- Panic during evacuation results in 100 fatalities (1/10th of 1%) and 5,000 injuries (5%). These casualties will occur within 30 minutes of the attack; some of these injuries will be permanently disabling. Some of these injuries will be due to body crushing and will require immediate assistance; however, most will be broken bones and concussions from falls.
- Motor vehicle accidents result in 10 fatalities (1/100th of 1%) and 50 injuries (1/20th of 1%). These casualties will occur within 1 hour of the attack. Some of the injuries will be permanently disabling. They will be due to body crushing and high-speed impacts as drivers try to circumvent clogged traffic, and they will require immediate assistance.
- Liquid contamination results in 35 fatalities (1/20th of 1% of liquid exposures) and 35,000 injuries (50% of liquid exposures), with 3,500 individuals (10%) suffering permanent disability, primarily blindness. Fatality occurs in individuals with liquid contamination over more than one-third of their bodies; in this scenario, it would be a small number—but if the attack occurred in hot weather, the percentage could be much higher. Also, some individuals with pre-existing respiratory problems may not survive significant lung damage caused by inhalation of vapors. Depending on the degree and route of exposure, most symptoms will appear between 2 and 8 hours after exposure. However, liquid exposure of the eyes and skin will result in immediate pain. Fatalities due to systemic poisoning and/or bone marrow depression will occur in several days. All injuries due to liquid exposure will require immediate care. Mustard is a known carcinogen and can result in fatality several years after exposure. Most people with casualties will completely recover in 1 to 4 years, except for those who are permanently blinded. In order to prevent the spread of the agent to others (or to other parts of a victim's body), expedient decontamination (i.e., clothing removal and heavy water spray) should occur as soon as possible after the attack. More deliberate decontamination with 0.5% sodium hypochlorite solution, or Fuller's

Earth, should follow for stubborn liquid contamination. Eyes should be flushed with copious amounts of water for 5 to 10 minutes.

- Vapor contamination results in five fatalities (1/100th of 1% of the population in the vapor hazard area) and 5,000 injuries (10% of the population in the vapor hazard area), with 500 individuals suffering permanent disability, primarily blindness (1% of the population in the vapor hazard area). Fatality occurs mainly in individuals with pre-existing respiratory problems who may not survive significant lung damage caused by the inhalation of vapors. Depending on the degree and route of exposure, most symptoms will appear between 2 and 24 hours after exposure. Fatalities due to systemic poisoning and/or bone marrow depression will occur in several days. For an evenly distributed population density in the downwind vapor hazard area, approximately one-tenth of those exposed will require immediate care due to exposure above the EPA's Acute Exposure Guideline Level (AEGL) 3, approximately one-quarter will require delayed care due to exposure above the AEGL2 level, and the remainder will require minimal care due to exposure above the AEGL1 level.

Property Damage –

There will be little direct property damage due to the attack. However, the stadium site and other contaminated property (15,000 automobiles, two campus dormitories, numerous athletic facilities, and off-campus residences) will be a total loss due to decontamination measures and/or psychological impacts of future usability.

Service Disruption –

Loss of use of the stadium and adjacent athletic facilities is expected. Additionally, some public transportation and other facilities may be lost due to contamination carried by fleeing victims. Overwhelming demand will disrupt communications (landline telephone and cellular) in the local area. Finally, some victims may self-transport to health care facilities and could possibly contaminate those facilities.

Economic Impact –

Decontamination, destruction, disposal, and replacement of a major stadium could cost up to $500 million. Enrollment at the college will be negatively affected, and the local community will experience significant losses resulting from the attack. Additionally, an overall national economic downturn is possible in the wake of the attack due to a loss of consumer confidence.

Long-Term Health Issues –

Many will be permanently blinded, and many more will carry lifetime scars. Many may suffer significant damage to the lungs. In addition, mustard is a known carcinogen, and systemic poisoning from the arsenic in lewisite is also a concern.

Scenario 6: Chemical Attack – Toxic Industrial Chemicals

Casualties	350 fatalities; 1,000 hospitalizations
Infrastructure Damage	50% of structures in area of explosion
Evacuations/Displaced Persons	10,000 evacuated 1,000 seek shelter in safe areas 25,000 instructed to temporarily shelter-in-place as plume moves across region 100,000 self-evacuate out of region
Contamination	Yes
Economic Impact	Billions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Months

Scenario Overview:

General Description –

In this scenario, terrorists from the Universal Adversary (UA), represented by Fariqallah, a radical Shi'ite Muslim group, conduct a standoff weapon attack on a Petroleum, Oil and Lubricants (POL) refinery. At the same time, multiple Vehicle-Borne Explosive Devices (VBIEDs) are detonated in a local port, targeting the Coast Guard station and two merchant vessels unloading at pier side. Two of the ships contain flammable material. Cobalt, nickel, molybdenum, cadmium, mercury, vanadium, platinum, and other metals will be released in plumes from their burning cargoes. One of the burning ships contains industrial chemicals, including isocyanides, nitrides, and epoxy resins. Casualties occur onsite due to explosive blast and fragmentation, fire, and vapor/liquid exposure to Toxic Industrial Chemicals (TICs). Downwind casualties occur due to vapor exposure.

Detailed Attack Scenario –

The leaders of several sleeper cells of a domestic terrorist organization affiliated with the UA are notified via coded e-mail to meet with a representative of UA Central Command, who travels to and around the United States posing as a legitimate businessman. Some cell leaders are individually instructed to begin collecting weapons and assembling VBIEDs. Others are instructed to conduct discrete, long-term reconnaissance activities at several major port facilities in the United States.

UA then uses contacts in the shipping industry to have two crates of Rocket-Propelled Grenades (RPGs) and launchers shipped to the United States in a sea-borne cargo container. As one of more than 6,000 arriving in the United States daily, and shipped from a legitimate source, the container passes through customs, and the crates are delivered to one of the sleeper cells.

After two years of surveillance activities, UA Central Command decides to attack a U.S. port with nearby petroleum refining facilities. Using aerial bombs, UA operatives fashion two huge Improvised Explosive Devices (IEDs). These weapons are placed in crates and then into shipping containers. Both are wired with remote triggers and booby traps to ensure eventual detonation. Using the same shipping contacts, the two containers are shipped to the port on separate ships, but both are due to arrive on the same day.

UA leadership identifies four operatives with clean records and legitimate traveling documents. These four men then undergo artillery training. Working on UA-controlled BM-21 Katyusha Rocket Launchers, the group practices welding the rocket launch tubes onto the bed of a commercially purchased 1995 Ford F700 dump truck. Live fire practice is undertaken to make sure the team can acquire and engage area targets at the maximum range of the weapon—approximately 15,000 meters (9 statute miles). Their practice includes the deployment of a forward observer and communication between spotters and shooters so that fire may be adjusted on target. UA team members also construct three dump-truck VBIEDs, each containing a 1,500-pound Ammonium Nitrate Fuel Oil (ANFO) + C-4 shaped charge. The VBIEDs will be detonated pier side against the hulls of merchant ships in City One's port.

On the day of the attack, the three VBIEDs breach their target perimeters and are detonated within a 3-minute span. The VBIEDs cause severe damage. Secondary explosions and fires occur onboard vessels that are docked nearby and in containers stacked along the piers. The resulting plumes contain HAZMAT, including cobalt, nickel, molybdenum, cadmium, mercury, vanadium, and platinum. One of the burning ships contains industrial chemicals, including isocyanides, nitrides, and epoxy resins. Casualties occur onsite due to explosive blast and fragmentation, fire, and vapor/liquid exposure to TICs. Downwind casualties occur due to vapor exposure.

The rocket team successfully launches against the refinery a few minutes after the last VBIED detonation. Two rockets strike near the center of the refinery, damaging a hydro cracking tower and setting a gasoline storage tank on fire. With aim calibrated, the remaining rockets are fired, starting numerous fires and damaging acres worth of equipment. The effect is cataclysmic. Refinery hydro cracking and catalytic cracking systems also catch fire. Within an hour of the attack's onset, surviving attack team members depart the city.

Planning Considerations:

Geographical Considerations/Description –

Size and location of the port and downwind population at risk can be adjusted to meet local conditions. A river port or a large rail facility could be substituted for the port for inland jurisdictions.

Timeline/Event Dynamics –

Total time to plan and prepare for the attack would be on the order of 2 years, including reconnaissance, weapons training, and accumulation of weapons. Time to execute the attack would be several weeks to coordinate the shipping and coincident arrival of the containers aboard separate ships at the port. Time on the ground would be 2 to 3 minutes at each site. Fires resulting from the attack would take many hours, possibly days, to extinguish.

Meteorological Conditions –

Wind speed, temperature, humidity, and precipitation determine the success or failure of a chemical attack.

- *Wind Speed:* Wind speed determines how fast a primary cloud moves. High winds can disperse vapors, aerosols, and liquids rapidly, thereby shrinking the target area and reducing the population's exposure to the agents. The best wind speed for an attack is between 4 and 6 knots.
- *Temperature:* Higher air temperatures may cause the evaporation of aerosol particles, thereby decreasing their size and increasing the chance that they will reach the lungs. The best air temperature for an attack is between 65ºF and 75º F.
- *Humidity:* High humidity may lead to the enlargement of aerosol particles, thereby reducing the quantity of aerosol inhaled. The best low-range humidity for an attack is between 30% and 40%.
- *Precipitation:* The best condition for an attack is no precipitation.

Assumptions –

- Seven thousand people are in the actual downwind-vapor hazard area. Few are contaminated with hazardous liquids on scene. First responders will order the evacuation of areas immediately threatened by fire. After the first secondary device explodes, they will increase the area of evacuation to 1,000 yards in all directions. As soon as the involvement of one or more TIC is clear, they will order shelter-in-place of a 45° arc centered north-northeast of the site and extending 6 miles; this will affect up to 700,000 people. Many people in this area will self-evacuate, clogging roads and delaying response assets. However, when authorities are unable to quickly identify the exact TIC involved, and casualties begin to occur, they will err on the side of limiting culpability and order an evacuation of the aforementioned area.
- Temperature is above the freezing point of involved TICs.
- Importation of weapons is not detected by law enforcement or intelligence communities. VBIEDs and a rocket truck are able to evade any security precautions long enough to conduct the attack.

Mission Areas Activated –

Prevention/Deterrence:

The ability to prevent the attack is contingent on preventing weapons acquisition, IED assembly, and site reconnaissance. Deterrence measures must be taken by visibly increasing security and apprehension potential at the site before and during the attack.

Emergency Assessment/Diagnosis:

The presence of multiple chemicals and exposure symptoms will greatly complicate assessment and identification efforts. Actions of incident-site and EOC personnel tested during and after the attack include dispatch; TIC detection; and hazard assessment, prediction, monitoring, and sampling.

Emergency Management/Response:

This is a large-scale incident with tens of thousands of potential exposures in the downwind plume. Thousands may die before the release is contained. Actions of incident-site, EOC, and JIC personnel tested after the attack include alerts, activation and notification, traffic and access control, protection of special populations, resource support and requests for assistance, and public information activities.

Hazard Mitigation:

Mitigation measures will be complicated by multiple TICs. Secondary device concerns (i.e., delayed remote detonation of IEDs) will also have to be taken into account. Actions of incident-site personnel tested after the attack include isolating and defining the hazard; establishing, planning, and operating incident command; firefighting; performing bomb disposal dispatch and IED render-safe procedures; preserving the scene; conducting mitigation efforts; decontaminating responders; and performing site remediation and monitoring.

Evacuation/Shelter:

Evacuation and/or sheltering of downwind populations will be required. Two hospitals are in the downwind area and protective action will need to be taken at those locations. Actions of incident-site, local-area, and EOC personnel tested after the attack include reception-site and shelter operations and veterinary services.

Victim Care:

Within an hour, there are more than 1,000 persons with severe injuries that include trauma, burns, and smoke inhalation. There are hundreds more in the area with severe respiratory distress, seizures, and/or comas. Up to thousands of victims may require respiratory assistance. Thousands may require short-term and possibly long-term treatment. Some victims will require decontamination. Actions of incident-site, local-area, hospital, and EOC personnel tested after the attack include protective action decisions and communication, emergency aid, search and rescue, triage, treatment and stabilization, patient screening and decontamination, patient transport, patient status reporting, hospital treatment, human remains handling, and next-of-kin notification.

Investigation/Apprehension:

Searching for suspects and evidence in an industrial area while wearing PPE will be a significant challenge. Actions of incident-site personnel tested after the attack include dispatch, site control, criminal investigation, pursuit and tactical deployment, and apprehension of suspects.

Recovery/Remediation:

Decontamination/Cleanup: The extent of decontamination required will depend on the TIC. Regardless, monitoring and sampling a large industrial port facility and refineries will be a challenge. Actions of incident-site personnel include decontamination of contaminated areas, disposal of decontamination wastes, environmental testing, repair of destroyed/ damaged facilities, and public information activities.

Site Restoration: There will be significant damage to the port and refineries as a direct result of the attack and subsequent fires. Decontamination of some materials may be difficult or impossible. Decontamination of the waterway may present a significant challenge as well. Site restoration will be a major challenge, particularly for the refineries. Environmental impact issues are likely to significantly delay rebuilding efforts.

Implications:

Secondary Hazards/Events –

Once they grasp the situation, authorities will evacuate or order shelter-in-place for a significant area downwind of the refineries and the port. Numerous injuries will occur as a result of population panic once downwind casualties begin to occur. Further injuries are likely to occur due to motor vehicle accidents in the surrounding roadways. The rule of thumb is 1 fatality per 10,000 evacuated. Significant contamination of the waterway may also result, including oil and cargo spills from sunk or burning ships.

Fatalities/Injuries –

Assuming a densely populated area, 7,000 people may be in the actual downwind area. Of these, 5% (350) will receive lethal exposures, and half of these will die before or during treatment. An additional 15% will require hospitalization, and the remainder will be treated and released at the scene by EMS personnel. However, approximately 70,000 "worried well" may seek treatment at local medical facilities.

The following problems and resultant fatalities/injuries occur:

- Panic during evacuation results in seven fatalities and 70 injuries (based on 1/100,000 and 10/100,000 evacuated). These casualties will occur within 1 hour of the attack; some injuries will be permanently disabling. These injuries will be due to body crushing/high-speed impact as drivers try to circumvent clogged traffic, and many will require immediate medical assistance.
- Fires will result in 15 fatalities and 50 injuries. These casualties will occur within 2 hours of the attack; some injuries will be permanently disabling. These injuries will be mainly burn, smoke inhalation, and blast/fragmentation (from secondary devices); most will require immediate medical assistance.
- Liquid contamination will result in 3 fatalities and 350 injuries (35 permanently disabled). These casualties will occur within 2 hours of the attack; some injuries will be permanently disabling. Injuries will be primarily due to skin and eye contact with corrosive materials such as sodium hydroxide, hypochlorites, bromine, and high-strength acids, among others. Initial decontamination will consist of flushing eyes with water, removing clothing, spraying with heavy

water, and scrubbing lightly. Fatalities are due to exposure to hydrofluoric acid. Additional decontamination will depend on the specific chemical detected or suspected. For example, for phenol burns, the exposed area would be cleansed with 70% isopropanol (rubbing alcohol) to limit skin damage and absorption of the chemical.

- Vapor, particulate, and aerosol exposure will result in 175 fatalities (half of those who receive lethal doses) and 1,400 injuries (140 permanently disabled). These casualties will occur within 4 hours of the attack; some injuries will be permanently disabling. Releases of cobalt, nickel, molybdenum, cadmium, mercury, vanadium, platinum, and other metals will have occurred in the plumes. One of the burning ships in the port contains resins and coatings including isocyanides, nitrides and epoxy resins. However, casualties in this area are primarily due to exposure to gaseous, non-flammable, heavier-than-air compounds released by port facility damages—these include chlorine and acid gasses. Initial decontamination will consist of flushing eyes with water, removing clothing, spraying with heavy water, and scrubbing lightly. Casualties will be both immediate (primarily respiratory distress due to inhalation of corrosive gases) and long term (inhalation of heavy metals). Additional decontamination will depend on the specific chemical detected or suspected. For most of the chemicals listed here, washing for 15 minutes with soap and water is recommended.

Property Damage –

All three refineries sustain significant damage, with 50% of the equipment and facilities requiring significant repairs or replacement. Two ships in the port sink at their moorings; the port sustains heavy damage near the ships and at a dozen points where IEDs were dropped. Depending on which chemicals are released, there may be significant property damage in the downwind area. This may occur either directly due to the corrosive effects of the chemicals or the corrosive effects of any decontamination methods employed. There will be as many as 700 motor vehicle accidents during the evacuation. Departing personnel and vehicles from the immediate site area may spread liquid and solid contamination.

Service Disruption –

Refinery capacity on the West Coast is significantly diminished, resulting in fuel shortages and price increases. The port is temporarily closed due to bomb damage and TIC and heavy metal contamination, with significant economic impacts on the region. Environmental surveys of the surrounding area result in the long-term evacuation of several city blocks downwind of the port. Contamination in the waterway may also result in cleanup requirements and use restrictions, including long-term prohibitions on swimming and fishing. Additionally, some public transportation and other facilities may be lost due to contamination. Communications (landline telephone and cellular) in the local area will be disrupted by overwhelming demand; improvements in wireless phones will mitigate this demand. Significant disruptions in health care occur due to the overwhelming demand of the injured and the "worried well." Authorities will need to verify portability of the water supply.

Economic Impact –

Decontamination, destruction, disposal, and replacement of major portions of the refineries could cost billions of dollars. Similar costs could be expected at the port. Loss of the port will have a significant impact on U.S. trade with the Pacific Rim. Additionally, an overall national economic downturn is possible in the wake of the attack due to a loss of consumer confidence.

Long-Term Health Issues –

These issues are highly dependent on which TIC exposures occur and to what degree they occur. In addition to their toxic effects, many are known carcinogens. Long-term damage to internal organs and eyes is possible, depending on which TICs are present.

Scenario 7: Chemical Attack – Nerve Agent

Casualties	5,700 fatalities (95% of building occupants); 300 injuries
Infrastructure Damage	Minimal, other than contamination
Evacuations/Displaced Persons	Temporary shelter in place instructions are given for 50,000 people in adjacent buildings
Contamination	Extensive
Economic Impact	$300 million
Potential for Multiple Events	Extensive
Recovery Timeline	3 to 4 months

Scenario Overview:

General Description –

Sarin is a human-made chemical warfare agent classified as a nerve agent. Nerve agents are the most toxic and rapidly acting of the known chemical warfare agents. They are similar to certain kinds of pesticides (insect killers) called organophosphates in terms of how they work and what kind of harmful effects they cause. However, nerve agents are much more potent than organophosphate pesticides. Sarin is a clear, colorless, odorless, and tasteless liquid in its pure form. However, sarin can evaporate into a vapor and spread into the environment. Sarin is also known as GB.

In this scenario, the Universal Adversary (UA) releases sarin vapor into the ventilation systems of a large commercial office building in a metropolitan area. The agent kills 95% of the people in the building and kills or sickens many of the first responders. In addition, some of the agent exits through the rooftop ventilation stacks, creating a downwind hazard.

Detailed Attack Scenario –

Increased military activity in the Near East and Southwest Asia, coupled with a perceived cultural penetration into Muslim lands, has heightened Salafist Jihadi animosity toward the United States. Concurrently, the unique regional grievances of the different networks/organizations that comprise the Global Salafist Jihad (GSJ) are driving suspicions that symbolic targets will be attacked in the near future. There is significant evidence to indicate that EZ and several affiliated groups may be planning attacks within or against the United States and its interests. EZ and affiliated groups' operatives have been involved in multiple, worldwide terrorist attacks in response to the U.S.-led "War on Terrorism," Middle East policies, and perceived persecution of Muslims.

U.S. intelligence sources, in conjunction with friendly foreign governments, have noticed increased communications between suspected Harakat Al Jihad Al Telameeth (HJT), Front Salafiste Pour La Liberation Des Terres Etranges (FSLTE), and EZ operatives in their respective regions. Additionally, the FBI Field Office in New York has been monitoring a local mosque whose imam, Abdul al-Khataoui, is known for his radical preaching. The FBI office was aware that al-Khataoui spent time in Europe prior to coming to the United States and released a red flag through the Europol system. The French authorities responded with information that al-Khataoui was a member of the student group La Liberation de Chechnya (LLC) at the University of Louvain. The LLC was the same group that FSLTE ideological leader Omar Sheikh Mohammed al-Mohammud led. This group is known to the authorities for its vehemently anti-American/Western outlook and strong ties to EZ.

Recently, Indonesian authorities detained members of a HJT cell suspected of committing the bombing of a Western embassy in Jakarta less than 1 year ago. The cell leaders—Dr. Nik Wal Husin and Bucat Dunglao—remain at large, but intense interrogation of captured cell members indicates HJT's interest in Weapon of Mass Destruction (WMD) tactics and Dr. Husin's involvement in former EZ advanced weapons development in Afghanistan. Prior to the arrests in Indonesia, Sudanese authorities detained five FSLTE operatives after local authorities discovered that they had produced a mustard agent derivative in a local chemical manufacturing facility. The entire chemical agent was recovered and destroyed; however, several operatives associated with the cell escaped. These individuals have since been identified and are currently being monitored.

In this scenario, the UA as represented by HJT (with EZ and FSLTE operatives in support) will attack a large metropolitan office building in the United States with sarin gas. The chosen building is the global headquarters of MNC, a corporation with extensive overseas operations in Muslim countries, particurarly two industrial mining/manufacturing complexes in the Southern Philippines and Indonesia. HJT will coordinate financing and tactical expertise via EZ intermediaries and FSLTE weapons experts, respectively. HJT will recruit three tactical operatives, two from a Malaysian university and the third from a religious college in Indonesia. HJT, with assistance from FSLTE, will assemble dissemination devices and synthesize the precursor chemicals in Indonesia, test the sarin gas, and then transport the dispersion devices and the sarin separately to EZ/HJT/FSLTE operatives in the United States. The recruited HJT operatives will infiltrate the United States and, with operational Command and Control (C^2) from an EZ operative linked to the New York mosque, execute the operation. The operation will consist of eight 1-gallon dispersion devices (each filled 90%) that will be set off using time-delay devices.

The second fire crew to arrive at the building is the first to realize what is happening. Due to the quantity of chemical agent that escaped the building when the EMS and first fire crew entered the building, victims outside the building experience symptoms. The second fire crew quickly notifies central dispatch and return upwind, taking the outside victims with them. They soon begin to experience dimness of vision themselves.

Meanwhile, the agent is beginning to vent from the roof top ventilation system of the building. (While additional agent is seeping from doors and windows, it is insignificant compared to the rooftop venting.) The heavier air plumes propagate downwind from the release points, sickening people on the street and in two subway stations. Ground-level concentrations peak at about 1 Milligram per Cubic Meter (mg/m^3), resulting in 1% lethality among the exposed population. Upon seeing others collapsed in the street, residents remain in their buildings, effectively sheltering-in-place. Others already on the street panic and attempt to exit the area as rapidly as possible. City (county) officials will order shelter-in-place in the downwind area and communicate the order through mass media.

Rescue personnel in full level-A protection conduct rescue efforts in the buildings and in an approximately 1/8 square-mile downwind area. Approximately 5% of the occupants are found unconscious and experiencing seizures. These victims are extracted, placed on respiratory support, treated with atropine and/or nerve agent antidote, decontaminated if required, and transported to medical facilities.

Planning Considerations:

Geographical Considerations/Description –

Size, location, and maximum occupancy of the building can be adjusted to meet local conditions. For purposes of estimating Federal response requirements, the building is assumed to have an occupancy of 6,000 personnel (e.g., a 20-story building with 300 occupants per floor), and the outdoor/subway population density of the surrounding areas is 3,900 people per square mile (1/10th of the total population density in the vicinity of Times Square, New York).

Timeline/Event Dynamics –

The attack will require 12 months to plan, including putting the faux janitors in place, shipping the agent, and fabricating the spray devices. Once all is ready, the cell with take less than 10 minutes to execute the attack. First responders should arrive at the facility within 10 to 15 minutes of the attack.

Meteorological Conditions –

Wind speed, temperature, humidity, and precipitation determine the success or failure of a chemical attack.

- *Wind Speed:* Wind speed determines how fast a primary cloud moves. High winds can disperse vapors, aerosols, and liquids rapidly, thereby shrinking the target area and reducing the population's exposure to the agents. The best wind speed for an attack is between 4 and 6 knots.
- *Temperature:* Higher air temperatures may cause the evaporation of aerosol particles, thereby decreasing their size and increasing the chance that they will reach the lungs. The best air temperature for an attack is between 65ºF and 75º F.
- *Humidity:* High humidity may lead to the enlargement of aerosol particles, thereby reducing the quantity of aerosol inhaled. The best low-range humidity for an attack is between 30% and 40%.
- *Precipitation:* The best condition for an attack is no precipitation.

Assumptions –

- The agent is effectively dispersed by the combination of the spray system and the building's Heating, Ventilating, and Air Conditioning (HVAC) system.

- Of the building occupants, 95% are overcome and incapacitated before they can exit the building. A few are able to make 911 calls, but collapse during the call.
- If the 20-story building has a 100-foot by 100-foot footprint and 10-foot ceilings, then there are 2 million cubic feet (or 56,600 cubic meters), giving a concentration of 176.7 mg/m^3 if evenly dispersed. The LCt_{50} (dose of chemical that kills 50% of the subjects) for sarin is 100 Milligrams per Minute per Cubic Meter of Air (mg/min-m^3). (Therefore, for this scenario, the assumption is that 95% of the building occupants will die.)
- HVAC system vents will discharge 30% of the agent into the atmosphere over the course of an hour, by which time responders should be able to disable the HVAC systems. The AEGL3 downwind hazard area will cover about one-eighth of a square mile from each site, with the no-effects level 16 times that size. Current building codes require 6 to 10 air changes per hour with 15% to 25% fresh air. This means that if the agent had the same density as air (which it does not: the agent's density is 4.9 times that of air), then the amount of agent not absorbed by people or building materials would be discharged into the atmosphere in 24 to 66 minutes. Having a heavier-density agent means that the agent will linger longer in the building. Any agent remaining in the buildings when the HVAC system is turned off will begin to settle in low-lying areas and begin to be absorbed by porous materials.
- Neither law enforcement nor intelligence communities detect the importation of the agent, the construction of spray devices, or the infiltration of the janitorial staffs. Terrorists are able to evade any building security forces long enough to conduct the attacks.
- For at least for the three buildings and their contents, officials would follow current DoD rules regarding the release of material that has previously been contaminated with CWM for public use, which have been accepted by the Occupational Safety and Health Administration (OSHA) and EPA in the chemical weapons disposal program.

Mission Areas Activated –

Prevention/Deterrence:

The ability to prevent the attack is contingent on the prevention of CWM importation, weapons assembly, and site reconnaissance. Deterrence measures must be taken by visibly increasing security at the site before the attack.

Emergency Assessment/Diagnosis:

The ability for a member of the emergency staff to recognize the attack before becoming a casualty will be key to avoiding first-responder casualties. Actions of incident-site and EOC personnel tested during and after the attack include dispatch; agent detection; and hazard assessment, prediction, monitoring, and sampling.

Emergency Management/Response:

This is a large-scale incident with thousands of potential exposures and a downwind plume. Actions of incident-site, EOC, and JIC personnel tested after the attack include alerts, activation and notification, traffic and access control, protection of special populations, resource support and requests for assistance, and public information activities.

Hazard Mitigation:

Actions of incident-site personnel tested after the attack include isolating and defining the hazard; establishing, planning, and operating incident command; preserving the scene; conducting mitigation efforts; decontaminating responders, and conducting site remediation and monitoring.

Evacuation/Shelter:

Evacuation and/or sheltering of downwind populations will be required. Actions of incident-site, local-area, and EOC personnel tested after the attack include reception-site and shelter operations and veterinary services.

Victim Care:

Tens of thousands of persons will require monitoring and decontamination as they are allowed to leave their buildings. Hundreds will require hospital treatment. Actions of incident-site, local-area, hospital, and EOC personnel tested after the attack include protective action decisions and communication, emergency aid, search and rescue, triage, treatment and stabilization, patient screening and decontamination, patient transport, patient status reporting, hospital treatment, and next-of-kin notification.

Investigation/Apprehension:

Tracking and apprehension of the suspects will be included. Actions of incident-site personnel tested after the attack include dispatch, site control, criminal investigation, tactical deployment, and suspect apprehension.

Recovery/Remediation:

Decontamination/Cleanup: Anything exposed to a high- vapor agent concentration will require decontamination, including bodies. Actions of incident-site personnel include decontamination of building and other contaminated areas, disposal of decontamination wastes, environmental testing, and provision of public information.

Site Restoration: There will be little damage to the building as a direct result of the attack. However, decontamination of some materials may be difficult or impossible. Moreover, current DoD rules, which have been accepted by OSHA and EPA for use in the chemical weapons disposal program, preclude release of previously contaminated material for public use unless treated to the 5X condition (i.e., 1,000º F for 15 minutes or monitoring in a sealed enclosure at a temperature not less than 70º F at a concentration less than 0.0001 mg/m^3). Even if structures and property could be technically decontaminated, the psychological impact on future usability would be significant.

Implications:

Secondary Hazards/Events –

Numerous injuries will occur as a result of panic on the street, including falling and crushing injuries. Further injuries are likely to occur due to motor vehicle accidents in the surrounding roadways.

Fatalities/Injuries –

Assuming 6,000 occupants in the building, the initial fatality count will be 5,700 (95%) and 300 injured, including the initial EMS and fire personnel at each building. Patients who experience prolonged seizures may sustain permanent damage to the central nervous system—assume 350 patients in this category (300 inside plus 50 outside). Fatalities and major injuries will occur due to falling and crushing during the panic on the street and due to vehicle accidents.

The following problems and resultant fatalities/injuries occur:

- Panic during evacuation results in 10 fatalities and 50 injuries; these casualties will occur within 30 minutes of the attack. Some of these injuries will be permanently disabling. Some of these injuries will be due to crushing and require immediate assistance; however, most will be broken bones and concussions from falls.
- Motor vehicle accidents result in 10 fatalities and 50 injuries; these casualties will occur within 1 hour of the attack. Some of these injuries will be permanently disabling. These injuries will be due to crushing and high-speed impact (as drivers try to circumvent clogged traffic) and require immediate assistance.
- Vapor exposure in the building results in 5,700 deaths, including three EMS crews, three fire crews, and 300 experiencing severe agent poisoning symptoms (difficulty breathing and seizures).
- Vapor exposure on the street results in 1,500 people being exposed and 15 fatalities (1%). The remaining experience the full range of inhalation nerve agent symptoms, including mitosis and rhinorrhea, excessive salivation and nausea, vomiting, abdominal cramps, involuntary defecation and urination, confusion, tightness in the chest and difficulty breathing, seizures, flaccid paralysis, coma, and respiratory failure. All will experience severe depression of blood cholinesterase and require hospital treatment. Assuming a high-density population such as New York City, as many as 250,000 may initially be sheltered-in-place and then evacuated after the HVAC systems are disabled and the vapor cloud dissipates. These people will not require treatment or decontamination, but may require mental health support.

Property Damage –

Little direct damage due to the attack, except the building interiors and contents, will be highly contaminated by agent condensing on surfaces. The three buildings and their contents will be a total loss due to decontamination measures and/or psychological impacts of future usability. GB is classified as a non-persistent agent from a military viewpoint—not an environmental health viewpoint. The DoD position is that anything that ever comes into contact with chemical agent has to be treated to a 5X condition prior to being released for public use. (Note that the latter method applies to GB and VX nerve gas only, not other CWM.) Valuable and removable property and equipment could be removed from the building, bagged, monitored, and then released if no agent is detected at the 0.0001-mg/m^3 monitoring level. Airing and washing should decontaminate adjacent structures adequately, however. Some motor vehicles will be involved in accidents.

Service Disruption –

Loss of use of the contaminated building is assumed. Overwhelming demand will disrupt communications (landline telephone and cellular) in the local area. There will be large numbers of "worried well" swamping the medical system. Loss of three fire crews and three EMS crews will impact readiness for other events in the short term.

Economic Impact –

Decontamination, destruction, disposal, and replacement of the large commercial office building could cost up to $300 million. Business in the buildings may never reopen due to the loss of so many key personnel and the perception within society of risks associated with the area. Additionally, an overall national economic downturn is possible in the wake of the attack due to loss of consumer confidence.

Long-Term Health Issues –

Those who survive usually recover within 4 to 6 weeks, with full restoration of the cholinesterase level within 3 to 4 months. Patients who experience prolonged seizures may sustain permanent damage to the central nervous system. Assume a maximum of 350 personnel in this category.

Scenario 8: Chemical Attack – Chlorine Tank Explosion

Casualties	17,500 fatalities; 10,000 severe injuries; 100,000 hospitalizations
Infrastructure Damage	In immediate explosions areas, and metal corrosion in areas of heavy exposure
Evacuations/Displaced Persons	100,000 instructed to temporarily shelter-in-place as plume moves across region 50,000 evacuated to shelters in safe areas 500,000 self-evacuate out of region
Contamination	Primarily at explosion site, and if waterways are impacted
Economic Impact	Millions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Weeks

Scenario Overview:

General Description –

Chlorine gas is poisonous and can be pressurized and cooled to change it into a liquid form so that it can be shipped and stored. When released, it quickly turns into a gas and stays close to the ground and spreads rapidly. Chlorine gas is yellow-green in color and although not flammable alone, it can react explosively or form explosive compounds with other chemicals such as turpentine or ammonia.

In this scenario, the Universal Adversary (UA) infiltrates an industrial facility that stores a large quantity of chlorine gas (liquefied under pressure). Using a low-order explosive, UA ruptures a storage tank man-way, releasing a large quantity of chlorine gas downwind of the site. Secondary devices are set to impact first responders.

Detailed Attack Scenario –

The UA Central Command, seeing opportunities for furthering their objectives, encourages local UA cells to plan and execute operations. The leadership of a local UA cell, inspired by the Central Command's call for action, begins to research companies that use chlorine in their manufacturing process. They focus on companies located near large residential areas. The selected site stores chlorine as a liquefied gas in a 60,000-gallon tank at 250 Pounds per Square Inch Gage (psig). The storage tank is equipped with a number of pipe connections and has a 16-inch diameter inspection man-way.

The local UA cell rents a safe house near the facility; conducts detailed reconnaissance of the facility; and acquires the necessary detonation cord, explosives, and light weapons. A four-man tactical team is prepared for the operation. The attack is timed for the evening with the most favorable wind conditions in the following 1-week window. The attack will occur after dark but before the late night news shows begin (i.e., between 8:00 p.m. and 11:00 p.m.).

On the evening of the attack, the four-man tactical team is driven to a secluded area adjacent to the industrial park where the attack site is located. They make their way to the site perimeter, gain access by cutting a hole in the fence, and quickly go to the chlorine storage tank. Having observed and timed the routes of the plant's armed guards, they easily avoid them, and along the way plant several IEDs that are timed to go off between 20 and 60 minutes after the tank is ruptured. When the terrorists reach the tank, they wrap the man-way flange with several turns of detonation cord and then cover the cord in tape that is painted the color of the tank. A timed detonator is attached to the cord and hidden beneath the flange so that it is out of sight. The timer is set for 30 minutes.

Just as the terrorists are being picked up at the perimeter of the industrial park, the device activates, blowing off the man-way and opening a 16-inch hole in the side of the tank. The liquefied chlorine surges from the tank, freezing everything it touches and quickly generating a large vapor cloud of greenish-yellow gas.

Upon hearing the small explosion, control-room personnel immediately dial 911 and direct the on-duty outside operator to investigate. Control-room monitors indicate the sudden loss of pressure in the chlorine tank. In quick succession, the plant's air monitoring systems begin to alarm, and a perimeter guard reports the strong smell of chlorine in the air. There is no further word from either the guard or the outside operator.

All plant personnel evacuate upwind of the leak, and the control room immediately notifies the city (county) EOC. The city (county) HAZMAT team arrives 10 minutes later and begins to move in to investigate. A battalion fire chief also arrives and begins to set up incident command at the site. Just as the HAZMAT team is reporting to incident command, an IED explodes 15 feet from the HAZMAT team. Casualties occur onsite due to the explosive blast and fragmentation. The battalion fire chief decides to withdraw the team and await assistance from the bomb squad.

While this is occurring, the city (county) 911 system begins to receive numerous reports of a strong smell of chlorine and then of burning skin, eyes, and breathing difficulty. Many people begin to self-evacuate from the area. The combination of the outward flow of workers and residents, and the possible presence of secondary devices, slows the response to the point that virtually the entire contents of the tank are vaporized. This caution is justified when three more secondary devices explode onsite.

Downwind casualties occur due to vapor exposure over a large area. However, due to the late hour of the attack, most people are indoors and effectively shelter-in-place. The terrorist attack leads the 11:00 p.m. newscasts, along with instructions from the city (county) officials to shelter-in-place. Most people heed the instructions, but 1/10th (70,000 people in all) of the downwind population ignore the advice and self-evacuate.

Planning Considerations:

Geographical Considerations/Description –

Size and location of the chlorine storage facility and downwind population at risk can be adjusted to meet local conditions. Bulk storage of chlorine occurs in tanks as large as 120,000 gallons in the United States. (See Figure 8-1 for an example of such a tank.)

Figure 8-1. *Large bulk chlorine storage tank manufactured by Trinity Industries with the flanged man-way located at the far right (bottom) of the tank.*

Timeline/Event Dynamics –

Total time to plan and prepare for the attack would be approximately 1 to 2 years, including reconnaissance and weapons training and accumulation of weapons. The execution of the attack may be delayed up to several weeks to ensure the optimal weather conditions. The actual infiltration, explosive-charges setting, and ex-filtration could take place in as little as 20 minutes. Except in very cold conditions, the release would be complete in less than an hour. The plume would travel downwind and be dispersed below the detection level in 6 hours.

Meteorological Conditions –

Wind speed, temperature, humidity, and precipitation determine the success or failure of a chemical attack.

- *Wind Speed:* Wind speed determines how fast a primary cloud moves. High winds can disperse vapors rapidly, thereby shrinking the target area and reducing the population's exposure to the agents. The best wind speed for an attack is between 4 and 6 knots.
- *Temperature:* Higher air temperatures will increase the evaporation rate of the chlorine. The best temperature for an attack is between 75ºF and 85º F.
- *Humidity:* High humidity may lead to reaction of the chlorine to hydrochloric and hydrochlorous acid, which will fall out of the air, thereby reducing the quantity of vapor inhaled. The best low-range humidity for an attack is between 30% and 40%.
- *Precipitation:* The best condition for an attack is no precipitation.

Assumptions –

- There are 700,000 people in the downwind vapor-hazard area, which could extend as far as 25 miles. Many (1/10th, or 70,000) people in this area will self-evacuate, clogging roads and delaying response assets.
- Neither law enforcement nor intelligence communities detect importation of weapons or surveillance of targets. Terrorists are able to evade security precautions long enough to conduct the attack.

Mission Areas Activated –

Prevention/Deterrence:

The ability to prevent the attack is contingent on the prevention of weapons acquisition, specifically IEDs, and site reconnaissance. Deterrence measures must be taken by visibly increasing security and apprehension potential at the site before and during the attack.

Emergency Assessment/Diagnosis:

The presence of secondary devices will complicate assessment and identification efforts. Actions of incident-site and EOC personnel tested during and after the attack include dispatch; chlorine detection; and hazard assessment, prediction, monitoring, and sampling.

Emergency Management/Response:

This is a large-scale incident with tens of thousands of potential exposures in the downwind plume. Thousands may die before the release is contained. Actions of incident-site, EOC, and JIC personnel tested after the attack include alerts; activation and notification; traffic and access control; protection of special populations; resource support and requests for assistance; and public information activities.

Hazard Mitigation:

Mitigation measures will be complicated by secondary device concerns (i.e., delayed detonation of IEDs). After the attack, incident-site personnel must isolate and define the hazard; establish, plan, and operate incident command; fight fires; conduct bomb disposal dispatch and IED render-safe procedures; preserve the scene; perform mitigation efforts; decontaminate responders; and conduct site remediation and monitoring.

Evacuation/Shelter:

Evacuation and/or sheltering of downwind populations will be required. Two hospitals located in the downwind area will require protective action. Actions of incident-site, local-area, and EOC personnel tested after the attack include reception-site and shelter operations and veterinary services.

Victim Care:

Within an hour, there are more than 10,000 severe injuries with respiratory difficulty and/or vehicular accident trauma. There are tens of thousands more in the area with severe respiratory distress—140,000 may require short-term and possibly long-term treatment. Actions of incident-site, local-area, hospital, and EOC personnel tested after the attack include protective action divisions and communication, emergency aid, search and rescue, triage, treatment and stabilization, patient screening and decontamination, patient transport, patient status reporting, hospital treatment, human remains management, and next-of-kin notification.

Investigation/Apprehension:

Searching for suspects and evidence in an industrial area while wearing PPE will be a significant challenge. Actions of incident-site personnel tested after the attack include dispatch, site control, criminal investigation, pursuit and tactical deployment, and apprehension of suspects.

Recovery/Remediation:

Decontamination/Cleanup: Because chlorine is a gas, the extent of decontamination required will be minor and largely related to any releases by the secondary devices. Regardless, monitoring and sampling a large industrial facility will be a challenge. Actions of incident-site personnel include decontamination of contaminated areas, disposal of decontamination wastes, environmental testing, repair of destroyed/damaged facilities, and public information activities.

Site Restoration: There will be significant damage to the plant as a direct result of the attack. Decontamination of waterways may present a significant challenge as well. Environmental impacts, especially public safety concerns, are likely to significantly delay rebuilding efforts.

Implications:

Secondary Hazards/Events –

Once they grasp the situation, authorities will instruct residents to shelter-in-place throughout a significant area downwind of the site. Numerous injuries will result from population panic once downwind casualties begin to occur, and as many as 10% of the people will self-evacuate. Additional injuries are likely, due to motor vehicle accidents in the surrounding area. One fatality per 100,000 evacuated is expected. Local waterways or wetlands will absorb the chlorine gas, creating hydrochloric acid and increasing the acidity (lowering the potential of hydrogen, or pH) of the water.

Fatalities/Injuries –

In a high-density area, such as Houston or Chicago, as many as 700,000 people may be in the actual downwind area. Of these, 5% (35,000) will receive potentially lethal exposures, and half of these will die before or during treatment. An additional 15% will require hospitalization, and the remainder will be treated and released at the scene by EMS personnel. However, approximately 450,000 "worried well" will seek treatment at local medical facilities.

The following problems and resultant fatalities/injuries occur:

- Panic during evacuation results in one fatality and 70 injuries, based on the assumption that 70,000 will self-evacuate. These casualties will occur within 1 hour of the attack; some injuries will be permanently disabling. The injuries will be due to accidents as drivers try to circumvent clogged traffic, and many will require immediate medical assistance.
- Explosions result in three fatalities and seven injuries. These casualties will occur within 10 minutes of the attack; some injuries will be permanently disabling. The injuries will be mainly due to blast/fragmentation (from secondary devices), and most will require immediate medical assistance.
- Vapor exposure results in 17,500 fatalities (half of those who receive lethal doses), 122,500 serious injuries (12,000 permanent disability), and 350,000 minor injuries. These casualties will occur within 4 hours of the attack; some injuries will be permanently disabling. Chlorine vapor is detectable by smell at 320 Parts Per Billion (ppb). Sore throat, coughing, and eye and skin irritation begin at exposure to 10 Parts Per Million (ppm); 350,000 people will be in this category and can be treated (skin washing and eye flushing) and released. However, the time required to treat this many casualties will be days, so many will self-treat based on broadcast instructions. Exposure above 15 ppm leads to burning of eyes and skin, rapid breathing, narrowing of the bronchi, wheezing, blue coloration of skin, pain, and accumulation of fluid in the lungs. A total of 140,000 people will be in this category, which will severely strain medical resources. Exposure to hundreds of ppm leads to skin burns and lung collapse; 430 ppm for 30 minutes is the minimum lethal dose recorded, which will affect 35,000 people, half of whom will die before or during treatment. (Note: The above exposure information is taken from the CDC

Agency for Toxic Substances and Disease Registry [ATSDR], Medical Management Guidelines for Chlorine[1].)

Property Damage –

The storage tank will be lost, along with some sensitive control systems damaged by the freezing liquefied gas. The secondary devices will cause damage to other plant facilities and equipment in a 20-meter radius of the blasts. In areas of heavy chlorine exposure, there will also be heavy corrosion of metal objects.

Service Disruption –

The plant will be temporarily closed due to bomb damage, with significant local economic effects. Environmental surveys of the surrounding waterways indicate heavy contamination, which may result in cleanup requirements and use restrictions, including long-term prohibitions on swimming and fishing. Overwhelming demand will disrupt communications (landline telephone and cellular) in the local area. Significant disruptions in health care will occur due to the overwhelming demand of the injured and the "worried well." Authorities will need to verify potability of the water supply.

Economic Impact –

Decontamination, destruction, disposal, and replacement of major portions of the plant could cost millions. The local economy will be affected by a loss of jobs at the facility if it is unable to reopen.

Long-Term Health Issues –

Most of the injured will recover in 7 to 14 days, excluding people with severe lung damage. Those individuals will require long-term monitoring and treatment.

[1] Centers for Disease Control and Prevention, Agency for Toxic Substances and Disease Registry, Medical Management Guidelines for Chlorine. August 22, 2003 (update). Available online at http://www.atsdr.cdc.gov/MHMI/mmg172.html.

Scenario 9: Natural Disaster – Major Earthquake

Casualties	1,400 fatalities; 18,000 hospitalizations
Infrastructure Damage	150,000 buildings destroyed, 1 million buildings damaged
Evacuations/Displaced Persons	300,000 homes destroyed 250,000 seek shelter in safe areas 250,000+ self-evacuate the area
Contamination	From hazardous materials, in some areas
Economic Impact	Hundreds of billions
Potential for Multiple Events	Yes, aftershocks
Recovery Timeline	Months to years

Scenario Overview:

General Description –

Earthquakes occur when the plates that form under the Earth's surface suddenly shift, causing binding and pressure, and most earthquakes occur at the boundaries where the plates meet. A fault is a fracture in the Earth's crust along which two blocks of the crust have slipped with respect to each other. The severity of an earthquake can be expressed in several ways. The magnitude of an earthquake, usually expressed by the Richter Scale, is a measure of the amplitude of the seismic waves. The moment magnitude of an earthquake is a measure of the amount of energy released—an amount that can be estimated from seismograph readings. The intensity, as expressed by the Modified Mercalli (MM) Scale, is a subjective measure that describes how strong a shock was felt at a particular location.

The Richter Scale is logarithmic, so a recording of 7, for example, indicates a disturbance with ground motion 10 times as large as a recording of 6. A quake of magnitude 2 is the smallest quake normally felt by people. Earthquakes with a Richter value of 6 or more are commonly considered major; great earthquakes have magnitude of 8 or more. The MM Scale expresses the intensity of an earthquake's effects in a given locality in values ranging from I to XII. The most commonly used adaptation covers the range of intensity from the condition of "I – Not felt except by a very few under especially favorable conditions," to "XII – Damage total. Lines of sight and level are distorted. Objects thrown upward into the air." Evaluation of earthquake intensity can be made only after eyewitness reports and results of field investigations are studied and interpreted. The maximum intensity experienced in the Alaska earthquake of 1964 was X; damage from the San Francisco and New Madrid earthquakes reached a maximum intensity of XI.

In this scenario, a 7.5-magnitude earthquake, with a subsequent 8.0-magnitude earthquake following, occurs along a fault zone in a MMA. MM Scale VIII or greater intensity ground shaking extends throughout large sections of the metropolitan area, greatly impacting a six-county region with a population of approximately 10 million people.

Detailed Scenario –

A 7.5-magnitude earthquake occurs along a fault zone in a MMA. MM Scale VIII or greater intensity ground shaking extends throughout large sections of the metropolitan area, greatly impacting a six-county region with a population of approximately 10 million people. Subsurface faulting occurs along 45 miles of the fault zone, extending along a large portion of highly populated local jurisdictions, creating a large swath of destruction. Ground shaking occurs for approximately 25 seconds. The area within 25 miles of the fault is subjected to shaking of MM Scale intensity of VIII or greater, strong enough to cause considerable damage to ordinary buildings and great damage to poorly built structures. Soil liquefaction occurs in some areas and adds to the destruction, since even earthquake-resistant structures may fail when liquefaction occurs. The primary cause of damage is the resultant ground shaking from the fault rupture. Quicksand-like conditions in areas of liquefaction contribute to the destabilization and collapse of numerous buildings, transportation structures, and utilities.

This initial shock is followed by an 8.0-magnitude earthquake that causes further damage.

Planning Considerations:

Geographical Considerations/Description –

The earthquakes occur in a densely populated urban and suburban area with a past history of earthquake activity. The highest points in the MMA are approximately 5,000 feet above sea level, and the lowest land elevations are a few feet above sea level. Most of the built environment and the population are located in the lower elevations.

Timeline/Event Dynamics –

While scientists have been predicting a moderate-to-catastrophic earthquake in the region sometime in the future, there were no specific indications that an earthquake was imminent in the days and weeks prior to this event.

A 7.5-magnitude earthquake strikes along the seismic zone, causing damage to a large multi-State area of several hundred square miles. Rapid horizontal movements associated with the earthquake shift homes off their foundations and cause some tall buildings to collapse or “pancake” as floors collapse down onto one another. Shaking is exaggerated in areas where the underlying sediment is weak or saturated with water. (Note: In the central and eastern United States, earthquake waves travel more efficiently than in the western United States. An earthquake of a given size in the central and eastern United States may cause damage over a much broader area than the same size earthquake in California.)

Several hours later, a subsequent earthquake of magnitude 8.0 occurs. Based on past events, aftershocks are also possible. Sizeable aftershocks may occur for months after the original jolt.

Assumptions –

- Despite rigorous efforts on the part of State and local agencies, the magnitude of destruction is overwhelming to their capabilities.
- Some 100,000 disaster victims are not able to immediately return to permanent housing within the MMA.
- State and local capabilities for triaging and treating casualties in the disaster area have been overwhelmed. Most primary medical treatment facilities are damaged or inoperable.
- The port facility is closed completely for 1 month and will require months of work to restore operations. Major airports in the metropolitan area will be closed for approximately 10 days.
- Electric power and potable water are not available to large segments of the population for the first 10 days following the disaster.
- Delivery of food, medicine, gasoline, and other necessities is severely limited for the first 10 days following the disaster.
- Communications systems—including telephones, radios, and cellular systems—gradually recover to 90% capacity in the first week following the earthquakes.
- There is also a 10-day disruption of sanitation/sewage services in the metropolitan area while the wastewater facility infrastructure is repaired.

Mission Areas Activated –

Infrastructure Protection:

After the earthquakes occur, actions could be taken to protect critical facilities from terrorist attacks and to maintain civil order.

Emergency Assessment/Diagnosis:

Disaster assessments are underway throughout the area; however, they have been greatly hampered by poor access, limited communications, bad weather, and lack of adequately trained assessment teams. Aerial reconnaissance has reported extensive damage to private residences and public buildings and facilities.

Using real-time seismic data from the Department of the Interior U.S. Geological Survey (USGS), the Federal Emergency Management Agency (FEMA) runs the HAZUS[1] earthquake model to provide a preliminary "best guess" at the level of expected damage and which areas suffered the most, subject to confirmation or modification through remote sensing and field assessments. Joint FEMA/State Preliminary Damage Assessment Teams have been deployed. Remote sensing has been initiated through the National Geospatial Agency and other methods and services, as available.

Emergency Management/Response:

State and Federal disaster field offices are stood up. On-scene coordinators from the EPA and USCG are on scene to manage hazardous material spills. The American Red Cross

[1] See http://www.fema.gov/hazus/index.shtm for more information.

(ARC) has committed thousands of volunteers and is coordinating with the State on delivery of emergency medical treatment, shelters, and food distribution. A JIC has been established to distribute instructions to the public and answer myriad requests for information. All Urban Search and Rescue Teams will be placed on alert, and at least six or more will be activated and deployed. Incident Support Teams will also be activated. Urban Search and Rescue Teams are focused on searching for survivors. As the emergency response transitions into recovery, the teams focus on the recovery of bodies.

Debris removal operations are well underway, with hundreds of contractors employed in every stage of the operation. Power and telephone lines continue to be repaired, and communications are improving. Public utilities are coming back slowly, but in many areas, water and sewer operations may take years to fully restore. All FEMA National Emergency Response Teams and the DHS national operations centers will be activated. Regional Operations Centers will stand up and begin operating immediately. All Federal emergency support functions will be activated and asked to perform damage assessments and report findings.

Hazard Mitigation:

Federal support will be required to coordinate the development of plans to execute mitigation efforts to lessen the effects of future disasters. Mitigation to minimize or avoid future impacts would largely be an issue for recovery and restoration.

Evacuation/Shelter:

Structural engineers are inspecting critical building, bridge, freeway, waste facilities, etc., and inspection teams are deployed to inspect hundreds of homes for safe habitability. Temporary housing strategies and options are being worked.

Victim Care:

Due to the massive number of injured and displaced persons, the DoD has issued a warning order for the activation of task forces for the delivery of mass care and health and medical services. National Disaster Medical System (NDMS) and Disaster Medical Assistance Teams (DMATs) are deployed, along with supplies and equipment to the disaster sites. Disaster Mortuary Operational Response Teams (DMORTs) have also been sent to deal with victim identification and handling of bodies.

Recovery/Remediation:

HAZMAT will contaminate many areas, and decontamination and site restoration will be major challenges.

Implications:

Secondary Hazards/Events –

Natural Gas and Oil Hazards:

Hazardous contamination impacts of concern include natural gas compression stations and processing plants, oil refineries and major tank farms, and natural gas/crude oil pipelines.

Fire:

Two of the largest peacetime urban fires in history, San Francisco in 1906 and Tokyo in 1923, occurred after earthquakes. Most urban areas have high concentrations of fuels, flammable hazardous materials, and ignition sources. Contributing factors for potential spread of fires into conflagrations will be: (1) increased demand for fire department services for not only fires but also search and rescue and HAZMAT events; (2) delays in notification, given effects on communications systems; and (3) delays and limitations in response, given damage and debris on transportation routes and potential impacts on water systems.

As a result of these earthquakes, more than 2,000 spot fires have occurred, and controlling these fires is hampered by lack of water and disrupted roadways. The widespread debris has severely impeded access and heightened the risk of fire.

Flooding:

Flooding may occur due to levee failures and breaks in water mains and sewage systems.

Damage or Presumed Damage to Infrastructure and Critical Facilities:

Transportation lines and nodes, power generation and distribution, communications lines, fuel storage and distribution, structures of concern (e.g., dams, levees, nuclear power plants, HAZMAT storage facilities), and structures for provision of essential services (e.g., hospitals and schools typically used as shelters) may be damaged and will require damage assessment in order to continue operating. Reduced availability of services will be disruptive and costly.

Disease:

Given extensive damage to housing, response will include efforts to provide shelter. Concentrations of people will increase opportunities for transmission of disease.

Debris:

Ground shaking from the earthquakes has generated massive amounts of debris from collapsed structures. FEMA's HAZUS models have preliminarily estimated the amount of debris to be more than 120 million tons. Damage to unreinforced masonry buildings extends over a wide area, contributing to the debris generated by the earthquakes.

HAZMAT:

Fuel pumps in several gas stations have sustained damages, leaking thousands of gallons of gasoline into the streets. There are numerous reports of toxic chemical fires, plumes with noxious fumes, and spills. Several other local waste treatment facilities have reported wastewater and sewage discharges. More than 300 wastewater facilities are vulnerable to spills or releases, and inspections of these facilities are underway. In addition to possible hazardous chemical spills, local building inspectors worry that asbestos contamination is likely in older buildings that suffer the brunt of the damage. A large refining spill has contaminated the port facility and is spilling into the harbor.

Significant concern for spilled HAZMAT from storage, overturned railcars, and chemical stockpiles make progress very slowly as triage is conducted.

Search and Rescue:

As many as 20,000 people are missing and may be trapped under collapsed buildings and underground commuter tunnels. The earthquakes have trapped workers in their offices and commuters on freeways. Some children are in schools that suffered damage, and worried parents are unable to determine the status of their children for many hours. Specialized Search and Rescue Teams attempt to extricate trapped persons from collapsed structures, and light rescue is performed to free people from loose rubble.

Fatalities/Injuries –

Approximately 1,400 fatalities occur as a direct result of the earthquakes. More than 100,000 people are injured and continue to overwhelm area hospitals and medical facilities, most of which have sustained considerable damage. Approximately 18,000 of the injured require hospitalization. Both fatality and injury estimates are expected to rise.

Property Damage –

More than 1 million buildings were at least moderately damaged (40% of the buildings), and more than 150,000 buildings have been completely destroyed. Older buildings, notably those constructed prior to the adoption of seismic building codes, sustained major damages. In areas where liquefaction occurred, many well-designed structures overturned when underlying soil foundation conditions failed.

Service Disruption –

Medical Services:

Of the 196 hospitals in the region, only 23 were reported to be operating with functionality greater than 50%, leaving approximately 8,800 hospital beds in the area available for earthquake casualties and patients already admitted to area hospitals. Backup generators are running out of fuel, and hospital officials are searching for alternative locations for patients in need of care.

Fire and EMS:

Fire and EMS stations are also damaged, with only 40 of the 241 stations operating at greater than 50% capacity. Dozens of the region's fire engines and trucks are damaged to the point that they are no longer functional.

Transportation:

Aerial reconnaissance of the area showed the collapse of hundreds of bridges and significant obstructions on major highways. Damages to several major freeways impede emergency response vehicles trying to aid in response activities. Sections of one major highway have buckled and have been covered by landslides debris. Railways and airport runways have also sustained moderate to severe damage. Traffic gridlock has been constant. Even at 72 hours after the incident, many individuals are stranded without transportation or access to their homes. Because of communications disruptions and moderately damaged runways and instrument landing systems, the MMA airports have canceled flights.

Energy:
The utility companies have reported widespread power outages, and power generation and distribution systems are out of commission. There are also numerous ruptures to underground fuel lines, oil lines, and natural gas lines.

Water:
More than 1 million people are without water due to water main breaks and power outages.

Wastewater Treatment:
Wastewater primary interceptors were reported broken in the vicinity of the fault line, closing down systems and leaking raw sewage into the streets.

Homelessness:
More than 300,000 households have been displaced due to structural damage to housing, and an additional 8,000 have been temporarily displaced due to utility disruptions. Approximately two-thirds of displaced persons are in need of short-term shelter. Half of the existing, pre-designated shelters have been damaged and cannot be used until structural inspections can be performed. Television coverage shows thousands of victims huddled in makeshift shelters or picking through debris near their former homes.

Disease and Illness:
There is concern that with raw sewage, contaminated water, and contaminated food will cause illnesses and disease outbreaks that will threaten public health.

Business Impacts:
Many businesses have lost employees and customers as segments of the population relocate to temporary housing in other areas outside of the MMA.

Military Facilities:
The Air Force station, Army base, and other military facilities located in the metropolitan area have reported moderate building damage, temporary loss of functionality of electric and water utilities, and difficulty in access due to bridge/overpass damage.

Port Facility:
The port has been adversely affected in its capacity to provide export/import and loading/unloading capabilities. Port cranes have fallen and been dislodged due to ground liquefaction, leaving ports completely non-functional. Damaged and sunken vessels litter adjacent piers.

Communications Systems:
Damage to microwave dishes and other vital parts of the communications infrastructure has resulted in limited communications capabilities. Cellular towers have also been

damaged, and the high cellular traffic after the earthquakes has saturated the system. Offices that have become highly dependent on the internet have stalled as common carrier outages continue. Many Internet Service Provider (ISP) servers have failed, and constant power outages plague the systems.

Economic Impact –

The disruption to the Nation's economy could be severe, because the earthquakes impact major supply and transportation centers. Reconstruction, repairs, disposal, and replacement of lost infrastructure will cost billions of dollars. Replacement of lost private property and goods could also cost billions.

Long-Term Health Issues –

Many people will be killed, permanently disabled, or injured as a result of the earthquakes. This will also be associated with mental health issues relating to this catastrophic event.

Scenario 10: Natural Disaster – Major Hurricane

Casualties	1,000 fatalities, 5,000 hospitalizations
Infrastructure Damage	Buildings destroyed, large amounts of debris
Evacuations/Displaced Persons	1 million evacuated 150,000 seek shelter in safe areas 200,000 homes destroyed
Contamination	From hazardous materials, in some areas
Economic Impact	Billions of dollars
Potential for Multiple Events	Yes, seasonal
Recovery Timeline	Months to years

Scenario Overview:

General Description –

Hurricanes are intense tropical weather systems consisting of dangerous winds and torrential rains. Hurricanes often spawn tornadoes and can produce a storm surge of ocean water that can be up to 24 feet at its peak and 50 to 100 miles wide. The most destructive companion of hurricanes is the storm surge.

A typical hurricane is 400 miles in diameter and has an average forward speed of 15 Miles Per Hour (mph) in a range of 0 to 60 mph. The average lifespan of a hurricane is 9 days in a range of less than 1 day to more than 12 days. The highest wind speeds occur 20 to 30 miles from the center. Hurricane force winds cover almost 100 miles, and gale-force winds of 40 mph or more may cover 400 miles in diameter. A fully developed hurricane may tower 10 miles into the atmosphere.

A hurricane is categorized by its sustained wind intensity on a Saffir-Simpson Hurricane Scale, which is used to estimate the potential for property damage and flooding. "Major" hurricanes are placed in Categories 3, 4, and 5 with sustained wind intensities between 111 mph to greater than 155 mph. The most dangerous potential storm would be a slow-moving Category 5 hurricane, making landfall in a highly populated area.

The National Hurricane Center (NHC) provides the following description for a Category 5 hurricane:

- Winds are greater than 155 mph (135 kilotons or 249 kilometers per hour [~ 155 miles]).
- Storm surge is generally greater than 18 feet above normal.
- Complete roof failure occurs on many residences and industrial buildings, as well as severe and extensive window and door damage.
- Mobile homes are completely destroyed.
- Some complete building failures occur with small utility buildings blown over or away.

- Shrubs and trees are blown down. All signs are blown down.
- Low-lying escape routes are cut by rising water 3 to 5 hours before arrival of the center of the hurricane.
- Major damage occurs to lower floors of all structures located less than 15 feet above sea level and within 500 yards of the shoreline.
- Massive evacuation of residential areas on low ground within 8 to 16 kilometers (5 to 10 miles) of the shoreline may be required.

In this scenario, a Category 5 hurricane hits an MMA.

Detailed Scenario –

This scenario represents a Category 5 hurricane that makes landfall at an MMA. Sustained winds are at 160 mph, with a storm surge greater than 20 feet above normal. As the storm moves closer to land, massive evacuations are required. Certain low-lying escape routes are inundated by water anywhere from 5 hours before the eye of the hurricane reaches land.

Planning Considerations:

Geographical Consideration/Description –

The overall terrain of the MMA is generally low-lying land with topography ranging from flat to gently rolling hills. The coastal plain extends inland for approximately 100 miles. There are numerous bays, inlets, and rivers within the region.

Timelines/Event Dynamics –

After more than 25 inches of rainfall in the past 4 months, the MMA and the region (to include multiple States) are saturated, and rivers are at above normal levels for this time of the year.

Near the end of July, a tropical storm has developed in the Atlantic. The storm has been gaining strength as it has moved west at 10 mph. After 5 days in the open waters of the Atlantic, on August 11, the tropical storm was upgraded to a hurricane. The NHC warns that there are no steering currents that would cause this hurricane to turn away from making landfall in the continental United States. The NHC also warns that conditions are favorable for the storm to intensify over the warm Atlantic waters.

By August 15, the hurricane has steadied at a dangerous Category 4 level on the Saffir-Simson Hurricane Scale. Models indicate a track that includes a possible landfall along the coast adjacent to the MMA on the morning of August 17. Forecasters at the NHC are not sure whether the storm will strengthen or weaken over the next couple of days. Evacuation decisions are made difficult by this unpredictability of the storm's future intensity. The Governor and local officials order the evacuation of tourists and people living in certain designated low-lying areas along the coast.

On August 14, the Governor and local officials have broadened their evacuation orders to include the evacuation of all citizens within 5 to 10 miles of the coast in the areas projected to be within the path of the storm. Over the 2-day period, 1 million people have been ordered to evacuate from MMA and coastal regions. Interstates and other evacuation routes are clogged with extremely heavy traffic.

On the morning of August 17, the hurricane reaches its peak, with sustained winds at the inner wall of the eye of the storm recorded at 160 mph. At approximately 9:30 a.m., the hurricane makes landfall with a direct hit on the MMA and coastal resort towns. The MMA has been hit hard, with over 20 inches of rain since the afternoon of August 15. A storm surge of 20 feet has accompanied the storm. Forward movement of the storm system is slowed down by a strong high-pressure weather pattern. Outer bands of the storm still extend well into the warm waters, thus feeding its destructive center. In the afternoon, the hurricane begins loosing strength over land, but continues to be an extremely dangerous and strong storm. The hurricane has spawned tornadoes that have added to its destructive power.

By August 18, the hurricane has moved out of the MMA and surrounding region, but has left a path of destruction in its wake. The storm has now been downgraded to a tropical storm, with winds reduced to 60 mph near the barely discernable remnants of an eye. While the storm has weakened, the combination of already saturated land and high winds have caused widespread tree damage and power outages in multiple States. The rain associated with the storm has caused rivers to overflow their banks, and several rivers systems experience record flood levels.

Assumptions –

- Local, State, and Federal officials have the benefit of forecasts that predict a major hurricane will make landfall at the MMA. With this information, State and local officials have time to execute evacuation plans.
- Evacuation routes are not available 5 hours before the storm (surge waters and rainfall block highways leading from the MMA).
- Most of the local fire, police, and other response personnel and officials are victims of the storm and unable to coordinate immediate response resources.
- As result of the storm surge, flooding, and wind destruction, some 100,000 disaster victims are not able to immediately return to permanent housing within the MMA.
- State and local capabilities for triaging and treating casualties in the disaster area are overwhelmed. Most primary medical treatment facilities are damaged or inoperable.
- The port facility is closed completely for 1 month and requires months of work to restore operations. Major airports in the MMA are closed for approximately 10 days.
- The MMA area is completely without electric power and potable water for the first 10 days following the disaster.

- Food, medicine, gasoline, and other necessities that depend upon ground transportation and other infrastructures are also not readily available for the first 10 days following the disaster.
- Communications systems—including telephones, radios, and cellular systems—are only at 90% capacity in the first week following the storm.
- There is a 10-day disruption of sanitation/sewage services in the MMA.

Mission Areas Activated –

Preparedness:

The NHC and DHS/FEMA hold numerous video teleconferences with State and Federal emergency officials and provide them with the latest forecasts. As the storm approaches, State and local governments are given increasingly accurate forecasts and assessments of possible impacts. The path of the storm is predicted to a high degree of certainty 48 hours prior to landfall. Forecasters have difficulty predicting the intensity of the storm prior to landfall, but they urge officials to prepare for the worst.

Federal and State emergency management officials pre-position initial response resources outside of the projected path of the storm.

Emergency Assessment/Diagnosis:

Infrastructure Assessments: Intergovernmental and private sector efforts are underway to assess and analyze the impacts of the disaster on national, regional, and local transportation, communications, power, and other systems. Specific assessments will be made on the condition of highways, bridges, airports, communications systems, electric grids, dams, water treatment facilities, sewage systems, etc.

Rapid Needs Assessments: Joint Federal/State teams deploy immediately after the storm has cleared to locate areas of highest need and to estimate types of resources that will be immediately required.

Remote Sensing: Remote sensing products and assessments are requested to help determine the extent of the damages.

Modeling: Models are run given the path, size, and intensity of the storm to project damage and to estimate needs.

Search and Rescue Assessment: Immediate emphasis is on assessing needs for rescuing individuals trapped in structures or stranded in floodwaters.

Health and Medical Assessments: DHS/NDMS, in coordination with HHS/Assistant Secretary for Public Health and Emergency Preparedness (ASPHEP), has mobilized and deployed an assessment team to the disaster area to assist in determining specific health/medical needs and priorities.

Navigation Assessments: The USCG has deployed teams to assess the condition of the port and navigation channels and to identify obstructions to navigation.

Emergency Management/Response:

The following is a partial list of some of the emergency management/response actions required:

Search and Rescue Operations: There is a need for locating, extricating, and providing onsite medical treatment to victims trapped in collapsed structures. Victims stranded in floodwaters must also be located and extracted.

Mortuary Services and Victim Identification: There is a need for temporary morgue facilities; victim identification by fingerprint, forensic dental, and/or forensic pathology/anthropology methods; and processing, preparation, and disposition of remains.

Medical System Support: Emergency supplemental medical assistance is needed. Transportation of patients to operating facilities is required. Assistance is required to provide emergency restoration to medical facilities.

Debris Clearance and Management: Debris clearance, removal, and disposal operations are needed. Many structures will need to be demolished. Emergency garbage removal support is also required.

Temporary Emergency Power: Temporary emergency power is required at critical facilities.

Transportation Infrastructure Support: There is a need for the construction of temporary access routes in certain areas. Assistance is needed in coordinating alternate transportation services, such as the use of mass transit systems, to temporarily replace system capacity lost to disaster damage.

Infrastructure Restoration: Support is needed to assist in the restoration of power, communications, transportation, water, wastewater treatment, and other critical infrastructure.

Temporary Roofing: There is a need for temporary roofing assistance for homes and businesses that experienced roof failures and damages.

Vector Control: Measures will need to be taken to control vectors that may thrive in the areas after a catastrophic hurricane.

Law Enforcement Assistance: Support will be required to maintain law and order and to protect private property.

Hazard Mitigation:

Support will be required to coordinate the development of plans to execute mitigation efforts that lessen the effects of future disasters. This will include studies to assess flood and coastal erosion and development of intergovernmental plans to mitigate future damages.

Evacuation/Shelter:

State and local authorities have time to execute evacuation plans. Roads leading from the MMA are overwhelmed, and massive traffic jams hinder the evacuation efforts. Measures will need to be taken to provide temporary shelter and interim housing. Permanent housing support will also be required.

Victim Care:

Medical Assistance: There is a need for emergency medical assistance, which includes health surveillance; medical care personnel; health and medical equipment and supplies; patient evacuation; in-hospital care; food, drug, and medical device safety; worker health and safety; radiological, chemical, and biological hazards consultation; mental health care; and public health information.

Emergency Food, Water, and Ice: Disaster victims will require assistance in obtaining emergency food, water, and ice.

Sanitary Facilities: Portable/temporary sanitary facility will be required to support disaster victims (to include portable toilets and showers).

Protection from Health and Safety Hazards: Support will be required to test and analyze health and safety hazards and implement measures to protect the public.

Recovery/Remediation:

HAZMAT will contaminate many areas, and decontamination and site restoration will be a major challenge.

Implications:

The occurrence of a major hurricane in the MMA has caused significant numbers of deaths and injuries, has displaced thousands of people, has caused billions of dollars of property damage, and has greatly impacted the capability of local and State governments to provide the needed response.

Secondary Hazards/Events –

Tornadoes:

In addition to the massive destruction caused by the hurricane itself, there are also areas within the MMA and scattered inland areas that have sustained severe damage from tornadoes that were generated by the storm.

Coastal and Inland Flooding:

Storm surges and heavy rains have caused catastrophic flooding to low-lying areas of the MMA. Rainfall from the hurricane, in combination with earlier storms, causes significant flooding in multiple States along the coast.

Hazardous Materials:

Flooded and damaged petrochemical facilities, chemical plants, sewage treatment plants, and other facilities threaten the health of citizens, create a hazardous operating environment, and require cleanup and remediation. An oil tanker is blown off course during the storm, sustains serious damage, and leaks oil in to the waters adjacent to the MMA.

Fatalities/Injuries –

The catastrophic hurricane has resulted in more than 1,000 fatalities, and 5,000 people have sustained injuries requiring professional treatment.

Evacuations –

Coastal areas adjacent to the MMA were in the midst of a busy summer tourist season, with hotels and seasonal homes filled to near capacity. Tourists and residents in low-lying areas were ordered to evacuate 48 hours prior to projected landfall. Twenty-four hours prior to predicted landfall, officials warned Federal and State officials that the storm could make landfall as a Category 5 storm and that appropriate protective measures for this level storm should be taken. Massive evacuations have been ordered, and evacuation routes have been overwhelmed. As the storm approaches, evacuation routes become inundated or blocked by debris, and evacuation is no longer an option for many of those who waited for the storm to come closer.

Property Damage –

Flooding:

Major portions of the MMA were completely submerged during the height of the storm. Low-lying areas within a multi-State area experience floods associated with the record amounts of rainfall associated with the storm.

Structural Damage:

Structures in the low-lying areas were inundated when storm surges were at their peak. Many older facilities suffered structural collapse due to the swift influx of water and degradation of the supporting structural base. Newer facilities and structures survive the influx of water but sustain heavy damage to contents on the lower levels.

Debris:

Most of the shrubbery and trees within the storm's path have been damaged or destroyed, generating massive amounts of debris. This debris is interfering with transportation systems, and there is concern that the debris could become a health, fire, and safety hazard if not addressed in a timely manner. Debris has also been generated from structures destroyed from tornadoes and structures that have been destroyed or damaged by the hurricane. Many structures will need to be demolished.

Service Disruption –

Shelters:
Shelters throughout the region are also filled to capacity. Many of the designated shelters within the path of the storm have been damaged and can no longer provide adequate accommodations for disaster victims.

Search and Rescue:
The hurricane and the associated flood and surge waters have trapped hundreds of people in flooded areas. A few individuals have been trapped within destroyed and collapsed structures. Flooding associated with the storm has forced many to seek refuge on rooftops, bridges, and other high areas, and these individuals require transportation to safe haven. Until debris is cleared, rescue operations are difficult, because much of the area is reachable only by helicopters and boats.

Water, Food, and Ice:
All areas are in serious need of drinking water, as water treatment plants have been damaged and are without power. Food is in short supply, since roads are impassable and many of the grocery stores and restaurants sustained damage and are not open. Refrigeration is not available, and there is a large demand for ice to keep food from spoiling.

Sanitation Systems:
Sewage treatment plants in the region have been flooded and sustained damaged from the storm. It is estimated that the system will be down for about 10 days.

Homelessness:
The hurricane has destroyed and damaged many structures in the path of the highest winds and has left thousands of people homeless. Mobile homes and many small buildings have been completely destroyed. Roofs, windows, and doors of many residences have experienced failure and/or damage. Structures in areas less than 15 feet above sea level and within 500 yards of the shoreline have received flood damage and destruction.

Power:
Wind and downed trees have damaged nearly all of the electric transmission lines within the MMA. Power companies are completely overwhelmed and are predicting that it will up to 2 months to provide power to large portions of the service area.

Disease and Illness:
Standing water, septic conditions, and vector-transmitted diseases threaten public health. Contaminated water and food have caused illnesses. There is concern that outbreaks of mosquito-borne diseases will be a problem in the future.

Environmental/Health Impacts from HAZMAT:
Factories, chemical plants, sewage treatment plants, and other facilities in the MMA have suffered severe damage. Hundreds of thousands of gallons of extremely hazardous substances have spilled into the floodwaters, causing an immediate health and environmental risk to victims and responders alike. Flooding waters also contain chemicals and waste from ruined septic systems, businesses, and homes. There is also gasoline, diesel fuel, and oil leaking from underground storage tanks. During the height of the storm, a 95,000-ton tanker was blown off course and struck a bridge, breaching the hull of the vessel, which then began to leak oil into waters adjacent to the MMA.

Business Impacts:
Many businesses have experienced damage to buildings and infrastructure. Businesses located less than 15 feet above sea level and within 500 yards of the shoreline have received flooding-related damage and destruction. Roofs, windows, and doors of many businesses have failed. Businesses also have been impacted by the lack of infrastructure support and services (transportation, communications, water, electricity, etc.). Many businesses have lost employees and customers as segments of the population have relocated to alternative housing in areas outside of the MMA.

Military Facilities:
Military facilities (naval bases, air force base facilities, army, etc.) in the path of the hurricane are damaged, and assistance is needed to provide for the military community and to reconstitute the facilities.

Flood/Hurricane Protection Works:
The 20-foot storm surge breached and overtopped flood-control and hurricane-protection works.

Transportation—Highways, Mass Transit, Bridges, Railroads, Airports:
Major access roads in to the metro area were damaged by floodwaters or are impassable due to the large amounts of debris. Mass transit systems, to include subways, are in disrepair and lack power. Railroads into the MMA are closed due to debris and damage to infrastructure. The major airports are damaged, and runways are blocked with debris. A large barge struck and caused severe damage to a major bridge that services the MMA. Other bridges that connect from the mainland to coastal resort areas have sustained significant damage.

Port Facility:
The port has been adversely affected in its capacity to provide export/import and loading/unloading capabilities. Navigation structures have been temporarily closed, and there have been slowdowns in the delivery of goods vital to the economy of the United States. Channel dredging projects will require immediate surveys to assess dredging requirements to restore the channels. Numerous sunken vessels and other obstructions block navigation channels.

Medical Services:
Many hospitals have sustained severe damage, and those that are open are overcrowded with special-needs patients and family members. Backup generators are running out of fuel, and hospital officials are searching for alternative locations for patients. There is a need to transport special-needs populations to the closest appropriate hospital or other health care facility.

Communications Systems:
Due to damage and lack of power, communications systems—including telephones, radios, and cellular systems—are only at 90% capacity in the first week following the storm.

Schools/Education Systems:
Damage to schools within the MMA is high. Many windows have been blown out or damaged by flying debris. Roof conditions vary, with some schools having lost roofs completely and others having received significant damage. Schools that are not severely damaged are being used as shelters for disaster victims.

Animals:
Thousands of pets, domesticated animals, and wild animals have been killed or injured. Pets are of particular concern, and officials have been overwhelmed with requests for assistance in finding lost pets. It is estimated that 20,000 cows, pigs, and horses have died in flooded rural areas in the region, and carcass disposal is a major concern.

Economic Impact –

There are severe economic repercussions for the whole State and region. The impact of closing the port has national implications. The loss of the petro-chemical supplies could raise prices and increase demand on foreign sources.

Long-Term Health Issues –

The long-term health issues depend on victims' exposure to toxic chemicals and disease. Long-term environmental issues involve decisions about future land use.

Scenario 11: Radiological Attack – Radiological Dispersal Devices

Casualties	180 fatalities; 270 injuries; 20,000 detectible contaminations (at each site)
Infrastructure Damage	Near the explosion
Evacuations/Displaced Persons	10,000 evacuated to shelters in safe areas (decontamination required prior to entering shelters) 25,000 in each city are given shelter-in-place instructions Hundreds of thousands self-evacuate from major urban areas in anticipation of future attacks
Contamination	36 city blocks (at each site)
Economic Impact	Up to billions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Months to years

Scenario Overview:

General Description –

In this scenario, the Universal Adversary (UA) purchases stolen Cesium Chloride (CsCl) to make a Radiological Dispersal Device (RDD), or "dirty bomb." The explosive and the shielded Cesium-137 (^{137}Cs) sources are smuggled into the country. Detonator cord is stolen from a mining operation, and all other materials are obtained legally in the United States. Devices are detonated in three separate, but regionally close, moderate-to-large cities.

^{137}Cs is mostly used in the form of CsCl, which is easy to precipitate. CsCl is a fairly fine, light powder, and its median particle size is about 300 microns. Fractions below 10 microns are typically less than 1%. In an RDD, most will fall out within approximately 1,000 to 2,000 feet (although many variables exist), but a small amount may be carried great distances, even hundreds of miles.

Detailed Attack Scenario –

The UA, having learned from press and scientific reports how to make an RDD, activates a U.S.-based cell to carry out attacks on U.S. cities. The UA chooses ^{137}Cs because of its availability, high radioactivity, high dispersability, and the difficult nature of cleanup and remediation. The UA's goal is to conduct a highly visible attack creating fatalities, fear, and social and economic disruption.

The U.S. cell spends several years slowly acquiring a large quantity of prilled ammonium nitrate (NH_4NO_3). UA members plan attacks on three significant cities in regional proximity. Via black-market contacts, the foreign cell purchases three stolen seed irradiators that each contains approximately 2,300 curies of CsCl and several kilograms of highly explosive Pentaerythritol Tetranitrate (PETN). The CsCl powder is removed from its containment, transferred to plastic zip-lock bags, and placed in heavy lead-shielding containers. The explosive and the shielded ^{137}Cs sources are smuggled into the country in sea-land containers shipped separately to a U.S. port under assumed business names. Detonator cord is stolen from a mining operation without raising concern, and all other materials are obtained legally in the United States.

The sea-land containers are picked up and transferred to safe houses near the target cities, where rented vans await containing the ammonium nitrate and containers of fuel oil. The vans have been painted to appear as commercial delivery vehicles. At the safe houses, terrorists assemble the devices by carefully mixing the Ammonium Nitrate with Fuel Oil (ANFO; 95:5 by weight) inside the truck and fixing the detonator with a 0.5-kilogram highly explosive core as a booster. The total explosive yield in each device will be approximately 3,000 pounds. Because each radiation source gives off 760 rad per hour (at 1 meter), the sources are left in their lead containers until the final minutes—at that time, they are transferred to the van and inserted down into the explosive mixture. The vans arrive at the target downtown locations in the U.S. cities. Three to five individuals are involved in executing each attack.

At 11:15 a.m. during the school year, UA members detonate the 3,000-pound truck bomb containing the 2,300 curies of ^{137}Cs in the downtown business district of City One. The explosion collapses the front of one building and causes severe damage to three others. Windows are blown out of five other buildings. The area is contaminated with ^{137}Cs, and the contaminated detonation aerosol is lifted more than 100 feet into the air.

A similar scene plays out in two other moderate-to-large cities. The second and third explosions are timed to go off simultaneously in City Two and City Three, at approximately 12:30 p.m. on the same day. The time lag is intended to maximize press coverage and spread fear and uncertainty. Local first-response capacity, however, is depleted in City Two and City Three, because many responder assets have been dispatched to assist nearby City One with the response.

Planning Considerations:

Geographical Considerations/Description –

The three cities are regionally close. They are physically similar (for the sake of this assessment), with similar building environments and geographic topography that is essentially flat. The results in each city are essentially the same. The contaminated region covers approximately 36 blocks in each city and includes the business district (high-rise street canyons), residential row houses, crowded shopping areas, and a high school. Buildings in the affected areas are principally made of concrete and brick; some are stone faced. Building heights in the entire affected area range from 2 to 20 stories, and buildings in the immediate vicinity of the blast are 8 to 16 stories. The area within a radius of five blocks of the blast is a narrow urban canyon of medium-to-tall buildings abutting sidewalks, and streets are approximately 40 feet wide.

The entire scene is contaminated with ^{137}Cs, though not at levels causing immediate concern to first responders. Due to the size of the explosion, the radioactive contamination is blown widely such that the ground zero area is not as radioactive as might have been expected. The detonation aerosol contains 90% of the original ^{137}Cs source with radioactive particles whose sizes range from 1 to 150 microns—the size of most of the particles is approximately 100 microns. Larger particles either penetrate building materials in the blast zone or drop quickly to the ground as fallout within about 500 feet.

Variable winds of 3 to 8 miles per hour carry the radioactively contaminated aerosol throughout an area of approximately 36 blocks (the primary deposition zone). Complex urban wind patterns carry the contamination in unpredictable directions, leaving highly variable contamination deposition with numerous hot spots created by wind eddies and vortices. Radioactivity concentrations in this zone are on the order of 5 to 50 microcuries/m^2, with hot spots measuring 100 to 500 microcuries/m^2; however, traces of the ^{137}Cs plume carry more than 3.5 kilometers (~ 2.2 miles) on prevailing winds. Negative indoor building pressure draws radioactive aerosols into buildings via cracks around windows and doors. Exterior air intakes increase the contamination in the interior of larger buildings. In City One, the subway system is contaminated by radioactive aerosols entering through subway ventilation system air intakes.

In all cities, foot and vehicular traffic after deposition re-suspend and transfer contamination for hours afterward until the entire scene has been effectively controlled and cordoned, contributing to contamination spread beyond the 36-block primary deposition zone. People who were in the deposition zone also take contamination home with them in hair and clothing.

Timeline/Event Dynamics –

The attacks have no advance notice or intelligence that indicates their possibility. The explosions are instantaneous, but plume dispersion continues for 20 minutes while breezes navigate the complex environments before particles have fully settled. First responders do not recognize radioactive contamination for 15 minutes in City One. The explosions in City Two and City Three are promptly identified as "dirty bombs"—this provides some advantage to first responders and government officials in managing contamination on-scene, and in communicating with the public concerning topical contamination and spread of contamination.

Assumptions –

- As a result of the explosions, 90% of the 2,300-curies ^{137}Cs source is aerosolized and carried by winds, with radioactive particles ranging in size from 1 to 150 microns. The remaining fallout creates debris and contaminates surrounding structures.
- There is no precipitation. There are light, variable winds of 3 to 8 mph. The temperature is 65º F.
- The port of entry through which the smuggled materials enter is not equipped with radiation detection equipment that can detect the shielded ^{137}Cs source. The target and surrounding access routes are not equipped with radiation sensors that

can detect the shielded source. The acquisition of bomb-making materials does not draw the attention of law enforcement.

- First responders from City Two and City Three assist City One.
- A disposal facility is available for cleaning up waste.

Mission Areas Activated –

Prevention/Deterrence:

Prevention efforts should include such law enforcement goals as prevention of trafficking and importation of CsCl and weapon components, reconnaissance of the site, protection, and deterrence measures taken at the site before and during the attack. Target and surrounding access routes are not equipped with radiation sensors that can detect the shielded source. DHS would be involved in detection of the shielded ^{137}Cs radiation sources.

Emergency Assessment/Diagnosis:

The explosion in City One is not recognized as a "dirty bomb" until responding units arrive with gamma detection equipment. This leads to contamination of first responders and inadvertent contamination spread that might have otherwise been avoidable. The downwind aerosol dispersion will be a significant component of the hazard and will cause extended local and regional disruption. Actions of incident-site and EOC/Joint Field Office (JFO) personnel tested during and after the attack include providing personnel dispatch; assessing the extent of physical damage, including engineering assessments of buildings; assessing medical response needs; detecting and identifying the radiation source; establishing and preserving the site for crime scene analysis; collecting site data and information; making hazard assessments and predictions for responders and the public; and coordinating preliminary radiation monitoring, surveying, and sampling operations.

Emergency Management/Response:

Incidents result in 180 fatalities, 270 injuries, extensive environmental contamination, evacuation of thousands of individuals, and thousands of potentially exposed individuals in the downwind zone. Actions of EOC/JFO personnel required after the attack include mobilizing and operating incident command; overseeing victim triage; stabilizing the site; cordoning the site and managing and controlling the perimeter; providing notification and activation of special teams; providing traffic and access control; providing protection of at-risk and special populations; providing resource support and requests for assistance; providing public works coordination; providing direction and control of critical infrastructure mitigation; and providing public information, outreach, and communication activities.

Because first-responder assets (e.g., medical evacuation, fire, rescue, and EMS personnel) were promptly dispatched from nearby City Two and City Three to assist City One, City Two and City Three are low on response capacity, and officials find themselves unprepared when attacks strike their cities.

Hazard Mitigation:

Required actions of incident-site personnel include isolating the incident scene and defining the hazard areas, building stabilization, providing fire suppression, conducting debris management, conducting radioactive and hazardous contamination mitigation, decontaminating responders and equipment, conducting local-site contamination control, and decontaminating local citizens.

Evacuation/Shelter:

Evacuation and/or sheltering of downwind populations will be required. This must occur promptly and in an orderly fashion, but will likely not occur before the plume has passed and settled, given the lack of warning. Actions taken by Federal, State, and local EOC/JFO personnel performed after the attack include developing protective action recommendations and communicating them to the public (e.g., to evacuate the affected area and /or shelter-in-place, as appropriate, and self-decontamination); providing management of evacuation, whether ordered or spontaneous; protecting special populations, schools, and day care centers; establishing temporary sheltering alternatives and provision of food for evacuees; and offering veterinary services for pets.

Victim Care:

Injured people will require some decontamination in the course of medical treatment and, if possible, prior to hospital admission. Thousands more will likely need superficial decontamination and both short-term and long-term medical follow-ups. Actions of incident-site, local-area, hospital, and EOC/JFO personnel tested after the attack include conducting search and rescue; providing triage, emergency aid, treatment, and stabilization; decontaminating victims (ambulatory and non-ambulatory); establishing relief stations, impromptu decontamination centers, and site access portals; screening, monitoring, and decontaminating evacuees (numbers are expected to be up to 100,000 at each site); conducting victim/evacuee data and information collection and management; making radio-protective pharmaceutical decisions and efficiently providing protective and/or therapeutic drug administration; conducting patient status tracking and reporting; providing patient transport; treating ER walk-in radiation victims; providing hospital care; providing collection, decontamination, and cataloging of human remains and personal effects; and providing next-of-kin notification.

Investigation/Apprehension:

Actions of law enforcement personnel tested after the attacks include dispatching personnel, conducting site cordoning and control, collecting field data, conducting witness interviews, and performing tactical deployment and apprehension of suspects. Reconstruction of the attack will occur and will include information about the occurrence of importation of illicit materials, acquisition of materials within the United States, planning, movements, financial backing, communications, suppliers/accomplices tracking, and suspect apprehension.

Recovery/Remediation:

Decontamination/Cleanup: The extent of contamination will be a major challenge, because ^{137}Cs is highly water soluble and is chemically reactive with a wide variety of materials, including common building materials such as concrete and stone. Approximately 36 city blocks will be contaminated to varying degrees. Contamination will settle on streets, sidewalks, and building surfaces, and will be found in several kilometers of the subway system (City One). Building interiors will become contaminated due to ventilation systems, doors, windows (because negative building pressure can draw aerosols in through very small openings), and foot traffic. Personal property—including vehicles and items inside buildings—will also become contaminated, but many items can be adequately decontaminated for free release.

A summary of decontamination and cleanup activities is as follows:

- Some demolition will likely be required, but most surfaces may be systematically decontaminated to low levels (a lengthy, costly process).
- Officials may focus decontamination work first on critical infrastructure—such as major thoroughfares, the subway, and the water treatment plant—in order to restore basic functions as quickly as possible.
- Streets with cracks are cut, refilled, and resurfaced; some must be completely removed and repaved.
- Most sidewalks must be surface cleaned.
- Roofing materials are mostly removed, and roofs are resurfaced.
- Surface soil and vegetation are removed for disposal and replaced with fresh material.
- Exterior surfaces are decontaminated with an assortment of chemical treatments (e.g., stripping, vacuum blasting, scabbling), and collected wastes are hauled off for disposal.
- Contaminated building interiors are mostly stripped of surface coatings, carpet, drapery, furniture, etc., and are refurbished.
- Workers try to capture decontamination wastes for disposal, but much will escape into storm drains with each spring rain. Sewers become contaminated. Some are cleaned of hot spots, but others may be left fairly contained if cleaning them is not justified.
- Though concentrations are low, river sediment remediation will likely become a big issue with the public.

Site Restoration: Several buildings (those most damaged) will be torn down and eventually rebuilt. Decontamination activities are undertaken for building exteriors and interiors, streets, sidewalks, and other areas. Federal, State, and local officials and stakeholders hold numerous public meetings to evaluate current and future land use goals, dose/risk goals for the site, and the possible use of institutional controls if decontamination is unsatisfactory. Economic and tax incentives may need to be instituted, and Federal, State, and local governments might start a "save our city" campaign to build community support to reclaim and revitalize the area. (A heated debate is likely to ensue in public meetings and the press over the adequacy of site restoration goals and the resultant risks to the public, presenting major communication and negotiation challenges to local, State, and Federal officials.)

Implications:

Secondary Hazards/Events –

Small fires from ruptured gas lines occur in the vicinity of the blasts. Unstable building facades, rubble, and broken glass create physical hazards for rescue workers. Small amounts of lead, asbestos, and Polychlorinated Biphenyls (PCBs) are present in the air and on surfaces. Human remains present a biohazard, and some of these may be radioactive.

Fatalities/Injuries –

At each site, the blast results in 180 fatalities and about 270 injured requiring medical care. In addition, up to 20,000 individuals in each primary deposition zone potentially have detectable superficial radioactive contamination. Most of them also have internal contamination via inhalation and secondary ingestion. Most cases are seen in City One. In each city, tens of thousands of people located downwind have minor external and internal contamination and will require monitoring and medical surveillance.

Property Damage –

In each blast, one building and 20 vehicles are destroyed (i.e., not salvageable), and eight other buildings suffer varying degrees of damage, such as minor structural damage and broken windows. Radioactive contamination is found inside buildings as well as on building exteriors, streets, sidewalks, people, and personal property over an area of approximately 36 blocks in each city. Minor contamination may be an issue further downwind as investigators perform more thorough surveys. Most of the subway system in City One is contaminated.

Over the long term, decontamination efforts are expected to be effective, but some property owners choose demolition and rebuilding. Many square blocks will be unavailable to businesses and residents for several years until remediation is completed.

Service Disruption –

Transportation is severely hampered in each city. Bus, rail, and air transportation routes are altered, and officials build highway checkpoints to monitor incoming traffic for contamination. The subway system in City One, which carries 500,000 passengers a day, is completely or partially closed for an extended period. In each city, the entire contaminated zone is closed to all traffic for an extended period (though peripheral areas and some thoroughfares are opened within several weeks for limited use). Hospitals in each region, already at maximum capacity with injuries from the blasts, are inundated with up to 50,000 "worried well," most of whom were not in the blast or plume zone but are concerned about health issues (despite special relief stations established by the incident command for contamination monitoring and public outreach).

The sewage treatment plant is quickly contaminated as a result of people showering and decontaminating personal effects. In each city, 75 businesses are closed for an extended duration while radioactive contamination is remediated. Local tax revenues plummet, and people discover that insurance claims are rejected. The schools in the contamination zones are closed, and students meet in alternate locations. Nearby towns and cities close their doors to residents of the impacted cities for fear of contamination spread. Bus, rail, and air transportation routes are altered, and officials build highway checkpoints to monitor incoming traffic for contamination.

If one of the events occurred near a border, there would be a need for intense communication and cooperation between the two border governments that would engage their respective foreign affairs organizations and the full range of other Federal, State, and local agencies. In addition, the RDD attacks may warrant limiting access to or closing U.S. borders, which would have an immediate effect on Mexico and Canada.

Economic Impact –

Although technologies exist to decontaminate areas, these technologies were designed for smaller, isolated areas, and the process may take several years. Decontamination, destruction, disposal, and replacement of lost infrastructure will be costly (i.e., hundreds of millions of dollars per site). Economic losses in the area due to lost business productivity, tax revenue, and property will be significant. The entire contaminated area may be economically depressed for years.

Additionally, an overall national economic downturn may occur in the wake of the attack due to a loss of consumer confidence. Virtually all commercial insurance policies exclude radioactive contamination, so the Federal Government will be left with a massive bailout. Total economic impacts would almost certainly be in the billions of dollars. Some residents will show no signs of willingness to resettle their former domiciles. Schools may permanently relocate. Some businesses may relocate to an unaffected zone or another city altogether. However, depending on the city; its size; and its historical, economic, and political significance, the will to recover and repopulate would vary widely from long-term decline to complete revitalization.

Long-Term Health Issues –

The following is a summary of human health issues likely to occur over the long term:

- No one will suffer acute radiation syndrome.
- Approximately 20,000 individuals are likely to become externally contaminated at each site. A high percentage of these (perhaps 40% to 60%) will have measurable internal contamination via inhalation and primary and secondary ingestions that require treatment. Low-level contamination may enter food and water supplies and may be consumed at projected doses below EPA Protective Action Recommendations. The sum of the cumulative exposures results in an increased lifetime cancer risk proportionate to the dose.
- All exposed individuals will need to be monitored for health outcomes over their lifetimes, especially those that suffer internal contamination.

- Many individuals, including those close to but not within the affected area, will require mental health counseling for an extended period of time. First responders make up a unique group often in need of mental health services. The total number in need of mental health services may be on the order of 5,000 to 20,000 per site.

Scenario 12: Explosives Attack – Bombing Using Improvised Explosive Devices

Casualties	Approximately 100 fatalities; 450 hospitalizations
Infrastructure Damage	Structures affected by blast and fire
Evacuations/Displaced Persons	Evacuation of immediate area around each explosion results in approximately 5,000 people seeking shelter in safe areas
Contamination	None
Economic Impact	Millions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Weeks to months

Scenario Overview:

General Description –

In this scenario, agents of the Universal Adversary (UA) will employ a multiple prong attack to funnel personnel into predetermined locations. Utilizing multiple devices vehicle bombs, suicide bombers, and man-delivered IEDs, to inflict the greatest number of causalities.

Detailed Attack Scenario –

During an event at a large urban entertainment/sports venue, three suicide bombers are strategically pre-positioned inside the arena. The detonation of their devices will instill mass panic and chaotic evacuation of the arena.

Occupants evacuating the arena are most likely to move toward one of several locations. A portion of the occupants will remain in the immediate area around the venue, clogging ingress for emergency responders. Some will head toward public transportation, while others will head toward parking lots to retrieve their vehicles and depart the area.

The main thrust of the attack is at the evacuation points. In the area of the main evacuee collection area (most likely on a main street outside the venue), the UA has placed a Large Vehicle Bomb (LVB) disguised as a fire department/EMS service vehicle. It is conceivable to disguise 10,000 pounds of explosives in such a vehicle, but the actual amount could be scaled down and still achieve severe effects. Blast dispersal and damage patterns are determined based on the amount and type of explosive used.

Simultaneous to the detonation of the LVB, a second set of devices are detonated in an underground public transportation concourse (e.g., a subway). To accomplish this, pre-positioned IEDs, are detonated at strategic points in the concourse. In a third attack, a vehicle bomb is detonated in a parking facility near the entertainment complex. Using a second LVB, also disguised as an EMS vehicle, a fourth bomb is detonated in the lobby of the nearest hospital ER. Blast dispersal and damage patterns can be further detailed upon determination of the type and amount of explosive to be used.

(The simultaneous attack of four targets is a realistic, documented, and practiced terrorist tactic. The convergence of individual bombers to enhance explosive effect has also been used. The recent real-world incidents at Chicago and Rhode Island nightclubs illustrate the confusion created by rapid, mass evacuation.)

Planning Considerations:

Geographical Considerations/Description –

The incident is primarily designed for an urban environment, but could be adapted for more rural area events such as county fairs and other large gatherings. Casualty estimates would be reduced as a function of a reduced target population and less population density at target points. The primary urban location would be a downtown, high-capacity, entertainment center such as the MCI Center in Washington, DC, or the Superdome in New Orleans, Louisiana. The complex would be located within a short distance of an underground public transportation station.

Timeline/Event Dynamics –

Initially suicide bombers detonate their devices approximately 1 hour after the start of the entertainment event. The detonation of additional IEDs is delayed approximately 10 to 15 minutes after the initial suicide bombings in order to allow for detection, evacuation, and response of EMS providers. The detonation of the LVB at the hospital site will be the hardest to time for maximum effect and may need to be coordinated by some communication among cell members. In any case, the hospital device should be detonated before the arrival of casualties from the entertainment venue.

The timing of some of these events, with the exception of the evacuation stimulus, is not critical. The more people who evacuate the venue, the more potential explosives-related casualties are produced. If evacuation of the venue is delayed, detonation of the LVB near the venue can be expected to produce increased casualties inside the structure due to collapse, secondary and tertiary blast effects, increased exposure to products of combustion, thermal effects, and crowd surge.

Assumptions –

The disguised LVB contains a large amount of a readily attainable commercial explosive material such as ANFO or other explosive material. The estimated lethal air blast range for this vehicle (4,000 pounds of ANFO) is 300 feet (91 meters). Fatalities from secondary and tertiary blast injuries can be reasonably expected at 1.5 times that distance. Blast overpressures of approximately 8 psi can be predicted out to 190 feet (57 meters). This force is sufficient to cause the failure of brick wall panels. Overpressures of 10 psi, which are sufficient to cause structural destruction, can be expected if the vehicle is within about 150 feet (48 meters) of buildings.

A vehicle containing approximately 1,000 pounds (455 kilograms) of ANFO is predicted to have a lethal air blast range of 125 feet (38 meters). The UA operative in the transportation concourse can carry a backpack IED to produce an effect equal to 10 pounds of C-4 and shrapnel.

Evacuation population density should not exceed more than one person per 3 square feet of area in potential target zones. (For example, the area on F Street outside the MCI Center is approximately 100 feet by 30 feet, so casualties should not exceed 1,000 in this area.)

Mission Areas Activated –

Prevention/Deterrence:

The planning and execution of this event would require a significant level of relatively unsophisticated coordination. As such, the potential for detection in the pre-event planning stages exists. The completion of a targeting package would necessitate obtaining or creating diagrams of the venue, the transportation platform, the hospital ER, and the environments around these sites. Surveillance of the target locations would be conducted, and photographs and video documentation would be taken.

The LVBs, disguised as a fire department vehicle or ambulance, would necessitate obtaining vehicles at least reasonably similar to those used by the local fire/EMS department.

The assembly of suicide vests and vehicle bombs would require a significant level of preparation, increasing the potential for detection. Obtaining the precursor materials to make the explosive material could also create suspicion.

Emergency Assessment/Diagnosis:

The initial suicide bombings are the first recognizable indication that the attack is under way. In fact, these initial bombings are used to bring victims and first responders toward the subsequent bombs. Actions of incident-site and EOC personnel tested during and after the attack include dispatch; agent detection; and hazard assessment, prediction, monitoring, and sampling.

Emergency Management/Response:

This attack is a series of large events, which would require fire, law enforcement, and EMS, and other responders, necessitating mutual aid. It would require the activation of Urban Search and Rescue Teams. Actions of EOC and JIC personnel tested after the attack include alerts, activation and notification, traffic and access control, protection of special populations, resource support, requests for assistance, and public information. This event would require the establishment of a JOC.

Hazard Mitigation:

Primary hazards include fire; toxic atmosphere/smoke, un-detonated explosives, unstable structures, electrical hazards (main venue, transportation center), and low visibility (smoke/loss of electricity).

In addition to standard police, fire, and EMS response, a Public Service Bomb Squad (PSBS) or a Military Explosive Ordnance Disposal (EOD) unit will be required to respond to the entertainment venue and the hospital. Due to the use of a vehicle bomb disguised as a fire department vehicle or ambulance, additional law enforcement and PSBS assets will probably be requested at each receiving hospital in the area. Hospital personnel will want to ensure that arriving vehicles are not delivery systems for additional weapons. This process may slow patient care/triage at receiving facilities.

Evacuation/Shelter:

Protective measures would include the evacuation of residents and businesses in/around the area; a threat assessment for other transportation centers and hospital ERs, including those outside the area if there is a threat of additional attacks; and either evacuating or sheltering-in-place for hospital patients not immediately affected by the blast. It will be necessary to cordon the area to prevent looting/souvenir removal in the arena and surrounding area.

Victim Care:

Injuries range from “walking wounded” to multiple systems trauma, burns, and obvious fatalities. Triage will identify treatment priorities. Patient care at the target hospital will be affected by the diversion of resources to care for injured staff and patients at the ER blast site. Elimination of the ER facility at the target hospital will force other facilities to receive all patients from the entertainment venue blasts.

Investigation/Apprehension:

Investigation can begin during the rescue phase with photo documentation of the immediate scene, victim locations, and injury patterns. Coordination of Federal, State, and local investigative resources will begin early in the incident management.

Recovery/Remediation:

Decontamination/Cleanup: These will include decontamination of debris and remains at all sites and appropriate removal and disposal after evidence search and recovery.

Site Restoration: Restoration of the main venue could take more than 1 year (depending on the extent of the fire damage). Repair and restoration of the transportation center can be estimated at 4 months.

Implications:

Secondary Hazards/Events –

Secondary hazards include the disruption of electric power, natural gas lines, and water mains—the disruption will cause undermining of streets and flooding of underground transit ways. There may be toxic smoke resulting from fires and explosions. There will be loss of traffic controls in the area, and fleeing citizens would likely cause traffic accidents. Media response to the area may affect responders. Since one of the bombs was disguised as an emergency response vehicle, other legitimate vehicles may be impeded in their response to the scene and hospitals. Rumors will be rampant until a common operating picture evolves.

Fatalities/Injuries –

Casualties will result at all five incident sites and will include civilians, emergency personnel, and the suicide bombers. The initial suicide bombings around the arena can be expected to result in eight fatalities and 150 injuries, including minor cuts, burns, smoke inhalation, respiratory burns, and crushing injuries due to accumulation of victims at exits.

The LVB detonation outside the venue can be expected to result in the largest number of fatalities and injuries due to the population density expected. Blast pressure, thermal effects, and fragmentation will kill 30 people around the vehicle and another five people inside the entertainment center as a result of structural damage and fragmentation. Another 200 injuries, ranging from minor cuts and concussions to severe mechanical trauma and barotraumas, can be expected. (This site has the potential to result in the fatalities of fire and EMS personnel if they locate apparatus in the vicinity of the LVB.) The unconfined detonation of the vehicle bomb in the parking lot results in seven fatalities and 40 injuries. The detonation of an explosive device in an underground transportation facility results in eight deaths and 50 injuries (due to timing and the limited number of people in and around the devices at the time of detonation). The detonation of explosive devices at a hospital results in eight deaths and 40 injuries. These fatalities and injuries are summarized in Table 12-1.

Incident or Location	Fatalities	Serious Injuries
Initial suicide bombings	8	150
LVB	35	200
Parking facility car bomb	7	40
Public transportation concourse (subway)	8	50
Hospital ER	8	40

Table 12-1. *Summary of fatalities and serious injuries as a result of the bombings*

Property Damage –

Property damage would include severe blast damage to the entertainment venue, blast damage to buildings across from the entertainment venue, moderate damage to the transportation center, severe damage to vehicles and nearby buildings at the parking facility, and severe damage to the hospital ER.

Service Disruption –

Service disruption would be severe in the impacted city and would include traffic, public transportation, emergency services, and hospitals. The destroyed transportation venue (subway) may have a long-term impact.

Economic Impact –

The local economic impact includes loss of use of the entertainment venue for a period of 1 year during the repair of blast damage. There would likely be disruption of all services within four square blocks around the entertainment center for 1 week, followed by disruption to one block surrounding the venue for 3 months (for shoring of damaged buildings and evidence collection).

The public transportation line will be closed for 1 week, with the station closed for 3 weeks for evidence collection, decontamination, cleanup, and structural assessment. The hospital ER will be closed for 6 months. Depending on the layout of the hospital, a temporary ER may be available within 1 month.

Long-Term Health Issues –

Major health issues include severe burn treatment and therapy for the victims; permanent hearing loss; long-term tinnitus; vertigo for some exposed to the blast; and post-traumatic stress for victims, first responders, and nearby residents.

LVB Damage/Overpressure Template

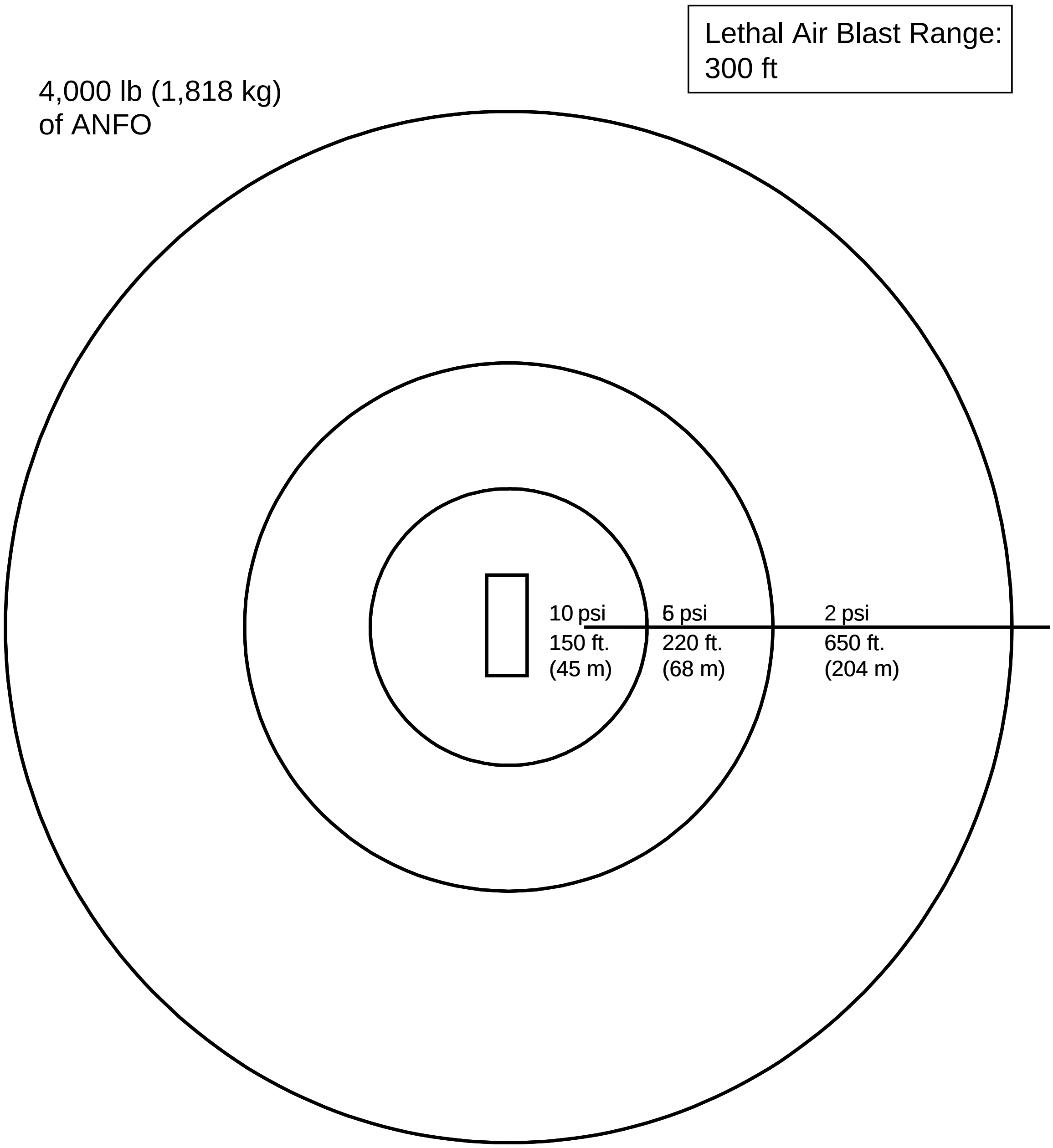

Figure 12-1. *Estimated overpressure (in psi) at distance from the blast seat for an LVB*

Vehicle Bomb Damage/Overpressure Template

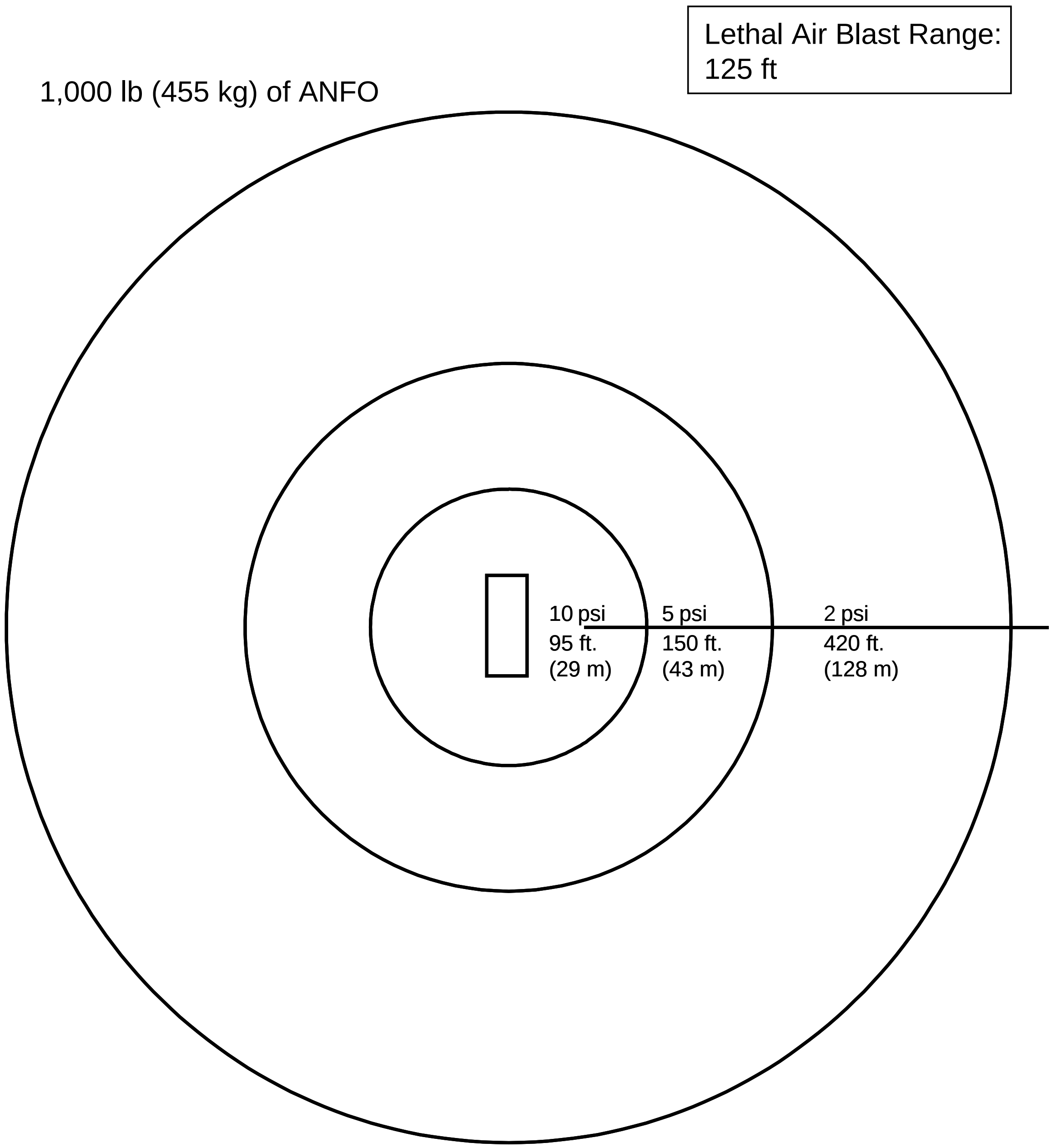

Figure 12-2. *Estimated overpressure (psi) at distance from the blast seat for a vehicle bomb*

Suicide Bomb Blast Damage/Overpressure Template

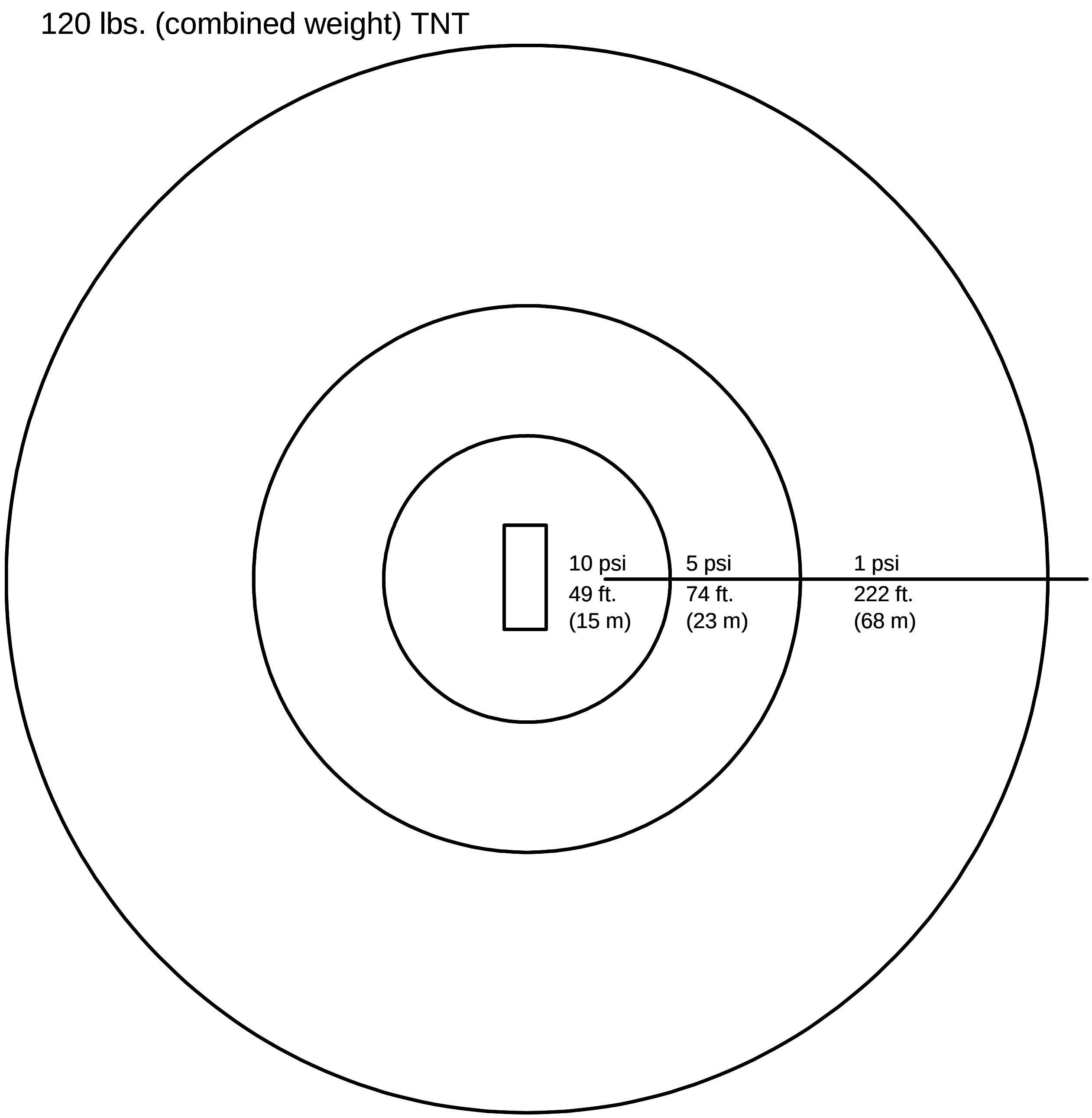

Figure 12-3. *Estimated overpressure (in psi) at distance from the blast seat for combined suicide bombs*

Sample Human Injury Criteria	
Blast Overpressure (psi)	**Injury**
0.5	Threshold for injury from flying glass
1.5	Threshold for multiple skin penetrations from flying glass
2.0 to 3.0	Threshold for serious wounds from flying glass
2.4	Threshold for eardrum rupture
3.0	Throws body to the ground
4.0 to 5.0	Serious wounds from flying glass near 50% probability
7.0 to 8.0	Serious wounds from flying glass near 100% probability
14.5	Fatality threshold for direct blast effects
29.0	99% probability of fatality from direct blast effects

Note: For this scenario, the majority of fatalities and serious injuries would probably be the result of thermal, secondary, and tertiary blast effects.

Table 12-5. *Sample human injury criteria data taken from the National Fire Protection Association (NFPA) 921 Guide for Fire and Explosion Investigations – 2001 Edition, Table 18.13.3.1[a]*

Sample Property Damage Criteria	
Blast Overpressure (psi)	**Damage**
0.15	Typical overpressure for glass failure
0.4	Minor structural damage
2.0	Partial collapse of walls and roofs of ordinary construction
2.0 to 3.0	Shattering of non-reinforced concrete or cinder block wall panels
2.3	Lower limit of serious structural damage
4.8	Failure of reinforced concrete structures
5.0	Snapping failure—wooden utility poles
7.0 to 8.0	Shearing/flexure failure of brick wall panels (8 to 12 inches thick, non-reinforced)
10.0	Probable total destruction of buildings

Table 12-6. *Sample property damage criteria data taken from the NFPA 921 Guide for Fire and Explosion Investigations – 2001 Edition, Table 18.13.3.1[b]*

Scenario 13: Biological Attack – Food Contamination

Casualties	500 fatalities; 650 hospitalizations
Infrastructure Damage	None
Evacuations/Displaced Persons	None
Contamination	Sites where contamination was dispersed
Economic Impact	Millions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Weeks

Scenario Overview:

General Description –

The U.S. food industry has significantly increased its physical and personnel security since 2001. A successful attack could, however, occur if the Universal Adversary (UA) was familiar with a specific production site. In this scenario, the UA uses their knowledge of the facility and careful planning to avoid apprehension and to conduct a serious attack on American citizens.

Detailed Attack Scenario –

A UA operative who is a worker at a meat processing plant obtains liquid anthrax and uses it to contaminate meat at the plant. At a beef plant in a West Coast State, two batches of ground beef are contaminated with anthrax and distributed to a city on the West Coast, a southwest State, and a State in the northwest.

From December 5 through December 15, hospitals in the West Coast city where the contaminated beef was distributed report a sudden influx of patients with severe gastrointestinal symptoms, including bleeding. On December 5, local health officials report that 30 people have been admitted for treatment, and four of them have died. Doctors are unable to identify the illness; therefore, the CDC quickly becomes involved to achieve a diagnosis. The public becomes increasingly alarmed as similar outbreaks are reported in other cities where the beef was distributed. For several days, there is intense speculation as to the nature and source of the mysterious and deadly illness.

As of December 15, 1,200 people have become ill, 300 have died, and 400 have been hospitalized in an ICU.

On December 17, the Department of Health Services in the West Coast city where the contaminated beef was distributed reports that autopsies indicate intestinal anthrax as the likely cause of the fatalities. Blood and tissue samples are sent to the State microbial diseases laboratory for further analysis. On December 18, test results indicate the presence of anthrax in blood samples drawn from the city's outbreak victims. Other communities where the contaminated beef was distributed attribute their mysterious outbreaks to intestinal anthrax. Hospitals are overwhelmed by the "worried well" in addition to people who are ill. The CDC suspects a possible food-borne connection to the outbreaks; the U.S. Department of Agriculture (USDA) Food Safety and Inspection Service, HHS, and FDA pursue epidemiological investigations. Ground beef is considered a possible source of the outbreak, but specific warnings and targeted recalls are not yet possible, as the source of the processed food is still unknown. Because of the unusual nature of the infection and the multiple disparate outbreak sites, bioterrorism is strongly suspected. By December 30, contaminated products are traced back to the beef production plant, and massive recalls are initiated. To date, 1,800 people have become ill, 500 have died, and 650 have been hospitalized in an ICU.

The affected plant is closed and decontaminated. Authorities consider whether to vaccinate and treat the workers with antibiotics.

Although no new cases seem to be appearing, there is uncertainty about outbreak containment. Investigations using precise microbial forensics demonstrate that the agent is of foreign origin.

Planning Considerations:

Geographical Considerations/Description –

Distribution of the agent is initially at one ground beef facility in a West Coast State. Following retail distribution, the tainted ground beef is in three cities (one on the West Coast, and one each in a southwest and northwest State).

Timeline/Event Dynamics –

- *D-1*: The biological agent is obtained by the terrorist (a plant worker).
- *D-Day*: The biological agent is inserted into ground beef at the production facility, and the packages are shipped to affected cities.
- *D+2*: The first signs of patients with unknown illness appear.
- *D+2 to D+12*: There is a significant influx of affected individuals into hospitals with 1,200 sick, 300 dead, and 400 hospitalized in an ICU.
- *D+5*: Health departments, the CDC, the FDA, and the USDA begin pursuing epidemiological investigations.
- *D+27*: A contaminated product trace is made to a ground beef production plant. Decontamination of the plant commences.
- *D+33*: No new cases of illness are reported.

Assumptions –

- There are multiple outbreaks using food industry distribution systems.
- The plant worker is a lone actor who has access to key locations within the production facility.
- Production facilities are unable to detect contamination.

Mission Areas Activated –

Prevention/Deterrence:

The ability to prevent the attack is contingent on the prevention of infiltration of the food production system. Prevention of catastrophic effects requires rapid disease diagnosis, and protective measures to assure food safety.

Emergency Assessments/Diagnosis:

Determining cause of illness and tracking the contaminated source is critical.

Emergency Management/Response:

Disease outbreaks occur in the three cities containing the tainted beef, which tests coordination of resources. Hospitals and medical staff will be tested, as well as transportation of the ill. Decisions regarding population protective measures will be needed, including alert and warning mechanisms, public information and education, and human and veterinary protective services.

Hazard Mitigation:

Once disease outbreak occurs, decisions must be made regarding meat supplies and production.

Victim Care:

Victim care will require diagnosis and treatment of affected population and distribution of prophylaxis for potentially exposed populations.

Investigation/Apprehension:

Epidemiology will be critical to trace the source of contamination. Investigation of crime and apprehension of the suspect will be needed.

Recovery/Remediation:

Decontamination/Cleanup: Contaminated foodstuffs require disposal.

Site Restoration: The plant and the sites where anthrax was dispersed may need to be decontaminated.

Implications:

Secondary Hazards/Events –

As a result of news of the contaminated food product, there is general public concern regarding food safety, and the “worried well” are taxing medical and laboratory facilities. The public floods into medical facilities seeking prescription drugs to prevent or recover from sickness. In addition, ground beef sales plummet, and unemployment in this industry rises dramatically. Additional cases may arise from frozen beef used after the initial incident.

Fatalities/Injuries –

The attack results in 500 fatalities, 650 hospitalizations, and 1,800 illnesses.

Property Damage –

Overall property damage is moderate, and due only to decontamination of affected facilities. However, property and facility disruption (downtime) are significant due to decontamination of affected facilities.

Service Disruption –

Service disruption is significant in the ground beef industry, and some moderate disruption occurs in other food industries due to the public's concern about food safety in general.

Economic Impact –

Although direct financial impact is significant, initial economic impact on the general economy is relatively low. However, the long-term financial impact on the beef marketplace and associated businesses could be significant, and other food industries' income is likely to be negatively affected by the public's overall perception of unsafe food. The societal impact of attacks on the food supply generates demands for increased, costly, federally directed food security programs and other measures to reduce the possibility of future attacks.

Long-Term Health Issues –

Anthrax may result in fatalities and serious long-term illnesses.

Scenario 14: Biological Attack – Foreign Animal Disease (Foot-and-Mouth Disease)

Casualties	None
Infrastructure Damage	Huge loss of livestock
Evacuations/Displaced Persons	None
Contamination	None
Economic Impact	Hundreds of millions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Months

Although this scenario depicts an intentional attack on the U.S. livestock industry, the accidental importation of certain diseases is also a hazard.

Scenario Overview:

General Description –

Foot-and-mouth disease is an acute infectious viral disease that causes blisters, fever, and lameness in cloven-hoofed animals such as cattle and swine. Pregnant animals often abort, and dairy cattle may dry up. It spreads rapidly among such animals and can be fatal in young animals. The disease is not considered a human threat.

In this scenario, members of the Universal Adversary (UA) enter the United States to survey large operations in the livestock industries. The UA targets several locations for a coordinated bioterrorism attack on the agricultural industry. Approximately 2 months later, UA teams enter the United States and infect farm animals at specific locations.

Detailed Attack Scenario –

Between November 1 and 3, UA teams travel to livestock transportation nodes in several States and contaminate animal shipments.

In one State, a cattle rancher notices that several of his animals are sick. A veterinarian arrives at the farm late on November 8 and suspects that the cattle have a case of infectious bovine rhinotracheitis, or bovine respiratory syncytial virus. Not certain of his diagnosis, he contacts State animal health authorities. On November 9, the Animal Health Department sends a Foreign Animal Disease (FAD) diagnostician to the farm. Suspecting a FAD, the diagnostician makes a determination of "highly likely" for a specific highly contagious FAD. Samples are sent to the Foreign Animal Disease Diagnostic Laboratory (FADDL) at the Plum Island (New York) Animal Disease Center. As a precautionary measure, the diagnostician immediately places the ranch under quarantine.

On November 8 in another State, a farmer on a corporate operation enters a swine barn and discovers several sick animals. He immediately calls the company veterinarian who, on examination of the animals, fears the existence of a FAD. The State Department of

Agriculture, the Consumer Services Emergency Programs Office, and the Federal Animal and Plant Health Inspection Service (APHIS) office in the State are contacted, and a FAD diagnostician is sent to the farm. The diagnostician makes a preliminary determination of the presence of a specific FAD. The farm is placed under quarantine, and tissue samples are taken and flown to FADDL Plum Island for priority-one testing and analysis. While the State awaits the determination of a FAD diagnosis, a partial activation of the EOC is ordered, and the State Highway Patrol and State Animal Recovery Team are placed on alert.

On November 8, in a third State, a slaughter house worker notices that several animals from a new shipment of cattle have arrived in generally poor condition. The cattle are feverish and will not eat. He attributes the symptoms to shipping fever and isolates them. Late in the day, another worker finds that their condition has deteriorated. After noticing their excessive salivation, he investigates and finds clinical symptoms of disease. He notifies the plant manager, who contacts the contracted veterinarian. Early on November 9, the veterinarian inspects the ailing animals and is concerned that they may have a specific FAD. The veterinarian notifies the State Animal Health Commission, which dispatches a FAD diagnostician. On examining the animals, the diagnostician determines that a specific FAD is highly likely. He arranges for tissue samples from the infected animals to be sent to FADDL Plum Island. The diagnostician discusses the need to activate a First Assessment and Sampling Team (FAST) with State authorities and APHIS Veterinary Service to assist in the field diagnosis to determine additional precautionary actions to be taken.

On November 9, FADDL Plum Island reports that samples taken from swine in the first State have undergone preliminary laboratory testing for the causative agent of a specific FAD. The samples have tested positive. Diagnosticians assigned to the case report clinical evidence of a specific FAD in the affected animals. In accordance with existing guidelines, this case has been designated “presumptive positive” for the FAD. The samples will undergo further testing to confirm infection. Later that day, FADDL Plum Island reports that samples taken from cattle in the second State have undergone preliminary laboratory testing for the specific FAD and have tested positive. Based on the preliminary laboratory results, combined with the diagnostician’s clinical observations, the second State’s case has been designated “presumptive positive” for a specific FAD. On November 10, FADDL Plum Island reports that three sets of samples taken from animals in three additional States have undergone preliminary laboratory testing and have tested positive for a specific FAD. On November 11, FADDL Plum Island isolates live FAD agent in samples from the first State to report the possible FAD, and determines the agent strain for possible vaccination protocol. A specific FAD infection is now confirmed in the United States.

As of November 12, several States are now reporting disease. Action taken includes quarantine, decontamination, possible vaccinations, and destruction of herds. Laboratory and rapid field identification of the agent is used to assist in monitoring, which will support control measures used to identify infected animals for quarantine and carcass/contaminated material disposal.

Planning Considerations:

Geographical Consideration/Description –

The U.S. livestock transportation system is highly efficient, and movements are rapid and frequent. Although the initial event will be localized at transportation facilities in several States, as the biological agent matures and the livestock are transported, the geographical area will widen to include surrounding States where the livestock are delivered.

Timelines/Event Dynamics –

- Late October to early November: The FAD is initially detected using clinical signs and veterinary medical detection and identification.
- Early November to mid-November: Federal, State, and local animal health professionals put in place surveillance, detection, containment, remediation, and disposal protocols.
- Mid-November: Surveillance, detection, containment, remediation, and disposal protocols continue until testing confirms the FAD is eradicated.

Assumptions –

- The biological agent will be distributed in several locations in several States simultaneously.
- No intelligence or other information will alert Federal, State, or local agencies of the FAD prior to the existence of clinical signs.
- Distribution of the FAD will be widespread due to rapid livestock transportation.
- Vaccination of affected livestock will not be implemented.

Mission Areas Activated –

Prevention/Deterrence:

The full breadth of the agricultural disease protection system will be challenged to prevent or detect further attacks.

Emergency Assessments/Diagnosis:

Investigations using epidemiological trace-back, microbial forensics, and other approaches will be used to determine the source of the agent and identity of the perpetrators.

Emergency Management/Response:

If the scope of the outbreak grows, the ability to effectively conduct intrastate and interstate C^2 activities, as well as the ability to successfully allocate resources, will be a challenge. This will be addressed through central coordination and effective communications using the Multi-Agency Coordination (MAC) Group system and other established national crisis management systems.

The States would be expected to emphasize the need for containment and would also require Federal funding to cover costs, Federal personnel to support State efforts, and the use and availability of the National Guard.

A comprehensive campaign to inform the public about the threat and impact that the disease presents to the Nation will be undertaken to combat the public's fear and the spread of misinformation about the disease.

Hazard Mitigation:

A stop movement order could halt the move of susceptible animals (and of conveyances and animals in transit, among other things) if considered by authorities. The specific parameters of the stop movement, the duration of the stoppage, how it would be enforced, and the economic implications of the stoppage will be assessed based on the extent of the outbreak. Equitable indemnification and when to begin reconstitution of the herds to begin economic recovery will be a major consideration.

Victim Care:

It will be necessary to euthanize and dispose of infected and exposed animals. Although the primary impact is on animals, the impact on farmers and farm communities should also be considered.

Investigation/Apprehension:

Investigation and apprehension will entail a criminal investigation, involving law enforcement and agricultural experts.

Recovery/Remediation:

Decontamination/Cleanup: Ranches, feedlots, transportation nodes, and other locations will require decontamination and cleanup.

Site Restoration: Cleaning and disinfecting are tools used to impede the spread of pathogenic microorganisms. To prevent the spread of disease, materials contaminated by, or exposed to, disease should be disinfected. All premises—including barns, corrals, stockyards, and pens, as well as all cars, vessels, aircraft, and other conveyances and materials thereon—should be cleaned and disinfected under supervision of a regulatory animal health employee whenever necessary for the control and eradication of disease.

Implications:

Secondary Hazards/Events –

Environmental issues regarding contaminated land and equipment must be considered and addressed. Disposal of carcasses of culled animals must be done in an environmentally conscious and expeditious manner.

Fatalities/Injuries –

There are no human fatalities or injuries. However, massive numbers of affected livestock are disposed of because the United States has a national policy not to vaccinate.

Property Damages –

Property damage will include livestock as well as the equipment, facilities, and land mass required for disposal of euthanized livestock (burial).

Service Disruption –

All transportation into and out of the affected areas will be severely limited to prevent further dispersion of the FAD to unaffected areas. Both commercial and private/personal travel will be limited.

Economic Impact –

The extent of economic impact will depend on the ability to limit the geographical spread of the outbreak. A great economic impact will be realized in many sectors of the economy, including but not limited to agriculture. Long-term matters will be centered mostly on foreign trade.

Economic factors will include the value of the affected livestock; the cost to Federal, State, and local governments to identify, contain, and eradicate the FAD; the cost of disposal and remediation; the loss of revenue suffered by related industries; the loss of revenue suffered by the retail industry due to public perception that the FAD poses a disease risk; the loss of export markets immediately on confirmation that the FAD exists; and the cost to renew the livestock lost to euthanasia.

Long-Term Health Issues –

The inevitable development and use of new technologies to include rapid detection, improved traditional vaccines/advanced molecular vaccines, and new therapeutics (including antiviral agents and other novel biomedical approaches) will lead to a physiological "hardening" of the U.S. farm animal population against FADs, thereby making them unattractive targets of bioterrorism. A widespread animal disease will not hurt humans but could have psychological effects.

Scenario 15: Cyber Attack

Casualties	None directly
Infrastructure Damage	Cyber
Evacuations/Displaced Persons	None
Contamination	None
Economic Impact	Hundreds of millions of dollars
Potential for Multiple Events	Yes
Recovery Timeline	Months

Scenario Overview:

General Description –

This scenario illustrates that an organized attack by the Universal Adversary (UA) can disrupt a wide variety of internet-related services and undermine the Nation's confidence in the internet, leading to economic harm for the United States. In this scenario, the UA conducts cyber attacks against critical infrastructures reliant upon the internet by using a sophisticated C^2 network built over a long period of time.

Detailed Attack Scenario –

The UA seeks to cause internal, untraceable disruptions in the United States to distract the populace and decision makers for months. The UA believes a cyber attack can effectively meet the goals of information extraction, undermining user confidence in the internet. Disrupting the underlying internet infrastructure will have significant economic impact by severely reducing the public's confidence in the U.S. financial infrastructure and affecting online banking, e-commerce, and other internet-based services.

The UA has spent several years to assemble a joint military and intelligence team. This team includes groups that discover and exploit computer vulnerabilities, create attacks related to those discoveries, conduct reconnaissance and battle damage assessments, and conduct actual cyber operations. The primary target is the confidence of the American people.

The attack campaign is conducted in three phases.

Phase 1 – Attack Preparation

<u>Objective:</u> Construct an attack network with underlying encrypted C^2 mechanisms with which to launch future attacks. This phase will initiate about 2 years prior and continue until approximately 1 week prior to the D-Day event. It will continue until several hundred thousand bots[1] are populated in the attack network.

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[1] A **bot** is common parlance on the internet for a software program that is a software agent. A bot interacts with other network services intended for people as if it were a real person. One typical use of bots is to gather information. (www.wikipedia.org)

Event 1.1: Deploy mole software

Attack Mechanism: Write a personal firewall and distribute it via a trusted computer security software provider, such as ZoneAlarm. The software would include an auto-update function. With auto-update, software can be morphed on-command but will appear benign to anyone initially inspecting and approving it. Even on well-run systems, people rarely check old software. The auto-update function will check if its time to start the attack, or just get the latest version. When conducting auto-updates, the software will only connect to known addresses and servers, reserving communications with the botnet[2] until it is time for the actual attack. When loaded onto a victim's computer, the software will participate in the botnet.

Event 1.2: Design and build a bot

Attack Mechanism: Write a bot to scan and deploy using a wide variety of vulnerabilities as they are identified. (Vulnerabilities and the ability to exploit them have a very short life span, relative to a 2-year planning cycle.) The bot will communicate using the same C^2 technology as the mole software but will not do so until it is time to launch the attack.

Event 1.3: Trading and bartering

Attack Mechanism: The internet underground has its own culture for trading and bartering for almost anything, including compromised systems. Compromised hosts (including routers) will be acquired from the underground, and the new bot will be installed. The hosts will also be repaired to prevent other unwanted infiltration.

Event 1.4: Build the C^2 network using traditional, widely available tools and techniques

Attack Mechanism: Use traditional scanning and probing techniques in addition to the newly created tools to build the C^2 network and botnet**.**

Phase 2 – Overwhelm Network Security Personnel

<u>Objective:</u> This goal of this phase is to wear down the first-responder capabilities of the Internet Service Provider (ISP) community just prior to D-Day. The attacks will occur for 2 to 3 hours during periods when first responders are normally not at work (e.g., 2:00 a.m. or holidays). Attacks should repeat randomly across the ISP and the core internet services community with the intent of demoralizing the first responders. These events will all take place in the last few days before D-Day.

Event 2.1: Forge Address Resolution Protocol (ARP) replies

Attack Mechanism: Forge ARP replies with random Internet Protocol (IP) and Mandatory Access Control address information. This is done using the widely deployed zombies. Poison ARP caches causing failures that are very difficult to trace and troubleshoot.

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[2] Botnet is a jargon term for a collection of software robots, or bots, which run autonomously. (www.wikipedia.org)

Event 2.2: Undermine Dynamic Host Configuration Protocol (DHCP)

Attack Mechanism: Randomly generate DHCP release requests on behalf of other systems on networks that have zombies deployed. Randomly generate DHCP requests with the intent of consuming network addresses. This will cause local system and network administrators to spend valuable time tracking down problems on local networks.

Phase 3 – Massive Network Outages

Objective: Attack major internet services to undermine consumer and government confidence in the functionality of the internet. This phase will also last only days.

Event 3.1: Attack DNS functionality

Attack Mechanism: Conduct Distributed Denial of Service (DDoS) attacks against the websites and their upstream providers. These attacks will use zombies from both inside and outside organizations. Unleash the botnet built over the past 2 years in a massive DDoS attack.

Planning Considerations:

Geographical Considerations/Description –

The problems are experienced across the Country, as well as internationally. Overseas trade could be affected due to the mistrust in the U.S. internet infrastructure and the problematic U.S. economy.

Timelines/Event Dynamics –

A year or two is needed for preparation. The attack is executed over a period of months to ensure extended press coverage and undermine confidence in the internet.

Assumptions –

- Initial reconnaissance is either undetected or detected but not effectively acted upon.
- The UA can avoid tipping off U.S. intelligence by using U.S.-based hosting companies as it gathers resources for the attack.
- C^2 issues of timing several nearly simultaneous attacks can be worked out by UA's organizational structure.

Mission Areas Activated –

Prevention/Deterrence:

The strength of private sector companies will be tested in regard to prevention and deterrence.

Infrastructure Protection:

Although physical infrastructure is not at great risk, internet software deteriorates, and numerous systems must be repaired. This requires software expertise, time, and money to correct. If not already impacted, numerous systems would have to shut down.

Emergency Assessments/Diagnosis:

The attack will be difficult to recognize. Each attack will end before anyone would have enough time to completely diagnose the problem.

Emergency Management/Response:

Emergency response will be split between technically bringing systems back online and instituting business continuity process, and controlling the public perception of the situation to restore confidence and prevent panicky behaviors.

Hazard Mitigation:

All ISPs, Domain Name Server/System (DNS) operators, and other organizations will need to evaluate their network topologies, diversity, integrity of backup processes, and other methods of attack prevention. Companies will also have to consider methods to improve the first-responder capabilities.

Victim Care:

Primarily, victim "care" will be based on economic assurance. Citizens will look for Government assurances that the internet is a stable and viable method for conducting business and other financial operations.

Investigation/Apprehension:

Using intelligence and law enforcement sources and methods, the investigators will need to determine the likely technical source and the identity of the perpetrators.

Implications:

Fatalities/Injuries –

No significant fatalities or injuries are expected, although collateral effects (e.g., involving hospitals, emergency services responses, and control systems) may have limited fatal consequences.

Property Damage –

No property damage is expected, although those control systems that are dual-homed may cause physical damage.

Service Disruption –

Service disruption would occur across many sectors with possible loss of confidence in the internet and services offered such as online banking and e-commerce.

Economic Impact –

The greatest impact will be intermittent and unpredictable disruptions to the internet, which will affect online banking, other e-commerce services, and general public confidence.

APPENDIX: Scenario Working Group Members

The Homeland Security Council receives interagency guidance via a number of Policy Coordinating Committees (PCCs). One of them is the Domestic Threat, Response, and Incident Management (DTRIM) PCC; the Scenarios Working Group (SWG) supports the DTRIM. The members of the SWG are as follows:

CHAIR: Janet K. Benini, Director of Response and Planning, White House Homeland Security Council

Arkin, Richard	Department of Energy
Avato, Steven	Department of Justice, ATF
Bar-shalom, Tali	White House Office of Science and Technology Policy
Biersack, Walter	Department of Energy
Broun, Laurence	Department of the Interior
Companion, Tod	National Aeronautics and Space Administration
Conklin, Craig	Department of Homeland Security, FEMA
Daly, Kevin	Department of Justice, FBI
Dickson, Howard	Department of Homeland Security
Dolce, Robert	Department of State
Edelman, Phil	Department of Health and Human Services
Fancher, Raymond	Department of Justice, FBI
Finan, William	Environmental Protection Agency
Fuller, Gordon	Department of Justice, FBI
Gillin, MAJ Jeff	Department of Defense
Gosnell, William	Department of Defense, USACE
Gruber, Corey	Department of Homeland Security, ODP
Guffanti, Marianne	Department of the Interior, USGS
Hastings, Thomas	Department of State
Hatchett, Richard	Department of Health and Human Services
Havens, Kathryn	National Aeronautics and Space Administration
Ippoliito, David	Department of Labor, OSHA
Irwin, William	Department of Defense, USACE
Jones, Gregg	Department of Defense
Jorgensen, Andy	Department of Defense
Kadlec, Robert	White House Homeland Security Council
Kerr, Larry	White House Office of Science and Technology Policy
Kevern, Thomas	Nuclear Regulatory Commission
Krueger, Steve	Department of Justice, FBI
Landry, Steve	Department of Homeland Security, ODP
Lim, Kent	Department of Commerce
Lowe, Tom	Department of State
Lustig, Teresa	Department of Homeland Security
Lystra, Clark	Department of Defense
MacKinney, John	Environmental Protection Agency
Maddox, Justin	Department of Energy
Malak, Patricia	Department of Homeland Security, ODP

Martin, Mark	Department of Justice, ATF
McClenney, Lucretia	Department of Veterans Administration
McCreight, Robert	Department of State
McGarry, Sherri	Department of Health and Human Services, FDA
Metzler, John	Department of Energy
Michling, Suzanne	Department of Defense
Mjoness, Mark	Environmental Protection Agency
Mize, W. Keith	Department of Energy
Morzinski, Gregory	Department of Defense
Mullin, Jonathan	National Aeronautic and Space Administration
Newton, Robert	Terrorist Threat Analysis Center
Nicholas, Paul	White House Homeland Security Council
Noji, Eric	Department of Health and Human Services, CDC
Park, Tom	Department of Homeland Security, FEMA
Pavetto, Carl	Environmental Protection Agency
Peluso, Francis	Department of Transportation, FAA
Pond, Robert	Department of Homeland Security, USCG
Pratt, Britt	Department of Agriculture
Siebert, Mark	Department of Justice, ATF
Sizemore, R. Tom	Department of Veterans Administration
Smith, Alan	Department of Agriculture, APHIS
Steele, Scott	Department of Justice, FBI
Stephens, David	White House National Security Council
Taborn, Michael	Department of Transportation, FTA
Thomas, Lori	Department of Agriculture
Tupin, Edward	Environmental Protection Agency
Venkayya, Rajeev	White House Homeland Security Council
Webster, James	Department of State
Weidner, John	Department of Homeland Security
Williams, John	Department of Agriculture
Williamson, Suzanne	Department of Justice, FBI
Winters, Stephen	Department of Defense
Young, Bruce	Department of Veterans Administration