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 – coordinated by the Homeland Security Council (HSC) and in partnership with the Department of Homeland Security (DHS) – has developed fifteen all-hazards planning scenarios for use in national, Federal, State, and local homeland security preparedness activities. These scenarios are designed to be the foundational structure for the development of national preparedness standards from which homeland security capabilities can be measured because they represent threats or hazards of national significance with high consequence. While these scenarios reflect a rigorous analytical effort by Federal homeland security experts, with reviews by State and local homeland security representatives, it is recognized that refinement and revision over time may 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:

The scenarios are broadly applicable and focus on a range of capabilities. In addition to providing the design basis for national preparedness goals and responder capability standards, the scenarios can provide the design basis for exercises throughout the Nation. They have been developed in a way that allows them to be adapted to local conditions. 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 – every part of the United States is vulnerable to one or more major hazards.

General Considerations for the Scenarios:

Because the attacks portrayed in some scenarios could be caused by foreign terrorists; domestic radical groups; State-sponsored adversaries; or in some cases, disgruntled employees, the perpetrator has been named, the Universal Adversary (UA). The focus of the scenarios is on response capabilities and needs, not threat-based prevention activities.

Since these scenarios were compiled to be the minimum number necessary to test the range of response capabilities and resources, other hazards were inevitably omitted. Examples of other potentially high-impact scenarios include nuclear power plant incidents[1], industrial and transportation accidents, and frequently occurring natural disasters. These either have well-developed and tested response plans, and/or the response would be a subset of the requirements for scenarios contained in this set.

Scenario Outline –

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

[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).

- Scenario Overview
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Intelligence Disclaimer –

While the intelligence picture developed as part of each scenario generally reflects possible terrorist capabilities and known tradecraft, neither the Intelligence Community nor the Federal Bureau of Investigation (FBI) 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 –

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 in this set were developed to test the full range of response capabilities and resources – and to assist Federal, State, and local governments as well as the private sector in preparedness – they have not been ranked. Each jurisdiction or organization should apply its own priorities, based on its responsibilities within the domestic incident management structure.

Multiple Events –

There is a possibility that multiple incidents will occur simultaneously or sequentially. When scoping resource requirements, 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. These incidents will invariably require the coordination and cooperation of homeland security response organizations across multiple regional, State, and local jurisdictions.

The Homeland Security Advisory System –

The scenarios do not specify changes in the levels of the Homeland Security Advisory System (HSAS). However, in all scenarios other than natural disasters, it is anticipated that the alert level would increase. This increases the Nation's ability to respond to the current attack, reduces the vulnerability to future attacks, and helps citizens prepare to protect themselves. At higher alert levels, the HSAS has increased resource demands and can also have national economic impacts.

The "Worried Well" –

In most incidents, citizens will seek medical treatment even though they may not be injured by the incident. For example, in the World Trade Center incident on September 11, 2001 (9/11), the uninjured who sought medical treatment was approximately fifteen times the number of people who presented for medical treatment due to smoke inhalation; and in the Tokyo subway attack it was five times the number of victims experiencing chemical poisoning. For planning purposes, most experts calculate ratios ranging from a ratio of five-to-one up to a ratio of ten-to-one.

Infrastructure Impact –

The effect of disasters on national, State, and local transportation, communication, medical, and utility infrastructure will have a considerable effect on response strategies. As on 9/11, when the entire civilian air transportation system and much of the national telecommunications system were shut down or disabled, a terrorist incident may have repercussions that affect critical infrastructures necessary for coherent emergency response. These critical networks must be layered and properly coordinated across both civilian and military sectors to ensure the continuity of critical infrastructure support for responding jurisdictions.

Decontamination activities could also affect wastewater resources in the following manner:

- Wastewater treatment could be adversely affected by the introduction of a new contaminant (especially chemical), resulting in improperly treated waste being discharged by the Publicly Owned Treatment Works (POTW) into natural waters.
- The new contaminant may not be inactivated by standard wastewater treatment, which would result in this new contaminant being passed along to water bodies.
- The new contaminant may react adversely with contaminants already in the wastewater stream.
- POTW workers may be exposed to harmful contaminants. The magnitude of the concern would depend on the contaminant, whether pre-treatment (i.e., treating decontaminated wastewater with bleach prior to discharge to POTW) would be effective, any reactions with the biology and chemistry in the specific POTW, and the amount of discharge.

Economic Impact –

Catastrophic disasters, depending upon the type, scope, and magnitude of the disaster incident, could threaten the economic sustainability of the communities affected and may cause severe disruption and long-term economic damage. Extreme disaster incidents can generate cascading economic situations extending outside the immediate community. Even in moderate disasters, of all businesses that close following a disaster, more than 43% never reopen, and an additional 29% close permanently within 2 years.[2] The American Planning Association notes, "Economic

[2] Institute for Business and Home Safety. Available online at www.ibhs.org/business_protection.

recovery is quite likely the most serious issue facing most communities in the post-disaster period, and almost certainly the central issue in every major disaster."[3]

Environmental Impact –

Catastrophic natural and manmade disasters and terrorist attacks can result in extreme environmental impacts that challenge government and community recovery time. Long after the emergency phase subsides, contamination from disasters may remain, consisting of chemical, biological, or radiological materials. While decontamination technologies may be well established for some types of contamination, others are only moderately effective – some contaminants, especially radionuclides, are very difficult and costly to remediate. While some decontamination techniques may be effective in small sites, these techniques may not be suited for decontaminating expansive areas of varying physical characteristics. Evacuation and relocation during cleanup and restoration activities can result in significant business loss and failure, leading to local and regional economic downturn. In addition, agricultural and industrial products from an area contaminated, or thought to be contaminated, can generate impacts that extend within a region and beyond.

International Dimensions –

It is important to underline the significant international dimensions that arise in connection with some of the more damaging and devastating scenarios in which significant loss of life and property, together with the possibility of foreign-directed terrorism, are involved. First, there is the hemispheric dimension of effects on U.S. relations with Canada and Mexico in terms of cross-border trade, transit, law enforcement coordination, and other key issues. Second, there is the immediate treaty connection the United States has with other North Atlantic Treaty Organization (NATO) allies if the United States comes under attack. Third, there is the significant lobbying the United States will undertake at the United Nations (UN) to articulate American needs and interests. In addition to humanitarian and law enforcement assistance from NATO allies, other nations may contribute special equipment in order to meet other necessities. Instances where a disaster or terrorist attack has disrupted major urban centers and international transit/trade routes through U.S. cities will typically require significant coordination with the State Department to ensure all economic, trade, commercial, consular, military cooperative, and humanitarian assistance is rendered as needed.

The State Department plays several key roles in post-disaster situations. It assists foreign citizens affected by the incident. It identifies the specific needs of affected U.S. areas where foreign offers of assistance can be mediated and arranged. Moreover, in cases where explicit terrorist activities may have occurred, the State Department is a leader in facilitating the investigations abroad needed to determine the origins of the attack, pursuing diplomatic and follow-up policies related to finding the guilty parties abroad, and rendering coordinated international assistance to U.S. recovery efforts.

[3] *Planning for Post-Disaster Recovery and Reconstruction* (1998). American Planning Association–Federal Emergency Management Agency, Planning Advisory Service Report No. 483/484, p. 53.

Common Response Threads:

Media Access and Support –

The support and cooperation of media in informing and protecting citizens is a critical aspect of emergency response. In many cases, media sources represent the best or only source of information available during the early stages of an incident. Cultivating good working relationships with the media provides opportunities to advise the public of important safety and health guidance and information and corrected misinformation, as well as to obtain critical information from news sources at the scene. Likewise, consistent public service guidance and information from emergency management officials to media sources are vital to reducing the probability of injury or illness, countering disinformation, and alleviating citizen anxiety during the emergency.

The Importance of Planning for Continuity of Operations –

The scenarios reinforce the need for governments and the private sector to make preparations to continue their essential operations in an environment in which primary staff and facilities are unavailable. This includes the need to backup key records and systems.

The Need for Capabilities-Based Planning –

Capabilities-based planning is a planning process that occurs under uncertainty in order to provide capabilities suitable for a wide range of challenges and circumstances, while working within an economic framework that necessitates prioritization and choice. The scenarios emphasize the need for domestic incident preparedness to proceed through a capabilities-based approach. They set the standards for preparedness across all mission areas and a minimum acceptable level of capabilities needed to respond to each scenario. 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, the requirement to quickly treat mass casualties, and the need to temporarily house large numbers of people are examples. This commonality builds flexible, adaptive, and robust capabilities to cope with diverse scenarios addressing all potential hazards.

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 man-made 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 abilitiy 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 plan to assemble a gun-type nuclear device using highly enriched uranium (HEU) stolen from a nuclear facility in another country. The nuclear device components are smuggled into the United States, and the device is 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 –

Culminating a 10-year effort, terrorists of the UA group finally succeed in acquiring a sufficient quantity of HEU to construct a simple, gun-type, improvised nuclear device (IND). The UA has been slowly acquiring, at great expense, HEU from various sources outside of the United States. The latest theft of 5 kilograms (~ 11 pounds) will likely be discovered at the next quarterly inventory at the primary facility, but by then the bribed security official, the UA terrorists, and the HEU will be long gone.

The carefully shielded HEU is transported to a UA camp overseas where UA operates with impunity. In an underground bunker, a nuclear weapons engineer and two technicians transform it, along with the earlier acquisitions, into the components required for a gun-type nuclear device. Other acquisition efforts have yielded all the necessary electronics, hardware, and propellant for the device. In fact, UA has built two nearly complete device systems with enough HEU for one functioning device. As a final test of the components, the engineer has assembled the complete device to check the fit of the components. He then disassembles it and reassembles the device with the second set of components. He disassembles that device and carefully cleans all of the electronics, hardware, and HEU to remove any trace of chemical propellant contamination. He reports to the UA Central Command that the nuclear device is ready. Central Command has already decided on ground zero: the center of a U.S. city.

The components of the device will be transported to the United States in eight different packages: two sets of hardware, two sets of electronics, two separate packages of propellant (enough for two nuclear devices), a neutron source, and the HEU. The propellant, neutron source, and the engineer will be smuggled across the border with different groups of illegal immigrants. The device electronics and hardware, falsely labeled as various items of electronic equipment, will be shipped as cargo to several small businesses operated by members of a UA sleeper cell. Agents from the sleeper cell collect the engineer and the device components and transport them to a UA safe house in a rural area. Finally, the HEU is encased in a 2-inch thick lead canister and smuggled into the United States, hidden in the rear of a sports utility vehicle (SUV) that is driven by a trusted member of UA. The driver is ostensibly returning from visiting relatives just across the U.S. border. After entering the United States, he also drives to the safe house where a senior member of the UA Central Command and two suicide bombers meet him.

By the time the HEU shortage is discovered and reported to the International Atomic Energy Agency (IAEA), all eight packages, as well as the engineer, are safely across U.S. borders. The IAEA reports the theft of 5 kilograms (~ 11 pounds) of HEU to governments worldwide. In the United States, the Department of Homeland Security (DHS) Secretary – after consultations with the Secretary of Energy, the Attorney General, and the Homeland Security Advisor – directs the U.S. Coast Guard and Bureau of Customs and Border Protection to increase vigilance at the borders. State and local homeland security authorities are also informed of the potential threat.

The nuclear device is assembled at the safe house. A used delivery van is purchased and painted to indicate that it belongs to a copier service company. A coded e-mail notifies UA Central Command that all is ready. UA Central Command generates a return coded e-mail that sets the time and place of the attack. A dry run of the route is made during Monday morning traffic to ensure the timing of the attack.

At 7:00 a.m. on Tuesday morning, the IND is loaded into the delivery van. The nuclear device is set with three ignition circuits: a manually activated detonator (disguised as a cell phone with power cord) to be carried by the passenger, a timer set to go off at 10:15 a.m., and a booby trap set to go off should anyone open the crate holding the IND. The crate is equipped with shielding materials to reduce the radiation signature. By 9:00 a.m., the vehicle enters the densely populated area, where the passenger arms the dead-man switch on the detonator. At about 9:30 a.m., the vehicle exits the freeway and when in place, the passenger detonates the 10-kiloton nuclear device. Most buildings within 1,000 meters (~ 3,200 feet) of the detonation are severely damaged. Injuries from flying debris (missiles) may occur out to 6 kilometers (~ 3.7 miles). An Electromagnetic Pulse (EMP) damages many electronic devices within about 5 kilometers (~ 3 miles). A mushroom cloud rises above the city and begins to drift east-northeast.

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 sheltering-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 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.

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

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 uranium 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 –

<u>Prevention/Deterrence:</u>

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.

<u>Emergency Assessment/Diagnosis:</u>

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.

<u>Emergency Management/Response:</u>

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 and 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 fire-fighting 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
- Implementing medical triage, treatment, and stabilization of casualties
- Performing search and rescue (fire, police, and Emergency Medical Service [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 pressed hard 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 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 afterwards. 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 of this scenario.

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. This data was 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 used 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) wide 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. 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 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 count of the outer contours includes 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, and 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.

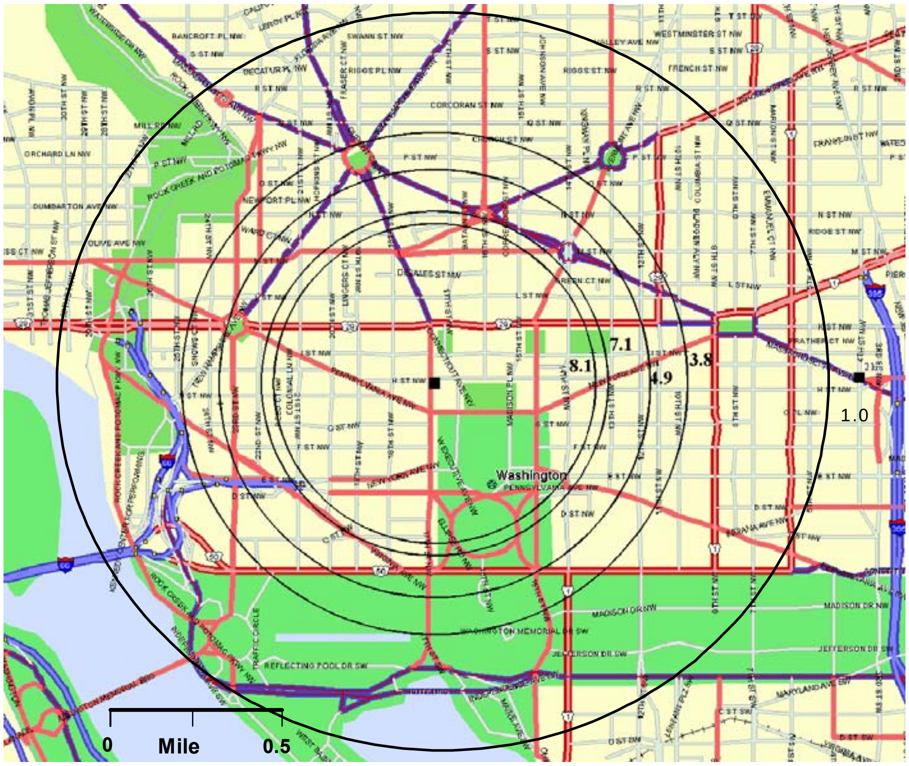
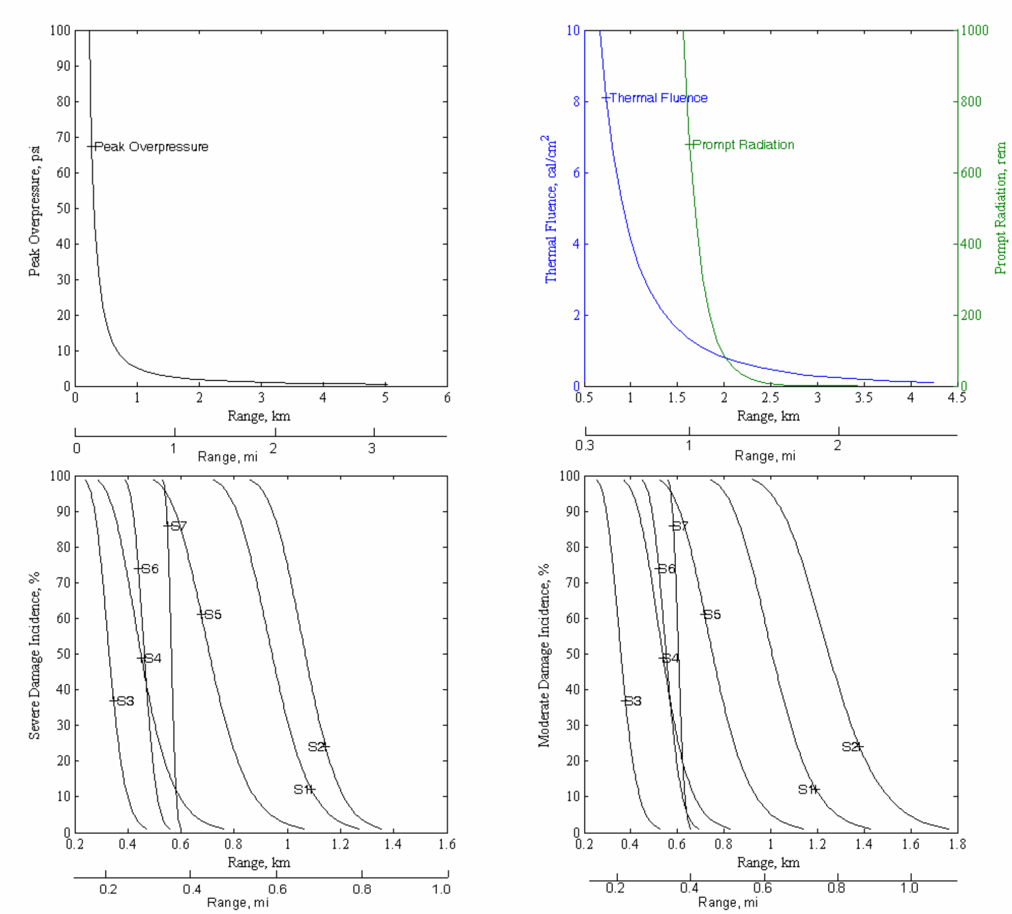


Figure 1-1. *Contours for 8.1, 7.1, 4.9, 3.8, and 1.0 psi overpressure from a 10-kiloton nuclear detonation superimposed on the central business district of Washington, DC*

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 office building; 3-10 stories; lightweight, low-strength, quickly failing walls (LSQFW); earthquake resistant designs (ERD)

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)*

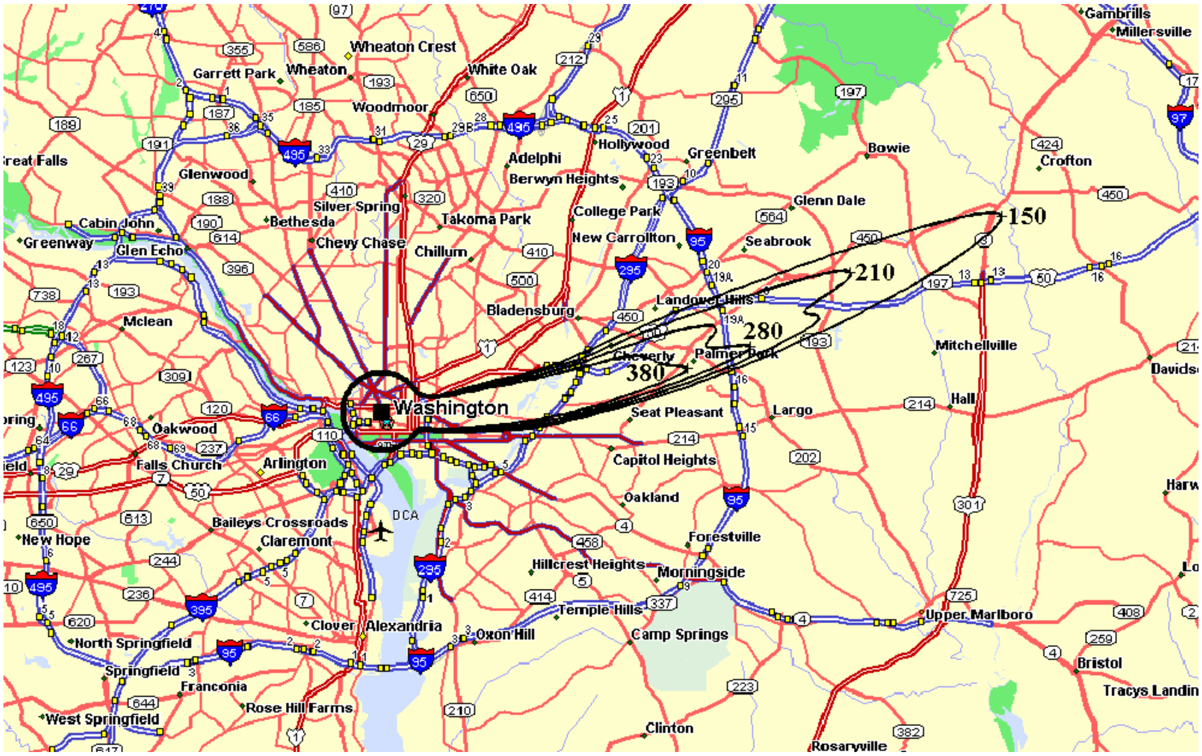


__Figure 1-3.__ Contours for acute (24-hour) exposure dose equivalent in REM for a 10-kiloton nuclear detonation

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

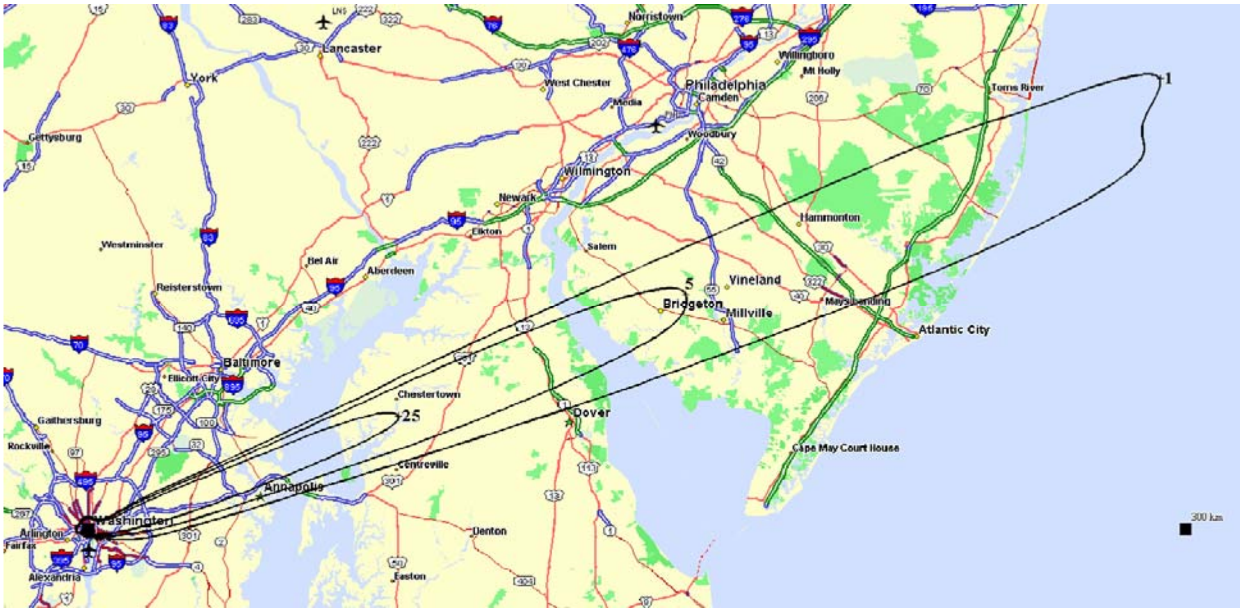


Figure 1-4: *Contours for chronic (96-hour) exposure dose equivalent in REM for a 10-kiloton nuclear detonation*

Casualties Due to Chronic Radiation Exposure								
Equivalent Dose (REM)	**Description**	**Distance**		**Area**		**Population Exposed**	**Fatal Cancers**	**All Cancers**
		km	**miles**	**km^2**	**$mile^2$**			
>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 twenty 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 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.

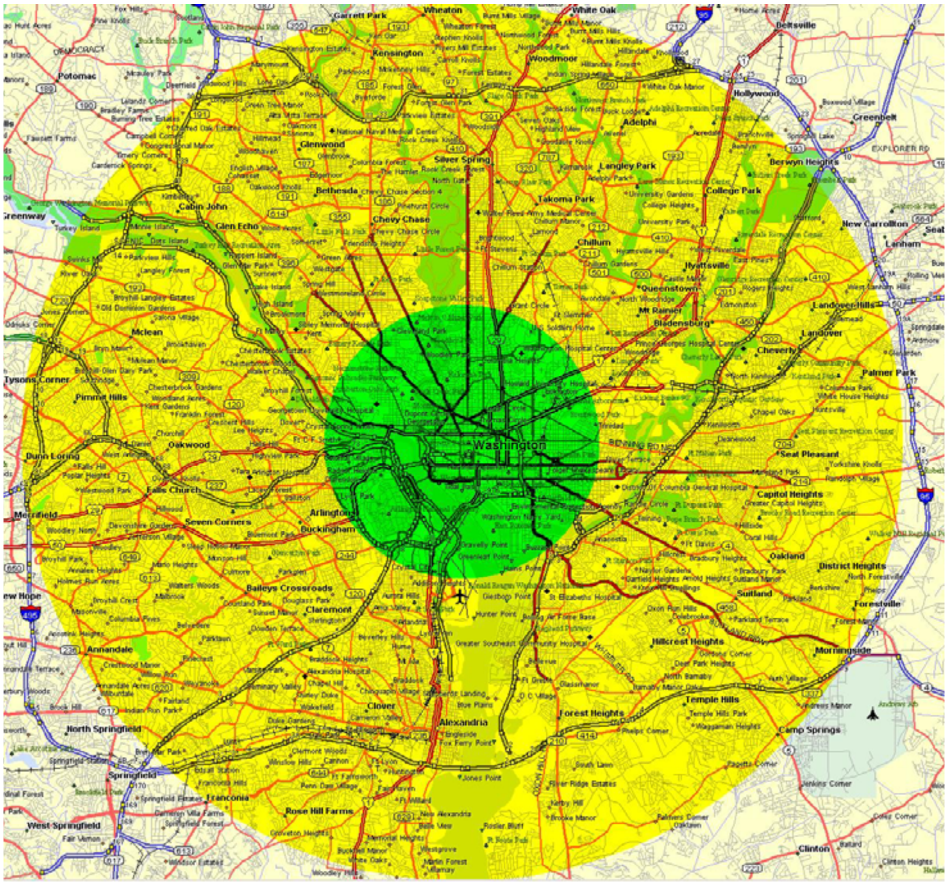


Figure 1-5. *Map of the additional population added to the Washington, DC, (nighttime) populations to account for workday commuters – the 5-kilometer (~ 3-mile) inner (green) region includes 481,000 additional people, and the outer annulus (yellow) includes 220,000 additional people*

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

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

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

Blast –

Blast casualties occur from the direct action of the pressure wave, the 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

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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.

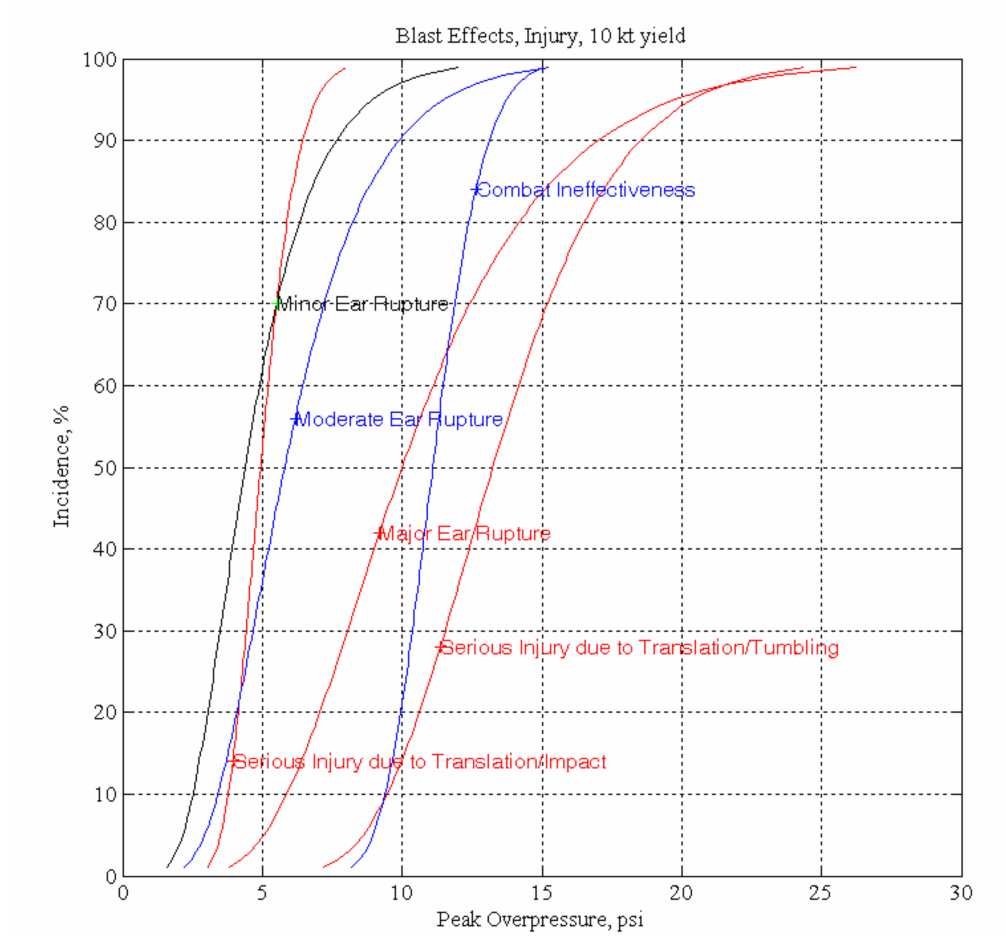
[4] H.G. Norment. DELFIC: Department of Defense Fallout Prediction System. *Volume I –Fundamentals*. Atmospheric Science Associates, DNA 5159-1, October 26, 1979.

[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.

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 that 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 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 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 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	**Kilometers**	**Miles**
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 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 low-strength, quickly failing walls (LSQFW) and earthquake resistant designs (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 or by radiation from the radioactive fallout, or both. Prompt effects 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, one 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 ten. For example, 1 week (7 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; 7 weeks later, it will be 1/100th.
- Multiplying the collective dose in person-REM to the population that survives beyond 60 days by $5x10^{-4}$, 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 10-kiloton nuclear device effects, 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 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 a dose of 100 rads of gamma rays, a person in a concrete blockhouse shelter with 9-inch walls would receive only 10 to 20 rads. 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 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.

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

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	
Multi-story 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)	**Percent 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 shows that **buildings typically do not provide significant filtration of (or protection from) radioactive particles in the 1 to 10 micron-size 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 affects 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 Figure 1-7 and Figure 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 of *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 of 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-size 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 radioactive 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.

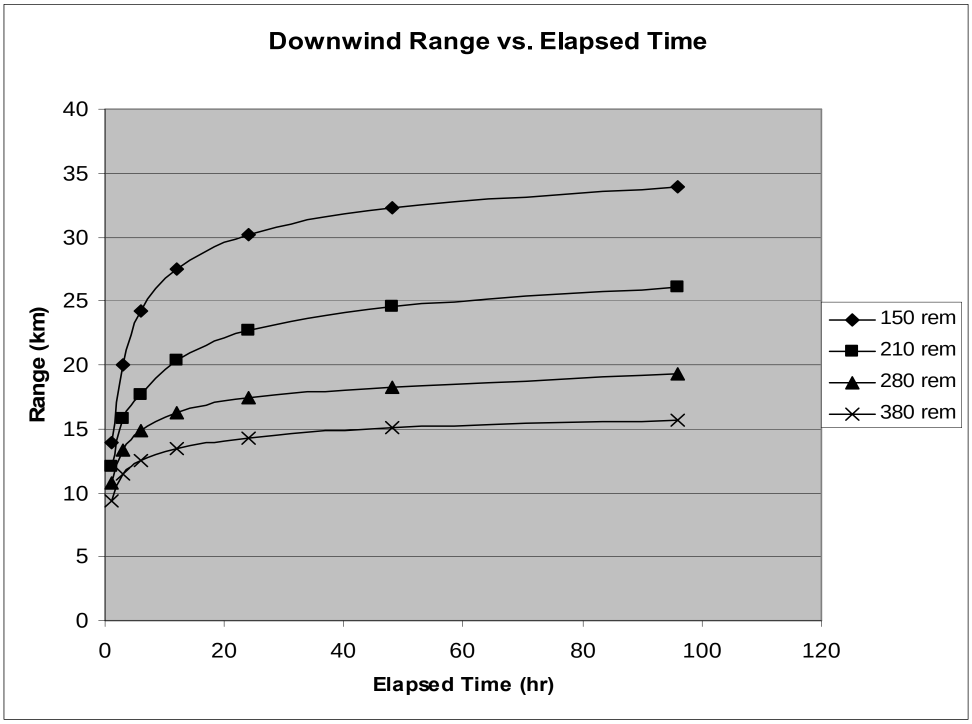


Figure 1-7. *Downwind maximum fallout distance (1 mile = 1.6 kilometers) as a function of elapsed time*

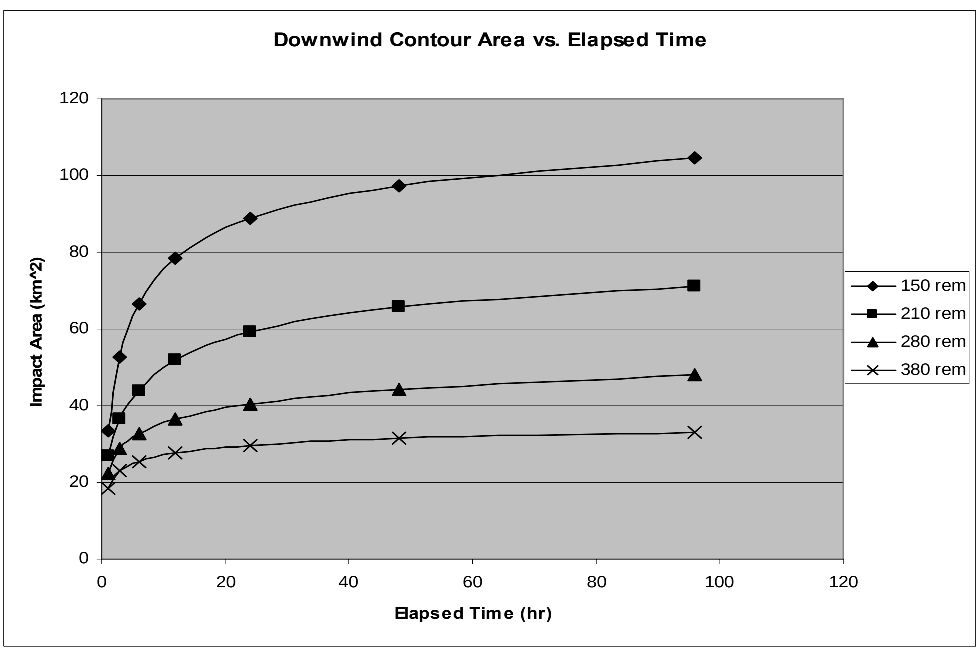


Figure 1-8. *Fallout footprint area (1 square mile = 2.56 square kilometers) as a function of elapsed time*

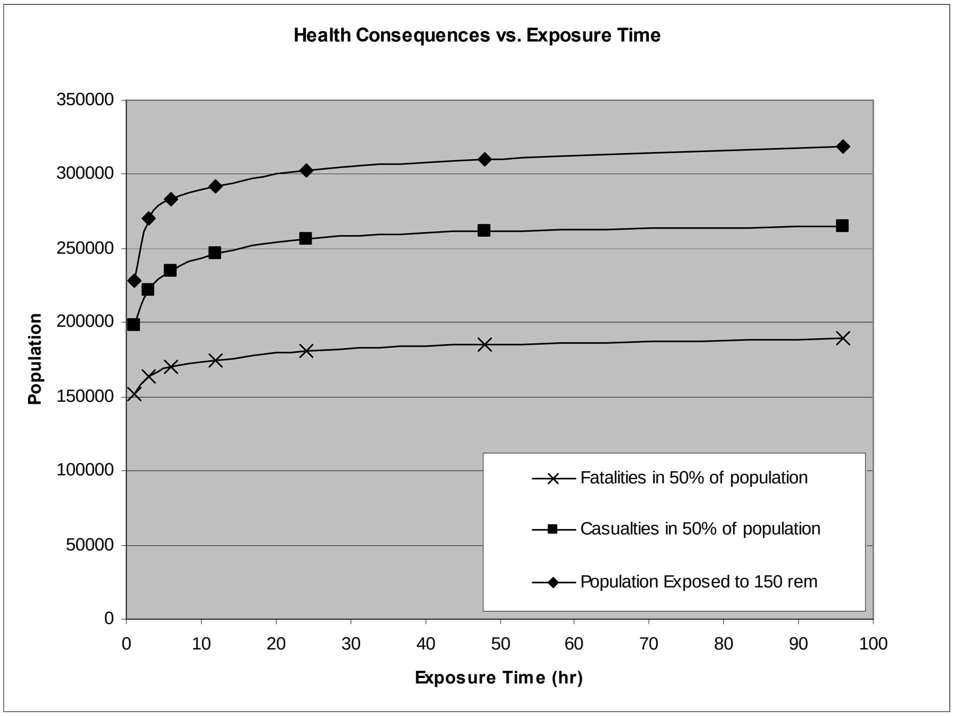


Figure 1-9. *Estimated fatalities, casualties, and total number of exposed people as a function of exposure time*

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 ten 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 limited, or the mobility of the population restricted, then these calculations may come closer to what might actually occur.

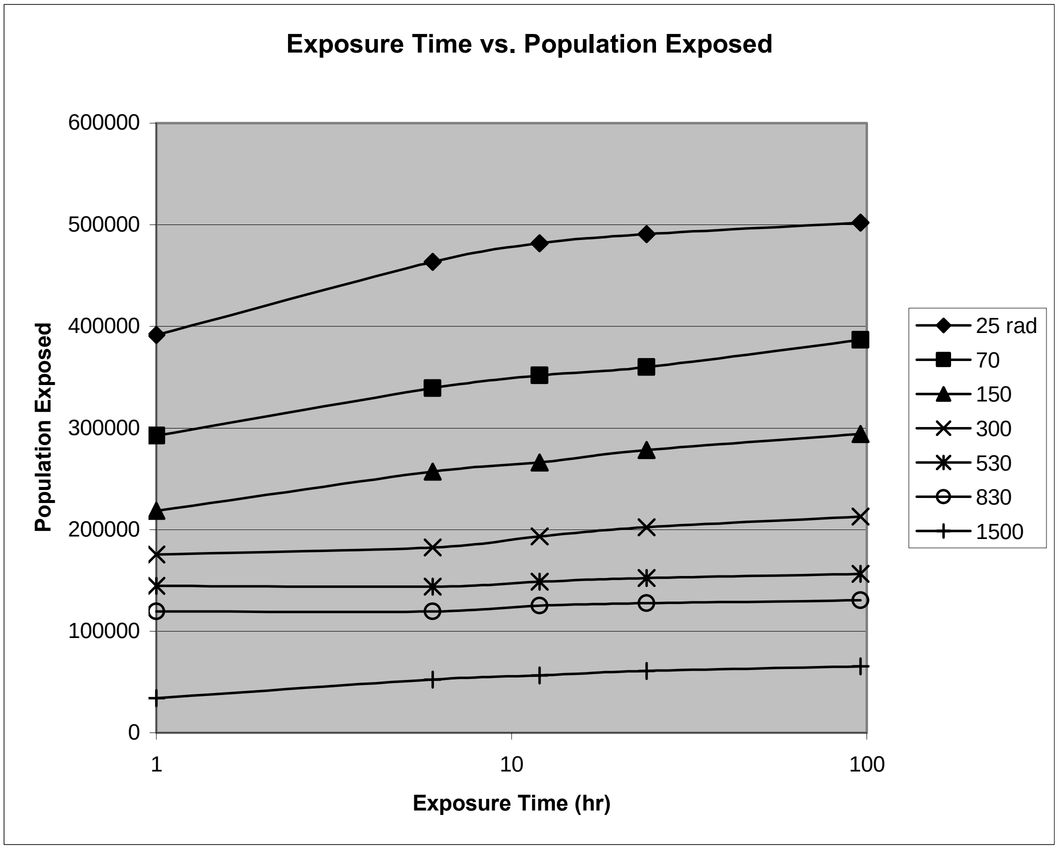


Figure 1-10. *Projected number of people exposed to a given dose as a function of time*

Population Receiving Dose as a Function of Time						
		Downwind Range		Area		
Exposure Time (hours)	Contour Level (rad)	kilometers	miles	square kilometers	square miles	Population Exposed
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 surface burst are shown in Table 1-14.

Cratering				
Effect (10 kiloton)	**Dry, Hard Rock meters (feet)**	**Dry, Soft Rock meters (feet)**	**Wet, Soft Rock meters (feet)**	**Wet Soil meters (feet)**
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 pounds per square inch (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 "roentgen equivalent in man" (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 that 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 firefighters 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, injested anthrax, and inhalation anthrax. Anthrax spores delivered by aerosol spray result in inhalation anthrax, which develops when the bacterial organism is 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"). For Federal planning purposes, it will be assumed that the Universal Adversary (UA) attacks five separate metropolitan areas in a sequential manner. Three cities will be attacked initially, followed by two additional cities 2 weeks later.

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 Strategic National Stockpile, Centers for Disease Control and Prevention (CDC), and Sandia National Laboratories (SNL), Albuquerque, New Mexico.

Detailed Attack Scenario –

On an autumn Monday morning, a specially fitted tractor-trailer 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 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 9/11, 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 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. Additional environmental sampling, both inside and outside buildings, may be warranted 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 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

[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.

antimicrobial drug resistance. Actions of incident-site and Emergency Operations Center (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 Strategic National Stockpile, 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 Prepositioned Equipment Pods (PEP), 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 ICS, treatment of exposed victims, mitigation efforts, obtainment of personal protective equipment (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 Strategic National Stockpile 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 Environmental Protection Agency (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 –

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 [PEP] 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	At a 15% attack rate: 87,000 fatalities; 300,000 hospitalizations
Infrastructure Damage	None
Evacuations/Displaced Persons	No evacuation required; shelter-in-place or quarantine instructions given to certain highly affected areas
Contamination	Isolation of exposed persons
Economic Impact	$87 to $203 billion
Potential for Multiple Events	Yes, would be worldwide nearly simultaneously
Recovery Timeline	Several months

Scenario Overview:[1]

General Description –

Influenza pandemics have occurred every 10 to 60 years, with three occurring in the twentieth century (1918, 1957-1958, and 1967-1968). Influenza pandemics occur when there is a notable genetic change (termed genetic shift) in the circulating strain of influenza. Because of this genetic shift, a large portion of the human population is entirely vulnerable to infection from the new pandemic strain. This scenario hypothetically relates what could happen during the next influenza pandemic without an effective preplanned response.[1]

Detailed Scenario –

In late February, an outbreak of unusually severe respiratory illness is identified in a small village overseas. At least twenty-five cases have occurred, affecting all age groups. Twenty patients have required hospitalization at the local provincial hospital, five of whom have died from fulminated pneumonia and acute respiratory failure. Surveillance in surrounding areas is increased, and new cases begin to be identified throughout the province. Specimens collected from some patients located in the continent where the original outbreak occurred are sent to the World Health Organization (WHO) Reference Center for Influenza at the Centers for Disease Control and Prevention (CDC) in Atlanta.

The CDC determines that the isolates are from a subtype never before isolated from humans. Isolates of the new strain, collected from patients in various overseas locales, are sent to the Food and Drug Administration (FDA) to begin work on producing a reference strain for vaccine production, and influenza vaccine manufacturers are placed on alert. 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 begin to set-up/start-up influenza surveillance systems.)

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[1] Adapted from Patriarcia et al., *Pandemic influenza: A planning guide for state and local officials (draft 2.1)*. Available online at http://www.cdc.gov/od/nvpo/pubs/pandemicflu.htm.

Over the next 2 months, March and April, outbreaks begin to appear in areas even more geographically separated. Although cases are reported in all age groups, young adults appear to be the most severely affected, and case-fatality rates approach 5%. The public is very concerned because a vaccine is not yet available and supplies of antiviral drugs are severely limited. Several weeks later, the CDC reports that the virus has been isolated from ill airline passengers (arriving from overseas) in four major U.S. cities. States and local areas are asked to intensify influenza surveillance activities, and vaccine manufacturers are requested to go into full production.

A few more weeks pass. In June and July, focal outbreaks begin to be reported throughout the United States. By late September, there is widespread occurrence of cases caused by the pandemic influenza strain. Rates of absenteeism in schools and businesses begin to rise. Phones at physicians' offices and health departments begin to ring constantly. Police departments, local utility companies, and mass transit authorities begin to have severe personnel shortages, resulting in severe disruption of routine services. Hospitals and outpatient clinics become severely short-staffed when the majority of physicians, nurses, and other healthcare workers become ill. Elderly patients with chronic, unstable medical conditions hesitate to leave their homes for fear of becoming seriously ill with influenza. Intensive care units at local hospitals become overwhelmed, and soon there are widespread shortages of mechanical ventilators for treatment of patients with pneumonia. Family members are distraught and outraged when loved ones die within a matter of a few days. Further deterioration in health and other essential community services occurs over the next 6 to 8 weeks as the illness sweeps across the Country. The peak of cases occurs in late October, but a "second wave" occurs in January and February.

Planning Considerations:

Geographical Considerations/Description –

The two most important geographic considerations for pandemic influenza are that it occurs almost everywhere and that it moves extremely rapidly. For example, in 1918, well before the advent of commercial passenger aviation, pandemic influenza spread across the United States within a 6- to 8-week period. Appendix 3-A illustrates the speed and global distribution of the 1957-1958 influenza pandemic. It may seem that, with large-scale international air travel, pandemic influenza may move faster than suggested by the timeline in Appendix 3-A. However, in the Appendix 3-A example, there are only 3 to 4 months between the April outbreaks in Far Eastern cities, such as Hong Kong, and the June-July outbreaks that are beginning to occur in the United States. Faster spread is possible, but the net result will still be the same: most people will not be vaccinated ahead of the pandemic (see the following section, *Timeline/Event Dynamics*). The earlier the pandemic arrives, the smaller the number of persons who will have been vaccinated. If there are any problems associated with vaccine production (see the section, *Assumptions*), then it is possible that no one will have been vaccinated ahead of the pandemic arriving in the United States.

The implication of these two time-and-space facts is that few, if any, medical personnel, medical equipment, or similar resources will be available for redistribution. In the United States, State, city, and local governments, as well as health care systems, essentially will have to cope using already existing resources. Obviously, available medical supplies, such as vaccines and drugs, will be distributed as available. But health care systems will not, for example, be able to "borrow" additional health personnel from the neighboring city or State.

On an international level, countries without resources (predominately developing countries) will likely request aid from the United States and other developed countries. However, current limitations regarding vaccine manufacturing, drug production and stockpiling – and limited stocks of relevant medical equipment – will make it extremely difficult, if not impossible, to simultaneously meet all national and international demands for medical supplies. Likely, 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 –

When planning and preparing for the next influenza pandemic, there are two equally important timelines. One describes the spread of the influenza pandemic and the other describes the effort to develop, test, produce, and distribute an effective vaccine. The following two appendices provide illustrations of each of these timelines:

- Appendix 3-A outlines the emergence and spread of the disease. This appendix and the previous brief narrative description provide an example of how the disease might spread.
- Appendix 3-B outlines the time needed to produce a pandemic influenza vaccine using currently available technologies. This appendix also provides the timeline for the production of the "standard" influenza vaccine in 1997.

Together, these two timelines show that the disease will likely arrive in the United States before people can be vaccinated. It actually is possible that, given potential problems with the current technology used to produce influenza vaccines (see the section, *Assumptions*), the pandemic could arrive before public health officials can vaccinate a "significant" number of people. The implication of this is that, as part of any pandemic influenza preparation and response plan, there must be a mechanism for allocating the vaccine among the population (i.e., a method for deciding who will be at the "head of the line").

Assumptions –

- A vaccine that is effective against the pandemic influenza strain can be produced. However, for a variety of technical reasons directly related to how the vaccine is currently produced, it is quite possible that there could be a notable delay in producing the vaccine. Even without a delay, technical problems with production could result in lower yields of vaccine material, causing fewer doses to be produced in the initial production runs.
- Most of this vaccine will not be ready before the pandemic arrives (see the earlier section, *Timeline/Event Dynamics*). Currently, annual production capacity in the United States is about 90 million doses of three-strain, inactivated influenza vaccine – this does not include the new, attenuated, live-virus vaccine. During a pandemic, production will probably focus on producing a single-strain vaccine, implying that approximately 270 million doses can be produced.
- Estimates of influenza-related deaths, hospitalizations, outpatients, and ill individuals who self-care are made using a wide variety of sources from a number of influenza epidemic years (see CDC website). Fatalities caused by the 1918 influenza pandemic were excluded from the fatality rates because the 1918 pandemic represents an extreme.

(The 1918-1919 influenza pandemic caused more than 500,000 deaths in the United States and more than 20 million fatalities worldwide. The 1957-1958 pandemic caused 70,000 fatalities in the United States; and the 1968-1969 pandemic caused 34,000 fatalities in the United Sates.) Advances in medicine may help prevent a repeat of the 1918 fatality rate. The result of this assumption is that the estimates of impact provided can be described as the "conservative, lower end" of estimates of possible impact.

- Estimates of the impact of pandemic influenza are made for a range of gross attack rates (percentage of clinical influenza illness cases per population). For each assumed gross attach, there are ranges of possible health outcomes.
- Estimates are given in totals, after the fact, and before the application of any systematic and effective, large-scale response. Influenza spreads among societies in a different pattern every year. Before the event, it is very difficult to accurately estimate what person-group (e.g., age, gender, risk status) will be the first affected by the next influenza pandemic and where it will occur.

Mission Areas Activated –

Prevention/Deterrence:

With the current state of technology and knowledge, it is impossible to prevent or deter an influenza pandemic. Other prevention and protection activities that can occur in the pre-pandemic years include increasing the use of annual influenza vaccinations. Increased annual, non-pandemic demand may increase the capacity for influenza vaccine production that will be available during an influenza pandemic year. There is a great deal of potential for increasing demand. Currently, a large percentage of high-risk individuals do not get annual influenza vaccinations. For example, less than 20% of high-risk children currently receive an annual influenza vaccination.

Increasing surveillance capacity, particularly in terms of the types of data collected, will help increase understanding of who becomes ill and the consequences of such illnesses (see the following section, *Emergency Assessment/Diagnosis*). Increasing international surveillance capacity also will improve the "early warning system" for early identification of a virus with pandemic potential and allow maximum time to develop a suitable vaccine.

Other pre-pandemic prevention activities include investing in the research and development of new methods for producing influenza vaccines and researching new types of vaccines. However, there is no certainty regarding the success of such projects. Even if such research and development were to result in new vaccines that could be produced faster, it is uncertain when such vaccines would be available.

Preparedness:

Pre-pandemic preparedness activities largely refer to the capacity to deal with the impact (see the section, *Emergency Management/Response*). Another possible pre-pandemic activity is the stockpiling of influenza antiviral drugs. Antiviral drugs for influenza consist of two classes: adamantanes (amantadine and rimantadine) and neuraminidase inhibitors (zanamivir and oseltamivir). However, the amount of drugs stockpiled will depend on selected goals. The question exists whether or not such drugs should be used primarily for treatment or extensively for prophylaxis (until sufficient vaccine is available). A large-scale use of influenza antiviral drugs for prophylaxis will potentially require an enormous stockpile. Furthermore, one of the older and cheaper drugs (amantadine) has side effects related to the central nervous system that prevent it from widespread use as a prophylactic among workers (e.g., its use could cause accidents). Additionally, widespread use of these two classes of antiviral drugs for treatment of ill people could cause antiviral-resistant strains of pandemic influenza to begin to circulate, which would limit the effective lifespan of these drugs. (Antiviral resistance appears to be much less of a problem with neuraminidase inhibitors.)

Another planning problem is that some of the benefits of using antiviral drugs are not well known/documented. This is particularly true in the case of using the neuraminidase inhibitors prophylactically. (The CDC recently convened an expert panel to provide some estimates of the anticipated benefits and side effects of using antiviral drugs. The results from this panel are being analyzed and documented.)

Emergency Assessment/Diagnosis:

Assessment of the rate of spread and the outcome of illnesses depends upon the surveillance system. Currently, there are four elements to U.S. nationwide influenza surveillance.[3] As happens every influenza season, all of these elements will be activated with the occurrence of a pandemic influenza. However, none of these elements allow for a measurement of the attack rate (i.e., the proportion of the population that becomes clinically ill), nor does it identify what person-group becomes ill (e.g., age, gender, risk status). This will hamper the optimal allocation of scarce resources.

Emergency Management/Response:

The effectiveness of emergency management during a pandemic will depend on the degree of pre-pandemic planning and preparation. Such preparedness includes Federal, State, and local public health and other government units creating pandemic influenza plans. Such plans ideally should contain clear guidelines on setting priorities for the use of scarce resources (e.g., vaccines, drugs, hospital beds, mechanical ventilators). The National Vaccine Program Office (NVPO) website (http://www.hhs.gov/nvpo/) has some guidelines for developing such documents However, approximately thirty-eight States have yet to complete such a plan. The U.S. Federal Government plan is currently under review.

Emergency management will have to deal with scarce resources (including vaccine and probably influenza antiviral drugs) without assuming that there will be a great deal of re-allocation of resources around the Country (see the earlier section, *Geographic Considerations/Description*).

Hazard Mitigation:

The success of any hazard mitigation will depend on how well scarce resources are distributed. Even if resources, such as vaccines, are distributed as optimally as possible, there will still be a large number of clinically ill persons (see Table 3-1 and Appendix 3-C). The number of ill persons will overburden the health care system. Essential public services (other than health care services) also may be compromised as workers in those service areas become ill. The degree of

[3] See http://www.cdc.gov/flu/weekly/.

mitigation of the chaos caused by such illnesses will depend on the amount of available vaccine and antiviral drugs (see the earlier section, *Prevention/Deterrence*) as well as the effectiveness of communication of information to the public.

Recent public health emergencies, such as the anthrax-letter attacks in October 2001 and the 2003 Severe Acute Respiratory Syndrome (SARS) epidemic, have clearly demonstrated that the public's response depends, in part, on the following factors:

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

Other factors also will influence public response and the overall success of hazard mitigation activities.

Evacuation/Shelter:

Evacuations will most likely have no meaningful effect on the spread of disease, and probably will be counter-productive (i.e., they will merely move a group of people likely to require services and health care to another site that is already overburdened or soon to be overburdened). Quarantine has not typically been used with much success to stop the spread of influenza. This is because influenza can be spread before an infected person becomes symptomatic, and it has a relatively short incubation period (i.e., 2 to 4 days).

Victim Care:

Victim care will rely, in part, on the use of available antiviral drugs for treatment. The amount of antiviral drugs available will depend on the amount stockpiled (see the earlier section, *Preparedness*, for additional comments regarding the stockpiling of influenza antiviral drugs). Public protection will rely primarily on the use of this stockpile to prevent the disease. Many victims may require hospitalization, especially those experiencing influenza-related breathing difficulty. However, hospital beds and medical equipment, such as mechanical ventilators, will likely be in short supply (see the earlier section, *Secondary Hazards/Events*).

Other, non-critically ill victims will require rest and recuperation. Their symptoms may perhaps be alleviated with over-the-counter medications.

There is also a need to plan to deal with the large number of fatalities (see Table 3-1 and Appendix 3-C) 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 this is an international incident, the U.S. Department of State's Bureau of Consular Affairs will need to be involved in order to assist foreign populations residing in the United States, foreign nationals in the United States, or U.S. citizens exposed or ill abroad.

Investigation/Apprehension:

For pandemic influenza, investigation is really 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. Having a detailed system for allocating resources potentially can reduce such difficulties. This system ideally should be in place well before an influenza pandemic actually occurs.

Of particular concern is the real likelihood that health care systems, particularly hospitals, will be overwhelmed. The only method of mitigating such an impact is to have one or more 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 caused by allocating given resources to a particular patient. 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. Patients might not be given all of the treatment, such as mechanical ventilation, that they and their physicians would normally expect to be used.

Another important secondary hazard is the disruption that might occur in society. Institutions, such as schools and workplaces, may close because a large proportion of students or employees are ill. A large array of essential services may be limited because workers are off work due to pandemic influenza. 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 impact are provided in Table 3-1 (see the last three bullets in the *Assumptions* section). The estimates are for impact before any effective, large-scale interventions are applied.

Health Outcomes	15% Gross Attack Rate* (5th, 95th percentiles)	35% Gross Attack Rate (5th, 95th percentiles)
Fatalities	87,000 (54,400; 122,200)	207,000 (127,200; 285,300)
Hospitalizations	314,400 (210,400; 417,200)	733,800 (491,000; 973,500)
Outpatient visits	18.1 million (17.5; 18.7)	42.2 million (40.8; 43.7)
Self-care ill	21.3 million (20.6; 21.9)	49.7 million (48.2; 51.2)
*Percent Gross Attack Rate refers to the mean percentage of the entire U.S. population that will have a clinical case of influenza. See Appendix 3-C for graphs and additional estimates.		

Table 3-1. *Mean estimates (5th, 95th percentiles) of the impact of the next influenza pandemic in the United States without any large-scale and/or effective interventions*

Additional scenarios/estimates can be generated for virtually any population level using the CDC's Flu-Aid program, which is a free software program designed to help State and local public health officials plan, prepare, and practice for the next influenza pandemic. The program is available at http://www2a.cdc.gov/od/fluaid.

There are patients who, due to pre-existing medical complications, are at high risk for having influenza-related adverse health outcomes. These pre-existing conditions include emphysema, asthma, diabetes, autoimmune diseases, immune systems deficiencies (e.g., AIDS), and chronic heart disease. Approximately 15% of the entire population has one or more of these conditions. However, some 84% of all fatalities will occur among those with these high-risk conditions.

Similar to the experience of the three influenza pandemics in the twentieth century, approximately 60% of the fatalities will occur among those less than 65 years of age. In non-pandemic years, approximately 80% (or more) of all influenza-related fatalities occur among those over the age of sixty-five.

As described in the section, *Secondary Hazards/Events*, the health care system will most likely be rapidly overwhelmed and standards of patient care at all levels may be reduced. It is unknown what the exact impact this reduction in quality of health care will have on estimated fatalities and hospitalizations.

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 –

Service disruption could be severe, depending upon the pattern of which persons become ill, when they become ill, and for how long they are ill. It is probably "safe" to assume that, even if health care workers are among the first to receive vaccinations and/or treatment, 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 both influenza-related emergency calls and the number of workers who fall ill to influenza. Beyond the “traditional” definition of essential services (e.g., fire, water, electricity, phone systems), severe disruptions could occur if large numbers of transportation workers are simultaneously off work due to influenza-related illnesses. Again, the exact extent of such disruptions will depend on the pattern of which persons become ill, when they become ill, and for how long they are ill.

Economic Impact –

Using the previous estimates provided regarding the numbers of fatalities, hospitalizations, etc., it has been estimated that the economic impact, in 2004 U.S. dollars, will range from $87 billion (15% gross attack rate) to $203 billion (35% gross attack rate). These estimates do not include any estimate due to economic disruption; however, they do include a value for time lost from work.

These estimates of impact can be used to consider the economic cost-benefits (net returns) of vaccinating various age and risk groups.

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. Costs for such care are not included in the estimates of economic impact.

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

February 1957	Outbreaks of influenza-like illness (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 the United States.
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 sixty 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: Timetable for Producing "Standard" Influenza Vaccine and Use in the United States (Inter-Pandemic Period*)

	STEPS	Planned Start	Planned Finish	1997 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CDC/WHO	Surveillance	1/1/97	12/31/97												
	Select candidate strains	1/1/97	2/15/97												
	Prepare re-assortants	1/1/97	3/1/97												
FDA	Standardize/test antigen	1/1/97	5/31/97												
	Review labels/license	5/15/97	6/15/97												
	Assign potency	3/15/97	8/31/97												
	Release vaccine	5/15/97	10/1/97												
	Produce concentrates	1/20/97	7/15/97												
	Formulate and test	5/1/97	8/31/97												
Manufacturers	Fill, text, package	5/10/97	9/15/97												
	Distribute	7/1/97	10/15/97												
	ADMINISTER VACCINE	9/1/97	12/31/97												

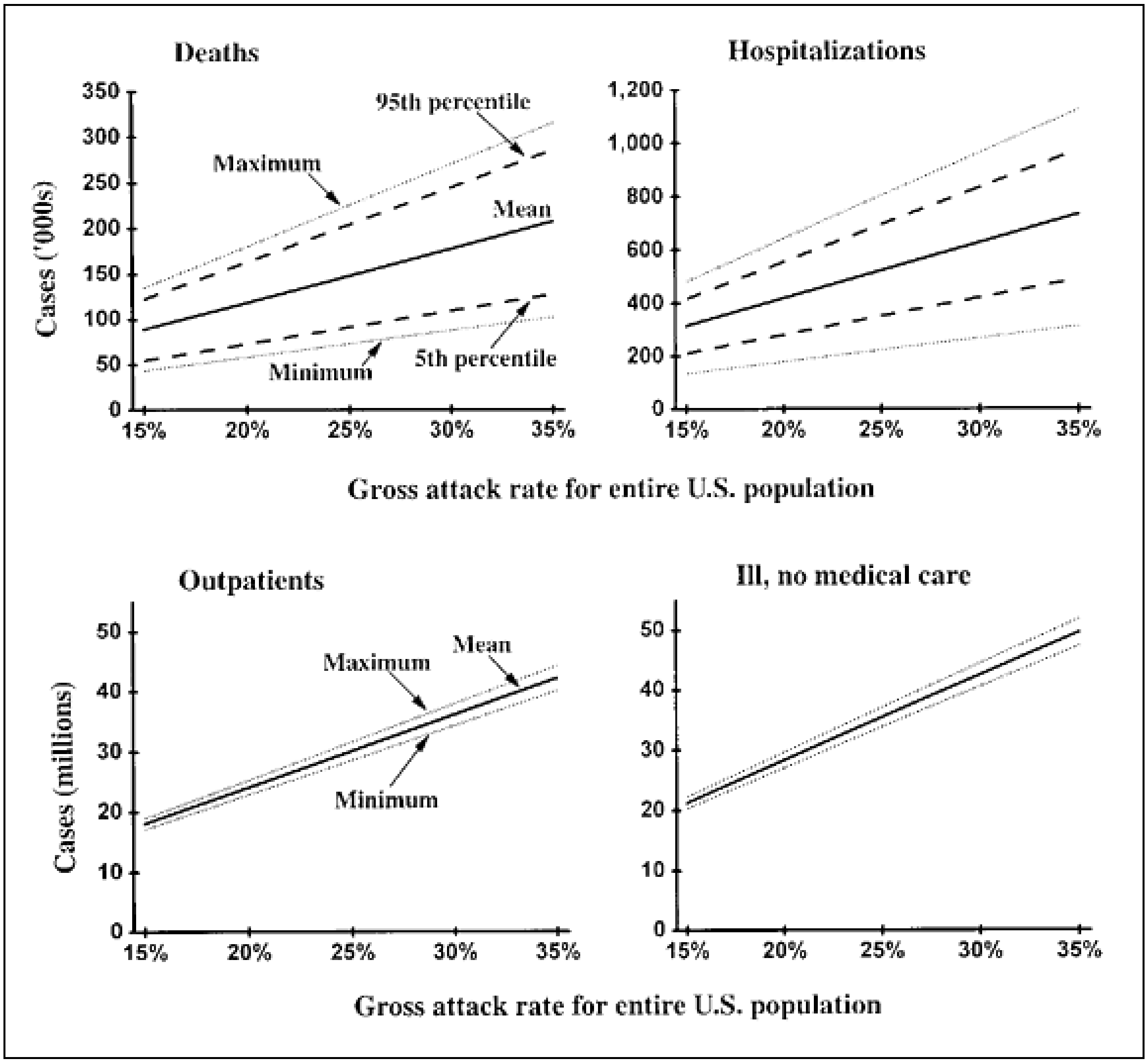
FDA Advisory Group
WHO
ACIP

*1997 is presented as an example for purpose of illustration; illustration refers to the production of a "standard" influenza vaccine. Actual dates and intervals will vary somewhat from year to year.

Table 3-2. *Estimated timetable for producing a "standard" influenza vaccine and use in the United States based on an inter-pandemic period (1997)*

APPENDIX 3-C: Impact of Influenza Pandemic in the United States

For each gross attack rate in Figure 3-1, the data consists of totals for all age groups and risk categories. The data reflects potential impact BEFORE any large-scale and effective prevention or intervention measures are implemented.



Source: Meltzer, M. I.; Cox, N. J.; & Fukuda, K. (1999a). The Economic Impact of Pandemic Influenza in the United States: Priorities for Intervention. *Emerging Infectious Diseases*, 5:659-671.
Available from: http://www.cdc.gov/ncidod/eid/vol5no5/meltzer.htm

Figure 3-1. *Impact of influenza pandemic in the United States: mean; minimum; maximum; and 5th and 95th percentiles of total fatalities, hospitalizations, outpatients, and self-care ill for different gross attack rates*

Scenario 4: Biological Attack – Pneumonic Plague

Casualties	XXXX fatalities; 6,000 illnesses
Infrastructure Damage	None
Evacuations/Displaced Persons	No evacuation required; shelter-in-place or 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 –

Plague is a bacterium that causes high mortality in untreated cases and has epidemic potential. It is best known as the cause of Justinian's Plague (in the middle sixth century) and the Black Death (in the middle fourteenth century), two pandemics that killed millions. A third, lesser-known pandemic began in China in the late 1800s and spread to all inhabited continents, causing nearly 30 million cases and more than 12 million deaths in the period 1896 to 1930. This third, or Modern Pandemic, prompted an intensive multinational research effort that resulted in the identification of the causative agent of plague (*Yersinia pestis*, a gram-negative bacterium) and conclusive evidence that rat fleas transmit the disease to humans during epidemics. Later studies indicated that smaller numbers of cases also arise as a result of persons being bitten by wild rodent fleas, handling infected animals, or inhaling infectious respiratory droplets coughed by persons with plague pneumonia. Others demonstrated that plague bacteria are maintained in nature through transmission cycles involving wild rodent hosts and flea vectors. Armed with this knowledge, public health workers were able to design and implement prevention measures that reduced the incidence and spread of plague in many regions.

In this scenario, members of the Universal Adversary (UA) release pneumonic plague into three main areas of a major metropolitan city: in the bathrooms of the city's major airport, at the city's main sports arena, and at the city's major train station. As a result of foreign and domestic travel, rapid dissemination to distant locations occurs.

Detailed Attack Scenario –

At approximately 7:00 a.m., five members of the UA discharge canisters in bathrooms at Major City Airport, releasing an aerosol of *Yersinia pestis* (plague). 50 people are exposed to these releases, including thirty-five passengers on a flight between Canadian and U.S. cities. That afternoon, the terrorists make a similar release in twenty-five bathrooms at the city's major sports arena during a playoff hockey game. 3,000 people are exposed, including 750 international travelers. Among the international travelers, 250 fly home to Canada the day following the game; 10 others fly to destinations in Europe, Asia, South America, and the Middle East. Finally, between 5:30 p.m. and 6:00 p.m., the terrorists discharge canisters in bathrooms in the city's major train station, exposing an additional 50 persons.

The first cases arrive in emergency rooms (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 alarms within hospitals and at the Department of Public Health (DPH). Observed incubation periods vary significantly between individuals and range from 1 to 6 days after exposure. It is estimated that the approximately eighty hospitals in the Major City metropolitan area 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 a couple of hundred. Intensive care 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 definitive 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 State and Federal 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 visitors and commuters at or passing through Major City Airport, the sports arena, and the train station on the morning of the attack 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 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 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 144 cases and 0 fatalities.

D+1 (Day plus one):

In both the United States and Canada, 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 2,668 cases and 57 fatalities.

D+2:

The Major City DPH and the State Department of Public Health (SDPH) continue to receive information that increasing numbers of persons are seeking medical attention at Major City 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 3,036 cases and 646 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 World Health Organization (WHO) issues a warning for all persons who may have gone through 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 4,419 cases and 1,357 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 Centers for Disease Control and Prevention (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 eleven 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 7,348 cases and 2,287 fatalities.

Assumptions –

- Sophisticated terrorist adversary with limited capacity to develop and deploy a weapon
- Point-source indoor release (in multiple locations) through small-orifice, single-fluid nozzle
- *Yersinia pestis* supply: Liquid slurry of 1 x 10^9 organisms per milliliter
- Release size: ~ 650 milliliters per canister discharge
- 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)
- Total initial exposures: 3,100 people
- 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 or no experience in identifying and/or treating plague.

Supplemental testing and confirmation for the plague 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 incident utilizing 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 Emergency Operations Center (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, air-borne spread through close contact. Identification of drug-resistant plague strains would require full utilization of personal protective equipment (PPE) and quarantine measures. Actions of incident site, EOC, and Joint Information Center (JIC) personnel tested after the attack include provision of public alerts, mobilization of the Strategic National Stockpile, 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. Intense communication and cooperation between the United States and the eleven countries of traveler destination will be required to engage the full range of Federal, State, and local foreign-affairs entities in order to either limit access or establish border closures.

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 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 Incident Command System (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 Strategic National Stockpile 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's Bureau of Consular Affairs will need to be involved in order to assist foreign populations residing in the United States, foreign nationals in the United States, or U.S. citizens exposed or ill abroad.

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.

Site Restoration: There will be little or no damage to venues as a direct result of the attack. Actions of incident-site personnel may include limited environmental testing and extensive public information provision about the fragility of the plague organism.

Implications:

Secondary Hazards/Events –

As the financial world in 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 normal occurring. Automatic teller machines (ATMs), especially drive-up machines, may run out of cash before they can be replenished. 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 ninth day is approximately [6,000]. The total number of fatalities is [XXXX]. 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 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 thirty-eight 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. 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 eye 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 over-packed 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. One of more than 6,000 arriving in the United States daily, and shipped from a legitimate source, the container passes easily 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 so equipped, with the spray booms attached to the wing struts and the tank and pump unit located in the cabin. This aircraft 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 in a commercial rental trailer 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.

Figure 5-1. *Cessna 182 Skywagon – owned by the United States Department of Agriculture (USDA) Areawide Pest Management Research Unit, College Station, Texas – used for spray drift tests*

The UA pilot takes off approximately 2.5 hours before game time, and the rest of the UA cell members scatter. All have scheduled flights out the Country later in the day, as well as a backup ground plan.

At his closest approach to the stadium, the pilot veers directly towards the target. Traveling at 150 knots, he is over the stadium grounds in 4 minutes. Ignoring frantic air traffic control calls and an approaching police helicopter, 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 kills 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, and the first ones out of the stadium are trying to get away as soon and as far as possible. Many auto 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 a police helicopter and law enforcement personnel on the ground, first responders begin to flow towards 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. The pursuing police helicopter loses visual sight of the airplane, but 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.

- <u>*Wind Speed:*</u> 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 65º Fahrenheit (F) 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 a single pilot, 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 Environmental Protection Agency (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 and heavy water spray 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 Emergency Operations Center (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 Joint Information Center (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-degree 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- 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 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 5 fatalities ($1/100^{th}$ 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 level, 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) land in several helicopters at fixed facility petroleum refineries. They quickly launch rocket-propelled grenades (RPGs) and plant improvised explosive devices (IEDs) before re-boarding and departing, resulting in major fires. At the same time, multiple cargo containers at a nearby port explode aboard or near several cargo ships with resulting fires. Two of the ships contain flammable liquids or solids. The wind is headed in the north-northeast direction, and there is a large, heavy plume of smoke. The smoke is visible drifting east into heavily populated areas. Releases of cobalt, nickel, molybdenum, cadmium, mercury, vanadium, platinum, and other metals have occurred in the plumes. One of the burning ships in the port contains resins and coatings including isocyanates, nitriles, and epoxy resins. Some IEDs are set for the use of a remote trigger for delayed detonation. Casualties occur onsite due to explosive blast and fragmentation, fire, and vapor/liquid exposure to the toxic industrial chemical (TIC). 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 IEDs. Others are instructed to conduct discrete, long-term reconnaissance activities at several major port facilities in the United States. Each cell is instructed to obtain helicopter pilot training for one of its members, using only people with clean records.

UA then uses contacts in the shipping industry to have two crates of RPGs and launchers shipped to the United States in a sea-borne cargo container. 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 2 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 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.

Four trained helicopter pilots are ordered to report to a safe house in the port city. Here, twelve other terrorists from other cells, all of whom have received extensive weapons training at overseas camps, join them. The terrorists also bring the RPGs, IEDs, and other weapons with them to the safe house, which is operated by a local-area cell that will provide logistical support to the operation. A senior representative from UA Central Command provides a detailed mission brief to the terrorists. The attack is set to occur on the first day that both ships will be in port. The pilots arrange to rent four helicopters from different aircraft rental agencies in the area.

On the day of the attack, the pilots are driven to various airports where they present their licenses and rent their helicopters. The four choppers take off and converge on an isolated ranch owned by one of the sleeper-cell members. Here, they quickly load up the other terrorists and weapons, and set out on parallel – but widely separated – routes to the port. The attack is timed to coincide with the remote bomb detonation in the shipping containers.

Terrorists in three helicopters first land at the fixed facility petroleum refineries and attack them with RPG launchers, setting major fires. They then quickly take off again and drop IEDs, setting additional fires. Refinery hydro-cracking and catalytic systems become involved in the fires. The fourth helicopter circles over the port just as the bombs are detonated in the two cargo containers aboard or near several cargo ships, with resulting fires. Two of the ships contain flammable liquids and solids. As it circles, the helicopter drops several IEDs in the port area, some of which have remote detonators. The wind is headed to the north-northeast, and there is a large, heavy plume of smoke over most of the port area, including the convention center and downtown business area; smoke is drifting northward through the area.

After the attack, the helicopters turn and flee, landing at separate locations where accomplices wait to speed them away in automobiles. Some IEDs are set for remote detonation. Casualties occur onsite due to explosive blast and fragmentation, fire, and vapor/liquid exposure to the TIC. Downwind casualties occur due to vapor exposure. Several emergency response personnel are killed when the IEDs are detonated. This causes the emergency personnel to back off from the port and hinders efforts to control the burning ships.

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. The ability to obtain several helicopters would seem to be limiting, however.

Timeline/Event Dynamics –

Total time to plan and prepare for the attack would be on the order of 2 years, including reconnaissance, pilot and 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 to execute the airborne phase of the attack would be on the order of 1 to 2 hours from liftoff from the originating airport. Time over target for the helicopters would be about 10 minutes. 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 65º Fahrenheit (F) 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-degree arc centered north-northeast of the site and extending six 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 and training of pilots are not detected by law enforcement or intelligence communities. Aircraft 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 aircraft and 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 Emergency Operations Center (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 Joint Information Center (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 respitory 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 personal protective equipment (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 one 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 Emergency Medical Service (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 7 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 hydrofluoric acid, the exposed area would be flushed with copious amounts of water, and then a 2.5% calcium gluconate gel would be applied to the affected area to draw out the fluoride ion.
- 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 have occurred in the plumes. One of the burning ships in the port contains resins and coatings including isocyanates, nitriles, 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 gasses) 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, 15 minutes washing 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 auto 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 three large commercial office buildings in a metropolitan area. The agent kills 95% of the people in the buildings, and kills or sickens many of the first responders. In addition, some of the agent exits through rooftop ventilation stacks, creating a downwind hazard.

Detailed Attack Scenario –

The UA manages to acquire 30 kilograms (7.2 gallons) of the nerve agent Sarin. The agent is contained in eight 1-gallon containers, each 90% full. These containers are packed along with absorbent material into a sealed 35-gallon drum. This drum is further over-packed into a 55-gallon drum along with more 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. Shipped from a legitimate source, the container passes through customs and is delivered to the UA cell operating in the United States.

Meanwhile, UA Central Command dispatches an attack planning and reconnaissance team to survey potential targets within the United States. The team decides on three large commercial office buildings located in a major metropolitan area. The buildings have easily accessible ventilation systems. Over a period of 3 months, UA manages to infiltrate the janitorial staff of all three buildings. During this period, UA also builds six agent dissemination devices. The devices are each powered by several carbon dioxide cartridges and capable of spraying 1.2 gallons of GB in a fine mist for 15 minutes.

A UA cell receives instructions to transport the drum in a commercial rental trailer to a safe house near the target metropolitan area. The terrorists build a temporary hood using materials purchased from a home improvement store. Upon arrival of the agent, they don chemical agent protective masks and double sets of rubber gloves. They transfer the agent to the six spray devices and tightly seal them. By a combination of careful planning, disciplined procedures, and luck, no one is exposed to the agent during this operation.

The following morning, the three UA janitors leave their buildings for the mid-morning break. Each quickly returns toting two 5-gallon paint buckets retrieved from a waiting UA van – each pair of buckets contains two spray systems, a pair of latex gloves, and a protective mask. Moving to the now-deserted heating, ventilating, and air conditioning (HVAC) spaces of their respective buildings, the terrorists don their masks and gloves. They place the spray systems into key HVAC intake ducts and activate them. Operating on a strict time schedule, all six devices are activated within 5 minutes of one another. The terrorists then quickly move to the nearest exit, unmask, and leave the buildings, heading upwind where waiting UA vans quickly pick them up.

Concentrations exceeding 100 milligram per cubic meter of air (mg/m^3) are present throughout the buildings within minutes. Symptoms appear immediately, with incapacitation occurring within 1 to 10 minutes of the vapor entering occupied areas. A few frantic calls to 911 are choked off as the callers collapse, leaving operators in the dark as to the true scope and nature of the emergency. Emergency medical services (EMS) personnel arrive at the three sites within 5 minutes of the first 911 call from each building and enter the building without respiratory protection. They find no one alive on the first floor before collapsing themselves. Fire services personnel quickly follow and suffer the same fate.

The second fire crew to arrive at one of the buildings 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 are experiencing 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 rooftop ventilation systems of the three buildings. (While additional agent is seeping from doors and windows, this 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 mg/m^3, resulting in 1% lethality among the exposed population. Upon seeing others collapsed in the street, building 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 one-eighth 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, each building is assumed to have an occupancy of 2,000 personnel (e.g., twenty-story buildings with 100 occupants per floor), and the outdoor/subway population density of the surrounding areas is 3,900 people per square mile (one-tenth of the total population density in the vicinity of Times Square, New York).

Timeline/Event Dynamics –

The attack will require 6 months to plan, including putting the faux janitors in place, shipping the agent, and fabricating the spray devices. Once all is ready, the janitors will take less than 10 minutes to retrieve the sprayers from the courier vans, emplace them, and activate them. 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 65º Fahrenheit (F) 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 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 twenty-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 "lethal dose" (or dose of chemical that kills 50% of the subjects), or LD_{50}, for Sarin is 100 milligrams per minute per cubic meter of air ($mg/min\text{-}m^3$). (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

acute exposure guideline level (AEGL) 3 downwind hazard area will cover about one-eighth of a square mile from each site, with the no-effects level sixteen times that size. Current building codes require six to ten 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. The heavier-density agent means it will linger longer in the building. Agent remaining in the buildings when the HVAC is turned off will begin to settle in low-lying areas and begin to be absorbed by porous materials. The buildings will probably never be safe to enter without appropriate personal protective equipment (PPE).

- 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.
- Current Department of Defense (DoD) rules, which have been accepted by the Operational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) in the chemical weapons disposal program, regarding release of material that has previously been contaminated with chemical warfare material (CWM) for public use would be followed, at least for the three buildings and their contents.

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

Emergency Assessment/Diagnosis:

The ability for a member of emergency staff to recognize the attack before becoming a casualty will be key to avoiding first responder casualties. Actions of incident-site and Emergency Operations Center (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 Joint Information Center (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, as previously defined. 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 2,000 occupants per 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 three buildings results in 5,700 deaths, including 3 EMS crews, 3 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 rhino rhea, 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, 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 (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) prior to being released for public use. (Note that the latter method applies to GB and VX nerve gas only, not other CWM.) If left in place, the drywall and other porous substances would be leaching minute amounts of agent for years. Valuable and removable property and equipment could be removed from the building, bagged, and monitored, then released if no agent is detected at the 0.0001 mg/m^3 monitoring level. The buildings themselves will likely be demolished and thermally treated truckload-by-truckload in a car-bottom furnace. Airing and washing should decontaminate adjacent structures adequately, however. Some motor vehicles will be involved in accidents.

Service Disruption –

Loss of use of the three contaminated buildings 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 three large commercial office buildings 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 cholinesterase level restoration 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 leaders of several UA sleeper cells 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. Cell leaders are instructed to conduct discrete, long-term reconnaissance activities at several major industrial facilities in the United States, each in heavily populated areas.

After 2 years of surveillance activities, UA Central Command decides on attacking an industrial facility that stores a large quantity of chlorine gas. (This could be a chlorine production or transshipment point, a paper plant, a textile mill, or a bleach production plant.) 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.

Four UA members that have been trained to infiltrate industrial facilities and use explosives are smuggled into the United States and transported to a safe house near the attack site. They also bring a detonation cord, improvised explosive devices (IEDs), and other light weapons with them to the safe house, which is operated by a local area cell that will provide logistical support to the operation. A senior representative from UA Central Command provides a detailed mission brief to the terrorists. The attack is timed on the evening of 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 people with special training are 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 at ranges varying from 20 minutes to 1 hour 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 diameter 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) Emergency Operations Center (EOC). The city (county) hazardous materials (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 back to incident command, an IED explodes 15 feet from the HazMat team. Casualties occur onsite due to 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 light up with numerous reports – first 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 lateness 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 one-tenth (70,000 people in all) of the downwind population ignores the advice and self-evacuates.

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 on the order of 2 years, including reconnaissance and weapons training, and accumulation of weapons. Time to execute the attack would include days to weeks to find the right weather conditions. The actual infiltration, explosive charges setting, and ex-filtration would take less than 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 75º Fahrenheit (F) 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 people (one-tenth 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 any 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) that 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; conducting bomb disposal dispatch and IED render-safe procedures; preserving the scene; performing mitigation efforts; decontaminating responders; and conducting 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 devisions 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 personal protective equipment (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: Since chlorine is a gas, the extent of decontamination required will be minor and largely related to any releases generated 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 shelter-in-place 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 roadways. The rule of thumb is one fatality per 100,000 evacuated. Any 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 –

Assuming 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 Emergency Medical Service (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 1 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 crushing and impact as drivers try to circumvent clogged traffic, and many will require immediate medical assistance.
- Explosions result in 3 fatalities and 7 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 – 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 Centers for Disease Control and Prevention (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 as well. In areas of heavy chlorine exposure, there will also be heavy corrosion of metal objects.

[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.

Service Disruption –

The plant will be temporarily closed due to bomb damage, with significant local economic impacts. Environmental surveys of the surrounding waterways indicate heavy contamination that 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 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 plant could cost millions. The local economy will be impacted 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, except for those with severe lung damage. These individuals will require long-term monitoring and treatment.

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 that a recording of 7, for example, indicates a disturbance with ground motion ten 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-earthquake following, occurs along a fault zone in a major metropolitan area. 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 major metropolitan area. 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 intensity 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 major metropolitan area 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 their capabilities.
- Some 100,000 disaster victims are not able to immediately return to permanent housing within the major metropolitan area.

- 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 for the first week following the earthquakes.
- There is also a 10-day disruption of sanitation/sewage services in the metropolitan area while wastewater facility infrastructure is being 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 United States 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 U.S. Environmental Protection Agency (EPA) and the U.S. Coast Guard (USCG) are on scene to manage hazardous material spills. The American Red Cross (ARC) has committed thousands of volunteers and is coordinating with the State on delivery of emergency medical treatment, shelters, and food distribution. A Joint Information Center (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

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

focused on searching for survivors and, 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 Department of Homeland Security (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 Department of Defense (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:

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

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 hazardous materials 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, hazardous materials 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. Damages to unreinforced masonry buildings extend over a wide area, contributing to the debris generated by the earthquakes.

Hazardous Materials:

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 suffering the brunt of the damage. A large refining spill has contaminated the port facility and is spilling into the harbor. Significant concern for spilled hazardous materials 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. Children were in schools, some of which suffered damages, and worried parents were 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 Emergency Medical Services:
Fire and Emergency Medical Services (EMS) stations were also damaged, with only 40 of the 241 stations operating at greater than 50% capacity. Dozens of the region's fire engines and trucks were 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 are impeding 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 and 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 major metropolitan area 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 a 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 major metropolitan area.

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 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 life span of a hurricane is 9 days in a range of less than 1 day to more than 12 days. Hurricanes' highest wind speeds are 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 that is used to estimate the potential for property damage and flooding. "Major" hurricanes are placed in Categories 3, 4, or 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 blow down. All signs 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 a major metropolitan area (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 dangerous Category 4 level on the Saffir-Simson Hurricane Scale and 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 was 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 combinations 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 are experiencing 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 will be 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 for 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 the Department of Homeland Security (DHS)/Federal Emergency Management Agency (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 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/National Disaster Management System (NDMS), in coordination with Health and Human Services (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 U.S. Coast Guard (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 on-site 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 locals 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 for 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:

Hazardous materials 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 and sustains serious damage and leaks oil into the waters adjacent to the MMA.

Fatalities/Injuries –

The catastrophic hurricane has resulted in more than 1,000 fatalities, and 5,000 thousand 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 are experiencing 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 survived the influx of water, but sustain heavy damage to contents on the lower levels.

Debris:
Most all 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 has caused illnesses. There is concern that outbreaks of mosquito-borne diseases will be a problem in the future.

Environmental/Health Impacts from Hazardous Materials:
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 other 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 has breached and overtopped flood control and hurricane protection works.

Transportation – Highways, Mass Transit, Bridges, Railroads, Airports:
Major access roads into 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 are lacking power. Railroads into the metro area 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 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. There are numerous sunken vessels and other obstructions blocking 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 in need of care. There is a need to transport special need populations to the closest appropriate hospital or other healthcare facility.

Communications Systems:
Due to damage and lack of power, communications systems – including telephones, radios, and cellular systems – are only at 90% capacity for 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 the 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 because it is easy to precipitate. CsCl is a fairly fine, light powder with typical particle size median at 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, or "dirty bomb," 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 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 contain approximately 2,300 curies of ^{137}Cs (CsCl), and several kilos 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-kilograms highly explosive core as a booster. The total explosive yield in each device will be approximately 3,000 pounds. Since each radiation source gives off a 760 radiation absorbed dose (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 locations downtown 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. Amid the destruction, ^{137}Cs contamination covers the scene 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 cities two and 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 cities two and 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 thirty-six 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 two to twenty stories, and buildings in the immediate vicinity of the blast are eight to sixteen 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 micron (or micro-meter, μm) 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 fall-out within about 500 feet.

Variable winds of 3 to 8 miles per hour carry the radioactively contaminated aerosol throughout an area of approximately thirty-six 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 5-50 microcuries/m^2, with hot spots measuring 100-500 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 thirty-six-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 cities two and 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 micron 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 miles per hour. The temperature is 65º Fahrenheit (F).
- The port of entry through which the smuggled materials enter is not equipped with radiation detection equipment capable of detecting the shielded ^{137}Cs source. The target and surrounding access routes are not equipped with radiation sensors capable of detecting the shielded source. The acquisition of bomb-making materials does not draw the attention of law enforcement.
- First responders from cities two and 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, detection of the plot, 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 capable of detecting the shielded source. The Department of Homeland Security (DHS) would be involved in detection of the shielded ^{137}Cs radiation sources.

Emergency Assessment/Diagnosis:

The explosion in city one would not be recognized as a "dirty bomb" until responding units arrive with gamma detection equipment. This would lead 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 Emergency Operation Center (EOC)/Joint Field Office (JFO) personnel tested during and after the attack include (1) providing personnel dispatch; (2) assessing the extent of physical damage, including engineering assessments of buildings; (3) assessing medical response needs; (4) detecting and identifying the radiation source; (5) establishing and preserving the site for crime scene analysis; (6) collecting site data and information; (7) making hazard assessments and predictions for responders and the public; and (8) 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 (1) mobilizing and operating incident command; (2) overseeing victim triage; (3) stabilizing the site; (4) cordoning the site and managing and controlling the perimeter; (5) providing notification and activation of special teams; (6) providing traffic and access control; (7) providing protection of at-risk and special populations; (8) providing resource support and requests for assistance; (9) providing public works coordination; (10) providing direction and control of critical infrastructure mitigation; and (11) providing public information, outreach, and communication activities.

Because first-responder assets (e.g., medical evacuation, fire, rescue, and Emergency Medical Service [EMS] personnel) were promptly dispatched from nearby cities two and three to assist city one, cities two and three are low on response capacity and officials find themselves unprepared when attacks strike their cities.

Hazard Mitigation:

Actions of incident-site personnel required include (1) isolating the incident scene and defining the hazard areas, (2) building stabilization, (3) providing fire suppression, (4) conducting debris management, (5) conducting radioactive and hazardous contamination mitigation, (6) decontaminating responders and equipment, (7) conducting local site contamination control, and (8) decontaminating local citizens.

Evacuation/Shelter:

Sheltering and/or evacuation 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 (1) 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); (2) providing management of evacuation, whether ordered or spontaneous; (3) protecting special populations, schools, and day care centers; (4) establishing temporary sheltering alternatives and provision of food for evacuees; and (5) 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 (1) conducting search and rescue; (2) providing triage, emergency aid, treatment, and stabilization; (3) decontaminating victims (ambulatory and non-ambulatory); (4) establishing relief stations, impromptu decontamination centers, and site access portals; (5) screening, monitoring, and decontaminating evacuees (numbers are expected to be up to 100,000 at each site); (6) conducting victim/evacuee data and information collection and management; (7) making radio-protective pharmaceutical decisions and efficiently providing protective and/or therapeutic drug administration; (8) conducting patient status tracking and reporting; (9) providing patient transport; (10) treating emergency room (ER) walk-in radiation victims; (11) providing hospital care; (12) providing collection, decontamination, and cataloging of human remains and personal effects; and (13) providing next-of-kin notification.

Investigation/Apprehension:

Actions of law enforcement personnel tested after the attacks include (1) dispatching personnel, (2) conducting site cordoning and control, (3) collecting field data, (4) conducting witness interviews, and (5) 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 thirty-six 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 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 twenty 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 thirty-six 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 transport 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 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, seventy-five 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 transport 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. On a more global scale, any large foreign populations resident in the United States (e.g., Canadian, Mexican, Caribbean) affected by the attack (i.e., citizen fatality or follow-up medical treatment for citizens exposed) would require involvement by the State Department's Bureau of Consular Affairs.

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	Approximatley 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) use improvised explosive devices (IEDs) to detonate bombs at a sports arena and create a large vehicle bomb (LVB). They also use suicide bombers in an underground public transportation concourse and detonate another vehicle bomb in a parking facility near the entertainment complex. An additional series of devices is detonated in the lobby of the nearest hospital emergency room (ER).

Detailed Attack Scenario –

During an event at a large urban entertainment/sports venue, multiple suicide bombers are strategically prepositioned around the arena. They ignite their bombs and self destruct in order to guarantee 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 occupants will head toward public transportation, and still 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 an LVB disguised as a fire department/Emergency Medical Service (EMS) service vehicle. While it is not unrealistic to estimate that up to 4,000 pounds of conventional explosives could be secreted in such a vehicle, 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 is detonated in an underground public transportation concourse (e.g., a subway). This is accomplished by the convergence of three suicide bombers at a strategic point in the concourse and the simultaneous detonation of their devices. In a third attack, a vehicle bomb is detonated in a parking facility near the entertainment complex. A fourth series of devices, delivered by suicide bombers using explosive vests, is detonated in the lobby of the nearest hospital ER. (The same effect could be achieved through the use of a second disguised LVB, avoiding the need for a suicide attack.) 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 real-world recent incidents at the 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 –

The initial suicide bombers self destruct approximately 1 hour after the start of the entertainment event. The detonation of additional explosives is delayed approximately 10 to 15 minutes after the initial suicide bombings in order to allow for detection, evacuation, and response of emergency services providers. The detonation of explosives 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, the fire and 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 between 2,000 and 4,000 pounds (907 to 1,814 kilograms) of a readily attainable conventional explosive material such as ammonium nitrate/fuel oil (ANFO) or a commercial high explosive. 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 one-and-a-half times that distance. Blast overpressures of approximately 8 pounds per square inch can be predicted out to 190 feet (57 meters). This force is sufficient to cause the failure of brick wall panels. Overpressures of 10 pounds per square inch, which are sufficient to cause structural destruction, can be expected if the vehicle is within about 150 feet (48 meters) of buildings.

A vehicle bomb containing approximately 1,000 pounds (455 kilograms) of ANFO explosive in the trunk is predicted to have a lethal air blast range of 125 feet (38 meters). Suicide bombers in the transportation concourse can combine carried/worn explosive vests or backpack devices to produce an effective yield of about 120 pounds of 2,4,6-trinitrotoluene (TNT).

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, with photographs and video documentation performed.

The LVB, disguised as a fire department ambulance/vehicle, would necessitate obtaining a vehicle at least reasonably similar to those used by the local fire/EMS department. The painting of the vehicle could be done in a garage facility owned by sympathetic persons.

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 Emergency Operations Center (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 emergency medical and other responders, necessitating mutual aid. It would require the activation of Urban Search and Rescue teams. Actions of EOC and Joint Information Center (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 Joint Operations Center (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, an 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 EOD 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 those 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 8 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 5 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 7 fatalities and 40 injuries. The detonation of an explosive device in an underground transportation facility results in 8 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 8 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
Large Vehicle Bomb	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.

Large Vehicle Bomb Damage/Overpressure Template

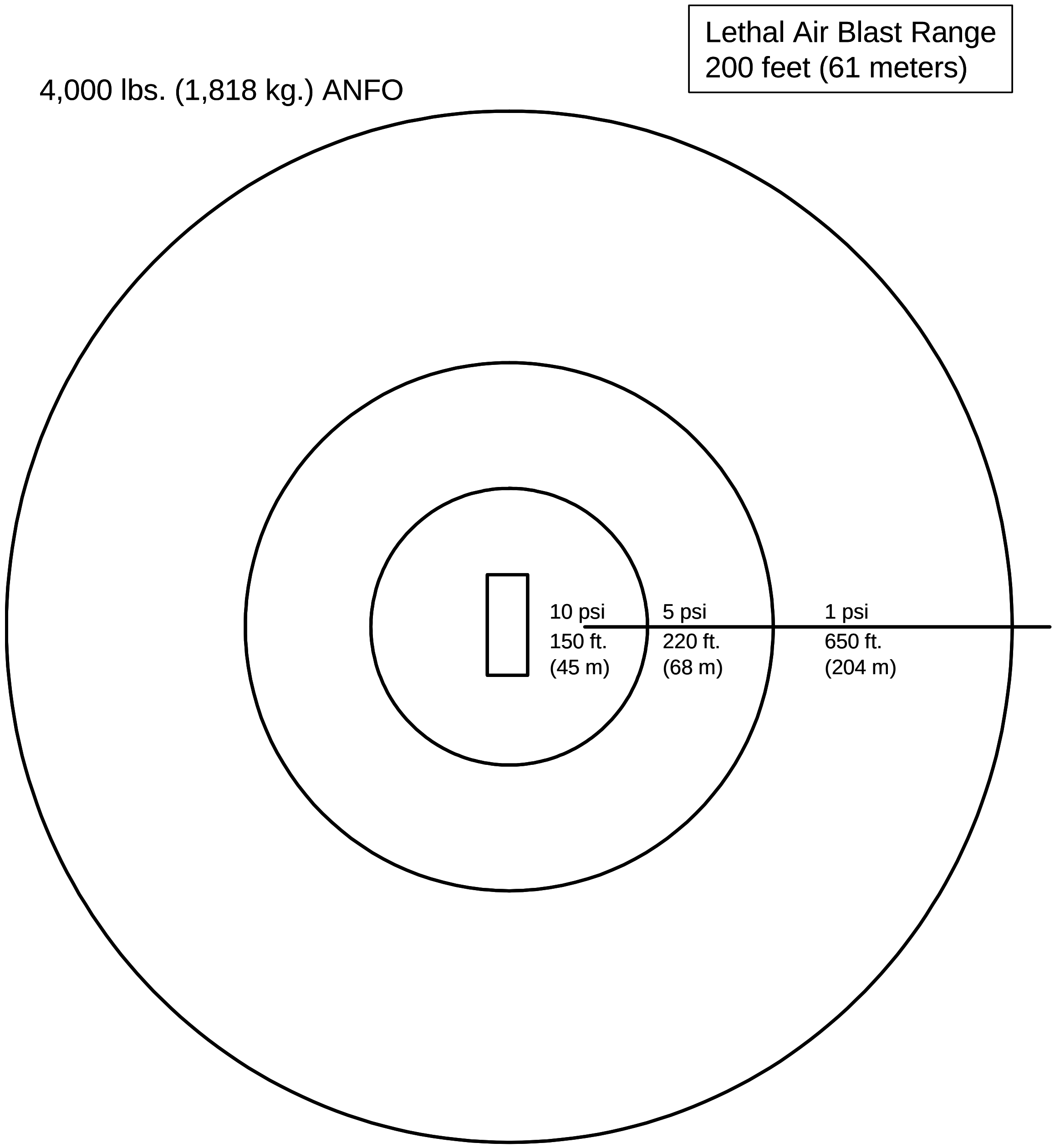


Figure 12-1. *Estimated overpressure (in pounds per square inch [psi]) at distance from the blast seat for a large vehicle bomb*

Explosion Site (ES)	Open Storage/STANDARD	Type of Weapon	
Type of Explosive	ANFO	Total NEW (pounds)	4,000

Range (feet)	Time of Arrival (milliseconds [ms])	Incident Pressure (pounds per square inch [psi])	Incident Impulse (psi-ms)	Reflected Pressure (psi)	Reflected Impulse (psi-ms)
150.0	66.03	9.46	120.7	23.74	268.9
16.0	1.28	908.2	284.2	7749.71	5039.9
20.0	1.82	641.85	276.9	5094.58	3593.8
24.0	2.45	470.47	290.8	3495.06	2751.1
28.0	3.18	354.60	317.3	2470.44	2208.1
32.0	4.02	273.48	353.1	1788.56	1832.9
36.0	4.95	215.14	397.0	1322.09	1560.2
40.0	5.99	172.21	383.5	995.76	1354.1
45.0	7.43	133.23	357.3	715.69	1158.8
50.0	9.04	105.28	328.9	527.19	1010.3
55.0	10.81	84.76	302.1	397.18	894.0
60.0	12.73	69.40	278.2	306.54	800.7
80.0	21.81	35.72	211.1	126.85	561.1
100.0	32.85	21.71	170.2	66.35	429.6
120.0	45.35	14.75	146.3	40.73	347.1
140.0	58.92	10.81	128.2	27.86	290.8
160.0	73.30	8.38	114.0	20.55	250.0
180.0	88.28	6.77	102.6	16.01	219.2
200.0	103.69	5.64	93.2	12.98	195.0
240.0	135.45	4.18	78.8	9.28	159.7
280.0	167.99	3.29	68.2	7.16	135.2
320.0	201.02	2.71	60.1	5.80	117.2
360.0	234.38	2.29	53.8	4.87	103.3
400.0	267.98	1.99	48.6	4.18	92.4
500.0	352.77	1.48	39.3	3.08	73.1
600.0	438.54	1.18	32.9	2.42	60.4
700.0	525.17	0.97	28.3	1.98	51.4
800.0	612.55	0.82	24.9	1.66	44.7
900.0	700.51	0.71	22.1	1.43	39.5
1,000.0	788.84	0.61	19.9	1.24	35.4

Table 12-2. *Overpressure summary tables calculated using Department of Defense (DDESB) Blast Effects Computer, Version 5, dated 25 October 2001*

Vehicle Bomb Damage/Overpressure Template

Figure 12-2 will be replaced.

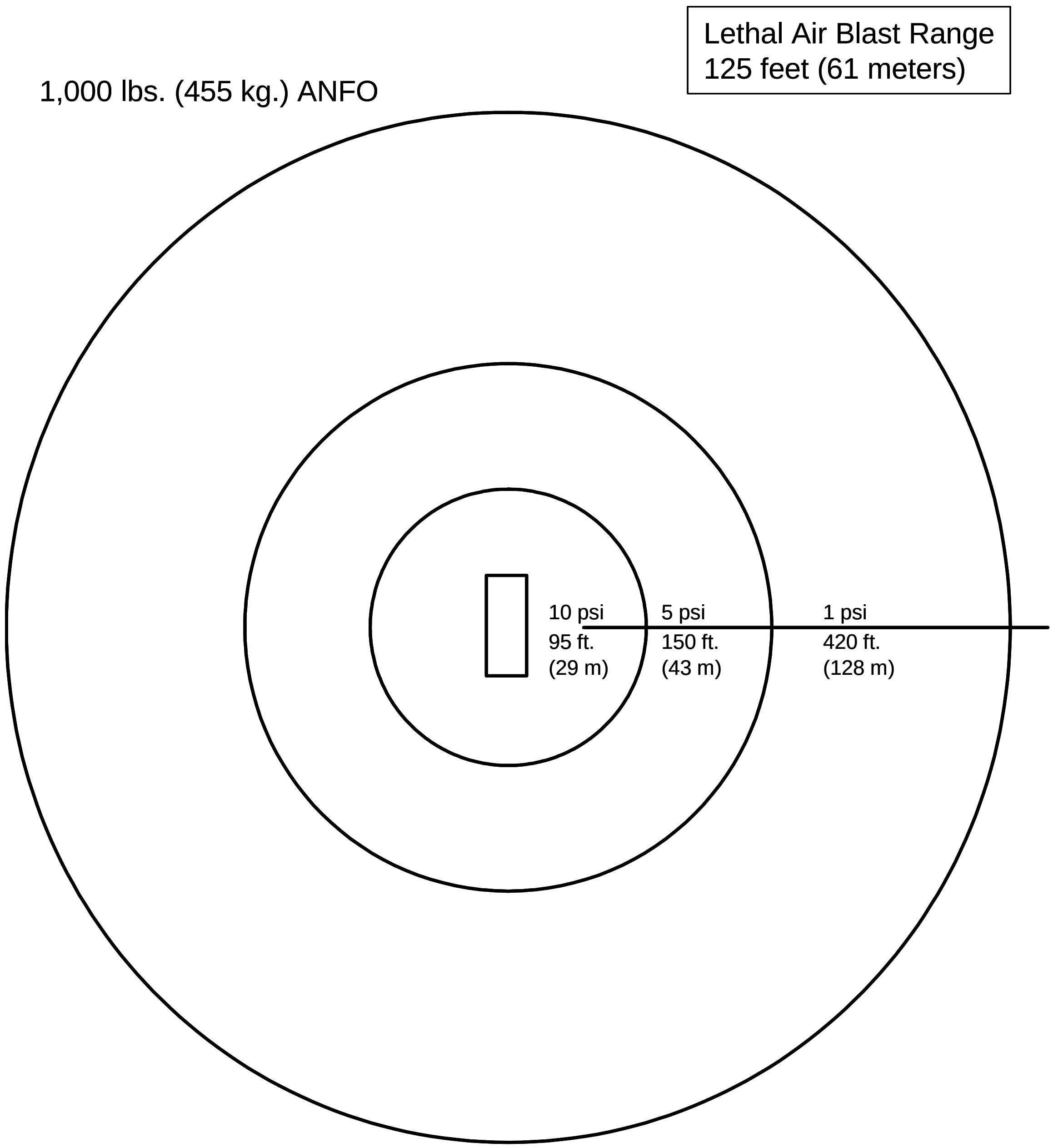


Figure 12-2. *Estimated overpressure (in pounds per square inch [psi]) at distance from the blast seat for a vehicle bomb*

Explosion Site (ES)	**Open Storage/ STANDARD**	**Type of Weapon**	**Bulk/Light Cased: STANDARD**
Type of Explosive	**ANFO**	**Total NEW** (pounds)	1,000

Range (feet)	**Time of Arrival** (ms)	**Incident Impulse** (psi-ms)	**Reflected Pressure** (psi)	**Reflected Impulse** (psi-ms)
92.0	39.81	77.8	25.24	174.6
16.0	1.70	188.2	3086.52	1597.6
20.0	2.50	220.8	1824.16	1167.3
24.0	3.45	246.5	1136.93	910.5
28.0	4.58	227.0	741.38	741.9
32.0	5.87	204.4	503.19	623.6
36.0	7.32	183.6	353.99	536.4
40.0	8.92	166.0	257.4	469.8
45.0	11.11	148.1	179.00	405.9
50.0	13.54	134.0	129.90	356.9
55.0	16.16	122.7	97.85	318.1
60.0	18.95	111.5	76.11	286.7
80.0	31.49	87.9	35.3	204.8
100.0	45.60	72.3	20.91	158.9
120.0	60.67	61.4	14.28	129.7
140.0	76.37	53.3	10.65	109.4
160.0	92.45	47.1	8.42	94.6
180.0	108.79	42.2	6.93	83.3
200.0	125.32	38.2	5.87	74.4
240.0	158.73	32.1	4.48	61.3
280.0	192.49	27.7	3.61	52.1
320.0	226.52	24.4	3.01	45.3
360.0	260.79	21.7	2.58	40.0
400.0	295.28	19.6	2.25	35.9
500.0	382.41	15.8	1.68	28.4
600.0	470.46	13.2	1.32	23.5
700.0	558.87	11.3	1.07	20.0
800.0	646.98	9.9	0.89	17.4
900.0	734.08	8.7	0.75	15.3
1,000.0	819.95	7.8	0.64	Out of range

Table 12-3. *Overpressure summary tables calculated using Department of Defense (DDESB) Blast Effects Computer, Version 5, dated 25 October 2001*

Suicide Bomb Blast Damage/Overpressure Template

120 lbs. (combined weight) TNT

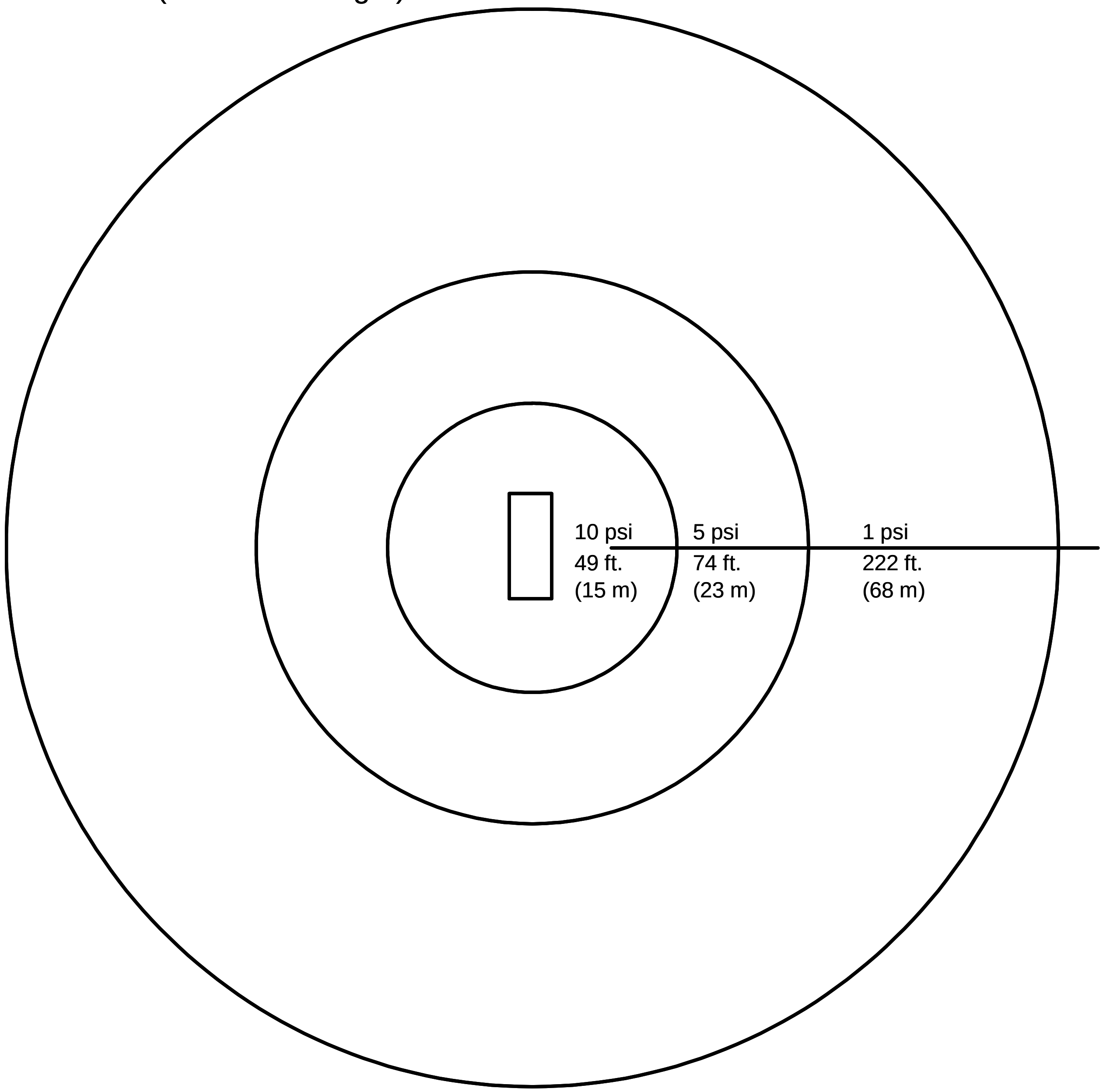


Figure 12-3. *Estimated overpressure (in pounds per square inch [psi]) at distance from the blast seat for combined suicide bombs*

Explosion Site (ES)	**Open Storage/ STANDARD**		
Type of Explosive	**TNT**	**Total NEW** (pounds)	120.00

Range (feet)	**Time of Arrival** (ms)	**Incident Pressure** (psi)	**Incident Impulse** (psi-ms)	**Reflected Pressure** (psi)	**Reflected Impulse** (psi-ms)
50.0	22.12	9.32	39.6	23.31	88.1
16.0	2.81	113.32	111.7	580.17	348.5
20.0	4.27	68.11	91.3	298.96	262.0
24.0	6.01	44.67	76.5	170.41	208.9
28.0	8.02	31.38	66.2	107.04	173.2
32.0	10.24	23.31	57.8	72.73	147.6
36.0	12.64	18.11	52.5	52.57	128.5
40.0	15.21	14.50	48.1	39.89	113.7
45.0	18.58	11.43	43.4	29.80	99.3
50.0	22.12	9.32	39.6	23.31	88.1
55.0	25.79	7.80	36.4	18.89	79.1
60.0	29.56	6.67	33.7	15.75	71.8
80.0	45.31	4.13	25.9	9.15	52.3
100.0	61.66	2.94	21.0	6.33	41.1
120.0	78.31	2.27	17l.6	4.81	33.9
140.0	95.14	1.84	15.2	3.86	28.8
160.0	112.11	1.55	13.4	3.22	25.0
180.0	129.19	1.33	12.0	2.75	22.1
200.0	146.39	1.16	10.8	2.39	19.8
240.0	181.09	0.93	9.0	1.89	16.4
280.0	216.14	0.76	7.8	1.54	13.9
320.0	251.42	0.64	6.8	1.29	12.1
360.0	286.79	0.54	6.1	1.10	10.7
400.0	322.10	0.47	5.5	0.95	9.6
500.0	409.03	0.34	4.3	0.68	Out of range
600.0	495.13	0.26	3.6	0.53	Out of range
700.0	581.92	0.21	3.0	0.43	Out of range
800.0	669.31	0.18	2.6	0.35	Out of range
900.0	757.23	0.15	2.3	0.30	Out of range
1,000.0	845.61	0.13	2.1	0.26	Out of range

Table 12-4. *Overpressure summary tables calculated using Department of Defense (DDESB) Blast Effects Computer, Version 5, dated 25 October 2001*

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-inches to 12-inches thick, non-reinforced)
10.0	Probable total destruction of buildings

Table 12-6. *Sample property damage criteria data taken from the National Fire Protection Association (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 only occur following the illegal acquisition of sensitive information revealing detailed vulnerabilities of a specific production site. However, in this scenario the Universal Adversary (UA) is able to acquire these restricted documents due to a security lapse. The UA uses these sensitive documents and a high degree of careful planning to avoid apprehension and conduct a serious attack on the American people.

Detailed Attack Scenario –

In November, the UA operatives deliver liquid anthrax bacteria to pre-selected plant workers. On December 3, the order is passed to conduct the contaminations. At a beef plant in a West Coast State, two batches of ground beef are contaminated with anthrax, with distribution to a city on the West Coast, a southwest State, and a State in the northwest.

From December 5 through December 15, local 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 thirty people have been admitted for treatment, and four of them have died. Local doctors are unable to identify the illness; the Centers for Disease Control and Prevention (CDC) quickly become involved in order to achieve a diagnosis. The public becomes increasingly alarmed. Public and government concern becomes even more intense as similar outbreaks are reported in the other cities where the beef was distributed. For several days, there is intense speculation as to the nature and source of this mysterious and deadly illness.

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

On December 17, the department of health services in the West Coast city where the contaminated beef was distributed reports that preliminary findings of autopsies conducted on fatalities to an unknown illness indicates intestinal anthrax as the likely cause. Blood and tissue samples are sent to the State microbial diseases laboratory for further analysis. On December 18, this laboratory produces test results that show the presence of anthrax in blood samples drawn from patients in this city's outbreak victims. Other affected 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 genuinely ill. The CDC suspects a possible food-borne connection to the outbreaks; the United States Department of Agriculture (USDA) Food Safety and Inspection Service and the Department of Health and Human Services (HHS) Food and Drug Administration (FDA) pursue epidemiological investigations. Ground beef is considered a possible source of the outbreak, but specific warnings and targeted recalls are not yet possible due to the unknown source of the processed food. Because of the highly unusual nature of this type of 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. As of this 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 or not to vaccinate and treat the workers with antibiotics.

While no new cases seem to be appearing, there is uncertainty as to whether the outbreaks are contained. 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 –

- *Day minus 30 (D-30)*: The biological agent is delivered to terrorists (plant workers).
- *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 – D+12*: There is a significant influx of affected individuals into hospitals with 1,200 sick, 300 dead, and 400 hospitalized in 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.
- Sympathetic workers are in 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 suspects 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 & 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 of the States, a cattle rancher is the first to notice 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, upon examination of the animals, fears the existence of a FAD. Telephone calls are made to 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, 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 Emergency Operations Center (EOC) is ordered, and the State Highway Patrol and the State Animal Recovery Team are placed on alert.

On November 8 in a third State, a slaughterhouse 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 who, upon examining the animals, assesses 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 come to the site and assist in the field diagnosis in order to determine what additional precautionary actions need 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 in order 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 clinical observations reported by the diagnostician on site, 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 has determined 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 supporting the determination of 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 –

<u>Prevention/Deterrence:</u>

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

<u>Emergency Assessments/Diagnosis:</u>

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

<u>Emergency Management/Response:</u>

If the scope of the outbreak grows, the ability to effectively conduct intrastate and interstate command and control 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 for costs incurred, 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 in order to combat the public's fear and the spread of misinformation about the disease.

Hazard Mitigation:

The halt of national movement of susceptible animals (and of conveyances and animals in transit, among other things) will be seriously considered using a stop movement order. 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 leading to 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 modes, and other locations will require decontamination and cleanup.

Site Restoration: Cleaning and disinfecting are tools used to impede the spread of pathogenic microorganisms. In order 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 seriously 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 issues will be centered mostly on foreign trade.

Economic factors will include the value of the affected livestock that must be disposed of; the cost of 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 upon confirmation that the FAD exists; and the cost to renew the livestock lost to euthanasia.

Long-Term Health Issues –

The inevitable development and utilization 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. Although psychological impacts will be realized, human health issues will not be a consideration if a farm animal disease-causing agent is used.

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 undermines the Nation's confidence in the Internet, leading to economic harm for the United States. In this scenario, UA conducts cyber attacks against critical infrastructures reliant upon the Internet by using a sophisticated command and control (C2) 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 four phases.

Phase 1 ─ Attack Preparation

Objective: Construct an attack network with underlying encrypted C2 mechanisms with which to launch future attacks. This phase will last approximately 6 months or until several hundred thousand bots are populated in the attack network.

Event 1.1 Deploy mole software

Attack mechanism: Write a personal firewall and offer it free to schools and other non-profits in the United States. Get the software listed on the approved General Services Administration (GSA) security purchasing list. 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 loaded onto a victim's computer, the software will participate in the botnet.

Event 1.2 Design and build a bot

Attack Mechamism: Write a bot to scan and deploy using a wide variety of known/unknown vulnerabilities. The bot will communicate using the same C2 technology as the mole software.

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 C2 network using traditional, widely avaible tools and techniques

Attack Mechanism: Use traditional scanning and probing techniques in addition to the newly created tools to build the C2 network and botnet**.**

Phase 2 ─ Testing and Initial First Responder Pain

Objective: This phase has two goals. The first is to test the C2l network and the second goal is to start wearing down the first responder capabilities of the Internet Service Provider (ISP) community. 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.

Event 2.1 Targeted attacks on individual ISPs

Attack Mechanism: Use a sample number of the zombies to launch "well known" attacks. (e.g., Code Red II, Slapper, SQLSlammer)

Event 2.2 Targeted attacks on individual Domain Name Service (DNS) providers

Attack Mechanism: Use a subset of the zombies to launch "well known" DNS attacks against root, gTLDs, ccTLDs, and high profile domains. (e.g., .com, Microsoft.com, ebay.com).

Phase 3 – Broaden Attack Scope and Complexity

Objective: Add more complexities to the apparently random attacks and increase the duration of the attacks to further strain the ability of the first responders. The phase will last 4-to-6 weeks.

Event 3.1 Instill confusion with first responders

Attack Mechanism: Spam and forge messages to the first responder e-mails and mailing lists (i.e., soc@us-cert.gov, cert@cert.org, nanog@merit.edu). Expand the attacks described in Phase 2, but increase the number of simultaneous attacks and their durations.

Removing these key communications channels from first responders will instill distrust in the veracity of the information.

Event 3.2 Attack public Password Generator Protocol (PGP) key servers

Attack Mechanism: Generate forged PGP keys for key first responders and post these keys to public key servers like http://www.keyserver.net/en/ and http://pgp.mit.edu/.

Event 3.3 Attack NTP time servers

Attack Mechanism: Attempt to compromise the NTP Time Servers. Compromised servers can have their clocks randomly "adjusted" as much as the slew will permit. This will cause authentication credentials to expire prematurely, audit and log records to have incorrect time stamps, and other failures.

Event 3.4 Forge Address Resolution Protocol (ARP) replies

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

Event 3.5 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 4 – Massive Network Outages

Objective: Attack major Internet services to undermine consumer and government confidence in the functionality of the Internet. This phase will last at least 4 weeks or longer, if necessary.

Event 4.1 Attack DNS functionality

Attack Mechanism: Attack DNS root and major domain servers. Both Distributed Denial of Service (DDoS) attacks and cache poisoning tools would be used to disrupt the integrity of the DNS infrastructure. Each instance of this event will last 24 hours, with additional attacks after service is restored. Cache poisoning efforts will last for the duration of the Time to Live (TTLs) (e.g., years) unless detected by DNS operators.

Event 4.2 Disable firewall capabilities

Attack Mechanism: This attack utilizes the mole software installed in Phase 1. Using either a software update or another predefined method, the underlying firewall functionality can be disabled, but forged logs and other indicators will deceive administrators into thinking the firewall is still functioning properly.

Event 4.3 Disable web services

Attack Mechanism: Conduct DDoS attacks against the web sites and their upstream providers. These attacks will ultilize zombies from both inside and outside organizations.

Event 4.4 Disrupt Internet routing

Randomly inject default routes: As DDoS attacks are underway, injecting default routes will result in lost and misdirected e-mail, presumably affecting first responder capabilities to communicate and mitigate the other attacks.

Event 4.5 Disclose parts of C2 network

Attack Mechanism: Disclose IP addresses, C2 mechanisms via newsgroups, listserv, etc. Allow C2 network to be morphed by other attackers and further increase the level and types of attacks. This will allow the overall Internet instability to continue for a long period.

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.
- UA can avoid tipping off U.S. intelligence by using U.S.-based hosting companies as it gathers resources for the attack.
- C2l 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 infrasture is not at great risk, Internet software deteroriates, 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 (1) technically bringing systems back online and instituting business continuity process, and (2) controlling the public perception of the situation to restore confidence and prevent panicky behaviors.

Hazard Mitigation:

All ISPs, DNS operators, and other organizations will need to evaluate their network topologies, diversity, integrity of back-up 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.