JOINT REGIONAL INTELLIGENCE CENTER

BULLETIN

16 August 2017

(U//FOUO) NUCLEAR ATTACK RESPONSE CONSIDERATIONS

(U) KEY POINTS

(U//FOUO) **A nuclear attack in the Joint Regional Intelligence Center area of responsibility (JRIC AOR) would lead to devastating casualties and critical infrastructure damage, and extended elevated radiation levels.**

- (U//FOUO) **Readers are encouraged to familiarize themselves with their agency's radiological and nuclear emergency response plans, and identify their emergency preparedness and response roles and responsibilities.** Pre-incident preparedness will reduce the number of casualties and enable effective response.
- (U//FOUO) **Electromagnetic pulse (EMP) may severely impact communication and other vital infrastructure, hindering effective response**.
- (U//FOUO) **Existing federal, state, and local capabilities and resources will be overwhelmed**; prioritization of capabilities and resources will be required.
- (U//FOUO) **There will be no significant federal assistance at the scene for 24–72 hours following the attack**. The full extent of federal resources will not be available for several days.
- (U//FOUO) **Immediate shelter, followed by evacuation, will be required for the general public**. With limited understanding of radiation risks, they will experience high anxiety and may be non-compliant.
- (U//FOUO) **Initial radioactivity levels will drop by more than half in the first hour and by more than 80 percent in the first day**.

(U) RADIATION PROTECTION BASICS

(U) **EVERYONE SHOULD SEEK SHELTER, REGARDLESS OF PROXIMITY TO GROUND ZERO OR ORIENTATION TO THE PATH OF FALLOUT.**[1] Protective actions include:

(U) **Initial Protection** | Lie face down and place hands under the body to protect exposed skin. Remain flat until the heat and shock waves have passed.

(U) **Respiratory Protection** | Extremely important; prevent internal contamination by holding a cloth over mouth and nose.

(U) **Decontamination** | If possible, remove clothing and shower to minimize skin burns due to radioactive particles; in an emergency, brush off visible particle contamination.

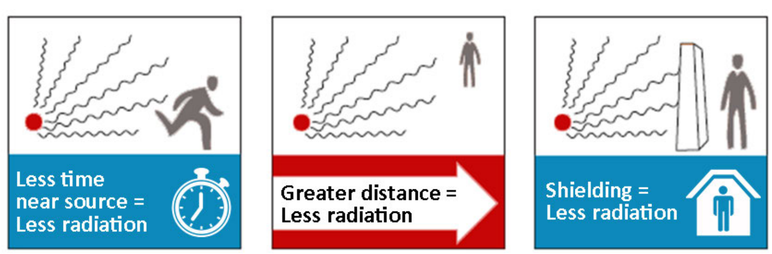
(U) **Food and Water** | Minimize ingestion of contaminated water and food to prevent internal contamination.

(U) **Three factors limit exposure to radiation and fallout:**[2]

(U) **Time** | Fallout radiation loses intensity rapidly. Radioactivity levels will drop significantly in the first hour after the explosion.

(U) **Distance** | More is better. An underground area such as a home or office building basement offers more protection than the first floor of a building. Doubling the distance from a radiation source reduces exposure four-fold.

(U) **Shielding** | Heavier and denser materials—thick walls, concrete, bricks, or earth—provide better protection. Exposure is reduced by about 50 percent inside a one-story brick building and by about 90 percent one level below ground. Cars and wooden houses also offer limited protection.



(U) Radiation protection. *Source: JRIC, based on US NRC graphic.*

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(U) BACKGROUND

(U//FOUO) On 30 July 2017, North Korea tested an intercontinental ballistic missile (ICBM) that appeared capable of reaching the West Coast of the United States. North Korea's propaganda videos feature ruins of San Francisco and Washington, DC. Other nefarious actors, including terrorist groups, may seek to obtain and use nuclear weapons or improvised nuclear devices (INDs) in the United States.

(U//FOUO) In light of North Korea's growing nuclear capability, the JRIC is providing an overview of general considerations for responding to a nuclear attack in the JRIC AOR.

(U) NUCLEAR EXPLOSIONS: THE BASICS

(U) The destructive forces associated with a nuclear explosion vary with the location of the point of burst in relation to the surface of the earth:

- (U) **High-Altitude Burst** | Detonation occurs above 100,000 feet; destructive forces do not significantly affect the ground. A high-altitude burst may produce an electromagnetic pulse (EMP; see page 3 below).[5,6]
- (U) **Airburst** | Detonation is below 100,000 feet. Because the fireball does not reach the ground and does not pick up any surface material, radioactivity in fallout from an airburst is relatively insignificant compared with a surface (ground) burst.[7]
- (U) **Surface (Ground) Burst** | Detonation occurs at or slightly above the surface of the earth and generates considerable radioactive debris (fallout).[8,9]
- (U) **Sub-surface Burst** | Detonation occurs underground or under water; depth determines destructive forces on the surface.[10,11]

(U) Nuclear explosions are classified based on the amount of energy ("yield") they produce and can be millions of times more powerful than the largest conventional explosions.

(U) The energy yield of a nuclear explosion takes three forms: thermal radiation (light and heat), blast or shock effect, and nuclear radiation. The energy released by a nuclear explosion depends on the design of the weapon and the altitude of the explosion, but is approximated as 50 percent blast and shockwave; 35 percent heat; 5 percent initial radiation; and 10 percent fallout radiation:

- (U) **Thermal Radiation** | Temperatures at the center of a nuclear explosion can reach tens of millions of degrees. Lethality will vary

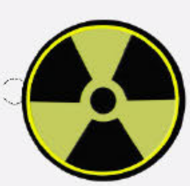
(U) Ionizing Radiation: A Primer[3,4]

(U) Uranium-235 and plutonium-239 isotopes[i] are key materials in nuclear weapons.

(U) A nuclear weapon explosion releases ionizing radiation primarily in the form of gamma rays and beta and alpha particles, which vary in rates of decay (half-life) and radioactivity. Very short and very long half-life isotopes present limited health risks compared with medium length half-life isotopes (from months to decades).

(U) The ability of a radionuclide to cause harmful health effects depends on the type of ionizing radiation it produces:

- (U) **Gamma Radiation and X-rays** | High-energy waves penetrate deeply into the body, or pass through it. Gamma radiation and x-rays are damaging to human tissue, and blocking them usually requires thick layers of concrete or lead.
- (U) **Beta Particles** | Fast-moving and able to travel through several feet of air, they penetrate further than alpha particles. Unless ingested or inhaled, beta particles pose little health danger, although direct contact with a strong source can cause serious burns.
- (U) **Alpha Particles** | Have high energy, but due to their large mass, do not travel far. Alpha radiation is blocked by skin, clothing, or even a sheet of paper. Alpha particles are dangerous carcinogens when inhaled or ingested.



(U) International symbol for ionizing radiation. Within the United States, this may be rendered as magenta on yellow, or black on yellow. *Source: ISO.org*

[i] (U) A radionuclide (radioactive nuclide, radioisotope, radioactive isotope, or isotope) is an atom that has excess nuclear energy, making it unstable and prompting it to release this energy as gamma radiation, create and emit a new particle (alpha particle or beta particle), or transfer the excess energy to one of its electrons. During those processes, the radionuclides undergo radioactive decay and emit radiation (energy). The terms are used interchangeably in this document.

with nuclear yield and position of the burst relative to the earth's surface. Close to the fireball, infrastructure and humans are incinerated. Although temperatures fall off rapidly with increasing distance, a nuclear blast is capable of causing skin burns and setting fires at considerable distances. Secondary fires may occur due to ignition of broken gas lines and ruptured fuel tanks.[12, 13]

(U) The 1952 Ivy Mike nuclear test; *Source: Atomic Heritage Foundation*

- (U) **Blast and Shock Effect** | In addition to thermal radiation, immediate destructive action and injuries are produced by a shockwave racing away from the explosion which can cause significant structural damage. Injuries caused by collapsing structures will likely exceed those from blast injuries.[14, 15]
- (U) **Nuclear Radiation** | Radiation from a nuclear explosion is divided into two categories: initial nuclear radiation and residual nuclear radiation (radioactive fallout).
  - (U) **Initial Nuclear Radiation** | Radiation emitted within the first minute after a nuclear explosion, composed mainly of gamma rays and neutrons; can produce harmful health effects even at a large distance from the source.[16, 17]
  - (U) **Radioactive Fallout** | In surface (ground) burst nuclear explosions, large quantities of pulverized earth and other debris are sucked up into the nuclear cloud. Radioactive gases created by the explosion condense on and into debris, producing radioactive particles known as fallout. It is impossible to predict what areas would be affected by fallout or how soon particles would fall back to earth at a particular location. Fallout volume and impact would depend upon the number and size of weapons, and explosion location(s). Distribution of fallout would be determined by topography and meteorological conditions, especially wind direction. The most hazardous fallout particles are readily visible as fine sand-sized grains. However, lack of apparent fallout should not suggest lack of radiation. These radioactive materials will emit gamma rays, and alpha and beta particles. Even if individuals are not close enough to a nuclear blast to be affected by the energy yield, they may be affected by fallout.[18, 19, 20]
- (U) **Electromagnetic Pulse (EMP)** | In a high-altitude nuclear detonation, the large quantity of gamma radiation absorbed by the surrounding air and ground will create a quick pulse of electromagnetic waves. This does not pose a biological hazard to people, except those with pacemakers or other implanted electronic devices. Electrical components attached to power lines or with antennas longer than 30 inches may be severely damaged; this could range from a minor interruption to a burnout of components. Most electronic equipment, including communication systems, computers, electrical appliances, and automobile and aircraft ignition systems could be affected. Aircraft in flight could be affected by EMP. Impacts on communications systems present serious threats to effective response.[21, 22, 23]

(U) KEY ASSUMPTIONS

(U//FOUO) A nuclear attack in the United States will have severe repercussions for government operations, infrastructure, the environment, and the overall health and well-being of citizens of the JRIC AOR, even if the AOR was not directly targeted. The consequences of a nuclear attack in Southern California[ii] would be catastrophic. Nonetheless, government

[ii] (U) See Appendix 1 for an abbreviated version of a nuclear bomb terrorist scenario in the Greater Los Angeles Region, developed by the Rand Corporation. A detailed scenario can be obtained at: http://www.rand.org/content/dam/rand/pubs/technical_reports/2006/RAND_TR391.pdf

[redacted]

entities and first responders are expected to remain operational to preserve human life, maintain order, and aid in the recovery process.

(U//FOUO) Pre-incident preparedness will reduce the number of casualties and allow a more effective response.[24] The following are key assumptions about a nuclear attack directly targeting the JRIC AOR:

(U//FOUO) **DAMAGE** | There will be extended, elevated radiation levels, destroyed or heavily damaged buildings, downed power lines, ruptured gas and water lines, airborne chemicals, sharp metal objects, broken glass, fires, and other hazards. Critical infrastructure damage may include impassable roads, destroyed bridges, and heavily damaged and inoperable communications, electricity distribution, and water supply systems.[25, 26]

(U//FOUO) **CONTINUITY** | Continuity of government/operations (COG/COOP) plans will be activated, but basic government, first response, and emergency operations will be threatened by significant casualties and destruction of critical infrastructure and key resources.

(U//FOUO) **COORDINATION** | Public health agencies in the JRIC AOR will conduct environmental monitoring and offer key guidance for minimizing exposure, decontamination, and food/water safety. An extraordinary level of intergovernmental coordination will be required to effectively manage and deploy limited resources for medical response, health care, emergency services, law enforcement, protective activities, emergency management functions, and technical expertise.

(U//FOUO) **RESOURCES** | Inventory, assessment, and prioritization of existing federal, state, and local capabilities and resources in the region will be necessary to help overcome the inability to request assistance through established routine protocols. Significant strain on communities within the JRIC AOR will produce intense competition for limited resources.[27]

(U//FOUO) **SELF-SUFFICIENCY** | Federal assistance will be mobilized as rapidly as possible; however, there will be no significant federal response at the scene for 24–72 hours following the attack, and the full extent of federal assistance will not be available for several days.[28]

(U//FOUO) **AD-HOC RESPONSE** | Surviving officials and first responders, including law enforcement, fire/emergency medical technicians (EMT), and medical personnel will be expected by their communities to spearhead the response to and the recovery from the attack.[29]

(U//FOUO) **TRIAGE** | The large number of casualties and requirements for immediate shelter to protect from fallout, followed by evacuation (when it is safe to do so), triage, casualty assessment, and medical care needs will quickly overwhelm the JRIC AOR and the State of California.[30]

(U//FOUO) **PUBLIC SAFETY** | Ongoing public messaging and tactical alert measures will be needed to manage public understanding of radiation risks, assuage high anxiety, and compel compliance with public safety orders. Social, psychological, and behavioral impacts will be widespread and profound, affecting how the incident unfolds and the severity of consequences.[31]

(U//FOUO) **CONTAMINATION** | Ground and water systems, existing food supplies, livestock, crops, and wildlife will be contaminated. The specific characteristics of the nuclear explosion and meteorological conditions will affect the extent of environmental contamination and subsequent response actions.[32]

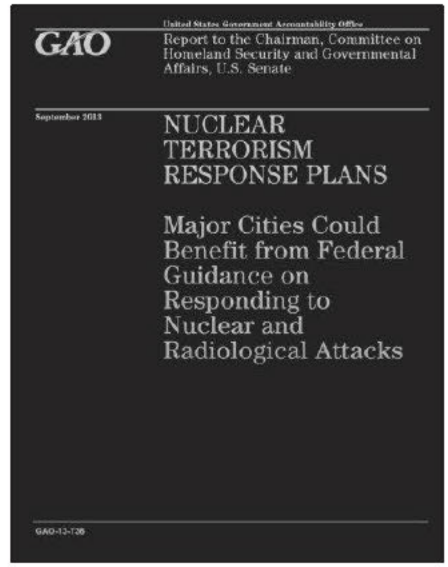
(U) EXISTING PREPAREDNESS FRAMEWORK

(U//FOUO) ***Readers are encouraged to familiarize themselves with these and their department's plans and identify their emergency preparedness and response roles and responsibilities.***

(U//FOUO) **Federal** | The general principles of emergency response by the United States Federal Government to a significant incident are outlined in the *National Response Framework*.[33] The Federal Government's response to a nuclear or radiological incident is further detailed in the *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans*.[34] The *National Response Framework* and the *Annex* would provide overarching guidance for the federal response following a nuclear attack in the JRIC AOR.

(U//FOUO) **State** | The *State of California Emergency Plan* outlines a state-level strategy to support local government efforts during a large-scale emergency.[35] The State of California will support the JRIC AOR following a nuclear attack in accordance with the principles established in the *Emergency Plan*.

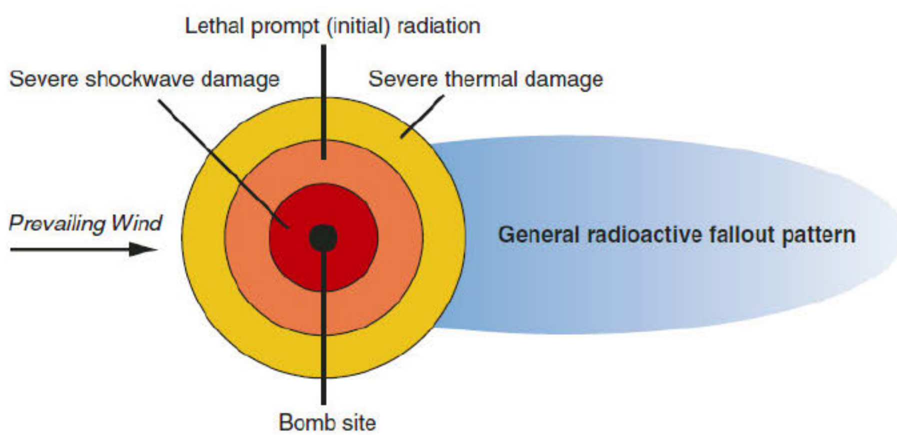
(U//FOUO) **Local** | Significant planning and exercise efforts for a nuclear attack have been performed by individual agencies and communities within the JRIC AOR over the years. Auxiliary plans—including COG/COOP, mass casualty/fatality, civil unrest, evacuation, mass prophylaxis, and other plans—have been developed and will be utilized following a nuclear attack.


United States Government Accountability Office
GAO
Report to the Chairman, Committee on Homeland Security and Governmental Affairs, U.S. Senate
September 2013
NUCLEAR TERRORISM RESPONSE PLANS
Major Cities Could Benefit from Federal Guidance on Responding to Nuclear and Radiological Attacks

(U) A 2013 Government Accountability Office Report examined characteristics of nuclear attacks, assessed at-risk cities, and their core capabilities for all hazards preparedness and response planning. *Source: US Government Accountability Office, report GAO-13-736.*

(U) CRITICAL SHORT-TERM CONSIDERATIONS

(U//FOUO) A nuclear explosion will produce a devastating number of casualties in a densely populated area due to the shockwave, thrown bodies, flying debris, and collapsed structures. Thermal energy, including the fireball and subsequent fires, will cause additional fatalities and injuries.[36, 37]



(U) Representation of the general pattern of damage and fallout; *Source: DHS*

(U//FOUO) Dangerous levels of initial nuclear radiation will affect those within a half-mile of ground zero. Fallout radiation will affect those within 10–20 miles (16–32 km) downwind from the explosion, in what is known as the dangerous fallout (DF) zone.[iii]

(U//FOUO) Any response operations within the DF zone must be justified, optimized, and planned.[38, 39]

[iii] (U) The dangerous fallout (DF) zone is the area in which fallout that impacts responder life-saving operations and/or has acute radiation injury potential to the population.

(U) INITIAL RESPONSE OPERATIONS: COMMUNICATIONS

(U//FOUO) Communications infrastructure impacts will include:

- (U//FOUO) Limited resources and mobility within the impacted area hindering attempts to repair and reestablish communications.
- (U//FOUO) Disruption or degradation of wireless communications transmissions in the hours following a detonation due to EMP or the presence of ionizing radiation.
- (U//FOUO) Communication volume exceeding bandwidth capacity, causing voice and data congestion.
- (U//FOUO) Damage to communications infrastructure and/or the electrical grid, limiting the effectiveness of equipment brought in from unaffected areas.[40, 41]

(U) INITIAL RESPONSE OPERATIONS: CONTAMINATION

(U//FOUO) **Ground radiation level monitoring will be imperative for the responders' safety**. Contamination from fallout may preclude response actions before sufficient radioactive decay has occurred. However, fallout will be subject to rapid radioactive decay and the DF zone will quickly shrink. Initial radioactivity levels will drop by more than half in the first hour and by more than 80 percent in the first day.[42, 43]

(U) INITIAL RESPONSE OPERATIONS: FUNCTIONS AND PRIORITIES

(U//FOUO) **The main objective of early response efforts is preservation of life.** Responder units within 1-2 miles of ground zero at the time of a nuclear explosion are likely to be compromised or nonfunctional. Response capabilities away from ground zero will depend on fallout levels and capability to physically reach affected areas.[44, 45]

(U//FOUO) Search and rescue and medical triage mission prioritization will be dictated by the nature and magnitude of impacts. Close to ground zero, victim survivability is very low, and the total risk (radiation and physical hazards) to responders is very high. Other zones will have varying injury volume and severity, guiding deployment of limited resources.[46, 47]

(U) INITIAL RESPONSE OPERATIONS: WORKERS' SAFETY

(U//FOUO) In addition to radiation, emergency response workers will face widespread fires, collapsing structures, chemical exposure, smoke/dust inhalation, and numerous other physical hazards.

(U//FOUO) Worker safety programs in the aftermath of a nuclear attack should adhere to the following principles:

- **Justification** | The benefit of the operation—the number of survivable victims rescued—should outweigh the risk of the operation to the responders.
- **Optimization** | The magnitude of the individual impact (radiation dose, or chemical or physical injury), the number of people impacted, and the likelihood of incurring such impacts should be minimized.
- **Limitation** | Radiation doses should be capped.[48, 49]

(U//FOUO) **Potassium iodide (KI)** | KI is effective in protecting the thyroid against the radioisotope iodine-131 (I-131). I-131 releases have occurred most frequently after incidents involving nuclear reactors like Chernobyl and Fukushima. Nuclear bomb detonation produces a small amount of local I-131 fallout. Most

I-131 distributes over large distances, typically with only 10 percent making its way to the earth's surface before undergoing spontaneous radioactive decay to stable xenon-131.[50]

(U) PUBLIC SAFETY CONSIDERATIONS: SHELTERING/EVACUATIONS AND SUSTENANCE

(U//FOUO) Shelters such as houses with basements, large multi-story structures, and parking garages or tunnels can generally reduce doses from fallout by a factor of 10 or more. Vehicles and single-story wood frame houses without basements provide only minimal shelter from radiation.[51, 52]

(U//FOUO) No evacuation should be attempted until basic information is available regarding fallout distribution and radiation dose rates. Evacuations should be prioritized based on fallout pattern and radiation intensity, availability and adequacy of shelter, impending hazards (e.g., fire and structural collapse), medical and special population needs, availability of food and water), and operational and logistical considerations.[53, 54]

(U//FOUO) Decontamination of persons is generally not a lifesaving issue. Simply brushing off outer garments may be sufficient protection until more thorough decontamination can be accomplished.[55, 56]

(U//FOUO) Food in sealed containers and in a refrigerator or freezer would be safe to eat. Bottled water will be free of radioactive contamination. Boiling tap water does not get rid of radioactive material. Radiation can be passed through breast milk. If possible, infants should be fed baby formula until further guidance. A damp towel or cloth should be used to clean all food cans, bottles, packaged foods, counters, plates, pots, and utensils before using them. Cleaning cloths should be sealed in a plastic bag and placed away from people and animals.[57]

(U) PUBLIC SAFETY CONSIDERATIONS: EARLY MEDICAL CARE

(U//FOUO) ***There is currently no federal or international consensus on medical triage systems for radiation mass casualty incidents.*** Life-saving tasks will take precedence over external radiation decontamination from fallout or visible debris. Conventional clinical standards of care will be modified to contingency and crisis standards of care to maximize the number of lives saved. Responders will encounter blast, radiation, and heat (or secondary fire) injuries.[58, 59]

(U//FOUO) The US Department of Health and Human Services provides guidelines and information for patient triage and treatment following a nuclear or radiological incident, including management and treatment of combined physical injuries and radiation exposure (for example, decontamination of open wounds or burns combined with high radiation exposure).[60, 61]

(U) PUBLIC SAFETY CONSIDERATIONS: FATALITY MANAGEMENT

(U//FOUO) The disposition of human remains will be complicated by internal and external radiological contamination. Special considerations for personnel handling and processing remains, waste, and final disposition may be required.[62, 63]

(U) PUBLIC SAFETY CONSIDERATIONS: POPULATION MONITORING AND DECONTAMINATION

(U//FOUO) ***Identification of individuals whose health is in immediate danger and require urgent care to prevent acute radiation health effects is the immediate priority of any population monitoring plan***. There is no universally accepted threshold of radioactivity (external or internal) above which a person is considered contaminated, and below which a person is considered uncontaminated.

- (U//FOUO) In most cases, external decontamination can be self-performed by brushing off large particles.[64, 65]

- (U//FOUO) Removing the outer layer of clothing can eliminate up to 90 percent of radioactive material. If possible, clothing should be bagged and kept away from humans and animals.
- (U//FOUO) As soon as feasible, a shower with copious soap and water will help remove radioactive contamination. Individuals should be advised against scrubbing, showering in very hot water, or using hair conditioner. If a shower is not feasible, using a clean wet cloth to gently blow the nose and wipe eyelids, eyelashes, ears, and skin not covered by clothing is recommended.[67]
- (U//FOUO) Decontamination of pets and service animals should be considered, since contaminated pets can present a health risk to pet owners, especially to children who pet them.[68, 69]
- (U//FOUO) Use of contaminated personal or mass transit vehicles for evacuation should not be discouraged in the initial days following a nuclear detonation; however, vehicles should be rinsed or washed.[70]

(U) CRITICAL LONG-TERM CONSIDERATIONS

(U) Long-term Health Consequences

(U//FOUO) Moderate to large radiation doses are known to increase lifetime incidence of cancer, and any radiation dose is assumed to contribute to an increased risk of cancer.[71]

(U) Waste Management

(U//FOUO) Cleanup of the most contaminated areas will not be feasible in the near term. Existing infrastructure for radioactive waste storage, transport, treatment, and disposal is not sufficient to handle the magnitude of waste produced by a large-scale nuclear incident. Close coordination between federal, state, tribal, territorial, and local jurisdictions will be necessary to identify suitable temporary management/storage sites.[72]

(U) Economic Impact

(U//FOUO) Access to business capital, embargos, decontamination of private property, unemployment from displaced businesses and employees, and disruption of supply chains may have long-term local and nationwide economic impacts.[73]

(U) Sign used to mark emergency shelters for nuclear and chemical warfare fallout in the United States*:* *Source: http://www.civildefensemuseum.com*

(U//FOUO) A nuclear incident will pose dilemmas about rebuilding communities and businesses. Evacuees from the impacted area may require permanent relocation.[74]

(U//FOUO) Agricultural embargos or stop-movement orders may be placed on the agriculture industry, as well as other goods and conveyances.[75, iv]

(U) SUGGESTED ADDITIONAL READING

- (U) California Office of Emergency Services (Cal OES); *State of California Emergency Plan*; July 2009; http://www.caloes.ca.gov/PlanningPreparednessSite/Documents/00%20SEP%207-01-09%20covrev%20(12).pdf

[iv] (U) See Appendix 1 for an economic impact scenario developed by the Rand Corporation. A detailed scenario can be obtained at: http://www.rand.org/content/dam/rand/pubs/technical_reports/2006/RAND_TR391.pdf

[redacted]

- (U) United States Environmental Protection Agency; *PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents*; January 2017; https://www.epa.gov/sites/production/files/2017-01/documents/epa_pag_manual_final_revisions_01-11-2017_cover_disclaimer_8.pdf
- (U) DHS, *National Response Framework*; June 2016; https://www.fema.gov/media-library-data/1466014682982-9bcf8245ba4c60c120aa915abe74e15d/National_Response_Framework3rd.pdf
- (U) DHS, FEMA; *Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans*; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf
- (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation*; *June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf

(U) US test launch of Titan II ICBM at Vandenberg Air Force Base, mid-1970s; *Source: National Museum of the US Air Force, Photo 140124-F-DW547-006*

- (U) RAND Corporation; Charles Meade, Roger C. Molander, *Considering the Effects of a Catastrophic Terrorist Attack*; 2006; https://www.rand.org/content/dam/rand/pubs/technical_reports/2006/RAND_TR391.pdf

(U) REPORTING, QUESTIONS, FEEDBACK

(U) To report suspicious activity to the JRIC, visit www.jric.org or call (562) 345-1100.

(U) To provide feedback about this product, please complete the online survey.

(U) Appendix One: RAND Corporation Catastrophic Nuclear Attack in the Greater Los Angeles Area Scenario[76]

(U) In the RAND scenario, terrorists conceal a 10-kiloton nuclear bomb in a shipping container and ship it to the Port of Long Beach. Unloaded onto a pier, it explodes shortly thereafter in a surface (ground) burst explosion. The scenario is highly likely to have a catastrophic effect, and the target is both a key part of US economic infrastructure and a critical global shipping center.

(U) Both short- and long-term repercussions of the attack could be overwhelming, particularly within the first 72 hours. The attack would devastate a vast portion of the Los Angeles metropolitan area. Because surface (ground) burst explosions generate particularly large amounts of highly radioactive debris, fallout from the blast would cause much of the destruction. In some of the most dramatic possible outcomes:

- (U) 60,000 people might die instantly from the blast itself or quickly thereafter from radiation poisoning.
- (U) 150,000 people might be exposed to hazardous levels of radioactive water and sediment from the port, requiring emergency medical treatment.
- (U) The blast and subsequent fires might completely destroy the entire infrastructure and all ships in the Port of Long Beach and the adjoining Port of Los Angeles.
- (U) 6,000,000 people might try to evacuate the Los Angeles region.
- (U) 2,000,000-3,000,000 people might need relocation because fallout will have contaminated a 500-km^2 area.
- (U) Gasoline supplies might run critically short across the entire region because of the loss of Long Beach's refineries—responsible for one-third of the gas west of the Rockies.

Table 1
Nuclear Weapon Effects

Effects	Comments
Immediate effects	
Blast wave	The blast wave is a pulse of pressure emanating from the explosion. For a 10-kiloton airburst, the blast wave would destroy most buildings to a radius of approximately one mile. For a surface explosion, the radius is reduced to approximately 0.6 miles.[a]
Flash radiation	Electromagnetic radiation, over a broad spectrum, emanates from the explosion. Because it is attenuated by air, the intensity decreases with distance. For a 10-kiloton airburst, everyone will be killed by lethal doses of flash radiation to a distance of 0.7 miles.[b] These effects would be attenuated by ground burst.
Delayed effects	
Radioactive fallout	The extent of fallout is sensitive to local wind conditions. If the fireball from the explosion does not touch the ground, fallout is limited to the particulate matter in the atmosphere. In contrast, ground bursts create large amounts of fallout by entraining surface materials in the nuclear reactions of the explosion. This fallout can be deposited over hundreds of square kilometers, creating regions that would be uninhabitable for at least several years.[a]
Fire	Fires are started by flash radiation and by disruptions from the blast wave. The spread of fire is largely controlled by the nature of local construction and geographic factors on the ground. Although the nuclear explosion in Nagasaki was almost twice as large as that at Hiroshima (22 kilotons compared with 12.5 kilotons), the area devastated by fire was four times as large in Hiroshima.[a]

[a] Samuel Glasstone and Philip J. Dolan, eds., *The Effects of Nuclear Weapons*, 3rd ed., Washington, D.C.: U.S. Department of Defense, U.S. Department of Energy, 1977.

[b] National Council on Radiation Protection & Measurements, *Management of Terrorist Events Involving Radioactive Material: Recommendations of the National Council on Radiation Protection and Measurements*, Bethesda, Md.: National Council on Radiation Protection & Measurements, Report No. 138, October 2001.

[redacted]

Table 2
Notional Direct Costs of a Long Beach Port Nuclear Explosion

Loss	Estimated Loss	Comments on Estimates
600,000 homes lost	$300 billion	Estimated ~ $500,000 per home
60,000 lives lost	$20 billion	Estimated ~ $350,000 in insurance benefits per life[a]
200,000 workers' compensation claims	$80 billion	Estimated ~ $400,000 per claim[b]
Port and surrounding infrastructure damage	$100 billion	Estimated
3 million people evacuated for three years	$300 billion	Estimated ~ $100 per diem per person
1 billion commercial square footage lost	$200 billion	Estimated ~ $200 per square foot[c]
Total	~ $1 trillion	

[a] This was the average life insurance payment for deaths from 9/11. If the payments from the Victims Compensation Fund were included, the value would be almost an order of magnitude larger. See Dixon and Stern, 2004.

[b] Estimated average claim from 9/11. See Dixon and Stern, 2004.

[c] Estimates of commercial construction costs in southern California from Charles Meade, Jonathan Kulick, and Richard Hillestad, *Estimating the Compliance Costs for California SB1953,* Oakland, Calif.: California HealthCare Foundation, 2002. Online at http://www.calhealth.org/public/press/Article%5C103%5CFinal%20RAND%20Report.pdf (as of May 18, 2006).

(U) ENDNOTES

[1] (U) National Academies and DHS; *News & Terrorism: Communicating in a Crisis. Nuclear Attack*; https://www.dhs.gov/xlibrary/assets/prep_nuclear_fact_sheet.pdf; accessed on 7 August 2017.

[2] (U) DHS; Nuclear Blast, https://www.ready.gov/nuclear-blast; accessed on 7 August 2017.

[3] (U) Institute for Energy and Environmental Research; Fissile Material Basics; https://ieer.org/resource/factsheets/fissile-material-basics/; accessed on 7 August 2017.

[4] (U) United States Nuclear Regulatory Commission (US NRC); Radiation Basics; https://www.nrc.gov/about-nrc/radiation/health-effects/radiation-basics.html; accessed on 7 August 2017.

[5] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[6] (U) US Department of Health & Human Services; *Nuclear Detonation: Weapons, Improvised Nuclear Devices*; https://www.remm.nlm.gov/nuclearexplosion.htm; accessed on 7 August 2017.

[7] (U) US Department of Health & Human Services; Radiation Emergency Medical Management, https://www.remm.nlm.gov/dictionary.htm; accessed on 8 August 2017.

[8] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[9] (U) US Department of Health & Human Services; *Nuclear Detonation: Weapons, Improvised Nuclear Devices*; https://www.remm.nlm.gov/nuclearexplosion.htm; accessed on 7 August 2017.

[10] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[11] (U) US Department of Health & Human Services; *Nuclear Detonation: Weapons, Improvised Nuclear Devices*; https://www.remm.nlm.gov/nuclearexplosion.htm; accessed on 7 August 2017.

[12] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[13] (U) National Academies and DHS; *News & Terrorism: Communicating in a Crisis. Nuclear Attack*; https://www.dhs.gov/xlibrary/assets/prep_nuclear_fact_sheet.pdf; accessed on 7 August 2017.

[14] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[15] (U) National Academies and DHS; *News & Terrorism: Communicating in a Crisis. Nuclear Attack*; https://www.dhs.gov/xlibrary/assets/prep_nuclear_fact_sheet.pdf; accessed on 7 August 2017.

[16] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[17] (U) National Academies and DHS; *News & Terrorism: Communicating in a Crisis. Nuclear Attack*; https://www.dhs.gov/xlibrary/assets/prep_nuclear_fact_sheet.pdf; accessed on 7 August 2017.

[18] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[19] (U) National Academies and DHS; *News & Terrorism: Communicating in a Crisis. Nuclear Attack*; https://www.dhs.gov/xlibrary/assets/prep_nuclear_fact_sheet.pdf; accessed on 7 August 2017.

[20] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

(U) ENDNOTES (continued)

[21] (U) FEMA; Independent Study (IS) 3: Radiological Emergency Management; https://training.fema.gov/is/courseoverview.aspx?code=IS-3; accessed on 7 August 2017.

[22] (U) National Academies and DHS; *News & Terrorism: Communicating in a Crisis. Nuclear Attack*; https://www.dhs.gov/xlibrary/assets/prep_nuclear_fact_sheet.pdf; accessed on 7 August 2017.

[23] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[24] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[25] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[26] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[27] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[28] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[29] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[30] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[31] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[32] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[33] (U) DHS, National Response Framework; June 2016; https://www.fema.gov/media-library-data/1466014682982-9bcf8245ba4c60c120aa915abe74e15d/National_Response_Framework3rd.pdf

[34] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[35] (U) Cal OES; *State of California Emergency Plan*; July 2009; http://www.caloes.ca.gov/PlanningPreparednessSite/Documents/00%20SEP%207-01-09%20covrev%20(12).pdf; accessed on 16 August 2017.

[36] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

(U) ENDNOTES (continued)

[37] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[38] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[39] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[40] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[41] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[42] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[43] (U) Lawrence Livermore National Laboratory, prepared for DHS; *Student Guide Improvised Nuclear Device (IND) Modeling and Response Planning: National Capital Region*; https://responder.llnl.gov/content/assets/docs/training/SG-NCR-Awareness-Briefing.pdf; accessed on 16 August 2017.

[44] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[45] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[46] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[47] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[48] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[49] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[50] (U) US Department of Health & Human Services; Radiation Emergency Medical Management, https://www.remm.nlm.gov/potassiumiodide.htm; accessed on 11 August 2017.

[51] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[redacted]

(U) ENDNOTES (continued)

[52] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[53] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[54] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[55] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[56] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[57] (U) California Department of Public Health; *Nuclear Explosion Fact Sheet*; http://www.bepreparedcalifornia.ca.gov/Documents/CDPH%20Nuclear%20Explosion%20Fact%20Sheet.pdf; accessed on 11 August 2017.

[58] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[59] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[60] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[61] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[62] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[63] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[64] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[65] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[66] (U) DHS; Nuclear Blast, https://www.ready.gov/nuclear-blast; accessed on 7 August 2017.

[67] (U) DHS; Nuclear Blast, https://www.ready.gov/nuclear-blast; accessed on 7 August 2017.

(U) ENDNOTES (continued)

[68] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[69] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[70] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[71] (U) Executive Office of the President, National Security Staff and Office of Science and Technology Policy; *Planning Guidance for Response to a Nuclear Detonation, June 2010*; https://www.fema.gov/media-library-data/20130726-1821-25045-3023/planning_guidance_for_response_to_a_nuclear_detonation___2nd_edition_final.pdf; accessed on 7 August 2017.

[72] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[73] (U) RAND Corporation; Charles Meade, Roger C. Molander, *Considering the Effects of a Catastrophic Terrorist Attack*; 2006; https://www.rand.org/content/dam/rand/pubs/technical_reports/2006/RAND_TR391.pdf; accessed on 7 August 2017.

[74] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[75] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.

[76] (U) DHS, FEMA; Nuclear/Radiological Incident Annex to the Response and Recovery Federal Interagency Operational Plans; October 2016, https://www.fema.gov/media-library-data/1478636264406-cd6307630737c2e3b8f4e0352476c1e0/NRIA_FINAL_110216.pdf; accessed on 7 August 2017.