Preparing to Save Lives and Recover after a Nuclear Detonation: Implications for U.S. Policy

CONFERENCE REPORT

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> *"Two decades after the end of the Cold War, we face a cruel irony of history — the risk of a nuclear confrontation between nations has gone down, but the risk of nuclear attack has gone up."* President Barack Obama, Remarks at the Nuclear Security Summit, April 13, 2010[i]

On April 29, 2010, the Center for Biosecurity of UPMC convened an invitational conference in Washington, DC, to examine critical issues associated with response to and recovery from a nuclear detonation and to consider the policy implications of those issues. The meeting was attended by more than 150 participants, who included federal, state, and local government officials, congressional staff, policy analysts, academics, members of the media, and experienced practitioners from the public health, medical, and emergency management communities.

Among the day's presenters were Joan Rohlfing, President, NTI; Brooke Buddemeier, Global Security Directorate, Lawrence Livermore National Laboratory (LLNL); John Fortier, Executive Director, AEI/Brookings Continuity of Government Commission; and White House officials David Marcozzi and Tammy Taylor, both of whom spoke off-the-record. The meeting also featured 3 distinguished panels that explored some of the most difficult challenges that would face policymakers in the event of a nuclear detonation. Panelists discussed proposals for strengthening preparedness efforts. See the Conference Agenda for a complete list of speakers, panels, and presentations.

The summary below highlights the day's discussions and conclusions and offers the Center for Biosecurity's recommended next steps.

INTRODUCTION: Nuclear terrorism is now considered the greatest threat to national security.

As noted by President Obama and others, the threat of nuclear terrorism is current, real, and requires the U.S. government's immediate and focused attention to address large gaps in the nation's preparedness for a nuclear detonation. While prevention should remain a top priority, the U.S. now must also be prepared to mitigate the consequences of a nuclear detonation in a major U.S. city. Joan Rohlfing (President, Nuclear Threat Initiative) specified 3 threats now facing the international community: the accidental launch or loss of control of a nuclear weapon, the use of nuclear weapons by a state actor, and the threat of nuclear terrorism.

Indeed, David Hoffman, author *of The Dead Hand: The Untold Story of the Cold War Arms Race and Its Dangerous Legacy*, confirmed that, with 23,000 nuclear warheads still in existence, the dangers we face today are not hypothetical.

While terrorists may at some point succeed in detonating a nuclear device in the U.S., there are steps that can and should be taken now to protect and save lives. They include planning for reliable delivery of information to and clear communication with the public, swift mobilization of emergency workers, effective medical response, and remedying vulnerabilities that threaten to undermine continuity of the U.S. government. Rapid and effective response will save lives and preserve our democracy in the wake of a catastrophic event.

CHALLENGE: Saving Lives and Protecting Survivors from Radioactive Fallout

Scale of damage: The scale of damage caused by nuclear terrorism (ie, a nuclear detonation) would be significantly less than that of the "mutually assured destruction" envisioned during the Cold War, when the large number of missiles armed with massive thermonuclear payloads made possible the destruction of most urban areas in the U.S. In comparison, it is estimated that a nuclear detonation would destroy an area within a ½-mile radius surrounding the site of detonation. While catastrophic loss of life would follow, numbers of dead would be counted in the tens of thousands rather than the millions predicted for full-scale nuclear war. Research now suggests that many thousands of lives could be saved by reducing exposure to dangerous fallout and delivering scarce medical resources to those most likely to benefit.[ii]

Brooke Buddemeier (Global Security Directorate, LLNL) presented results of computer modeling of a 10KT ground detonation in Los Angeles County. He first characterized 3 damage zones, based on proximity to the detonation:

- Severe: Significant damage within a ½-mile radius from detonation site; few survivors;
- Moderate: Significant damage within a ½- to 1-mile radius from detonation site; many survivors;
- Light: Broken windows and collapsed roofs in up to 3-mile radius from detonation.

Radiation Exposure Morbidity and Mortality: In addition to those killed and injured by direct effects of the explosion, it is anticipated that many more would die as a result of radiation exposure, which produces both acute and long-term health effects. Furthermore, people who are both injured and exposed to radiation are more likely to die than those who sustain injuries alone.

For comparison purposes, the average American is exposed to 0.36 rem*[1] per year from background radiation, and a computed tomograph (CT) of the abdomen and pelvis gives off 1.00 rem.[iii] Following a nuclear detonation, 30% to 50% of adults who receive a dose of 300 rem are likely to die within 30 to 180 days if they receive no medical treatment. With good medical treatment, 15% to 30% of those exposed will die. A dose of 600 rem will kill 95% to 100% of those exposed, absent medical treatment. The number of fatalities could be reduced by up to 50% with good medical treatment. Little can be done to save the lives of those exposed to 1,000 rem or more.

[1] For this document 1 Roentgen (R=gamma or x-ray exposure in air) ≈ 1 rad (absorbed dose) ≈ 1 rem (biological effect in tissue) Source: Buddemeier BR, Dillon MB. Key Response Planning Factors for the Aftermath of Nuclear Terrorism. Livermore, CA: Lawrence Livermore National Laboratory LLNL-TR-410067, August 2009. http://www.remm.nlm.gov/IND_ResponsePlanning_LLNL-TR-410067.pdf. Accessed June 28, 2010.

Buddemeier's computer model for injuries in an unsheltered situation illustrated the expected magnitude of injuries: 150,000 people would sustain potentially recoverable injuries if they received prompt, effective medical intervention; 125,000 people would be at risk of death from radiation exposure; and 40,000 people would likely die from exposure but would still need comfort care.

With effective matching of limited medical resources to those most likely to benefit, and an informed public able to take appropriate protective action, morbidity and mortality could be reduced, saving up to 175,000 lives in the L.A. County scenario. Those most likely to benefit from medical care are the anticipated 150,000 injured and the percentage of the 125,000 victims who receive high but non-fatal doses of radiation.

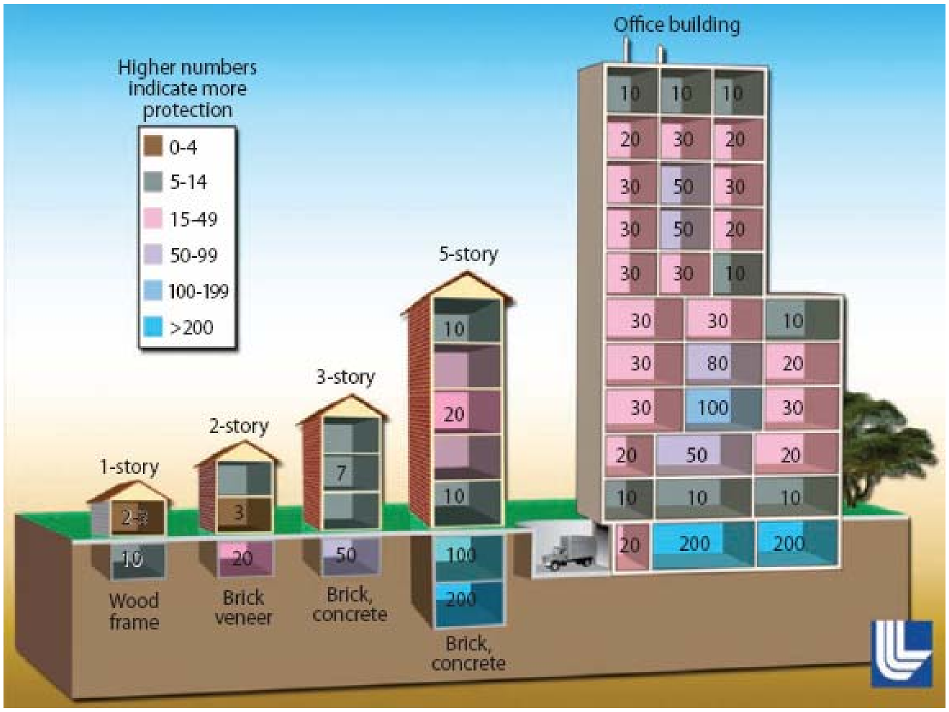
Early, adequate shelter, followed by an informed evacuation, can save lives: Advance knowledge of post-detonation protective actions is critical to maximizing the number of lives saved. Understanding the nature of nuclear fallout and the factors that reduce exposure to its harmful radiation can guide initial life-saving actions and should guide policy.

Toward that end, Buddemeier provided a brief tutorial. Nuclear fallout consists of explosion-generated dust and debris that combines with radioactive fission produced by a ground-level detonation. Fallout is drawn upward by the heat produced by the explosion, reaching heights of up to 5 miles. As the cloud cools, radioactive particles drop to the ground; they are visible as dust the size of sand or table salt on horizontal surfaces. Time, distance from the blast, and shielding will decrease the level of penetrating radiation resulting from fallout.

The most dangerous levels of fallout occur closest to the detonation site, because heavier particles drop to the ground first. More distant sites also have the protection afforded by radioactive decay as the fallout travels. However, fallout can be spread very rapidly by upper level winds, and dangerous levels can accumulate for up to 20 miles away during the first 24 hours following detonation.

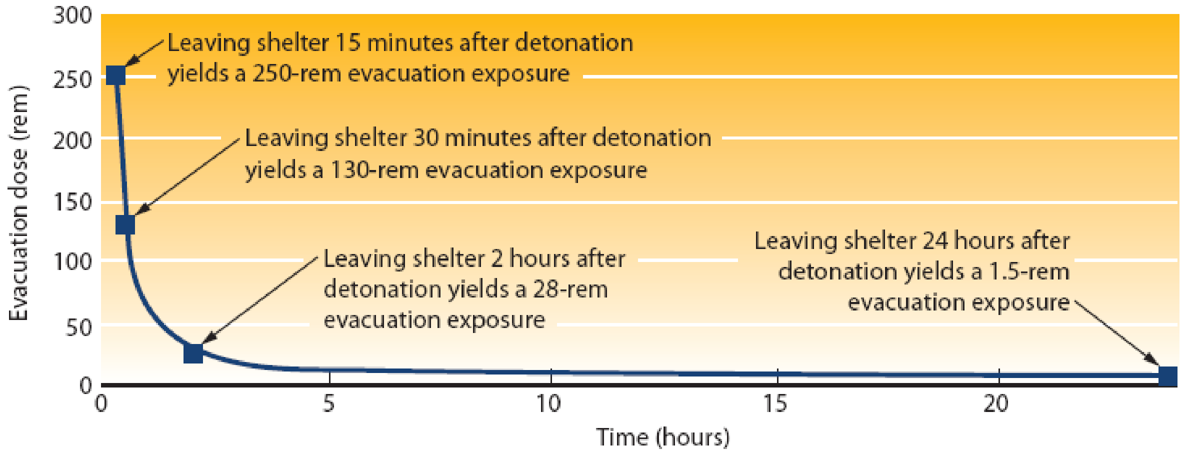
What is "adequate shelter"? Adequate shelters provide a shield from fallout's penetrating radiation. If a person is outside the area where buildings have collapsed, there will be a few minutes in which to take refuge in an adequate shelter. Buildings can serve as shelters, providing a shield that reduces exposure to penetrating radiation. However, not all buildings offer adequate shelter—hence the move away from the general advice to "shelter in place." The adequacy of a shelter depends on the degree to which it protects from penetrating radiation, which is expressed as "protection factor (PF)." The higher the PF, the more protection a shelter confers, and the lower a shielded person's exposure, as compared with an unsheltered person at the same location. A PF <10 is considered inadequate protection from penetrating radiation. Inadequate shelters include cars and light single-story residential or small commercial structures without basements. A PF ≥10 is considered adequate shelter, which may be found in, for instance, the periphery or top floor of office buildings, shallow basements, and multi-story brick or concrete buildings. Good protection (PF = 100) may be found in the cores of large office buildings and the basements of multi-story buildings. If it can be done in 30 minutes or less, people should move from inadequate to adequate or good shelter (Figure 1).

Figure 1: Sample Protection Factors (PFs) for a Variety of Building Types and Locations



Buddemeier BR, Dillon MB. Key Response Planning Factors for the Aftermath of Nuclear Terrorism. Livermore, CA: Lawrence Livermore National Laboratory LLNL-TR-410067, August 2009. http://www.remm.nlm.gov/IND_ResponsePlanning_LLNL-TR-410067.pdf. Accessed June 28, 2010.

Figure 2: Dose Exposure to Evacuees at Various Departure Times Following a Nuclear Detonation



Buddemeier BR, Dillon MB. Key Response Planning Factors for the Aftermath of Nuclear Terrorism. Livermore, CA: Lawrence Livermore National Laboratory LLNL-TR-410067, August 2009. http://www.remm.nlm.gov/IND_ResponsePlanning_LLNL-TR-410067.pdf. Accessed June 28, 2010.

Because radioactive particles decay quickly (ie, lose their strength), the passage of time is also an important factor in radiation exposure. The figure above shows how sharply radiation levels drop and demonstrates the benefits of avoiding outdoor exposure by waiting even 2 hours before evacuating.

Determining safe areas: Fallout does not often disperse in the cigar-shaped plume frequently shown in models. Actual dispersion depends heavily on prevailing wind and weather conditions that vary dramatically in any given area. Thus, one cannot know ahead of time which areas will be safe and which will be dangerous. Theoretically, there is an optimal time for staying put in adequate shelter and an optimal time to evacuate, but that time will vary by location. Practically speaking, the types of information needed to make those determinations will not be available for the first hour after a detonation, or longer. This means that most people will be safest if they quickly find shelter affording good protection and await news from officials about priority areas of evacuation and safe routes before leaving their shelter.

CHALLENGE: Advance Education and Post-event Communication

The public needs advance knowledge and information: With advance information about nuclear fallout and ways to protect themselves from dangerous exposure, the public could take action after a nuclear detonation that would save tens of thousands of lives. The first and best protective action is to find adequate shelter and stay there until officials provide additional information and instructions. However, as Buddemeier emphasized, the decisions with the biggest lifesaving effect will be those made in the first minutes or hours following a nuclear attack, but they often are not technically informed decisions and may, in fact, be counterintuitive. For example, people may think first of fleeing when it would be safer to stay put in adequate shelter.

Effective communication will be critical: To save lives, U.S. government policies and programs should focus on rapid, straightforward delivery of 3 key messages for survivors:

- A nuclear detonation has occurred nearby;
- Immediately seek adequate shelter, such as a basement or a room in the interior of a building; and
- Wait for more information and instruction before evacuating. Sheltered individuals should stay put for at least 24 hours following the detonation unless authorities provide different instructions.

Tammy Taylor (Senior Policy Analyst, National Security and International Affairs Division, Office of Science and Technology Policy, Executive Office of the President, The White House) noted that it is essential to educate people in advance because officials will not have accurate information immediately, and protective action will be effective only if people know what to do directly following the detonation.

Baruch Fischhoff noted that communication is central to risk management and planning, and suggested that, to be effective and useful, public communication should be concise, intuitive, scientifically-based, and adaptable for wide distribution in affected communities. Others noted that communications should be informed by research on protective behaviors. Fischhoff said that several valuable pieces of government guidance are available on the subject, including the Canadian government's 2-way approach to communication between the public and the government and the FDA's *Strategic Plan for Risk Communication*. Others recommended a DHS preliminary analysis of communications about nuclear terrorism.[iv]

During a later panel, Louisa Vinton (Senior Programme Manager and Chernobyl Coordinator, Western CIS and Caucasus Countries, UN Development Programme) emphasized the human cost of mass relocation through the example of the 1986 accident at the Chernobyl nuclear power plant, which released massive amounts of radioactivity. She pointed out that many lingering, negative consequences resulted, not from the accident, but from subsequent policy decisions.[2] Vinton advised that, post-detonation, U.S. policymakers should approach people as survivors with a hand in their own recovery, and equip them with meaningful, transparent information about radiation-related risk.

Rapid, accurate data will be needed to direct evacuation: Kathleen Kaufman (Director, Radiation Management Program, L.A. County Department of Public Health) explained that L.A. County could potentially face evacuation of millions of people following a nuclear detonation, and she noted that plume modeling must be augmented by actual measurements on the ground. Accurate information regarding the distribution of radiation levels will allow officials to create a complete "footprint" of fallout dangers and facilitate clear communication with the public as well as an informed, phased evacuation along safe routes.

To this end, L.A. County uses a telemetry system, coupled with GPS, to automate collection and display of readings on a map of the county. Following a nuclear terrorism event, staff from public health, law enforcement, the fire department, and EMS will drive around the county with meters and send measurements over cellular data bandwidth for central plotting and display. Both the L.A. County Sheriff and the police departments also have aerial measurement capability that will allow officials to distinguish between areas that have dangerous levels of fallout and those that are relatively safe — information that can be used to guide evacuation.

CHALLENGE: Medical Response when Need Will Be Great and Resources Limited

Evaluation, triage, and treatment: Norman Coleman (Office of the Assistant Secretary for Preparedness and Response, HHS) described several federal systems now in place to provide data for situational awareness and medical response following a nuclear detonation. The "RTR" system—Radiation-specific TRiage, TReatment, and TRansport sites—guides medical response, and the MedMAP system, which uses GIS to map medical care sites and assembly stations in real-time, provides improved situational awareness[3]. Toward a similar end, the National Library of Medicine and HHS have

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[2] Since the Chernobyl accident, more than 330,000 people have been relocated away from the more affected areas: 116,000 of them were evacuated immediately after the accident, whereas a larger number were resettled several years later, when the benefits of relocation were less evident. Although resettlement reduced the population's radiation doses, it was for many a deeply traumatic experience. Even when resettlers were compensated for their losses, offered free houses and given a choice of resettlement location, many retained a deep sense of injustice about the process. Many are unemployed and believe they are without a place in society and have little control over their own lives. Some older resettlers may never adjust. Source & ©: UN Chernobyl Forum, Chernobyl's Legacy: Health, Environmental and Socio-economic Impacts (2006)

[3] MedMap is an interactive geographic information system (GIS)-based mapping system in development by the Department of Health and Human Services (HHS). This system improves situational awareness by providing immediate resource information via electronic inputs from various data streams to help determine potential medical care sites and assembly centers, evacuation routes, hazards, potential impact areas and other pertinent data important for the response to hazards and events. Sources: Statement by RADM W. Craig Vanderwagen, Safeguarding Our Nation: HHS Emergency Preparedness Efforts. *Committee on Homeland Security, Subcommittee on Emerging Threats, Cybersecurity, Science, Technology and Government Affairs*: Washington, DC: U.S. Department of Health and Human Services; 2008. http://www.hhs.gov/asl/testify/2008/07/t20080722a.html. Accessed June 17, 2010.

implemented the Radiation Emergency Medical Management (REMM) website, which is devoted to clinical management of radiation casualties. Now in preparation is the second edition of the federal interagency publication, *Planning Guidance for Response to a Nuclear Detonation*, which is designed to help local jurisdictions with planning. Despite these achievements, however, some important challenges remain.

Dosimetry and diagnostics: One of the biggest challenges to medical response after a nuclear detonation will be determining the dose of radiation sustained by many thousands of survivors. Because dose determines prognosis, it is critical to triage and make decisions about whether advanced medical care or palliative care is best for a patient. At present, however, the rapid dosimetry and diagnostics needed for clinical triage and management of large numbers of people do not exist. Absent their development, healthcare providers will have to use other, less accurate indicators to estimate radiation doses and identify those patients most likely to benefit from medical care. In addition to rapid dosimetry and diagnostics, expanded laboratory capacity is also needed and essential to patient triage and care.

Comprehensive planning and policy are needed: As illustrated by Buddemeier, a 10KT detonation in a major U.S. city will injure and/or sicken tens of thousands of people, a number that will rapidly overwhelm a region's resources and ability to provide triage, transport, and treatment. Irwin Redlener (Director, National Center for Disaster Preparedness, Columbia University) reiterated known problems and emphasized that the lack of rapid dosimetry and diagnostics will render the response system dysfunctional. He also emphasized that planning must address the needs of vulnerable populations, and he pointed out that, in our current state of preparedness, the country would not be able to manage, for instance, a surge in the number of pediatric patients.

Crisis standards of care: The country also needs a system and policy to support rapid, national coordination of the healthcare system following a catastrophic event. David Weinstock (Department of Oncology, Dana-Farber Cancer Institute; Medical Advisor, Radiation Injury Treatment Network) posed several questions critical to the management and coordination of a diverse healthcare response. Among them was the question of crisis standards of care. For instance, to manage large numbers of patients with radiation sickness following a nuclear detonation, hospitals may be forced to deliver what would be considered, under normal operating conditions, to be substandard care. Yet, there is no standardized, national approach to this issue or policy to guide decision making in this realm. The result could be a scenario in which one hospital may attempt to follow state-of-the-art treatment guidelines developed for cancer patients, while another is following disaster care guidelines. Some hospitals in a community or region could refuse to accept survivors, while others accept responsibility for all who come through their doors. The legal and ethical questions that attend these scenarios have to be addressed in advance of crisis, and policy must be put in place to guide and support healthcare response.

With a gap between medical need and resources, crisis standards of care also will be needed for triage and treatment decisions. Protocols and plans now being developed by the federal government should help with decisions about when crisis standards should be implemented to optimize allocation of scarce resources. Ann Knebel (Deputy Director, Preparedness Planning, Office of the Assistant Secretary for

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U.S. Department of Health and Human Services. *Fiscal Year 2010 Public Health and Social Services Emergency Fund Justification of Estimates for Appropriations Committees*. Washington, DC: U.S. Department of Health and Human Services; 2009. http://dhhs.gov/asfr/ob/docbudget/2010phssef.pdf. Accessed June 17, 2010.

Preparedness and Response, HHS) differentiated between reactive and proactive triage (see table below) and emphasized the need for community involvement in triage decisions.

Reactive vs. Proactive Triage

Type of Triage	Reactive	Proactive
Timeframe	Early in event; often "no notice"	Later in "no notice" event
Incident Management	Not fully implemented	Fully implemented
Situational Awareness	Poor	Good
Resource Availability	Very dynamic	Static
Shortfalls	Stabilization through definitive care	Definitive care
Triage Decision Maker	Triage Officer	Triage Team
Triage Decision Basis	Clinical assessment	Clinical assessment & diagnostics
Decision Making	Unstructured; ad hoc	Structured
Regional Partners	Available	Unavailable

CHALLENGE: Recovery

Recovery is not well understood: The longer term goal of re-establishing vital, functioning communities after a nuclear detonation requires advance planning that is equal to planning for immediate, life-saving response. Recovery to the point where full and active community life has resumed following a nuclear detonation will be a complex process that, like response, would benefit greatly from advance policy development and planning. Indeed, Gavin Smith (Executive Director, Center for the Study of Natural Hazards and Disasters, UNC at Chapel Hill, and DHS Center of Excellence for the Study of Natural Disasters, Coastal Infrastructure and Emergency Management) argued that recovery is the least understood element of disasters, and that, too often, recovery is defined in terms of speed alone rather than quality.

No systems to support recovery: Smith called attention to serious gaps in the country's planning for recovery, and emphasized that communities with strong integration among local organizations and strong connections to the federal government are best positioned for recovery. Among the gaps he noted: no single federal agency is in charge of long-term recovery; there are very few robust plans for recovery on the state or local levels; and no system is in place to coordinate financial, technical, and policy resources among the nation's aid providers. The lack of a coordinating mechanism creates a disconnect between resources and those who may need them. Additionally, local capacity to receive disaster assistance must be enhanced in order to facilitate fast and effective recovery.

Demands of large-scale relocation: Among the biggest problems to be considered is the potential forced relocation of millions of survivors—some for months, others for years. Citing the lessons learned from the mass displacement following Hurricane Katrina, Ann-Margaret Esnard (Professor and Director, VPT Lab, Florida Atlantic University School of Urban and Regional Planning) argued that recovery and relocation plans must be comprehensive. Plans must address the needs of people who are relocated, the needs of the host communities that receive them, and the impact on host communities. She noted that existing disaster programs would not be helpful in managing the lengthy, indeterminate housing requirements that a nuclear detonation would impose.

Psychological recovery: Brian Flynn (Former Assistant Surgeon General, Associate Director, Center for the Study of Traumatic Stress, Uniformed Services University of the Health Sciences) addressed psychological recovery from nuclear terrorism and emphasized the importance of engaging and including local communities in recovery plans. He asserted that psychological recovery will depend upon engagement of people and resources outside of traditional mental health service delivery systems, and also will require greater use of private sector resources, expansion of existing private-public networks, and active use of emerging social media.

CHALLENGE: Continuity of the U.S. Government

A nuclear terrorist attack on Washington, DC, could jeopardize the continuity and legitimacy of the U.S. constitutional form of government. Presidential succession is specified by the U.S. Constitution, the Presidential Succession Act of 1947 (3 U.S.C. @ §19), and subsequent amendments to newly created cabinet offices. Should the President and Vice President be unable to discharge the duties of the office of President, then the Speaker of the House of Representatives, followed by the President Pro Tempore of the Senate, are next in line of succession. These officials are followed by the 15 members of the President's Cabinet.

USG vulnerabilities: The majority of the government officials in line for presidential succession live and work in the Washington, DC, metropolitan area; hence, many may be killed or incapacitated in the event of a nuclear detonation in the area, thereby jeopardizing the continuity of constitutional government. At the very least, noted John Fortier (Executive Director, American Enterprise Institute-Brookings Continuity of Government Commission), presidential succession would be complicated and confused if many of those in line for succession were killed or incapacitated. The confusion would be even greater during the periods surrounding election and inauguration, when the U.S. government is at its most vulnerable. Other complications would arise in reconstituting the U.S. House of Representatives, which requires special elections to fill vacancies.

Congressional action is needed now: Fortier argued that the Congress must remedy such vulnerabilities now to ensure that the U.S. government is able to function and maintain its constitutional legitimacy after a catastrophic event such as a nuclear detonation in the DC metropolitan region.

POLICY IMPLICATIONS: Center for Biosecurity Recommendations

The Center proposes several steps that the U.S. federal government should take now to prepare for effective response and efficient recovery following nuclear detonation:

- **Pursue pre-event education and communication with communities:** Prepare the public to recognize and seek adequate shelter and to refrain from evacuation unless otherwise instructed by government officials.

- **Improve medical response capacity:** Continue to support healthcare preparedness activities and pre-event development of strategies for triage, implementation of crisis standards of care, and transport of large numbers of survivors to locations where they can receive medical care.

- **Direct research toward better characterization of levels of persistent radiation:** This research should be prioritized as it will inform efforts to forecast acceptable levels of radiation. Without that ability, it will be difficult, if not impossible, to encourage repopulation of contaminated areas.

- **Anticipate and address long-term recovery challenges:** Specifically, recovery plans must address mass displacement of populations; the needs of individuals, families, and host communities; and efforts to return people to their homes.

- **Congress should take action to remedy vulnerabilities in presidential succession, reconstitution of the House of Representatives, and continuity of the U.S. government.**

The Center will continue to bring together key stakeholders to examine and discuss critical issues facing practitioners, leaders, and policymakers.

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[i] Obama B. Speech at The Nuclear Security Summit; April 13, 2010; Washington, DC. http://www.cfr.org/publication/21889/obamas_speech_at_the_nuclear_security_summit_april_2010.html. Accessed June 28, 2010.

[ii] U.S. Department of Homeland Security. *Lawrence Livermore National Lab (LLNL) Presentation- 409771: Modeling improvised nuclear device (IND) impacts to Tier I cities*. U.S. Department of Homeland Security, Office of Health Affairs.

[iii] RadiologyInfo.org. Radiation Exposure in X-ray Examinations. http://www.radiologyinfo.org/en/safety/index.cfm?pg=sfty_xray. Accessed June 14, 2010.

[iv] Homeland Security Institute. Nuclear Incident Communication Planning—Final Report. Department of Homeland Security Office of Health Affairs. March 15, 2009.