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Anthrax-Contaminated Facilities: Preparations and a Standard for Remediation

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Summary

Bacillus anthracis, the cause of the anthrax disease, was released into the United States postal system in autumn 2001, resulting in five deaths and contaminating several public and private facilities. Remediation costs were significant. Subsequently, extant federal procedures and policies were clarified and augmented, and new procedures and policies were created to fill identified gaps.

A number of additional emergency preparedness recommendations have been made by stakeholders, researchers, and others, including the following:

- Facility owners and managers should keep and maintain ownership records of valuable and important items; they should have detailed and current floor plans and information about air flow patterns, under routine and nonroutine conditions.
- Research and regulatory entities should consider having standardized sampling and analysis protocols and consensus procedures for developing protocols when needed; having standardized risk assessment procedures; and conducting further research on human dose-responses to bioagents, including anthrax, and developing nonthreshold dose-response models.
- Governmental entities should develop more extensive plans and procedures to maximize involvement of all stakeholders; conduct further training and drills, especially for sampling, analysis, and coordination procedures; determine the appropriate number and locations of devices to detect leaked remediation chemicals, and the conditions under which the devices would be needed; and determine the appropriate number, size, and locations of chlorine dioxide generators, given that EPA has concluded that chlorine dioxide gas shows the most promise for remediating contaminated facilities.

The criterion (not the standard) for determining a successful remediation has been and remains zero growth of anthrax surrogates from all postremediation samples. In conjunction with the recommendations above, and given remediation experience since 2001, it may not be necessary to develop a remediation standard because consistently achieving the zero-growth remediation criterion appears possible and would likely be demanded by stakeholders. This report will be updated as warranted.

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Anthrax-Contaminated Facilities: Preparations and a Standard for Remediation

Introduction

When anthrax¹ bacteria were released into the United States postal system in autumn 2001, several public and private facilities were contaminated. In addition to the five deaths that resulted, the cost of remediation — in dollars, time, and effort — was significant.² One private facility, four years after the bioterrorist incident, remains closed. The incidents in 2001 led to experience and knowledge that may help reduce the cost of future anthrax remediations. However, a few concerns remain.

This report provides background information on the 2001 anthrax incidents and federal preparedness plans, but it focuses primarily on preparations for future remediations and considerations for setting a remediation standard. Such a standard would define the level of remediation needed to permit safe reuse and reoccupancy of a facility contaminated with anthrax. Although such a standard does not exist, an anthrax remediation criterion (zero growth of anthrax surrogates from all postremediation samples) is commonly used to determine a successful remediation. Policy questions exist regarding what preparations should precede the next bioagent incident³ and whether to establish a remediation standard.

Background

Three releases of anthrax occurred in the United States in autumn 2001. In the first release, letters containing anthrax spores were mailed from New Jersey to media offices in New York City; the letters passed through the Hamilton Processing and Distribution Center (P&DC) in Trenton, New Jersey on September 18. The second release involved a package or letter sent in late September to American Media Incorporated (AMI) in Boca Raton, Florida. In the third release, letters addressed to

¹ The disease anthrax is caused by the bacterium *Bacillus anthracis*. The term *anthrax* will be used in this report to mean both the disease and its cause.

² “Remediation of United States Postal Service facilities alone cost more than \$200 million,” as reported in *Reopening Public Facilities After a Biological Attack: A Decision Making Framework*. The National Research Council. Washington, D.C. July 2005.

³ Although this report focuses on anthrax, preparedness procedures for anthrax may be useful for other bioagents as well.

Senators Tom Daschle and Patrick Leahy in the Hart Senate Office Building entered the Hamilton P&DC on October 9.

Numerous sites, including the Hart Senate Office Building, postal facilities, media offices, and residences, were contaminated directly or through secondary contamination. The contaminated postal facilities included physically large P&DCs such as the Hamilton P&DC, the Morgan P&DC in New York City (which processes all mail into and out of Manhattan), and the Curseen-Morris facility⁴ (which handles all mail to and from the federal government in the D.C. metropolitan area). Numerous smaller postal facilities also were contaminated, as were a number of federal government mail facilities downstream of the Curseen-Morris facility.

The releases caused 23 cases of anthrax; 12 were cutaneous, 11 inhalational.⁵ Five of the inhalational cases resulted in fatalities. Of the people who died, two worked at the Washington, D.C., postal facility; one worked at AMI; one worked in a New York City hospital; and one was an elderly woman who lived in Oxford, Connecticut. No route of exposure has been established for the last two of these deaths.⁶

Remediating Anthrax-Contaminated Facilities in 2001

The term “anthrax-contaminated facility remediation” refers to the decontamination of a large physical building or enclosed space, as opposed to the decontamination of people or open areas exposed to anthrax.

In autumn 2001, most experience with anthrax contamination involved civilian and military facilities, primarily facilities conducting anthrax research.⁷ However,

⁴ The name of this facility was changed from the Brentwood P&DC, to the Curseen-Morris P&DC, in memory of the two postal workers who died as a result of contracting anthrax there.

⁵ Cutaneous anthrax is the most common naturally occurring type of anthrax infection, usually occurring after skin contact with contaminated meat, wool, or leather from infected animals and sometimes resulting in a visible papule or ulcer on the skin. Deaths from cutaneous anthrax are rare (fatality rates of 20% without antibiotic treatment, less than 1% with it). Inhalational anthrax is the most lethal form of anthrax (the fatality rate for inhalational anthrax is estimated at 75%, even with antibiotics and all possible supportive care). Initial symptoms resemble a viral respiratory illness with a sore throat and mild fever; symptoms may progress to respiratory failure. Gastrointestinal anthrax usually follows consumption of raw or undercooked contaminated meat; symptoms include severe abdominal distress. The fatality rate for this form of anthrax is estimated to be between 25% and 60%.

⁶ “Investigation of Bioterrorism-Related Anthrax.” *Morbidity and Mortality Weekly*. United States Centers for Disease Control and Prevention. December 7, 2001. [<http://www.cdc.gov/od/oc/media/mmwrnews/n011207.htm#mmwr1>].

⁷ “Section VII - A Agent Summary Statements.” *Biosafety in Biomedical and Microbiological Laboratories*. United States Department of Health and Human Services.

(continued...)

little was known about addressing a simultaneous anthrax contamination in several geographically dispersed facilities, with members of the general public in close proximity to the anthrax and in various states of health (e.g., in the 2001 incidents, some were young, healthy workers, whereas others were elderly and not occupationally exposed). The facility remediation challenges that arose involved two main foci: challenges involving on-site issues and challenges involving issues that cut across organizations.

On-Site Issues in 2001

In autumn 2001, most remediation experience was based on civilian and military involvement with anthrax research facilities. Drawing on then-current common facility decontamination procedures, the on-site process to remediate public facilities involved as many as nine steps:⁸ (1) assessing the site, including environmental sampling to characterize the contamination; (2) isolating contaminated areas; (3) removing items for off-site treatment; (4) reducing the sources of contamination; (5) developing and designating risk zones and levels of required personal protection equipment, such as Tyvek coveralls and full-face air-purifying respirators; (6) cleaning and remediating contaminated areas; (7) sampling the environment following remediation (often called *postremediation environmental sampling*); (8) additional remediation and sampling, if the initial postremediation sampling showed areas that were still contaminated; (9) and disposal of decontamination wastes. Removing items for off-site treatment and reducing sources of contamination were complicated by a lack of records and, hence, questions regarding the ownership of items in a contaminated facility.⁹

On-Site Remediation Details. During the 2001 anthrax releases, important decisions had to be made on-site, on a case-by-case basis. For example

- Whether to remediate the entire facility at one time (e.g., the Curseen-Morris site) or to remediate the facility in subsections (e.g., the Hart Senate Office Building). This decision depended, to some extent, on the degree to which parallel facilities existed (i.e., other

⁷ (...continued)

Available at [<http://bmb1.od.nih.gov/sect7a2.htm>].

⁸ Compiled from numerous reports of the time and from “Lessons Learned: Remediation of Anthrax Contamination,” Dorothy A. Canter, Ph.D. U.S. Environmental Protection Agency. Presented at the 2003 Eighth International Kilmer Memorial Conference in Osaka, Japan. Polyscience Publications, Inc. Laval, Canada. 2004.

⁹ Personal communication with Sabre Technical Services, September 2005. Sabre is the firm that remediated the former-AMI building. In 2001, AMI published newspapers from that building, which contained large numbers of photographs and other valuable documents when the building was contaminated. AMI sold the building, which remains closed, and the items included in the building, mainly due to a dispute over ownership. The issue of maintaining precrisis records of ownership is described later in this report.

locations where the functions of the contaminated facility could be accomplished without excessive difficulty).¹⁰

- To determine which chemical should be used to remediate the contaminated facilities. In 2001, no chemicals or pesticides were registered by the United States Environmental Protection Agency (EPA) for remediating anthrax sites. This remains the case today. Prior to 2001, different chemicals and physical agents had been used against anthrax. The process of choosing the appropriate chemical for each facility slowed the pace of remediation.
- To determine which bacterium should be used to indicate the effectiveness of remediation actions. For example, when the decision is made to fumigate, biological indicators are placed throughout the facility prior to fumigating. (The biological indicators are species that are not pathogenic to humans but are similar to anthrax in terms of genetics and resistance to the fumigation chemicals.) Typically, a million spores of surrogate indicator species are placed on a carrier, such as a paper strip or disk. A species that is more resistant than anthrax to the fumigation chemicals could be used to add a margin of safety to the remediation efforts (i.e., if a species more resistant to the chemicals is killed by the treatment, then there is a greater likelihood that the anthrax will be killed by that treatment).
- To determine the number and placement of spore strips used to indicate the effectiveness of the remediation. Typically, at least one spore strip is used for every 100 square feet fumigated; however, a different number could be used. In fact, the space in the Hart Senate Office Building was tested with one spore strip for each square foot fumigated.¹¹

In addition, decisions were made for each site concerning the quality of the test strips, the handling of biological and other samples, and the methods used to analyze the data.¹²

Cross-Organization Issues in 2001

Managing the Situations. Managing the anthrax contamination situations involved more than on-site efforts. Several other decisions and actions, involving

¹⁰ “Fumigating Buildings Containing Anthrax.” Center for Infectious Disease Research and Policy. University of Minnesota. December 2003.

¹¹ EPA reported that 3,000 test strips were used in the 3,000 square foot Daschle suite in the Hart Senate Office Building. “Senate Hart Building Decontamination Progressing” United States Environmental Protection Agency. December 2, 2001. [<http://yosemite.epa.gov/opa/admpress.nsf/0/f93e59a8346b3cf985256b1700590dcb?OpenDocument>].

¹² Canter, op. cit.

various off-site organizations, were discussed and made in concert: establishing a unified command, an incident command system (including a federal on-scene coordinator, the Federal Bureau of Investigation, the facility manager or owner, and local incident commanders, such as local public health officials), and a command post; identifying funding sources for the response; assessing occupational and public hazards; developing and implementing prophylaxis and monitoring plans for exposed workers and members of the general public (e.g., administration of antibiotics such as Cipro); and developing and implementing long-term remediation plans, including procedures to certify that the site was safe to reoccupy. These cross-organization decisions and actions related to, and generally complied with, plans and procedures contained in the interagency Federal Response Plan, which was issued in 1992 and updated and reissued in April 1999.

Determining a Successful Remediation in 2001. In 2001, there was no established, acceptable limit for exposure to anthrax, either in workplace or public settings. Trying to set such a limit posed several difficulties: microorganisms such as anthrax live, thrive, or die at different rates in different hosts; some hosts may have or may develop immunity; different strains of the same bacterial species may show significantly different degrees of infectivity;¹³ the virulence of the microorganism may differ significantly among laboratory animals and humans, making it difficult or impossible to extrapolate safe limits from laboratory animal findings to humans; possible interventions of vaccines and antibiotics could complicate efforts to set an occupational or public anthrax exposure limit; and differences exist between the lethality of anthrax found in nature and anthrax that has been deliberately altered, or weaponized, to increase infectivity and virulence. Moreover, it was not known how few anthrax spores, natural or altered, a person would have to inhale to get sick or die.¹⁴

Given the variabilities and difficulties in trying to set an exposure limit and remediation endpoint¹⁵ for anthrax, the criterion used in 2001 to judge the effectiveness of site remediation efforts was zero growth of anthrax surrogates from all postremediation environmental samples. This criterion did not ensure that all

¹³ Infectivity is the proportion of persons exposed to an infectious agent who become infected by it. Virulence is the ability of an infectious agent to produce disease.

¹⁴ It has been estimated and reported in different studies that half the population of primates exposed to as few as 2,500 inhaled anthrax spores would die from that exposure, but large uncertainties accompany extrapolations to lower exposures, making lower dose-response estimates highly speculative. Mark Keim et al., "Principles for Emergency Response to Bioterrorism," *Annals of Emergency Medicine*, August 1999, volume 34, number 2, pp. 177-182. John Jernigan et al., "Bioterrorism-Related Inhalational Anthrax: The First 10 Cases Reported in the United States," *Emerging Infectious Diseases*, Nov-Dec 2001, volume 7, number 6, [<http://www.cdc.gov.ncidod/EID/vol7/no6/jernigan.htm>]. Lydia Barakat et al., "Fatal Inhalational Anthrax in a 94-Year-Old Connecticut Woman," *Journal of the American Medical Association*, February 20, 2002, volume 287, number 7, [<http://jama.ama-assn.org/cgi/content/full/287/7/863>]. Matthew Meselson et al., "The Sverdlovsk Anthrax Outbreak of 1979," *Science*, November 18, 1994, volume 266, pp. 202-208.

¹⁵ A remediation endpoint is the point at which remediation efforts would be aimed and the point at which, when reached, remediation efforts could stop.

anthrax spores had been killed by the remediation efforts, nor that there was zero risk of disease, but that the level of risk of developing disease was acceptably small.¹⁶ There was no science-based minimum number of spores known to cause disease in a person; however, two women in 2001 died from inhalational anthrax without any identified sources of exposure, supporting the idea that a very low number of anthrax spores could be enough to cause disease and even death.¹⁷

Remediating Anthrax-Contaminated Facilities Today

Remediation experiences since the autumn 2001 anthrax releases have led to higher levels of knowledge about, and preparedness for, decontaminating facilities.

On-Site Issues

In general, current steps to remediate a facility are refinements of steps that evolved during the 2001 incidents. The steps today are practiced in drills to increase the likelihood of successful remediation of another anthrax situation. However, a few remaining on-site issues exist.

For example, determining ownership of items in a contaminated facility, such as valuable documents, remains an issue. Remediation and other recovery efforts could be facilitated if facility owners, managers, and insurers maintained ownership records of important items within a facility (note the situation involving the former-AMI building, described earlier in this report).

Another issues involves limiting public exposure to chemicals being used in a facility undergoing remediation, and determining the analytic method used to measure levels of chemicals outside the facility. In the past, EPA has deployed its Trace Atmospheric Gas Analyzer (TAGA) to check for inadvertent releases of remediation fumigant. TAGA is a self-contained mobile laboratory, resembling a bus, capable of real-time sampling and analysis in the low parts per billion range for various chemicals in the air. Other means of analyzing for trace gases exist, but they do not use a single unit like a TAGA and do not necessarily work in real-time or with concentrations so small. EPA now has two TAGAs, one based in Las Vegas, Nevada, and one in Edison, New Jersey.¹⁸ It is important to consider the appropriate level of protection for people living and working near a remediation site, and the appropriate methods for providing such protection, especially for simultaneous events involving several contaminated facilities in separate locations.

¹⁶ Canter, op. cit.

¹⁷ Barakat, op. cit., and Jernigan, op. cit.

¹⁸ It may be useful to note that both TAGAs were deployed to check for air contaminants in areas affected by hurricanes Katrina and Rita, which raises questions about the appropriate numbers and repositioning of TAGAs, and the mix of public versus private monitoring, especially given monitoring demands in terror and nonterror incidents. Further information about EPA's TAGAs can be found at [<http://www.epa.gov/earth1r6/6lab/taga.htm>].

On-Site Remediation Details. Important site-specific details include the following:

- On-site decisions whether to remediate an entire facility, or to remediate in subsections, must continue to be based on site-specific conditions. One factor that slowed remediation activities in 2001 was the lack of information about ventilation in the contaminated structures. Remediation could be facilitated if building owners, managers, and insurers maintained information about air flow in a facility.
- On-site decisions regarding the best remediation chemicals or physical agents to use must continue to be based on site-specific conditions, including the types of important items (e.g., books, photographs, or computer equipment) and ventilation in the facility. Since the 2001 anthrax releases, EPA has approved seven chemicals for use against anthrax, which may be used only by authorized personnel following the specific requirements of the crisis exemption, and only with approved decontamination plans.¹⁹ In addition to these chemicals, other ways to remediate anthrax facilities are now more widely known.²⁰ However, available remediation technologies remains an issue. Following its examination of myriad approaches to remediation, EPA reported that “chlorine dioxide has shown the most promise for use as a fumigant for biologically contaminated buildings.”²¹ For remediating large facilities, chlorine dioxide is produced by a machine on-site. It may be useful to consider how many, and how large, chlorine dioxide generators, private and public, are appropriate nationwide, and where they should be prepositioned to facilitate future remediations.
- Decisions about which indicator species to use, the number and placement of indicator strips, the quality of the strips, and the methods for handling and analysis, continue to be made based on site-specific conditions. One could argue, however, that given the greater level of experience and expertise now available, these

¹⁹ EPA evaluates pesticides to ensure that they meet federal safety standards, before they can be marketed and used domestically. The agency can issue exemptions for various reasons, including public health emergencies. See CRS Report RL31921, *Pesticide Law: A Summary of the Statutes*, by Linda-Jo Schierow. The seven chemicals approved by EPA for use against anthrax, to be used by authorized personnel following the specific requirements of the crisis exemption (which includes having approved decontamination plans), are vaporized hydrogen peroxide, chlorine dioxide, sodium hypochlorite (bleach), paraformaldehyde, methyl bromide, peroxyacetic acid with hydrogen peroxide, and ethylene oxide.

²⁰ *Compilation of Available Data on Building Decontamination Alternatives*. United States Environmental Protection Agency. EPA/600/R-05/036. March 2005.

²¹ *Decontamination and Consequence Management Synopsis Report*. United States Environmental Protection Agency. EPA/R-05/031. April 2005. This information is available at [<http://www.epa.gov/NHSRC/news/news041205.htm>].

decisions could be incorporated into a remediation standard and not left to site-by-site determinations, which may slow remediations and increase costs.

Cross-Organization Issues Today

Managing the Situations. There have been many cross-organization policy and procedure changes since 2001. The National Response Plan (NRP) has superseded the Federal Response Plan. The NRP is now accompanied by six other national priorities, which are part of the National Preparedness System (NPS).²² The NRP “establishes a comprehensive all-hazards approach to enhance the ability of the United States to manage domestic incidents,” according to the United States Department of Homeland Security (DHS).²³

In addition to the NRP, the NPS includes the National Incident Management System (NIMS), which identifies standard operating procedures to ensure that emergency responders communicate and cooperate to achieve the best response to disasters. One important element of NIMS is the Incident Command System (ICS). ICS operates in the framework of five functional areas: command, operations, planning, logistics, and finance. ICS requires the identification of responsible officers and staff prior to a disaster to ensure that functions and assignments are carried out during the response.

It is beyond the scope of this report to discuss in detail ways to improve the NRP or NPS, but it may be useful to note that all the cross-organization procedures and policies continue to evolve, sometimes driven by incidents that illuminate possible areas for improvement.²⁴

Determining a Successful Remediation Today. Today, no public or occupational exposure limit for anthrax exists, for the same reasons that existed in 2001. The criterion used to define a successful remediation in 2001 (i.e., zero growth of anthrax surrogates in all postremediation samples) continues to be used. Despite the similarity between 2001 and today with regard to exposure limit and a successful remediation criterion, several recommendations have been made by various organizations for ways to improve remediation efforts.

²² “A Common Approach to Preparedness.” United States Department of Homeland Security. Available at [http://www.ojp.usdoj.gov/odp/docs/Goal_041305.pdf]. See CRS Report RL32803, *The National Preparedness System: Issues in the 109th Congress*, by Keith Bea.

²³ “Emergencies and Disasters.” United States Department of Homeland Security. Available at [http://www.dhs.gov/dhspublic/interapp/editorial/editorial_0566.xml].

²⁴ The United States Government Accountability Office has reported on cross-organization improvements for handling anthrax situations, including *Agencies Need to Validate Sampling Activities in Order to Increase Confidence in Negative Results*, GAO-05-493T; *Better Guidance Is Needed to Ensure an Appropriate Response to Anthrax Contamination*, GAO-04-239; and *Public Health Response to Anthrax Incidents of 2001*, GAO-04-152.

National Research Council Remediation Recommendations

The Department of Homeland Security funded the Restoration and Domestic Demonstration and Application Program to study and develop, among other things, the criteria that must be met for a remediation effort to be declared successful. The National Research Council (NRC)²⁵ convened a committee of experts, and their findings and recommendations were reported in *Reopening Public Facilities After a Biological Attack: A Decision Making Framework*, released in summer 2005.²⁶ The committee did not recommend an actual standard for defining a successful anthrax remediation. It did describe criteria that, if met, would facilitate the reoccupation and reuse of the facility with minimal attendant risk. The committee's 28 recommendations are condensed here and presented with more detail in **Appendix A**. NRC committee recommendations fell into four categories.

- Planning and preparing — including building managers having detailed physical information about their facilities (e.g., air flow patterns and floor plans); health department and law enforcement authorities having predrawn agreements for information flow; deployment of effective bioagent monitoring and health surveillance systems; facility operators having training for prompt responses to emergencies; and the NRP containing detailed technical information about remediation and clear lines of responsibilities among authorities.
- Basing future actions on experience rather than establishing new procedures with each incident — including having a response plan that can be tailored for a specific situation but not creating a new response plan for every situation; using a standard method for assessing risk; and using standardized sampling and analytical techniques, so that results are comparable and consistent. All of these will help reduce costs and increase confidence in the estimation of the extensiveness of remediation needed.
- Involving representatives of all stakeholders, and independent experts free of conflicts of interest, in all decisions and actions — including creating precrisis agreements for using relevant sampling protocols where they exist and agreements on how to develop protocols where they don't, and jointly developing risk assessment and management procedures, which will increase acceptance of remediation decisions and actions.

²⁵ On its website, the National Academies says that it brings together scientific and technological experts to advise the federal government and the public. The National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council, compose the National Academies. [<http://www.nationalacademies.org/about>].

²⁶ *Reopening Public Facilities After a Biological Attack*, op. cit.

- Conducting research to accelerate threat identification and improve understanding of human responses to different doses of bioagents — including developing a system that can inexpensively and quickly identify threat agents; conducting research to clarify human dose-responses to bioagents while further developing nonthreshold dose-response models; and targeting research to improve the validity of interspecies dose-response extrapolations. These actions will help clarify the minimum remediation level needed to insure safe reoccupancy and reuse of facilities.

American National Standards Institute: 9/11 Commission Recommendations

Known generally as the 9-11 Commission, the National Commission on Terrorist Attacks Upon the United States²⁷ noted that the private sector, which controls 85% of the critical infrastructure in the nation, remains largely unprepared for a terrorist attack, with the principal contributing factor being the lack of a widely embraced private sector preparedness standard. The Commission asked the American National Standards Institute (ANSI)²⁸ to develop a consensus on a “National Standard for Preparedness” for the private sector. The proposed standard would establish a common set of criteria and terminology for preparedness, disaster, and emergency management and business continuity programs. Included in the standard is consideration of risk assessment methodologies for anthrax and other biological hazards, a recommendation also made in the NRC study. In its final report, the Commission endorsed ANSI’s recommended standard for private preparedness.²⁹

Conclusions

The actions and recommendations following the 2001 anthrax incidents have not resulted in the adoption of a specific, numeric remediation standard. The general remediation criterion continues to be for zero growth of anthrax surrogates from all postremediation environmental samples taken from a contaminated facility. What has developed since 2001 is a set of recommendations, mostly relating to preparation before a crisis, compiled from comments by public and private sector researchers, remediators, facility managers, and others. The recommendations tend to fall into

²⁷ On its website, the 9-11 Commission states that it is an independent, bipartisan commission created by law in late 2002. [<http://www.9-11commission.gov>].

²⁸ On its website, ANSI states that it is a nearly 90-year-old, “private, non-profit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system,” with a membership of approximately 1,000 company, organization, governmental, institutional, and international members. [<http://www.ansi.org>].

²⁹ The National Commission on Terrorist Attacks Upon the United States. *The 9/11 Commission Report*. U.S. Government Printing Office. July 22, 2005. Pages 397-398.

two categories: on-site preparations and cross-organization preparations. Congress, in its EPA and DHS oversight responsibilities, may wish to consider the benefits and costs of recommending, or not recommending, the implementation of these steps preparing for future bioagent incidents.

Recommendations for On-Site Preparations

- Have and maintain records of ownership of valuable and important items in facilities.
- Have detailed and current floor plans and information about air flow patterns, under both routine and nonroutine conditions.

Recommendations for Cross-Organization Preparations

- Have standardized sampling and analysis protocols and consensus procedures for developing protocols, when needed.
- Have standardized risk assessment procedures.
- Conduct more research on human dose-responses to bioagents, including anthrax, and develop nonthreshold does-response models more fully.
- Further develop plans and procedures to maximize involvement of all stakeholders.
- Conduct additional training and drills, especially for sampling, analysis, and coordination procedures.
- Determine the appropriate number, capabilities, and locations of private and public TAGAs or other leak detectors and the conditions under which they would be necessary.
- Determine the appropriate number, size, and locations of chlorine dioxide generators, given that EPA has concluded that chlorine dioxide gas has shown the most promise for remediating contaminated facilities.

Remaining Policy Questions

There remains a policy question that has relevance both on-site and across organizations: Is there a need for a nonzero standard? Some researchers are concerned that if several important facilities were simultaneously contaminated, and if there were little or no parallel capability for those facilities, there might be significant pressure to abandon the zero growth remediation criterion and remediate to a less stringent level. Given lessons learned since 2001, it may now be possible to use chlorine dioxide gas to remediate a large facility to the zero growth criterion, at the cost of one week and \$4 per square foot, compared with approximately 14

weeks and \$27 per square foot for the Hart Senate Office Building in 2001-2002.³⁰ If this estimate can be reliably confirmed, in conjunction with the recommendations described earlier, it may not be necessary to accept a remediation criterion less than zero, nor to develop a remediation standard, because consistently achieving the zero growth remediation criterion would appear to be reasonable and would likely be demanded by stakeholders.

³⁰ On the Hart Senate Office Building, *Capitol Hill Anthrax Incident: EPA's Cleanup Was Successful; Opportunities Exist to Enhance Contract Oversight*. United States Governmental Accountability Office. June 2003. GAO-03-686. On the current remediation estimate, personal communication with Sabre Technical Services, in September 2005. Insurance is a related concern; Sabre reports an insurance arrangement with American International Group, Inc., which requires remediation to the zero growth criterion. It may be helpful to note that continuity of operations is a segment of federal contingency planning, linked to continuity of government. See CRS Report RL31594, *Congressional Continuity of Operations (COOP): An Overview of Concepts and Challenges*, by R. Eric Petersen and Jeffrey W. Seifert; CRS Report RL31857, *Continuity of Operations (COOP) in the Executive Branch: An Overview*, by R. Eric Petersen; and CRS Report RL31978 *Emergency Preparedness and Continuity of Operations (COOP) Planning in the Federal Judiciary*, by R. Eric Petersen.

Appendix A: NRC's Recommendations

A summary of NRC's twenty-eight recommendations, in preparation for reopening public facilities, follow.³¹

1. Remediation decisions and plans should consider the infectivity and virulence of the biological agent in the particular situation at hand. Infectivity and virulence can vary between natural and weaponized forms of anthrax, and given that uncertainty, it is impossible to set an acceptable threshold below which exposure would pose zero risk.
2. In considering how to respond to new biological attacks, authorities should base their plans on lessons learned from prior experiences, rather than try to develop a new response plan for each new incident. Important considerations should include the critical policy dimensions of the biological quality of the hazard, the public nature of the building, the people's perception of the attack, and the national security implications of the event.
3. Representatives of affected parties, as well as independent experts who are free of conflicts of interest, should be involved in risk management decision making. Stakeholder involvement in risk assessment and management would contribute to more widespread acceptance of the legitimacy of the results.
4. After a facility has been remediated, some type of medical monitoring is critical to ensure confidence that a facility is safe. The purpose and outcome of the monitoring must be transparent to affected parties. There should be a centralized and sustained effort to track the health of those exposed to the bioagent.
5. Risk managers should assume that any given contamination incident could be worse than initially perceived. Information about remediation efforts should be made available widely, which will facilitate broader participation in risk management activities.
6. Agreements among health departments and law enforcement agencies should be drawn up in advance of incidents to facilitate the flow of information during a crisis. Efforts to get broader participation in, and acceptance of, remediation efforts will be helped by the unobstructed and transparent flow of information during a crisis.
7. A standard risk assessment approach, developed and validated over the past 20 years, should be used as one part of decision making to determine the adequacy of remediation efforts. Use of a well-validated method for assessing risk will increase acceptance of its results.
8. A practical, as opposed to theoretical, analysis of risk also will increase its acceptance, but more sampling source and dose-response data are needed for

³¹ *Reopening Public Facilities After a Biological Attack*, op. cit.

this. Gathering and validating as much data as possible should be done in preparation for a crisis. Trying to gather and validate data during a crisis will impede remediation efforts.

9. Research should be conducted to develop a system that can inexpensively and quickly identify threat agents. Remediation efforts can be facilitated with sound and detailed information about the threat agent.
10. Characterizing the threat agent should be done before selecting the approach for large scale remediation. The remediation approach chosen should be able to destroy the amount of agent present at the start of the procedure (i.e., at its highest concentration, prior to any dispersal).
11. Existing monitoring and surveillance systems need to be evaluated for their abilities to detect and limit the spread of bioagents in a cost-effective manner. Systems that prove effective could be deployed in public facilities that are likely targets for attacks. Such systems could help better inform remediation decisions.
12. Because bioagents can spread beyond their point of initial release through air-handling systems, reaerosolization, foot traffic, air currents, and adhesion to people and clothes, an extensive survey should be done to determine the extent to which biological contamination has spread. This consideration can affect the extensiveness of remediation required.
13. Building operators should, in preparation for a crisis, gain a thorough understanding of how air flow occurs in their buildings, under both routine and unusual conditions, such as during partial breakdowns or maintenance. Remediation efforts can be impeded by needing to determine air flow, a process made more difficult in a crisis by the presence of a bioagent.
14. The training and education of facility managers and building designers should include information about vulnerabilities to weaponized agents, so they will be better prepared to respond to bioterror attacks and subsequent remediation efforts.
15. The concept of a threshold below which no risk to a population exists is not supported by current data; dose-response data for most pathogens of concern are incomplete. As such, nonthreshold dose-response models should be developed further and used more extensively to reduce the possibility of remediating to an arguable endpoint.
16. Targeted research should be conducted to help inform decision making based on extrapolations of dose-response data between species for pathogens of concern. Dose-response data from nonhuman species may be relevant and useful to humans, if the proper mechanisms for extrapolation are discovered.
17. Samples of bioagents should be collected and handled by protocols that are appropriate to the threat. Accepted protocols should be used where they exist, and new protocols should be developed with the involvement of relevant public

and private entities (e.g., the Centers for Disease Control and Prevention [CDC] and the American Society for Microbiology).

18. Because surface sampling with dry wipes led to false negatives in one instance, and to inconclusive results in another, wet surface-swipe techniques should be used, with complementary vacuum surface-sampling.
19. Sampling and analyses should be standardized. Knowing that the sampling and analyses are consistent and comparable will increase confidence in the estimate of the initial extent of contamination and, therefore, the extensiveness of remediation needed.
20. A general sampling plan, to guide more specific surface-, air-, and bulk-sampling methods, should be a consensus document drawn up by stakeholders. This would increase acceptance of sampling results, a step toward acceptance that remediation was successful.
21. EPA precluded use of paraformaldehyde for remediation because of fears of its possible carcinogenicity, despite its proven efficacy against bioagents. The NRC committee recommended that the National Cancer Institute lead an interagency task force to reevaluate the chemical's possible carcinogenicity. This could result in the addition of another available remediating agent.
22. Chlorine dioxide has been used successfully to remediate several buildings contaminated by anthrax. The committee recommended that the chemical be considered, at this time, the standard for remediation and that new methods and processes should be expected to be at least as effective, safe, and cost-effective.
23. The committee recommended that EPA and CDC should establish standards for remediation and validation of contaminated buildings, and for the training of remediation teams.
24. A remediation technique that meets the current federal sterilization standard could possibly leave a large number of viable anthrax spores in a contaminated setting, possibly resulting in unacceptable residual risk. The committee recommended that current and emerging remediation techniques should be thoroughly evaluated to determine how efficiently they kill bioagents, including anthrax.
25. Owners and managers of high-value facilities should plan and prepare for a prompt and well-organized response, which will minimize the time that a facility will be nonoperational due to remediation efforts. The committee recommended that the NRP be augmented with more scientific and technical information on bioweapons, remediation, sampling and surveying, epidemiology, and forensics. There should be descriptions of how response and recovery teams should operate, clear lines of responsibility for actions, from the short through the long term.
26. Expanding on the previous recommendation, the committee recommended that airport operators should assemble, adopt, and maintain detailed plans to

identify, contact, and mobilize the diverse and specialized resources needed to facilitate remediation and recovery. These plans and resources should be updated periodically and stored in locations that would be accessible in a crisis.

27. Physical information about facilities, including floor plans, material characteristics, air flow patterns, and air sampling data should be included in preparation plans. Current contact information for individuals and organizations that would be needed in a crisis also should be included in preparation plans.
28. Planning should identify the interested parties, form them into working groups, and have them interact regularly in anticipation of coming together to guide an actual recovery effort. The committee recommended that actions be taken to maximize trust among the participants and stakeholders.