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Report on the Homeland Security Workshop on Transport and Disposal of Wastes from Facilities Contaminated with Chemical or Biological Agents

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Report on the Homeland Security Workshop on Transport and Disposal of Wastes From Facilities Contaminated With Chemical or Biological Agents

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Notice

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Foreword

The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The National Risk Management Research Laboratory is the Agency's center for investigation of technological and management approaches for preventing and reducing risks from pollution that threatens human health and the environment. The focus of the Laboratory's research program is on methods and their cost-effectiveness for prevention and control of pollution to air, land, water, and subsurface resources; protection of water quality in public water systems; remediation of contaminated sites, sediments and ground water; prevention and control of indoor air pollution; and restoration of ecosystems. NRMRL collaborates with both public and private sector partners to foster technologies that reduce the cost of compliance and to anticipate emerging problems. NRMRL's research provides solutions to environmental problems by: developing and promoting technologies that protect and improve the environment; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to ensure implementation of environmental regulations and strategies at the national, state, and community levels.

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Hugh W. McKinnon, Director
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List of Abbreviations

CDC	Centers for Disease Control and Prevention
DHS	Department of Health Services
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
HWI	hazardous waste incinerator
LRN	Laboratory Response Network
MWI	municipal waste incinerator
NIOSH	National Institute for Occupational Safety and Health
NYSDEC	New York State Department of Environmental Conservation

Summary

This report summarizes discussions from the "Homeland Security Workshop on Transport and Disposal of Wastes From Facilities Contaminated With Chemical or Biological Agents." The workshop was held on May 28–30, 2003, in Cincinnati, Ohio, and its objectives were to:

- Document the current understanding of the challenges faced when handling, storing, transporting, and disposing of wastes from public and private facilities contaminated with chemical and biological agents.

- Identify research needs and opportunities for improving coordination between federal, state, and local government agencies and other stakeholders in order to fill gaps in the current understanding of these waste management challenges.

The workshop panelists included representatives from federal agencies (e.g., the Environmental Protection Agency, the Department of Defense, the Department of Transportation, and the Centers for Disease Control and Prevention), state agencies, local agencies, academia, and waste management companies. During the workshop, panelists gave presentations on specific topics, including the waste management challenges posed by the World Trade Center disaster and the anthrax contamination of office buildings in New York City and Washington, D.C. Following each presentation, the workshop panelists engaged in free-flowing discussions to elaborate upon the issues presented.

This initial report summarizes discussions on the following seven topics: classes of chemical and biological agents; detection; effectiveness of decontamination; triaging of wastes; handling, storage, and transport of wastes; landfilling; and incineration. For each topic, this initial report outlines the current state of knowledge, identifies associated research needs, and lists action items identified during the discussions. The technical content of this report is based entirely on discussions at the workshop.

Although the workshop addressed seven individual topics, some cross-cutting themes emerged during the panelists' discussions. Examples of common themes include the following:

- Panelists noted that EPA's future work on handling wastes contaminated with chemical and biological agents should be sensitive to the fact that specific waste management challenges vary considerably with the type of agent (e.g., chemical versus biological) and type of waste (e.g., wastewater, personal protective equipment, building debris). Thus, a single set of guidelines that applies to all possible agents and waste streams might not be feasible. Several panelists recommended that EPA consider radiological contaminants and animal diseases in its ongoing work, whether by developing specific guidance documents on these issues or referring stakeholders to other resources for further information.

- The absence of widely accepted standards for effectively decontaminating biological agents

was discussed throughout the workshop. Incinerator and landfill operators, for instance, had reservations about receiving wastes that are not certified as being uncontaminated. But, for most biological agents, no firm research—or even a standardized analytical method—is available to answer the question, "how clean is safe?" Until this issue is resolved, some panelists feared that all wastes generated from buildings containing certain biological agents (particularly the persistent ones) might have to be handled as if they were contaminated.

- A number of panelists suggested that the Federal Government maintain the needed infrastructure for transport and disposal of these wastes. This infrastructure would include equipment to transport materials (e.g. trucks, barges) and disposal sites/equipment (e.g. secure landfills, incinerators) that would be in strategic locations around the country. The disposal options/sites would be pre-determined based on an evaluation of available sites/ equipment (see below) and a vulnerabilty assessment.

- Multiple panelists emphasized the need for state and local agencies to include waste management in their emergency response plans and mock terrorist attack drills. Such efforts may result in response workers seeking out information resources already available; these resources and documentation prepared during mock terrorist attack drills can prove invaluable should an actual event occur in the future. The panelists identified several ways that EPA can assist state and local agencies with their emergency planning efforts. The panelists said that EPA can prepare case studies, checklists, or guidance documents to inform these agencies of specific challenges in managing wastes that contain chemical or biological agents. Such documents should draw on the lessons learned from previous experiences managing wastes from terrorist attacks, and should emphasize the need for effective communications between multiple agencies. Finally, panelists suggested that EPA convene another workshop to help prepare practical information resources for state and local agencies.

- Panelists indicated that EPA can develop databases with relevant information (e.g., location, operating data, capacity, transportation routes) on landfills and incineration facilities across the country. Having a system linked to a mapping application would allow users to readily identify waste management facilities that can handle wastes from emergency events.

- An issue raised throughout the workshop was the need to consider public perception of risks and other sensitivities when deciding how to manage wastes containing chemical or biological agents. Many panelists said that EPA and other agencies will likely need to balance scientific judgments against public acceptability of waste management decisions. The panelists encouraged EPA to strive for pragmatic and protective solutions, which might not necessarily be solutions that achieve zero risks. As an example of a potential sensitivity, a panelist noted that people might be offended by using the term "waste" when referring to debris (and possibly human remains) from sites where human life has been lost or severely affected by an event.

- Another cross-cutting theme was the need for training to ensure the safety of all workers who might handle wastes containing chemical and biological agents. These workers include

decontamination crews, transporters, and employees of waste management facilities. Panelists suggested that existing courses on handling contaminated and decontaminated wastes be identified and new courses be developed and offered, possibly by EPA with assistance from OSHA and DOT. Panelists encouraged EPA and other agencies to consider who should develop and offer training courses on chemical and biological agents, what parties should fund the training, and when and how often employees should receive training.

- Throughout the workshop, panelists noted that EPA and other agencies might need to establish permit variance procedures for transporters and disposal facilities handling wastes potentially contaminated with chemical and biological agents in emergency situations. The procedures should include tracking, monitoring, reporting, handling and disposal requirements, and include additional testing required for specific wastes dependent on disposal methods.

- Owners and operators of waste management facilities expressed concern throughout the workshop about potential liability issues associated with managing wastes that possibly contain chemical and biological agents. These panelists encouraged EPA to consider these liability concerns in future work involving this waste management issue. The owners and operators expressed specific concern regarding the need to protect facility assets and to address unanticipated harm to employees and the surrounding community, damages resulting from permit violations related to disposal of bioterrorism waste, and remuneration for financial losses directly and indirectly associated with processing wastes containing chemical and biological agents.

- One decision-making approach that many panelists supported was to encourage state and local agencies to first identify the available waste management options (e.g., incinerators and landfills) and then "work backwards" to determine what types of wastes these facilities can handle. Several panelists supported this concept of "working backwards" because a relatively small number of waste management options are available, even though a large number of waste streams could be generated in buildings contaminated with chemical or biological agents.

- Recognizing that many public and private sector parties have relevant experience on most of the workshop topics, the panelists recommended that EPA continue to involve many stakeholders when evaluating waste management challenges. Panelists suggested that representatives from the following parties, in addition to the parties represented at the current workshop, might offer useful insights for the ongoing work: the United States Department of Agriculture, the National Institute for Occupational Safety and Health, the Occupational Safety and Health Administration, the Federal Emergency Management Agency, law enforcement agencies, analytical laboratories, and experts in risk communication and public perception of risk.

I. Classes of Chemical and Biological Agents

A. What do we know?

The workshop panelists discussed many types of chemical and biological agents that could be encountered in future waste management scenarios. The following list describes how the agents were classified into two general classes (chemical and biological), each having numerous sub-categories of agents. The list documents relevant features of each agent, such as their availability, toxicity, relevant chemical and physical properties, and persistence. It was noted during the discussion that the potential use of chemical and biological agents is an emerging threat and that novel agents may be used in the future that have not been considered in past threat assessments.

- **Chemical agents.** These classes of potential chemical agents were identified during the workshop:

  - *Industrial chemicals.* An extremely broad range of industrial toxic chemicals are manufactured, stored, and transported throughout the United States, often in large quantities. Examples include fuels, flammable chemicals, oxidizers, acids (e.g., hydrogen cyanide), bases, and pesticides. The workshop panelists did not go into detail on waste management challenges posed by releases of industrial chemicals, but several noted that federal regulations already require larger industrial facilities to have detailed emergency response plans that evaluate the potential off-site consequences of uncontrolled releases.

  - *Vesicants.* The workshop panelists discussed two types of vesicants (blistering agents): mustards and Lewisite. The information that was presented on these materials follows:

    The workshop panelists noted that mustard agents are relatively easy to synthesize from readily available precursors. On the other hand, the panelists characterized these agents as having moderate toxicity with a relatively low likelihood of mortality resulting from exposures, assuming that exposed individuals seek medical care. The main challenge identified for cleanup is the persistence and limited water solubility of these compounds. As an example of this challenge, panelists noted that incineration efficiently destroys mustard agents, but the agents' limited solubility complicates efforts to collect them from locations where they might be released. Mustard agents can, however, be readily oxidized using chlorine bleach.

    Lewisite is an organic arsenic compound that causes immediate pain after exposure, rather than delayed effects. Beyond the initial reaction, the arsenic within Lewisite might contribute to additional adverse health effects, depending upon the dose. Lewisite was not produced extensively in the United States; far larger quantities were

produced in Europe and the former Soviet Union. Lewisite can be produced easily by those with access to arsenic trichloride. Lewisite is rapidly hydrolyzed, which would greatly facilitate any cleanup efforts.

- *Nerve agents.* Several nerve agents were identified. The common link between these agents is their ability to inhibit acetylcholinesterase—this inhibition can ultimately result in serious effects, such as respiratory collapse and death. Two general types of nerve agents were presented.

  First, several "G Agents" were described. These agents include GA, GB (also known as Sarin), GD, and GF. They share many molecular structures: all have a phosphorus-oxygen double bond, most have a phosphorus-carbon bond, and most have a phosphorus-fluorine bond at the heart of their structure. Some of the G Agents, particularly GA, are relatively easy to synthesize from reagents that are widely available.

  Second, several "V Agents" were described, including Amiton and VX. The distinguishing feature of the V Agents is their phosphorus-sulfur bond at the heart of the chemical structure. The two types of nerve agents differ in several important regards. The V Agents, for instance, are less likely to be encountered because they are far more difficult to synthesize than are the G Agents. Further, the V Agents are far less volatile than the G Agents, but both agents can be dispersed in a manner that could present an inhalation hazard.

  Regarding decontamination and waste management, workshop panelists noted that the nerve agents are relatively persistent, except when exposed to water. Hydrolysis destroys these agents and typically (though not always) forms byproducts that are relatively non-toxic. These nerve agents can be efficiently destroyed in incinerators.

- *Glycolates.* The workshop panelists briefly discussed glycolates. These chemicals, which are typically solids, have toxic effects opposite to those of nerve agents. Glycolates can have transient incapacitating effects, but these chemicals are believed to be of limited concern because they are less toxic than other agents.

■ **Biological agents.** These classes of potential biological agents were identified during the workshop:

- *Pathogenic bacteria.* In general, bacteria are either grown in cultures or present in a dormant state (e.g., spores). Vegetative bacteria die rapidly in the environment due to dehydration and exposure to ultraviolet radiation. Dormant bacteria, on the other hand, can persist in the environment for long periods of time, even under adverse conditions. This distinction presents specific challenges for managing wastes that contain spores. Bacterial pathogens of concern include: *Bacillus antrhacis* (anthrax),

Yersinia pestis (plague), *Francisells tularensis* (tularemia), and *Burkholderia mallei* (glanders).

- *Viruses.* Viruses are far more difficult to weaponize, because they require a host organism or host cells to survive. Viruses identified as being of concern include *Variola major* (smallpox), Venezuelan equine encephalitis virus, Ebola virus, and many possible others.

- *Toxins.* There are a wide range of substances regarded as toxins. According to the literature, at one end of the range are the bacterial toxins, which are chemicals that are formed by bacteria. The toxins are not living organisms, but they are often classified as biological agents because living organisms produce them. Production of the toxins requires culturing, harvesting, purification, and formulation. Most bacterial toxins are solids and would have to be formulated in a manner to facilitate widespread dispersal. Examples of toxins identified during the workshop include botulinal toxin, staphylococcal enterotoxin, abrin, and many others. Some of these have previously been stockpiled for weapons purposes and targeted assassination attempts. Given the limited availability of many of these toxins, however, the likelihood that they would be used in a large attack is believed to be low.

  In the middle of the range of toxins are snake poisons, insect venoms, plant alkaloids, and other substances, such as ricin, batrachotoxin, and curare, which have been used as weapons. At the other end of the range are small molecules such as potassium fluoroacetate synthesized by chemical processes or hydrogen cyanide, which occurs in hundreds of plant and animal species. Further, a panelist noted that large scale production processes for biologically active peptides, bioregulators (e.g., histamines), and similar substances is an area rich in potential for weapons.

- *Other biological agents.* The panelists also identified other agents that may be encountered in future events and related waste management scenarios. These included prions (which are associated with chronic wasting diseases), agents genetically engineered to avoid detection, and infectious agents that affect livestock (e.g., hoof-and-mouth disease). Some of these agents may present unique challenges. Prions, for instance, are highly persistent and difficult to destroy, even by incinerators. As another example, an outbreak of hoof-and-mouth disease can lead to an extremely large volume of animal carcasses that need to be managed. The panelists recommended that EPA consider such agents in its ongoing homeland security efforts.

When discussing the chemical and biological agents, panelists noted that contaminated buildings will contain an extremely broad range of wastes. Generally speaking, such sites will contain building materials and debris, personal protective equipment from the cleanup crew, and decontamination wastes (e.g., wastewater). The specific waste components found at a given site depend on the type

of building affected. However, responders should expect to handle many classes of materials including, but not limited to, furniture (wood, metal, upholstered), carpet, floor and ceiling tiles, wallboard and paneling, fixtures, computers and electronic equipment, paper items, and putrescible wastes (e.g., food items).

B. What research or information needs were identified?

The workshop panelists identified several information gaps, along with associated research needs or action items to fill them:

- Several panelists indicated that planning for waste management events is difficult without a better sense of the threats realistically posed by specific agents. For instance, planning activities would be greatly facilitated if planners knew which agents are most likely to be encountered, whether a specific agent is more likely to be used in a localized manner (e.g., to contaminate an office) or in a widespread manner (e.g., to contaminate a city block), and what volumes of wastes are expected to be generated. With better threat assessment information, local and state agencies can proceed with their emergency planning accordingly. Panelists suggested that EPA might be able to obtain information on specific threats by coordinating with other federal agencies, such as the Department of Defense and the Department of Homeland Security.

- Several panelists said that state agencies, local agencies, first responders, and other stakeholders would benefit from having agent-specific fact sheets that answer many of the general questions that arose during the discussions, such as:

  How likely is it that terrorists have access to an agent?
  What are the agent's relevant chemical and physical properties?
  For biological agents, what is the infective dose?
  What is the agent's anticipated fate and transport behavior in the environment?
  How persistent is the agent?
  Will the agent adhere to building materials or vaporize and disperse?
  What are the preferred decontamination methods?
  How will the agent behave in a landfill?
  Is the agent effectively treated by incineration?
  Can the agent be dispersed via different environmental pathways (e.g., carried on clothing, survive in a water treatment system)?
  Are there potential vectors or reservoirs of infection of concern?

  Similarly, other panelists suggested that EPA, with assistance from CDC, develop guidance that lists all agents and decontamination procedures available, to the best of their knowledge. The guidance may take the form of a matrix, and would be added to as information becomes available. A computer-based document may be preferable, with guarded access if necessary.

- A specific research opportunity discussed during this session was using surrogate agents to study the fate and transport of selected chemical and biological agents. For instance, the fate and transport of anthrax spores in landfills can be studied using simulations involving other *Bacillus* species bacteria. Section VI.B revisits this issue.

- Several panelists asked EPA if its evaluation should be broadened to include waste management issues for radiological contaminants, such as those that might be released from a "dirty bomb" incident. EPA representatives responded that the Agency is discussing this matter internally and the scope of its effort might indeed be broadened to include radiological contaminants.

C. What information resources are currently available on this matter?

The workshop panelists identified several sources of information about the available chemical and biological agents:

- Many industrial facilities have already prepared detailed emergency plans and consequence scenarios that address large-scale releases of industrial chemicals. These plans should be available from state and federal offices responsible for managing reports submitted under the Emergency Planning and Community Right-to-Know Act.

- Profiles of selected biological and chemical agents are available from different sources. For instance, the Centers for Disease Control and Prevention (CDC) maintains a "Public Health Emergency Preparedness and Response" Web site (http://www.bt.cdc.gov) that has detailed information on selected chemical and biological agents. Further, speakers at the workshop showed examples of tables copied from publications that document relevant information (e.g., infective dose, persistence of organism, incubation period) on numerous biological or anti-microbial agents.

- A panelist noted that various parties have developed "response awareness courses" that might be a valuable resource on the types of events that may occur in the future. Specific references to preferred courses were not provided.

II. Detection

A. What do we know?

The workshop panelists discussed many technical and logistical challenges associated with identifying chemical and biological agents in environmental samples. This discussion focused largely on analyzing samples for biological agents, due to the additional information needed from laboratory analysis. Specifically, for chemical agents, laboratory analyses need only detect the presence and amounts of the agent of concern; for biological agents, on the other hand, the analyses not only need to detect the agent, but must assess whether the agent is still living, viable, or active and whether it poses a risk to public health.

The panelists identified many problems emergency responders might encounter when trying to detect the presence and viability of biological agents. For instance, environmental samples suspected of containing biological agents cannot be handled or shipped as one would handle most types of environmental samples. Further, relatively few laboratories have the licensing, equipment, and capability not only to analyze samples for biological agents but also to decontaminate or destroy the samples after they have been analyzed. Due to the high costs associated with gaining this expertise, many laboratories likely may not be capable of conducting these analyses in the future. Additionally, in times of heightened concern regarding bio-terrorism, the few licensed laboratories in a given area are often inundated with requests to analyze samples. Given this situation, the panelists highly recommended that state and local agencies, as part of their emergency planning, identify in advance analytical laboratories that can analyze samples that may contain biological agents.

As well as voicing concerns about simply identifying candidate laboratories, the panelists said that analytical results are often difficult to interpret. With no standard analytical methods for many biological agents, laboratories have been using various and different methods to detect them, which can lead to widely variable sampling results. Specific challenges identified include how to interpret analytical results in the absence of quantitative information on infective doses or detection limits, how to interpret analytical results that indicate the presence, but not the viability, of a biological agent, and how to interpret surface concentrations without knowing the associated exposure doses. Since some biological agents (e.g., *Bacillus antrhacis, Francisella tularensis*) can be naturally found in environmental samples in the absence of bio-terrorism attacks, the issue of "background" levels of contamination may be important for certain agents. The limitations of environmental sampling notwithstanding, the panelists noted that sampling for anthrax proved to be a valuable contribution to the decontamination efforts and epidemiological investigations, primarily because anthrax spores are so persistent in the environment.

When discussing detection of biological agents, the panelists briefly reviewed the Laboratory Response Network (LRN). CDC established this network to help laboratories use consistent and reliable methodologies when analyzing certain types of samples for biological agents. Though the LRN program has indeed helped to ensure that analytical results are of high quality and reproducible

across multiple laboratories, the program has limitations. For instance, relatively few laboratories are LRN-certified and only a subset of these can analyze samples for certain biological agents. Further, the LRN-certified laboratories are primarily accustomed to analyzing clinical samples—they are still developing procedures for analyzing environmental samples or samples of building materials. Finally, few, if any, of the LRN registered laboratories can analyze environmental samples for all classes of microorganisms (viruses, bacteria, and protozoa). This means that only a few laboratories have the necessary licensing and infrastructure (e.g., the ability to destroy samples) to analyze environmental samples for biological agents.

Another limiting factor identified was additional regulatory requirements under the recently promulgated "Select Agent Program." This program was established by the Public Health Security and Bioterrorism Preparedness and Response Act of 2002. The Select Agent Program further regulates the possession, use, and transfer of selected organisms, which again limits the number of laboratories with the necessary registration and capacity for analyzing samples for certain biological agents. Further complicating matters is the possibility—or probability—that samples requiring analysis for biological agents will be of a forensic nature, meaning that the analytical laboratory might have to coordinate efforts with appropriate law enforcement or intelligence agencies.

B. What research or information needs were identified?

The workshop panelists identified several information gaps, along with research needs or action items to fill them:

- State agencies, local agencies, and other parties responsible for emergency response and waste management need information on the challenges posed by analyzing samples for biological agents, such as identifying licensed analytical laboratories, shipping samples safely and in accordance with Department of Transportation (DOT) regulations, knowing how to interpret positive and negative detection results, being prepared to communicate analytical results to the public, and realizing that it can take days before reliable and definitive analytical results are obtained for some samples. By identifying these challenges and presenting possible solutions, EPA can help all stakeholders be better prepared to analyze environmental samples during emergency situations. The Federal Government should consider the development of an environmental response laboratory network to manage environmental samples. Laboratories are in place for clinical analysis for emergency circumstances for these agents but analagous laboratories do not exist to manage environmental samples.

- Workshop panelists said that there is no or limited information available on analytical methods for some biological agents, especially for analyzing *environmental* samples. Research can help develop methods for analyzing environmental samples and samples of building materials for biological agents. Where possible, analytical methods should be able to detect biological agents down to the level of the infective dose. Additionally, procedures should be developed to specify how to analyze samples containing multiple classes of agents

(e.g., chemical, biological, and radiological agents), given that few laboratories can handle such mixtures. Such procedures could address, for instance, how to process environmental samples that contain human tissues, which might contain blood-borne pathogens.

- Some panelists expressed concern that re-engineering of biological agents might eventually render them undetectable by current laboratory analytical methods. They suggested that research on the analytical methods should consider nuances associated with detecting weaponized forms of biological agents.

C. What information resources are currently available on this matter?

The panelists identified several sources of information on detecting chemical and biological agents. The resources identified during the workshop are discussed below. (This should not be viewed as a comprehensive account of all available resources.)

- Multiple federal agencies have jointly developed the BioWatch program, which is conducting air filter sampling in several cities to detect bio-terrorism attacks before morbidity or mortality is observed. Information on the sampling and analytical methodologies used should be available from EPA and CDC—two of the agencies sponsoring this network.

- The National Institute for Occupational Safety and Health (NIOSH) has published health hazard evaluations for the anthrax investigations at selected postal facilities. These reports include information on comparability of anthrax sampling and analytical methods.

- One panelist noted that CDC's Web page for the Select Agent Program lists links to information resources on many related topics (e.g., transportation concerns, occupational safety and health issues). These links are found at: http://www.cdc.gov/od/sap/addres.htm.

- The LRN should make information available on preferred sampling and analytical methods for certain biological agents, as well as lists of the laboratories that are currently certified to analyze samples potentially contaminated with such agents.

- The panelists noted that sampling and analytical methods for chemical agents should be available from Department of Defense installations engaged in related demilitarization activities. They did not cite specific publications that document these methods.

III. Effectiveness of Decontamination

A. What do we know?

The workshop panelists discussed available decontamination technologies for various chemical and biological agents. The discussion addressed specific experiences of decontaminating wastes from the anthrax incidents of 2001 and ongoing research on the effectiveness of existing and emerging decontamination methods.

Many different decontamination methods were identified during this session, including measures to separate or inactivate chemical and biological agents. These included using disinfectants, filtration, vacuuming, heat inactivation, incineration, ultraviolet radiation, and ionizing radiation. The approach used for a given scenario depends on the specific needs for the application. Specific types of disinfectants and fumigants include bleach, peroxides, ozone, and ethylene oxide. The panelists identified the strengths and limitations of the different methods. For instance, they agreed that ethylene oxide sterilization can decontaminate various materials effectively, but that using ethylene oxide to decontaminate buildings is impractical due to other hazards that ethylene oxide poses (e.g., toxicity, risk of explosions). Giving another example, a panelist noted that enzymatic decontamination has shown promise for destroying "G Agents," but further research is needed to demonstrate the overall utility of this technology. Though many decontamination technologies were reviewed, several panelists noted that bleach-based products continue to be the most widely available decontamination technology and have proven generally effective against both chemical and biological agents, given sufficient contact time.

The panelists identified many factors that responders to chemical or biological attacks must consider when selecting appropriate decontamination methodologies. These factors include, but are not limited to, the following:

- **What is the chemical or biological agent of concern?** The type of agent present is a critical consideration when one selects decontamination methods, for several reasons. Although researchers are striving to have decontamination technologies apply to broad ranges of agents, some technologies (e.g., enzymatic decontamination) have demonstrated effectiveness for only certain specific agents. Further, operational details for a given decontamination technology, such as minimum contact times needed, may also depend on the agent present.

- **What types of materials are contaminated?** The optimal decontamination technology for a given application generally depends on the material that is potentially contaminated. For instance, the optimal technology for decontaminating wastewater may differ from the optimal technology for decontaminating building materials. Further, the porosity of the contaminated materials affects decontamination decisions, because more porous materials (e.g., ceiling tiles) are much harder to decontaminate effectively than less porous materials (e.g., concrete).

The intended end use of contaminated material is yet another consideration: if the object to be decontaminated must be preserved for future use, some decontamination methodologies might be preferred over others.

- **How wide an area is contaminated?** The appropriate decontamination strategy also depends on the size of the contaminated area. If a chemical or biological agent exists only in a small area (e.g., within one room), then spot decontamination methods may be appropriate; however, spot decontamination is not feasible for contamination over broad areas. The extent of the contaminated area also may affect the decision on whether to conduct decontamination activities on site or at a remote location.

- **Does the decontamination method create additional wastes?** Most decontamination technologies leave residues that must either be cleaned or naturally dissipate, typically by off-gassing. The wastes formed by different decontamination technologies could be a limiting factor in some cases. For instance, though some decontamination foams have shown promise in terms of effectiveness of decontamination, they leave residues that have to be rinsed and the resulting wastewater must be collected and handled accordingly.

In addition to these general concerns, participants discussed many specific issues that arose in the decontamination of office buildings and postal facilities where anthrax was found. For instance, decontamination efforts at some sites were complicated by the fact that employees caused cross-contamination by moving items within and removing items from contaminated areas before first responders arrived. Further, cleanup officials at some sites had difficulties finding waste management companies willing to dispose of decontaminated materials—a perception issue that was revisited multiple times at the workshop (see Sections VI and VII).

B. What research or information needs were identified?

When discussing decontamination methods, workshop panelists identified several information gaps, along with research needs or action items to fill them:

- A central issue to the debate on the effectiveness of decontamination is deciding "how clean is safe?" Answers to this question will determine how effectively buildings must be decontaminated before they can be used again and how effectively building contents must be decontaminated before they can be handled as non-infectious waste. The workshop panelists noted that the Department of Defense should already have information on the effectiveness of decontamination for chemical agents, but indicated that the issue is largely unresolved for biological agents in environmental or residential settings. Some panelists believed that enough clinical and toxicological data might be available to support establishing cleanup levels for some biological agents; other panelists said that further research on related matters (e.g., detection methods, infective levels for surface contamination, number of samples needed to characterize contamination in a building) must be resolved before scientists can develop defensible decontamination criteria for many

biological agents. Panelists emphasized that reliable decontamination criteria must be developed such that site managers can assure the public and waste management companies that a building or its contents have been decontaminated effectively. Without such criteria, concern over potential exposures to biological agents might lead to requests for enormous volumes of building materials to be managed as waste.

- The workshop panelists again said that state agencies, local agencies, and other parties responsible for emergency response and waste management need information on the challenges posed by decontamination. They suggested that EPA or other agencies prepare informational materials on the pros and cons of selected decontamination methodologies for specific scenarios. These materials could, for instance, specify the composition of disinfectant and minimum contact time required to achieve adequate deactivation for different agents and materials. Panelists also indicated that informational materials should document how long specific biological agents remain viable in the environment. Parties responsible for decontamination would benefit from knowing the different types of wastes that they might encounter; these waste streams might include building materials, personal protective equipment, office materials, construction and demolition debris, furniture, human cadavers, and animal carcasses.

- Several panelists suggested that EPA consider publishing case studies to guide first responders and other stakeholders on the technical issues associated with decontamination and the broader waste management issues associated with materials containing chemical and biological agents. One suggestion was to prepare a case study that addresses the most difficult decontamination challenges, such as how to decontaminate buildings containing highly persistent biological agents (e.g., anthrax spores). The case study could address all issues relevant to decontamination, including setting up staging areas, identifying best practices to avoid cross-contamination, listing materials that would likely need to be decontaminated, and identifying residues (e.g., wastewater) that might be generated and how these residues should be handled. Panelists suggested basing a case study on anthrax, because the methods used to decontaminate anthrax spores are believed to work effectively for other biological agents.

- Further research and literature reviews should be conducted to document general specifications for effective decontamination and evaluate how effectiveness varies with disinfectant concentration, contact time, temperature, residence time in autoclaves, the effect of a mixture of agents, and other parameters. Several specific research needs were identified, such as examining how decontamination effectiveness varies with the porosity of the contaminated material, further evaluating enzymatic decontamination methods (particularly for G agents), assessing whether ionizing radiation can effectively decontaminate large items (e.g., couches) that are difficult to handle otherwise, and examining whether engineered or weaponized biological agents are more difficult to decontaminate than the agents in their natural forms.

C. What information resources are currently available on this matter?

The panelists identified several sources of information on the effectiveness of decontamination methods. The resources identified during the workshop are discussed below. (This should not be viewed as a comprehensive account of all available resources.)

- Multiple panelists noted that the Department of Defense has already researched laboratory analytical methods and effectiveness of decontamination for multiple chemical agents. More detailed information on this topic should be available from installations engaged in related demilitarization activities.

- CDC has compiled information on agent-specific decontamination methodologies on its bio-terrorism Web site: www.bt.cdc.gov.

- One panelist referred to publications by the State and Territorial Association on Alternative Treatment Technologies for further information on effectiveness of decontamination, with the most relevant publication being "Technical Assistance Manual: State Regulatory Oversight of Medical Waste Treatment Technologies" (EPRI Report TR-112222, 1998).

IV. Triaging Waste

A. What do we know?

The workshop panelists raised several issues related to triaging wastes at sites contaminated with chemical or biological agents. Triaging, for purposes of this workshop, was defined as the initial characterization and management of wastes that occurs at the site where wastes are generated and the associated decision process for managing the handling, storage, transport and disposal of wastes. The discussion was based largely on lessons learned from triaging wastes generated during the World Trade Center disaster and at buildings that received mail contaminated with anthrax spores. Though these events had considerably different waste management challenges in terms of the nature and volume of wastes generated, the parties who managed these sites identified many common experiences that can be applied to other sites with wastes containing chemical or biological agents.

The panelists listed numerous activities associated with triaging wastes on site. Such activities include establishing site security, restricting site access, constructing staging areas to avoid cross-contamination, implementing health and safety measures for first responders, characterizing and defining waste streams, deciding whether wastes need to be decontaminated on site, properly packaging wastes, and storing wastes safely before shipping them off site. Though the panelists recognized that the type of triaging activities needed for a given site ultimately depends on site-specific conditions, they identified some general categories of wastes that may need to be considered for triaging activities. One such class of wastes is items and materials that will be disposed of or destroyed after being decontaminated, such as spent personal protective equipment, wastewater from decontamination, and debris (e.g., carpet, furniture, ceiling tiles). Another is wastes that may include items (e.g., personal property, human remains) that might need to be returned to family members, provided the materials can be properly decontaminated. Yet another is wastes that will likely include materials of a forensic nature, which law enforcement officials might need to examine before the materials leave the site. Finally, the appropriate timing and options to store, dispose, transport and dispose of wastes depends upon the identifying the risk associated with each available scenario.

Several panelists said that triaging wastes can be complicated by the fact that some wastes from buildings contaminated with chemical and biological agents can be difficult to classify according to existing waste management and transportation regulations. As an example, panelists noted that no explicit guidance describes precisely how much decontamination is needed to have a waste that once was classified as hazardous or infectious become municipal waste or construction and demolition debris. Panelists noted that response workers to the buildings contaminated with anthrax spores needed to refer directly to regulatory agencies to determine whether decontaminated building materials should be classified as municipal waste, medical waste, or perhaps "special waste" (a term used in some states' waste management regulations). These distinctions can be critical: the waste classification generally dictates the available waste management and transportation options, which, in turn, can affect how wastes are triaged. Some panelists suggested that regulatory agencies should be prepared to classify wastes from buildings contaminated with biological agents, possibly by

issuing variances, exemptions, or special permits.[1]

The panelists who triaged wastes from the World Trade Center disaster and the buildings contaminated with anthrax spores identified several factors that affected how they triaged wastes. These include current regulations for storing and transporting wastes, existing infrastructure for handling wastes on site, the available waste disposal and treatment options, and external pressure to complete site cleanup activities expeditiously to help affected areas quickly return to "normalcy." Suspecting that the same factors will likely weigh heavily in most future waste management challenges, the panelists emphasized the importance of local agencies and emergency responders being prepared to address the waste triaging challenges. The following general themes emerged from these discussions:

- **The need to coordinate efforts among all parties.** The panelists who worked on the World Trade Center disaster and the buildings contaminated with anthrax spores strongly believed that continual, effective communication between all stakeholders is a critical element to handling wastes containing chemical or biological agents. The stakeholders identified during this discussion include local emergency responders, local government officials, waste management companies, state environmental agencies, and federal agencies with expertise on specific technical issues. Federal agencies mentioned during this discussion included CDC, EPA, DOT, the Department of Defense, and the Department of Agriculture. Further, involving law enforcement entities may be helpful as they will likely need some of the debris associated with future attacks.

- **The need to plan thoroughly and in advance of events.** Panelists emphasized that thorough advanced planning for emergency events can greatly mitigate the challenges posed by managing wastes containing chemical or biological agents. Specific matters that local and state agencies should research and resolve before complex waste management issues arise include making lists of contacts for key stakeholders; identifying all waste management companies in a jurisdiction that are approved, capable, and willing to receive wastes that might contain chemical or biological agents; becoming familiar with applicable state and federal regulations for classifying, storing, transporting, and disposing of these wastes; working with local emergency responders to identify and set up needed perimeter security to control public exposure and ensure environmental health and safety; developing plans for dust suppression controls to contain and manage contamination; ensuring that adequate personal protective equipment is readily available to first responders; and identifying public and private contractors that have the equipment and capability to help triage and transport wastes. Several panelists strongly recommended that local and state agencies incorporate waste triaging and management into their emergency response drills and mock events. Some

[1] The terminology used in this paragraph is meant to illustrate the general concern panelists expressed about the ambiguities of existing regulations and the fact that wastes from bioterrorism events do not fall neatly into the waste classifications. The paragraph is not meant to be a technical review of all existing EPA and DOT regulations for waste management and transportation, respectively.

panelists indicated that EPA can assist with these planning efforts in various ways. For instance, a panelist suggested that EPA consider developing a database that documents relevant information (e.g., location, operating data, capacity, transportation routes) on waste management facilities that agencies can access as needed. Interfacing such a database with an electronic mapping application would facilitate rapid identification of waste management facilities near sites of emergency events.

- **Basing waste triaging plans on available waste management options.** Recognizing that relatively few options are available for managing wastes from buildings contaminated with chemical and biological agents (e.g., disposal, incineration, selected alternative treatment technologies), several panelists suggested that the specific waste management options should dictate the triaging strategies. For instance, if decontaminated building debris from a site is to be incinerated, the dimensions of the incinerator inlet should determine how wastes need to be sorted and sized on site. For this reason, several panelists recommended that parties responsible for managing wastes *first* identify the available waste management options, then work backwards to develop triage plans accordingly.

B. What research or information needs were identified?

When discussing triaging wastes, workshop panelists identified several information gaps, along with the research needs or action items to fill them:

- Few information resources have been developed to address the unique challenges posed by managing wastes containing chemical and biological agents; thus, EPA can assist responders to future events by developing general guidance documents on how to triage wastes effectively. Panelists suggested that these documents answer specific questions that have already been asked at the World Trade Center and anthrax sites, such as:

  When is it preferable to store wastes temporarily on site?
  How should wastes be packaged?
  What chain of custody must be followed if law enforcement parties are involved?
  What regulations affect storage and transportation of wastes for different scenarios (e.g., storage incidental to transportation versus storage for other purposes)?
  How are certain types of wastes classified under these regulations?
  Are there any minimum specifications for constructing staging areas?
  What waste management options are preferred for specific agents?
  Can personal property and human remains be returned to families?

  Guidance to stakeholders could also identify best practices for several general issues, such as handling wastes with a mixture of agents, coordinating with other stakeholders, and effective planning. Also, guidance is needed at the federal level to assess what materials should be used for forensic evidence and what can be returned to families. Such guidance should list references to other information resources on topics (e.g., forensics, transportation,

health and safety) that other federal agencies typically address.

- Panelists said that local agencies and emergency responders can obtain practical information on how to triage building wastes by reviewing specific case studies or by incorporating waste management into their emergency response drills. The panelists noted that EPA can help by developing case studies and by encouraging stakeholders to involve environmental officials in future drills. Case studies should clearly establish agency roles in emergency operations for different agents of concern. EPA can also assist by developing a database that documents important information (e.g., capacity, location, transportation routes) on the universe of facilities that could potentially manage wastes from sites attacked with chemical or biological agents.

- The panelists suggested specific topics that EPA can investigate for additional insights into effective waste triaging strategies. One panelist, for instance, recommended that EPA consult with Japanese officials to learn how they triaged wastes in cleaning the Tokyo subway station where Sarin was released.

C. What information resources are currently available on this matter?

The panelists identified several sources of information on triaging wastes that might contain chemical or biological agents. The resources identified during the workshop are discussed below. (This should not be viewed as a comprehensive account of all available resources.)

- The Federal Emergency Management Agency Publication 325 ("Debris Management Guide") provides guidance on how to triage large volumes of wastes, primarily from natural disasters. The document is available online at www.fema.gov/rrr/pa/dmgtoc.shtm.

- The United States Army Corps of Engineers has developed guidance on removing debris containing chemical, biological, or radiological agents.

- A panelist noted that the Department of Energy has a Web site dedicated to waste management (www.em.doe.gov/em30/). The Web site focuses on managing radioactive wastes, but the concepts presented on the site could pertain to waste management challenges for building decontamination debris.
- In developing a triage, it is critical to incorporate the need for the timing for recovery and occupancy of residences and businesses. This is important in restoring normalcy to the impacted area and assisting in it's economic recovery.

V. Storing, Handling, and Transporting Wastes

A. What do we know?

The workshop panelists discussed numerous topics related to storing, handling, and transporting wastes from buildings contaminated with chemical and biological agents. Experiences with these issues were based largely on the waste management challenges faced at buildings that were contaminated with anthrax spores in 2001. The discussions for this topic area focused primarily on six specific issues:

- **Temporary on-site storage of wastes.** The workshop panelists identified several factors that will determine whether wastes should be stored temporarily at sites contaminated with chemical or biological agents. Generally speaking, prolonged on-site waste storage increases the likelihood that building occupants, trespassers, or others might inadvertently or intentionally release chemical or biological agents. Similarly, prolonged storage of vector-borne agents (e.g., plague) would raise concerns about rodents, dogs, or other animals spreading agents from wastes to local communities. Given these concerns, the panelists emphasized the need to have all wastes properly containerized (see the next bulleted item), stored in secure locations, and promptly sent to waste management facilities when possible.

  Several panelists noted that the need for on-site waste storage will likely depend on site-specific conditions. For example, when the American Media Inc. office building in Florida was contaminated with anthrax spores, on-site waste storage was a sensible option because the entire building was shut down. For the media sites in New York City, on the other hand, on-site waste storage was not preferred because the affected skyscrapers remained open for business. Another consideration is the capacity of the disposal or incineration facilities that will receive the waste streams: on-site waste storage might be necessary when these facilities have limited capacity to handle waste streams containing chemical and biological agents.

  Given that most contaminated building scenarios will require some on-site waste storage, the panelists identified additional factors for site coordinators to consider. For instance, constructing staging areas or exclusion zones may be necessary to prevent cross-contamination of biological agents. Representatives from EPA's Environmental Response Team indicated that they already have procedures and emergency response kits that help with these construction tasks. Other panelists noted that some states might require permits for on-site storage areas.

- **Containerization.** The workshop panelists discussed the containers that should be used for handling wastes from building contamination sites. The panelists generally agreed that containerization must occur on site, in order to prevent cross-contamination and to protect the workers who later handle wastes. Federal and state transportation regulations would likely dictate the finer details of waste containerization. For example, DOT regulations

specifically address packaging issues (e.g., selecting appropriate containers, labeling, placarding) for shipments of hazardous materials (see 49 CFR 173, 178–180), but the extent to which these regulations apply depend on the type of waste being managed. DOT has guidance on packaging and transport for chemical/biological wastes. These are a modification of procedures for medical wastes. Infectious agents, including regulated medical waste, typically require triple packaging that can withstand a 30-foot drop or being impaled by a steel rod. An issue that is not resolved, however, is exactly how waste providers should determine whether decontaminated items are infectious—an important consideration because items that are not classified as infectious can be shipped as municipal solid waste or construction and demolition debris (unless state regulations dictate otherwise). The panelists reiterated that further research is needed on the effectiveness of decontamination, because the current regulatory framework does not provide objective criteria for determining when wastes contain infectious agents.

The panelists identified many different types of containers that are used to ship packaged wastes. These include open containers (e.g., dump trucks covered with tarps) and closed containers (e.g., trailers). Although non-hazardous wastes that are no longer infectious could technically be shipped in open containers, at least according to federal transportation regulations, panelists noted that most states would likely require wastes from sites containing biological agents—including decontaminated wastes—to be packaged and shipped in closed containers. This should be planned in advance and coordinated among DOT, CDC, and DHS. One panelist noted that use of "macro-encapsulation" containers might be a viable option for some sites. These containers, made from high-density polyethylene plastic, are sealed after being loaded with wastes. The entire containers are then disposed of in landfills; there is no need to open them or handle their contents.

- **Handling.** The workshop panelists generally agreed waste handling should be minimal in order to prevent chemical and biological agents in wastes from entering the environment. To minimize handling and avoid cross-contamination, all size reduction and packaging of wastes should occur at the site where waste is generated, so that haulers and employees of waste management companies do not become exposed to the agents. Further, appropriate technologies for moving wastes at landfills or incinerators depend on the nature of the waste being shipped. Landfill operators, for instance, generally should not use handling techniques (e.g., tipping, using steam shovels) that can breach containers of infectious waste. It was also noted that procedures need to be in place for respectful management of contaminated cadavers to minimize worker and public exposure.

- **Transportation modes.** The panelists said that wastes from most building contamination sites will likely be shipped via truck, rail, or barge. The most appropriate and efficient transportation mode will vary from one location to the next—it will depend on the proximity of the waste site and eventual waste management location to railroads and barge stations, existing infrastructure, equipment availability on short notice, public acceptance, and overall project costs. Because the safety and security of shipping wastes containing chemical or

biological agents may be an overriding concern, the need for escorts and dealing with the potential for spills must also be considered. It was noted that in general, though, there is inadequate transportation infrastructure for major events.

The panelists suspected that shipping containerized waste in enclosed trucks will probably be the most efficient transportation mode for most locations, though exceptions clearly occur. For instance, barge transport was a logical and economical choice for shipping wastes generated during the World Trade Center disaster, because New York City already had the necessary infrastructure to support this transportation mode and a permitted landfill with capacity and barge access. In this case, hauling wastes in trucks was not desirable given that trucks would have to travel through densely populated and highly congested areas. State and local agencies ultimately should be able to determine the most appropriate transportation modes within their jurisdictions based on the available waste management sites and the existing road, rail, and barge infrastructure. Cost-benefit analyses can help determine whether investing in certain transportation modes (e.g., constructing transfer stations) is worthwhile.

- **Transportation regulations and requirements.** Noting that existing regulations will largely dictate how on-site coordinators transport wastes, workshop panelists emphasized the need to become familiar with DOT regulations and those of state transportation authorities. As noted previously, the applicability of DOT's hazardous materials regulations depends primarily on how the on-site coordinator characterizes wastes. However, experiences from transporting debris from the anthrax-contaminated buildings indicate that, for specific responses to bioterrorism events, states sometimes implemented more stringent shipping requirements than DOT does. (Some questions remained about whether states truly had the authority to do so.) Generally speaking, specific requirements that might apply for a given scenario include driver training, registration, tracking, identifying transportation routes, decontaminating containers, the need for police escorts, and limiting waste shipments to vehicles dedicated entirely to transporting regulated medical waste or hazardous waste.

  Panelists who worked on these sites strongly recommended that on-site coordinators work directly with DOT and state officials to learn exactly what regulations apply, and whether exemptions for emergency situations can be issued. DOT can issue letters of interpretation or guidance documents to address specific challenges that future waste management scenarios raise. Throughout this discussion, several workshop panelists emphasized the need to track wastes containing chemical and biological agents from the origin, through storage, to the ultimate waste disposal or incineration facility. To emphasize concerns about tracking, one panelist noted that failure to account for where wastes containing chemical or biological agents presents an opportunity for terrorists to retrieve these agents and use them for future attacks.

- **Worker and public safety.** Panelists noted that transporting wastes containing chemical and biological agents poses health risks not only to transporters, but also to residents who live along transportation routes. A DOT representative indicated that DOT's worker training

requirements (49 CFR 172, Subpart H) are limited to topics such as security, safety, and general awareness of hazards; some transporters might also be required to have written safety and security plans. Other panelists noted that EPA and OSHA might have additional training requirements for waste transporters, but these requirements were not discussed further. During this discussion, some panelists asked under what circumstances, if any, should transporters be immunized against agents, receive prophylactic therapy, or enter medical monitoring programs. Panelists were unaware of any specific requirements that address these issues and suggested that employers in such cases consult with clinicians for further insights.

B. What research or information needs were identified?

Workshop panelists identified several information gaps regarding handling, storing, and transporting wastes, along with research needs or action items for filling these gaps:

- On-site coordinators for buildings contaminated with chemical and biological agents would benefit greatly from having clear guidance or other information materials on waste storage, handling, and transportation. Examples of resources that can be developed include concise summaries of DOT regulations, review of USDA regulations (for "foreign waste" categories) checklists for on-site coordinators, case studies for selected building contamination scenarios, and training or outreach materials for transporters. Another suggestion was to standardize sizing and packaging of wastes to minimize handling, meet DOT regulations, and accommodate disposal sites. A panelist suggested that a matrix be developed to determine "what wastes fit where" and how such waste must be sized and packaged for acceptance at a given facility; such a matrix should recognize the possibility of using unconventional packaging types (e.g., a mobile material packaging unit might be most appropriate for some waste management scenarios). Vulnerability analysis should be conducted on the transportation options.
- As in other areas discussed, multiple panelists strongly encouraged that future guidance documents urge state and local agencies to plan in advance for how they will handle the technical challenges of storing, handling, and transporting wastes that might contain chemical or biological agents. Agencies can accomplish this by incorporating waste storage, handling, and transportation directly into future emergency response drills and mock terrorist attacks, such that first responders and on-site coordinators can determine whether they are prepared to handle these wastes. Additionally, state and local agencies can plan in advance by identifying preferred transportation modes, locating waste management facilities that are willing to accept wastes, and listing points of contact at state and federal transportation, environmental, and health agencies. Panelists noted that EPA can assist in these efforts possibly by developing an electronic database with information (e.g., location, capacity, transportation routes) on waste management facilities across the country. Some panelists suggested that parties responsible for emergency planning identify, in advance, any equipment (e.g., waste containers) that might be needed to respond to future events.

- Several panelists reiterated that waste storage and transportation challenges would benefit from further research on decontamination effectiveness for biological agents. Specifically, panelists said that waste generators need objective criteria to determine whether or not a waste should be considered infectious—a distinction that strongly influences the applicable DOT regulations. On another note, one panelist recommended that EPA or other agencies consider researching how effectively staging areas or exclusion zones truly contain biological agents, given past experiences that found such areas to be not entirely effective.

- The panelists raised additional issues for EPA and other agencies to consider, such as whether generators, transporters, and waste management companies will be liable for inadvertent releases of chemical and biological agents; the extent to which environmental monitoring is necessary at transfer stations and staging areas; and whether government agencies should consider investing in infrastructure for waste transportation. Another action item raised was how to handle large volumes of body parts and human cadavers that are potentially contaminated with biological agents. Several panelists were concerned about this issue given that body parts and human cadavers, even if they contain infectious agents, are not considered regulatory medical waste or hazardous waste in most jurisdictions. These panelists suggested that an inter-agency effort, perhaps including DOT, the Department of Homeland Security, and the Department of Health and Human Services, is needed to address this issue.
- A number of panelists indicated that the Federal Govemment may need to provide the needed infrastructure for containing and transporting wastes to effectively manage major events. This would include an evaluation of the needed capacity and locational requirements.

C. What information resources are currently available on this matter?

The panelists identified several sources of information on handling, storing, and transporting wastes from buildings contaminated with chemical or biological agents. The resources identified during the workshop are discussed. (This should not be viewed as a comprehensive account of all available resources.)

- DOT has many information resources on transporting wastes. The information ranges from the original hazardous material transport regulations (primarily in 49 CFR 171–180) to statistics on accidental releases from different types of containers and transportation modes. Further information can be obtained on these issues by visiting the DOT Web site on hazardous material transportation (http://hazmat.dot.gov), by contacting the agency's hotline (800-467-4922 or 202-366-4488), or by submitting questions via electronic mail (infocntr@rspa.dot.gov). A specific DOT guidance document of interest is "Guidelines for Transporting Anthrax and Anthrax-Contaminated Objects and Materials." This is available online at: http://hazmat.dot.gov/guide_anthrax.htm.

- The New York State Department of Environmental Conservation (NYSDEC) developed a guidance document to help generators and transporters understand the regulatory framework

for storing, handling, and transporting wastes from biohazard incidents. The document ("New York State Department of Environmental Conservation Program Policy for the Handling, Storage, Transport, Treatment and Disposal of Waste Generated from a Biohazard Incident") is not yet available on the agency's Web site, but a draft copy of the document has been forwarded to EPA. Such draft document has been modified in format and scope since the May 2003 meeting in Cincinnati and will likely undergo additional changes before it is finalized for distribution.

- Several panelists indicated that the Department of Defense likely has prepared internal guidance on storage, handling, and transportation of wastes containing chemical agents for the installations engaged in demilitarization activities.

- Virginia has regulations in place on use of barges and ships and has identified standards for containers.

VI. Disposing of Wastes in Landfills

A. What do we know?

Discussions on landfills began with a brief review of the different types of disposal sites. Workshop panelists suspected that wastes from contaminated buildings, if accepted by landfills, would likely end up in either construction and demolition landfills, municipal solid waste landfills, or hazardous waste landfills. Each type of landfill has different regulatory requirements, which largely dictate whether the landfills have liners, leachate collection systems, daily covers, mandatory worker safety training, or the need to preserve the integrity of containerized wastes. These factors might affect future decisions on what kinds of wastes can be disposed of in the different types of landfills.

Another factor that might influence future waste management decisions is the available capacity of the different landfills. Data presented by the panelists indicated that every state has multiple municipal solid waste landfills and construction and demolition landfills. These landfills have widely varying capacities, but many of them may not be able to handle large volumes of wastes generated during terrorist attacks. The larger landfills are more likely to have the equipment and personnel needed to manage wastes from such events, assuming the landfill operators are willing to accept these wastes—an important issue discussed in greater detail below. Unlike the construction and demolition landfills and municipal solid waste landfills, few hazardous waste landfills are currently operating, possibly fewer than 25 nationwide. Though the hazardous waste landfills may have the necessary infrastructure to handle wastes from terrorist attacks, they might not be a reasonable waste disposal option for areas without nearby landfills.

In terms of capacity alone, landfills appear to be far more capable than incinerators at managing large volumes of waste over short time frames. However, past experiences have suggested that landfill operators are extremely hesitant, if not completely unwilling, to accept wastes that might be contaminated with biological agents. The landfill operators at the workshop stated that scientific issues still need to be resolved before they feel comfortable disposing of wastes that contain, or might contain, biological agents. Operators expressed concern about risking their assets and assuming other liabilities simply by processing a single waste stream, even if the waste involved has already been decontaminated in autoclaves. Thus, on-site coordinators might have difficulty identifying landfills willing to accept wastes that might contain biological agents, due to perceived risks and liabilities. Specific concerns raised by landfill operators follow:

- **Unresolved scientific issues.** Noting that scientists have not developed widely accepted decontamination criteria, landfill operators who attended the workshop expressed concern about disposing of wastes potentially contaminated with biological agents. This concern will likely remain until scientists develop (and regulators adopt) specific guidance on the effectiveness of decontamination. Landfill operators also noted that only very limited scientific information is currently available on the fate of chemical and biological agents in landfill environments and whether these agents might eventually be released in leachate or

to the air. Another concern was that chemical or biological agents might contaminate landfill equipment or otherwise damage landfill assets. The next section of this report lists specific research needs that panelists identified to address these and other unresolved scientific issues.

- **Absence of guidance or clear regulatory framework.** The landfill operators at the workshop emphasized that operating permits typically dictate the types of wastes (usually by waste codes) that landfills are allowed to receive. However, waste codes have not been developed to classify building debris or spent personal protective equipment possibly contaminated with chemical or biological agents. As long as regulations and agency guidance documents do not specify when landfills can accept and dispose of these types of wastes, the operators suspected that most landfills will continue to refuse wastes that might be contaminated with biological agents. As the next section describes, the workshop panelists offered many suggestions for EPA to consider when developing guidance for landfills on this issue. Such guidance should acknowledge that waste management regulations vary from one state to the next.

- **Other issues.** The panelists identified many other concerns that landfill operators have expressed about disposing of special wastes at their facilities. First, several panelists wondered how they can ensure that wastes from terrorist incidents do not endanger their workers, including haulers, equipment operators, environmental monitoring personnel, and others with site access. Panelists asked, for instance, if landfills would need to implement additional health and safety training, medical monitoring, or vaccination programs, or to require employees to receive prophylactic therapies. Second, operators asked if landfills that receive special wastes will need to monitor the air, groundwater, or leachate for chemical and biological agents. Finally, the panelists raised many additional issues that EPA and landfill operators might need to consider, such as liability concerns, public perception, and the need for vector control. One panelist noted that legal issues may require negotiations and provisions proposed to Congress to address industry's concern regarding liability in the event of a terrorist attack that requires private firms to assist with the public disaster.

In this discussion, panelists suggested three options for EPA to consider when developing guidance on disposing of wastes from buildings contaminated with chemical or biological agents. First, several panelists suggested the possibility of constructing "mono-fills" to handle special waste streams at existing landfill sites. Landfill operators could isolate the wastes of concern in these mono-fills, which can either serve as temporary storage areas or as permanent disposal sites. Second, some panelists said that EPA might be able to coordinate special waste disposal activities with the Department of Defense: many states have military installations that not only have active landfills, but also have security measures to prevent unauthorized access. Third, several panelists suggested that EPA consider evaluating the feasibility of temporary waste storage options using "macro-encapsulation units." This technology has been used to dispose of decontaminated furniture from an office building that received an anthrax-tainted letter. In that case, the furniture items and other materials were placed into a macro-encapsulation unit, which was filled with cement kiln dust and then sealed. Use of the high-pH cement kiln dust is believed to render the macro-encapsulation unit

unsuitable for microbial growth. Some panelists indicated that macro-encapsulation units, which have capacities of approximately 20 tons, could be useful when temporary storage of wastes is needed.

B. What research or information needs were identified?

Workshop panelists identified several information gaps regarding disposing of wastes in landfills, and noted research needs or action items for filling these gaps. They discussed the following issues:

- Several panelists recommended that EPA develop data, whether modeled or experimental, that characterize the fate of selected biological and chemical agents in landfills. One suggestion was to perform bounding calculations to assess the fate of chemical agents in landfills; these calculations could be based on conservative transport assumptions and the agents' relevant chemical and physical properties (e.g., vapor pressure, solubility, octanol-water partition coefficient). The calculations can provide insights, for example, on whether disposing of wastes containing chemical agents would produce unacceptable air concentrations at the landfill surface.

- Other panelists recommended that EPA conduct experiments to simulate the movement of chemical or biological agents through landfill environments. One suggestion was that researchers use lysimeters filled with waste to determine whether agents in the waste will enter leachate or air. Such experiments could investigate contaminant mobility for many landfill conditions and waste matrixes. Another suggestion for experimental research was to evaluate whether biological agents would remain viable in the pH conditions typically found in different types of landfills. Similarly, panelists suggested that EPA examine whether biological agents remain viable under the high pH conditions present in macro-encapsulation units filled with wastes and cement kiln dust. Finally, one panelist suggested that experimental research can eventually consider the fate of chemical and biological agents in test cells at select landfills.

- The panelists identified many other unresolved scientific issues, such as whether chemical or biological agents might damage landfill liners, leachate collection systems, and gas recovery systems and how waste generators can demonstrate that their waste streams are decontaminated. The panelists did not identify specific research projects that can address these information gaps.

- Panelists said that landfill operators would benefit greatly from EPA preparing a protocol or guidance document that addresses technical issues associated with disposing of special wastes. Specific issues such a document could address include: what wastes may and may not be accepted, when wastes must be containerized, under what circumstances temporary storage of wastes is preferred, under what circumstances segregating wastes into a mono-fill is preferred, what minimum landfill design features are needed to receive special wastes, what additional environmental monitoring is needed, and whether landfill operators will be

held liable for disposing of wastes according to these guidelines. Once these and other related issues are addressed in an authoritative document written by EPA, waste management decisions might be less complicated to address. Some panelists indicated that EPA might need to have its eventual guidance documents subject to peer review, possibly by independent panels or by bodies like the National Academy of Sciences. Other panelists noted that guidance documents should acknowledge that waste management regulations can vary from one state to the next.

- The Federal Government may need to pre-determine potential landfill sites that would be available to dispose of chemical/biological agents. This assessment should include location, security, and capacity issues. This assessment should include existing facilities as well as new facilities that would offer more security and/or the ability to be operated as a monofill.

- Several panelists suggested that EPA consider developing a dynamic database that periodically tracks landfill capacity (in active cells) for different types of landfills around the country, including those on military installations. This database could be accessed by parties responsible for disposing of wastes that contain chemical or biological agents.

- Some panelists recommended that EPA review the literature and consult with other agencies about existing information on the fate of biological agents in landfills. One panelist, for instance, indicated that modeling studies conducted by environmental agencies in the United Kingdom have already examined the environmental fate of prions. Panelists cautioned EPA about using literature on the fate of biological agents in soils, because landfills and soils are considerably different environments.

C. What information resources are currently available on this matter?

The panelists identified several sources of information on disposing of wastes from buildings contaminated with chemical or biological agents into landfills. The resources identified during the workshop are discussed. (This should not be viewed as a comprehensive account of all available resources.)

- One document cited at the workshop is the National Response Team's 2002 draft-final document titled "Technical Assistance for Anthrax Response." The document is available from NRT's Web site (http://www.nrt.org). It addresses a wide range of technical issues for anthrax, including sampling and analysis, decontamination, storage, and disposal.

VII. Incineration

A. What do we know?

Incineration technologies were discussed extensively, especially considering that many potential waste streams from terrorist attacks might not be allowed in, or accepted by, landfills. Based on experiences from weapons demilitarization operations and management of wastes from anthrax-contaminated buildings, panelists generally accepted that incineration is a viable option for treating wastes that might contain chemical or biological agents. But the panelists, particularly the representatives from incineration facilities, listed several scientific, technical, and public perception issues that need to be resolved or considered to ensure that wastes are incinerated properly and in a manner that does not harm the environment, compromise worker safety, or damage the assets at incineration facilities.

The panelists identified five general types of thermal treatment technologies that might be used to treat wastes containing biological and chemical agents. This discussion addressed the typical sizes, capacities, and other relevant features of the technologies:

- **Hazardous waste incinerators (HWIs).** The panelists reviewed various hazardous waste incineration technologies, but focused on fixed hearth and rotary kiln incinerators as the most likely candidates to manage wastes containing biological and chemical agents.[2] A panelist noted that 7 fixed hearth and 37 rotary kiln HWIs currently operate in the United States, though many of them are dedicated to specific waste streams at industrial facilities or are located at military installations. Advantages of using HWIs include the fact that regulations already require these incinerators to have waste tracking mechanisms and employee safety training programs. Possible disadvantages include the fact that most HWIs are located in relatively remote areas, the limited capacities of HWIs, and size limitations. For perspective on typical waste processing capacities, one panelist noted that the three rotary kiln HWIs he contacted before the workshop could process between 50 and 175 tons of hazardous waste per day. Typically, the sizing for the feed stream is the rough dimensions of a drum.

- **"Waste-to-energy" facilities.** The panelists said that municipal solid waste incinerators might be able to handle wastes containing chemical and biological agents. Panelists noted several potential advantages to these facilities: when compared to HWIs, the waste-to-energy facilities tend to be closer to urban centers, where terrorist attacks on buildings would most likely occur; they generally have much larger processing capacities than HWIs; and they are believed to have more flexibility to implement specific engineering changes (e.g., altering

[2] The panelists acknowledged that other types of facilities, such as cement kilns, boilers, and industrial furnaces, combust hazardous wastes. They did not discuss such facilities in detail, because these facilities typically require homogeneous waste streams and likely would not be able to process the wide range of wastes that would probably be generated in a building contamination scenario. One panelist said that cement kilns might be able to treat contaminated carpets, but this issue was not discussed extensively.

the feed inlets) in order to accommodate special wastes.

Potential disadvantages included public perception associated with incinerating special wastes near population centers and permit restrictions for these facilities. Another limitation is the fact that, while waste-to-energy facilities are designed to receive and process many thousands of tons of waste per week, they are not particularly suited for large bulky items. Processing larger items can cause operational upsets (e.g., plugging the feed chute or ash discharger) and can complicate efforts to homogenize wastes, which is needed to achieve optimum combustion conditions. The need to homogenize wastes raised further concern that doing so can generate dusts in the pit area, where workers might be exposed to chemical and biological agents. Another possible limitation associated with waste-to-energy facilities is the fact that many facilities are municipally owned and privately operated and have business and financial relationships with their client communities. As a result, some owners and operators might not be able to offer or make available their waste-to-energy facilities for wastes from terrorist attacks.

The panelists did not indicate exactly how many waste-to-energy facilities operate in the United States, though they noted that the number is likely far greater than the number of HWIs.

- **Medical waste incinerators (MWIs).** Participants noted that MWIs likely could handle, and would be allowed to process, certain types of wastes containing chemical or biological agents, even though they are permitted to handle wastes primarily from clinical and research settings. Regulators might need to issue permit modifications or exemptions for MWIs to process these wastes. One panelist noted that an estimated 115 MWIs currently operate in the United States, including 22 commercial MWIs. The processing capacity for these incinerators is generally 1 ton of waste per hour. The most notable limitation for MWIs is the size of the waste that can be processed: one panelist pointed out that the typical hopper size for most MWIs is 3 feet by 5 feet by 5 feet.

- **Autoclaves.** Panelists briefly reviewed information on autoclaves, which sterilize wastes using steam, heat, and pressure. Autoclaves range in size from bench-top devices to large commercial operations. These commercial facilities can process up to 96 tons of waste per day, and some have waste inlet openings up to 8 feet in diameter. Potential advantages of using commercial autoclaves to sterilize waste include the ease with which processing conditions can be altered for specific waste streams, the ability to process large waste items, and the fact that these facilities often have testing requirements for spore destruction. Potential disadvantages include worker safety issues (which already have been documented for an autoclave where elevated mercury exposures occurred) and the issue of disposing of decontaminated wastes.

- **Alternative treatment technologies.** The panelists identified several other technologies that might hold promise for future waste management challenges. Specific suggestions include

plasma treatment technologies, ionizing radiation, and thermal microwave technologies. The panelists did not discuss these technologies in detail (except for the potential use of plasma technologies to treat large numbers of human cadavers following a bio-terrorism attack) and indicated that the performance of these technologies has yet to be verified.

The panelists identified many technical challenges that need to be resolved for incinerating wastes containing chemical and biological agents, regardless of the type of incinerator being considered. Discussions focused on considerations for the incinerator operators and the waste generators:

- **Challenges faced by incinerator operators.** The panelists listed many potential challenges that incinerator operators face when receiving wastes that potentially contain chemical or biological agents. For instance, operators said that further research is necessary to determine optimal operating conditions (e.g., temperature, residence time) for adequate treatment of wastes; several operators added that the optimal conditions will likely depend on the specific chemical or biological agent of concern and the type of waste being treated (e.g., office materials, personal protective equipment, animal carcasses). Further, operators need guidance on proper waste handling procedures,[3] approaches to handling process upsets and pressure excursions, and how incinerator residues (e.g., ash, baghouse dusts) should be managed. The operators also indicated that processing wastes not specifically identified in their operating permits would require permit modifications, exemptions, or variances. The operators expressed concern about whether trial burns would be required and whether building wastes might contain chlorine, metals, and other constituents in amounts that would cause incinerators to exceed their permitted emission limits or cause corrosion of the equipment in the case of chlorinated disinfectants. Some incineration facilities, operators said, might require capital investment (e.g., a dedicated conveyor system) to address the unique challenges posed by processing wastes containing chemical or biological agents.

  The incinerator operators also expressed concern about protecting their business assets, including their employees and equipment. Specific concerns about worker safety echoed those raised earlier in the workshop: Under what circumstances should workers be vaccinated, issued prophylactic therapy, or tracked by medical monitoring programs? What process upsets and other operating conditions might cause incinerators to release untreated wastes into the workplace air? Is supplemental training needed before facilities receive wastes containing chemical or biological agents? The panelists generally agreed that proper sizing and packaging of wastes at the site of contaminated buildings will help alleviate, but not eliminate, worker safety concerns at incineration facilities. Another approach proposed to addressing worker safety issues is having environmental, health, or safety agencies provide

[3] There was some dissent on this matter. One panelist noted that operators of medical waste incinerators are already trained in the proper management and handling of infectious and highly hazardous substances and wondered why further training is considered necessary. On the other hand, several panelists added that incinerator operators and facility personnel might require special training on chemical and biological agents to address the "fear of the unknown" and to ensure that all facility personnel are comfortable handling materials potentially contaminated with chemical and biological agents.

on-site operators for the time when special wastes are processed. An incinerator operator took exception to this suggestion, noting that incinerator operators are already extensively trained and experienced with the specific equipment and technologies used at their facilities. This panelist suggested that outside agencies should work cooperatively with site operators and personnel, rather than presume that they can or should take over operations at a given facility.

During this discussion, incinerator operators wondered if EPA could assist (whether directly or financially) with developing training courses specific to handling chemical and biological agents. These operators emphasized that workers should be trained on any unique hazards posed by chemical and biological agents *before* an event occurs, such that workers can be educated and prepared to handle wastes in the future.

In addition to worker safety issues, the incinerator operators asked about protection of their equipment, which often times represents an investment of millions of dollars. Some operators, for example, might be hesitant to jeopardize the ongoing operation of their incinerators by processing a single waste stream from a terrorist event that might contaminate or corrode their equipment. The operators recommended that EPA consider these liability concems, possibly by indemnifying facilities that properly process wastes containing chemical or biological agents from unforeseen damages that might result or otherwise assuring operators that a financial mechanism is in place to reimburse facilities for damages caused by or long-term costs associated with managing waste streams containing chemical or biological agents. Another panelist noted that liability concerns might be addressed by provisions proposed to Congress.

Finally, many panelists noted that public perception issues might be extremely difficult to address for incineration facilities. Some operators suspected that activists and community members would likely protest if wastes containing chemical or biological agents are treated by incinerators in their cities. Panelists suspected that strong public opposition to incineration could be a significant obstacle to managing wastes, especially for the waste-to-energy facilities, which tend to be located in or near densely populated urban settings.

- **Considerations for the "generators" of wastes.**[4] The workshop panelists also noted that the generators of wastes containing chemical and biological agents should be made aware of specific challenges that incinerator operators face. For instance, the generator should identify the size limitations of the incinerator that will receive the waste before shipping materials off site, so that wastes can be packaged accordingly. The generator also should determine the maximum throughput that the incinerator can handle, so that the waste stream does not overwhelm the incinerator's operations. Finally, the generators need to be aware of specific packaging and labeling requirements; some incinerators, for example, might require

[4] "Generator," in this section, is meant to refer to the party that collects the waste at the site of an incident and ships the packaged waste to the incinerator. This will likely be a local or state agency.

that each waste item have a label specifying the heat content, volatility, and composition (at least of chlorine and metals) of the waste material. Most of these issues can be resolved during planning for terrorist attack scenarios.

The workshop panelists raised several additional waste management options or scenarios for EPA to consider. First, they debated whether mobile incineration units would be viable options for processing wastes from buildings contaminated with chemical and biological agents. While the mobility of these units is clearly an advantage, panelists were concerned about the need for obtaining operating permits on short notice, the destruction efficiencies that the mobile units can achieve, whether public perception will preclude the use of mobile incinerators in urban settings, and the limited capacity and inlet size restrictions for the existing mobile incineration units. Second, some panelists wondered if a combination of waste management technologies (e.g., disinfecting wastes in an autoclave, disposal of disinfected wastes in a landfill) might be preferred for certain types of wastes. Third, some panelists said that EPA should be aware that some incinerators that are currently closed can be brought back online, if necessary, with relatively low capital investment. Finally, the panelists discussed the unique challenges of handling human cadavers or body parts that are contaminated with biological agents. As noted previously, the panelists indicated that multiple agencies might need to coordinate efforts to ensure that contingency plans are in place to handle large numbers of potentially contaminated cadavers.

B. What research or information needs were identified?

Workshop panelists identified several information gaps for incinerating wastes from buildings contaminated with chemical and biological agents, and noted associated research needs or action items for filling these gaps. The following issues were discussed:

- Several panelists identified opportunities for scientific research into ensuring that incineration facilities properly destroy wastes. For instance, some panelists indicated that bench-scale and pilot-scale experiments using surrogate agents could characterize the minimum residence time and temperature needed to properly treat chemical and biological agents bound to different matrixes. Such research could range from examining fundamental heat transfer and mass transfer behavior that can be incorporated into computational models to conducting trial burns that examine destruction efficiencies and residue content for more challenging waste streams (e.g., rolled-up carpet soaked in water). Other waste sources that may present problems for incineration include animal carcasses, wastewater from decontamination and radioactive wastes. A concern was also raised about the combustion products produced, e.g. disinfectant dosages resulting in significant dioxin formation and metals from electronics. One panelist noted that EPA is already conducting some research on these incinerator performance issues, and another panelist indicated that EPA has already conducted modeling of full-scale medical waste incinerators for spore destruction.

- For the benefit of the state and local agencies that might be faced with waste management challenges in the future, EPA could develop an inventory of different types of incinerators

and throughput capacity across the United States, including HWIs, MWIs, waste-to-energy facilities, and commercial autoclaves. Panelists suggested that such an inventory can identify the locations, capacities, types of units, inlet size restrictions, accessibility by rail car, and other features of incineration facilities. The inventory should include all types of incinerators that might receive wastes containing chemical and biological agents, including incinerators at military installations and "captive" incinerators at industrial facilities that typically process only those wastes generated on site. When reviewing the existing infrastructure, EPA can also identify engineering challenges that prevent incinerators from accepting wastes (e.g., inlet size restrictions) and determine how these challenges might be addressed.

- Several panelists noted that state and local agencies should consider the available incineration capacity when developing plans for how to handle wastes contained with chemical and biological agents. These agencies should identify a number of issues including which incinerators are willing and able to accept wastes containing chemical and biological agents, what types and sizes of wastes they can process, how wastes should be packaged before being sent to the incinerator. This recommendation is consistent with a general theme expressed throughout the workshop: very few waste management options are available for wastes generated when buildings are contaminated with chemical or biological agents. Recognizing this, several panelists recommended that the state and local agencies first identify the limited number and type of facilities that are willing and capable to receive the wastes, and "work backwards" to specify what types of wastes should be sent to the identified facilities.

- A number of panelists indicated that operator training is needed to handle these types wastes. This should be built on training that exists for operators.

- Some panelists indicated that EPA could continue to examine the effectiveness of alternative treatment technologies (e.g., plasma, ionizing radiation, thermal microwave). These panelists noted that EPA has already published specifications for verifying the effectiveness of new technologies for treating medical waste, as has the State and Territorial Association on Alternative Treatment Technologies.

C. What information resources are currently available on this matter?

The panelists identified several sources of information on incinerating wastes from buildings contaminated with chemical or biological agents. The main resources identified during the workshop are discussed below. (This should not be viewed as a comprehensive account of all available resources.)

- The Integrated Waste Services Association has prepared a report documenting the locations, capacities, and other information about selected waste-to-energy facilities across the United States. This report—*The 2002 IWSA Directory of Waste-to-Energy Plants*—is available on the association's Web page: http://www.wte.org.

- Several panelists noted that the Department of Defense should have information available on incineration of chemical agents, particularly from installations that are in the process of obtaining operating permits for demilitarization activities. The incinerators at these sites might be the most appropriate destination of wastes from terrorist attacks involving chemical agents, assuming they can handle the types of wastes that must be disposed of or treated.

- One panelist encouraged EPA to obtain and review a testing protocol recently used to evaluate a technology's effectiveness for deactivating prions. Testing was conducted by the USDA for a technology developed by a company named Waste Reduction by Waste Reduction.

VIII. List of Participants

The following pages list the panelists who participated in the workshop. The list does not include those who were invited to participate but could not attend the workshop.

Homeland Security Workshop on Transport and Disposal of Wastes from Facilities Contaminated with Chemical/Biological Agents

Marriott Kingsgate Conference Center
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May 28-30, 2003

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