RESOURCE PAPER[1]
FOR THE MARCH 30, 2004 WORKSHOP
AT
DOT/RSPA VOLPE CENTER
ON

CLEANUP AND RECOVERY OF PASSENGER TRANSPORTATION FACILITIES AFTER A BIO-ATTACK

Introduction

A bio-terror attack against transportation targets or delivered via transportation vehicles is deemed to be a credible and potentially very damaging threat to the nation. Of special concern is the release of a bio-agent in crowded passenger terminals, many of which are multi-modal, linking aviation with rail, transit, water ferries, taxis, and adjacent parking garages. Hence, the public health consequences of a bio-attack on a major airport must consider not only the potential exposures of employees and passengers, but also the threat of rapid and large-scale contaminant dispersal via people, baggage, and vehicles. Perhaps equally important is the potential for huge economic losses resulting from the long-term closure of an airport or major intermodal terminal, and repercussions for wider regional, national, and international transportation networks. Considerable uncertainty remains in regard to forecasting downstream costs: for example, the cleanup and recovery of anthrax- contaminated facilities, from a few mailed letters identifying the agent, has proven to be lengthy, difficult and costly.

Department of Transportation – Roles and Activities

The nation's transportation system must have a robust ability to deter, withstand, or recover from any terrorist attack- be it biological, chemical, or nuclear in nature. Planning and displaying the ability for rapid recovery and consequence mitigation could help to break the resolve of potential enemies. Doing otherwise would accomplish the terrorist's goals to cause panic, hurt people, and inflict lasting economic damage. To that end, the U.S. Department of Transportation (DOT), in coordination with the U.S. Department of Homeland Security (DHS) and State and local authorities, maintains a critical presence in prevention, preparedness, and response activities. Since 9/11/2001, the DOT has centralized its 24/7 *Crisis Management Center* (CMC), and developed new protocols for communication and coordination with agencies responsible for homeland security, transportation operations, and emergency response. It has also developed Continuity of Operation (CO-OP) plans. DOT officials must continue to develop viable and cost-effective plans, programs and training materials for transportation authorities to

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meet these threats,[2] even in the absence of complete information and clear understanding of threats, their probabilities and consequences. As a special case of terrorist incidents, a bio-attack is of greatest concern due its insidious nature, delayed detection and effects, and potentially widespread impacts.

As an agency within the DOT Research and Special Programs Administration (RSPA), the Volpe Center has long served as a bridge between transportation policymakers, the transportation community at large, industry, and academia. In support of DOT security goals, the Center has developed training tools and a knowledge base for the DOT operating Administrations. An example is the set of nationwide emergency preparedness and security forums for transit authorities conducted by the Volpe Center on behalf of the Federal Transit Administration (FTA).[3] In addition, the Center, in 2002, organized two workshops: one on Bioterrorism and Public Health Responses (with the Harvard School of Public Health), and another on Quarantine vs. Evacuation for RSPA's Office of Emergency Transportation. Both the Volpe Center and the Harvard Kennedy School of Government have developed case studies on bioterrorism in transportation;[4] they will conduct related training for the DOT Executive Leadership Institute (TELI).

The Economic Value of Transportation to the Nation

Transportation is the most basic component of the nation's socio-economic fabric, and it is essential to preserve the ability to efficiently move people and goods both under normal and emergency conditions. The DOT Strategic Plan 2003-2008[5] cites sobering figures on the enormous size and connectivity of transportation networks, as well as great economic value of the system: transportation economic activity represents 11 percent of the GDP, or about $1.1 trillion per year, supporting one in every eight jobs. <There is an extra line space here that should be deleted>The economic value of aviation to the US is reflected in 2002 figures. Total travel expenditures were about $460 billion for domestic, and $66 billion for international travel.[6] The Air Transport Association (ATA) Office of Economics[7] and the Airports Council International (ACI) latest figures[8] cite direct and indirect economic benefits of airports amounting to $507 billion in 2001. Air travel also generated a payroll of $157 billion for 7.2 million jobs, with cumulative U.S. tax revenues of $93.2 billion. Of the over 5,000 public use airports nationwide, there are about 50 major hub airports, most of them linked with transit (bus, light rail) and other

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[2] *Deterrence, Protection and Preparation: The New Transportation Security Imperative*, TRB Special Report 270, 2002.

[3] Connecting Communities and security training materials archived at http://transit-safety.volpe.dot.gov/training/Archived/EPSSeminarReg/default.asp and http://transit-safety.volpe.dot.gov/Security/Default.asp

[4] "Charting a course in a storm: US Postal Service and the anthrax crisis," Harvard University, Kennedy School of Government Case program, 2003, by Kirsten Lundberg for Prof. Arnold Howitt, for the DOT Volpe Center DOT Executive Leadership Institute.

[5] Available at www.dot.gov/stratplan2008/strategic_plan.htm

[6] Cited by Travel Industry Association of America, TIA www.tia.org/Travel/econimpact.asp

[7] See http://www.airlines.org/econ/

[8] *The Economic Impact of US Airports 2002*, ACI-North America, available at www.aci-na.org

ground transportation modes. The latest FAA Airport capacity analysis[9] shows that in 2000, Boston's Logan Airport and the Denver International Airport, each handled over 500,000 operations and 13 million passengers. In comparison, larger airports, such as Los Angeles, Dallas-Fort-Worth, and O'Hare, handled 800,000-900,000 operations and 29-31 million passengers.

A depressed air and surface transportation market due to fear and panic after a bio-attack would have regional, national, and global adverse economic impacts. For instance, after 9/11, Boston's Logan Airport experienced about a 20 percent drop in both flights and passenger traffic, with associated losses in revenues from sources such as parking fees, the volume of commerce, freight activity, and mail income. Larger losses occurred at the Capital's Dulles and National airports after 9/11, in part due to regulatory security measures, but also due to public reluctance to fly.

The volume of passenger traffic at rush hour for large and visible intermodal transit-rail facilities, like Pennsylvania Station in New York City and Union Station in Washington, DC exceeds similar figures for even the largest airport.[10] At those locations, mass transit generates in excess of 9.5 billion trips, which is 16 times the volume of annual air passenger-trips. More than 456,000 commuters pass through Penn Station in one morning rush hour, equivalent to 2.5 days of passenger volume at O'Hare Airport. A bio-attack against such a busy passenger terminal could indeed inflict a heavy human toll and economic losses.

Background: Legislative and Executive Branch Response and Preparedness

Prepared in response to the Presidential Homeland Security Directive (HSPD-5), the U.S. Department of Homeland Security (DHS) *Initial National Response Plan* (NRP) provides chain of authority guidance for field incident response, management, and cooperation between federal, state and local agencies. This *Plan* assists in the correct application of detection and surveillance technologies and identification of the type and amount of bio-agents involved, focusing on minimizing the probability of bio-attack. It also guides the correct emergency response by public health officials – whether by quarantine, evacuation, treatment on site, or some other method. Although the guidance is very helpful, there still remain open questions in regard to consequence management and mitigation, cf. materials, methods and efficiency of remediation of contaminated facilities, and the recovery of operations after a bioattack.

The *Public Health Security and Bioterrorism Preparedness and Response Act of 2002* (PL 107-188) allocated considerable resources to the U.S. Department of Health and

[9] FAA Office of System Capacity (http://www2.faa.gov/ats/asc/02ACE.html). The 2002 plan, Ch.3 and Appendix B lists the volume of operations and enplanements at large airports--page 8 has the data for 2001 and projections for 2013.

[10] Kwan Quon, DOT/FTA expert on WMD testimony to NRC Committee on Standards and Policies for *Decontaminating Public Transportation Facilities Affected by Exposure to Harmful Biological Agents: How Clean is Safe?* Available at http://www4.nas.edu/cp.nsf/Projects

Human Services (HHS) – the Food and Drug Administration (FDA) and Centers for Disease Control (CDC) for bioterrorism risk reduction and impact mitigation, and for First Responder and public health readiness. Similarly, the *Aviation and Transportation Security Act* (PL 107-71) has addressed, to some extent, bio-incident prevention and detection through the screening of passengers and baggage.

Activities Directed toward Pre-attack Issues

During the post 9/11 period, national attention and budget resources have centered on preventing terrorism, assessing risks and vulnerabilities, deploying detection technologies, and bolstering the capabilities of emergency responders. Additional resources have addressed the capacity of the public health system, with a specific focus on enhancing medical surveillance and enhancing its ability to provide early warning of a bio-attack. Funding for the Bioshield program, including its BioWatch and BioSense components, has been approximately $6 billion, and will increase substantially in 2005. In contrast, financial resources aimed at understanding the aftermath of a bio-attack, including facility cleanup and the operational recovery phases for equipment, workers and travelers, have been relatively modest so far. The DHS Domestic Demonstration and Application Program (DDAP) is currently sponsoring the bio-defense restoration research efforts, being carried out at both the Sandia National Lab (SNL) and Lawrence Livermore National Lab (LLNL).[11]

The 2002 Integrated Chemical and Biological Defense Research, Development and Acquisition Plan for Chem-Bio Point Detection and Decontamination Technology Areas was developed jointly by the Department of Defense (DOD) and Department of Energy (DOE). It includes a technology roadmap for RDT&E of decontamination technologies, as well as acquisition transition plans. This plan is also applicable to civilian biodefense. Similarly, the DOE Program for Response Options and Technology Enhancements for Chemical/Biological Terrorism (PROTECT), has been utilized by the Federal Transit Administration (FTA) and transit authorities in Washington, DC and Boston, MA to instrument and monitor subway stations security for levels of chemical and biological agents.[12] Technology transfer for both bio-detection and for bioremediation from the military to the civilian sector can and must be effected with due consideration for the specific requirements and needs of terrorism in an urban transportation environment. Such requirements include: mass market availability, high reliability of detection of low-levels of bioagents, at low cost, with high automation and ease of use, as illustrated by the recent Lincoln Lab "Urban test-bed" feasibility study of bio-weapon sensors derived from a military system, tested the in the Boston subway.[13]

The National Institute of Occupational Safety and Health (NIOSH) conducted an evaluation of the vulnerability of building heating, ventilation, and air-conditioning (HVAC) to bio-contamination in 59 buildings between November 2001 and April 2002,

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[11] *Proceedings of the Restoration Workshop*, Sept. 17, 2003, co-sponsored by LLNL and SNL; compiled and edited by S. Mancieri, R. Kirvel, M. Tucker and E. Raber

[12] See PROTECT specifics at www.nn.doe.gov/cbnp

[13] "Detection of Biological Attacks in a Subway System: A Sensing System Design Based on Measurements in the Boston Subway", by T. J. Dasey et al, Technical Report TR-1091, Jan. 2004

including several transportation buildings.[14] Following that evaluation, NIOSH issued its "Guidance for Protecting Building Environments from Airborne Chemical, Biological and Radiological Attacks" in May, 2002.[15] The U.S. Department of Labor (DOL), Occupational Safety and Health Administration (OSHA) Salt Lake City Technical Center (SLTC) also compiled and posted safety and health resources on anthrax in workplace on its website.[16] Other useful resources are posted on the DOE Lawrence Berkeley Lab (LBL) website, e.g., Advice for Safeguarding Buildings against Chemical or Biological Attack.[17]

Several published guidelines are available to safeguard facilities targeted for biological or chemical attack, but they are relatively untested. For instance, the National Academy of Sciences, Federal Facilities Council (FFC) conducted a December 2001 workshop on Chemical and Biological Threats to Buildings.[18] That workshop assessed existing decontamination procedures, and received sponsorship by 21 federal agencies, including the Federal Aviation Administration (FAA) and United States Coast Guard (USCG).

The Whole Building Design Guide (WBDG) also strives to balance security and sustainability against the costs of protecting the occupants and assets of buildings. Its resources include the integration of physical security with threat assessments for explosives and weapons of mass destruction (WMD); it includes a review of available federal codes and standards addressable through such integration.[19] The report also contains a review of physical technologies for air filtration and decontamination.

Lessons Learned from the Anthrax Incidents

The recent anthrax attacks provide important "lessons learned" to transportation officials for improving bio-terrorism response preparedness. Among these is that the threat of a future bio-attack on a major transportation node is made more likely by several factors:

- Low cost and wide availability of raw materials for bio-weapons
- Relatively low-tech means for preparing and dispersing bio-agents
- Low probability of immediate detection due to delays in symptoms for exposed individuals, varying with agent, dose, release scenario and vulnerability
- Difficult forensics for identifying the source and release location of bio-agents
- Difficulty in apprehension of the perpetrators

Naturally emerging diseases such as SARS also provide useful analogs to epidemics due to contagious bio-agents, such as smallpox. The World Bank, for example, estimated economic losses due to SARS and its associated public health scare exceeded $25 billion in Southeast Asia, and over a billion dollars in Toronto. Even those high losses do not include the lost income to airlines and other transportation providers.

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[14] Available at www.cdc.gov/mmwr/preview/mmwrhtml/mm5135a4.htm
[15] Available at www.cdc.gov/niosh
[16] Available at www.osha.gov/SLTC/etools/anthrax/response.html
[17] Available at http://securebuildings.lbl.gov
[18] Available at http://www7.nationalacademies.org/ffc/
[19] Available at www.wbdg.org/design/index.php?cn=2.7.4&cx=0

As evidenced by the quarantine response during the recent SARS epidemic, the global transportation system is vulnerable to any bio-attack, whether its disruption is perpetrated by terrorists or by natural causes. Airports were closed, flights were cancelled, travel within large metropolitan areas (like Toronto and Hong-Kong) ceased, with major travel and tourism business losses. Even if non-contagious bio-agents or hoax-powders had been used -- as the 2001 anthrax in the mail and copycat incidents have shown -- there are enormous economic and psychological impacts. Public health costs rise suddenly, normal operations become disrupted, exposed people and facilities undergo extensive testing to assess the impacts, and buildings and equipment require decontamination to restore normal operations.

In the fall of 2001, hundreds of people were exposed to anthrax spores delivered via the mail. Only 22 cases of anthrax were diagnosed nationwide, including 5 deaths in Washington, New York, Florida and Connecticut. Of the 32 postal workers definitely exposed, 13 were infected (7 with cutaneous, and 6 with inhalation anthrax), of whom 2 died as a result. By some estimates, almost 10,000 individuals took preventively the antibiotic CIPRO, mostly the result of public panic. Thousands of mailed powder samples suspected to be anthrax spores had to be analyzed at specialized bio-labs nationwide, mostly due to hoaxes. Hundreds of postal facilities nationwide were also tested for the presence of anthrax spores, and dozens were decontaminated, with tons of mail being irradiated as a precaution. As recently as the November 2003, 11 mail handling centers in the Washington Metro area were still closed as a precaution when anthrax traces were detected at a Navy mail handling facility.[20]

The U.S. Postal Service (USPS) estimated that direct and indirect damages from the anthrax letters exceeded $300 million; the cost of mail sanitizing equipment alone was over $2.5 billion. The U.S. General Accounting Office (GAO)[21] reported that the cleanup of anthrax contamination from the Hart Senate Building and of nearby Congressional offices and mail facilities cost the Environmental Protection Agency (EPA) over $27 million.

In order to reopen these facilities as quickly and safely as possible, three different methods of decontamination were applied repeatedly to hundreds of employees and contractors, The EPA and its team of contractors had a major role in cleanup of the Capitol Complex and USPS facilities. Its Emergency Response Program provided technical assistance to the USPS in the decontamination of nineteen postal facilities across the U.S., and also led the cleanup and remediation of the Senate Hart building and other nearby structures. Recently, the EPA Environmental Technology Verification (ETV) Program established an ETV Building Decontamination Technology Center at Battelle Labs, to test and validate cleanup materials, technologies and protocols.[22]

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[20] "Protecting America's Highways and Transit System against Terrorism," by A. Howitt and J. Makler, TRB 2004 Annual meeting paper.
[21] GAO-03-686, "Capitol Hill Anthrax Incident: EPA's Cleanup was Successful; Opportunities Exist to Enhance Contract Oversight,, June, 2003
[22] Available at www.epa.gov/etv/centers/center9.html

Although the large USPS facilities at Brentwood, DC and Hamilton Township, NJ took over two years and $200 million to clean up, some postal workers expressed apprehension about their personal health and safety.

For transportation stakeholders at federal, state, and local levels, these incidents provided valuable lessons regarding communication and coordination gaps, as well as training and resource needs. Further capacities to deal with these gaps and needs can also be derived from national emergency response preparedness exercises involving bio-agents, such as SOONER SPRING (conducted in Oklahoma City in 2002) and the DHS Office of Domestic Preparedness biennial exercise dubbed TOPOFF 1 and 2 (for Top Officials). TOPOFF 2 included a simulated bio-attack in Chicago and a dirty bomb attack in Seattle, with involvement of distant regions (Capital region and Canada).[23] Some towns and localities like Hibbing, Minnesota, have also conducted bio-terrorism drills centered at airports, with an emphasis on the rapid evacuation of exposed people to nearby hospitals. None included realistic decontamination and reclamation exercises.

Although many commercial products and vendors are available to transportation authorities, not all major airports and only a few transit facilities have purchased and systematically deployed bio-detection trigger and analysis systems. Commercial investment to date has been limited by the lack of benchmarking studies and absence of standards for reliability and effectiveness. Guidance available from the CDC and the Office of Science and Technology Policy (OSTP) indicates that the "gold standard" for verification of a bio-attack require time consuming cultures of bacteria for reliable agent identification; this capability now exists at relatively few CDC-certified labs.

Workshop Scope and Objectives

This workshop will convene program managers from federal and state agencies, expert practitioners, researchers and industry service providers to share their insights and shed light on the complex and important set of issues related to assured recovery of transportation facilities and operations after a bio-attack.

The goal of the workshop is to inform and educate transportation officials, including policy decision-makers, facility owners and operators about what is known, what is being planned, and what research, institutional and resource issues must be addressed through the proactive development of policies, programs and plans for cleanup and recovery of transportation facilities and operations after a bio-attack.

Invited presenters will review the state-of-the-art bio-agents remediation technologies and procedures for contaminated facilities, and knowledge gaps regarding cleanup technologies applicable to large transportation facilities. Related institutional coordination and jurisdictional issues, and resource needs for federal, state, and local transportation authorities, will also be discussed.

[23] See e.g., http://www.dhs.gov/dhspublic/interapp/press_release/press_release_0146.xml

Some Existing Knowledge Gaps and Needs

National preparedness efforts in the wake of the anthrax mail attacks have focused primarily on the front end of bio-attack prevention, detection and health-related emergency response preparedness, training first responders and strengthening the public health components.[24] Related efforts include vulnerability assessments, and bio-detection and monitoring technologies. Identifying and strengthening the public health response includes guidance for quarantine or evacuation, prophylaxis, and treatments. Disease incidence bio-surveillance, and the bio-safety labs response network (LRN) ensures that bio-agents can be identified with confidence to guide CDC in distributing push-packs from the National Pharmaceuticals Stockpile (NPS), and to guarantee the availability of vaccines and prophylactic antibiotics, and hazmat suits. The full economic impact due to a single bioattack on a major transportation node on interconnected transportation facilities and operations has yet to be estimated. Aspects of bioterrorism preparedness requiring further research and development, test and evaluation (RDT&E) include:

- Identification of cost-effective critical infrastructure protection (CIP) strategies
- Implications of shelter-in-place strategies for Continuity of Operations Plans (COP)
- Identification of cost-effective materials and processes for building cleanup and rehabilitation that can be used against bio-agents (bacterial or viral) and toxins
- Criteria and feasibility of stockpiling and crisis distribution logistics of sterilants and decontaminants
- A knowledge base of industry suppliers and detoxification for both people and facilities plants, and equipment
- System-wide and logistics chain analysis of transportation emergency response to, and recovery from a bio-attack, including the impacts on inter-linked critical infrastructure categories (public health, telecommunications) and social networks

Dispersion Scenarios of a Bio-agent Release

At Logan Airport, arriving passengers may transfer to buses, the subway system, taxicabs, private vehicles, and water ferries. Any bio-agent release could contaminate the entire city and spread to suburbs via humans, vehicles, and luggage within a few hours; it could be also carried to international and domestic flights via exposed passengers, air and ground crews, and luggage. Detection lags of hours to days may be expected. A positive test for anthrax, for example, requires about 10 hours, by which time widespread public and occupational exposures for people, and contamination of both facilities and equipment is possible, even likely.

Understanding the Aftermath: Cost of Bio-Attack Consequences

Immediate detection of a bioagent, with an alarm and alert requiring evacuation of Logan Airport, say, would result in an indefinitely long cleanup and closure period, and could also shut down the entire urban and regional transportation system. As a regional hub,

[24] "*Ready or Not? Protecting the Public's Health in the Age of Bioterrorism,"* Dec. 2003, by the Trust for America's Health at www.healthyamericans.org

the number of passengers flying through or from Logan Airport[25] is over 23 million per year and expected to grow. Upgraded terminal infrastructure represents over $4 billion in sunk costs, and brings in about $325 million in annual revenues.

Forecasting tools are needed to produce credible economic damages. In order to assess the full cost of a bio-attack, we must have a better understanding of the duration and efficiency of cleanup operations and cost estimates forpublic health treatment. More complete cost-accounting must include: personnel decontamination and treatment, facilities and materials processing, down-time for the cleanup of a contaminated facility, disposal of contaminated materials (e.g., incineration, landfills), replacement of damaged plant and equipment, business losses network-wide and industry-wide due to both illness and panic, impacts of rerouting passengers and vehicles, system-wide repercussions of facility closure, workforce and labor impacts, insurance and liability impacts, and the lasting effects of psychological trauma.

A robust and resilient transportation system must exploit the full knowledge spectrum, including the technology base for industrial facility decontaminants and their effectiveness against multiple potential bio-agents on many types of materials, surfaces, and volumes. Many difficult and unanswered questions remain. Who will pay for the full cost and downtime of transportation nodes and operations prior to the recovery of operations? How will it be paid to the remediation firms or local and state agencies? Who will perform the cleanup of transportation facilities and equipment? Who will certify the cleanup, and what is the most efficient certification process? "How clean is clean enough"[26] so that workers and the public can return to the site without fear, and such that the economic and psychological dimensions of a bio-attack are minimized from a systems perspective?

Issues for Consideration and Discussion at the Workshop

Invited speakers and participants will address the following distinct, yet interlinked, issues during the course of this workshop. Each issue encompasses a range of questions that will collectively elicit several points of view and existing knowledge from workshop participants. Some insights may fall naturally out of presentations and discussions, while others may require special focus.

1. Vulnerability assessment and ranking of passenger transportation targets to bio-terrorism attacks.

All States and transportation authorities have recently performed vulnerability assessments and submitted to DHS their prioritization of targets. How do major transportation nodes rank in this national assessment? What are the most credible scenarios for terror bio-attack against passenger transportation nodes, or multi-modal

[25] Leo Flavio, "Impact of 9/11 on Airport Finances and Development, the Logan Experience." Presentation at the FAA Aviation Forecast Conference. Washington, DC. March 2003.

[26] "*How clean is clean enough? Recent developments in response to threats posed by chemical and biological warfare agents,"* Preprint for International Journal of Environmental Health Research. UCRL-JC-151878 Rev.1, July 7, 2003, by E. Raber et. al, LLNL.

transportation facilities, such as major airports, ports and ferry terminals, railroad stations, subway stations, and transit nodes, bus terminals? Can all six high-priority, bio-agent types and amounts as defined by the CDC be rapidly and reliably identified by existing bio-sensors? How soon can appropriate public-health response measures (quarantine, evacuation, facility shutdown, shipments of "push-packs" from the CDC National Pharmaceutical Stockpile) be received by first responders? From the standpoints of public health emergency responses and economic impacts on transportation, what lessons have we learned from natural epidemics and emerging infectious diseases (e.g., influenza-A, SARS, West Nile, etc.)

2. Institutional issues: roles and responsibilities of federal, state and local transportation agencies using case-studies

Who must pay for and perform cleanup of an airport or rail/transit terminal in case of bio-attack? How rapidly can these resources and providers be mobilized? Is there sufficient definition of the respective roles and responsibilities of DHS, CDC, EPA, FEMA and other federal agencies, vis-à-vis state emergency and local transportation authorities, to ensure prompt remediation of contaminated facilities?

3. Validation, certification and approval of remedial procedures

What are the major key sterilants and disinfectants used in case of bio-attack, and what is their level of toxicity? How must different volumes, and areas with diverse surface textures, as well as equipment, and HVAC enclosures in a given contaminated facility be treated during cleanup? Which disposal methods should be used for residually contaminated materials? (e.g., incineration, burial in landfills, etc.)?

4. Knowledge gaps for decontamination technologies, materials and application protocols

What decontamination methods are available in case of bio-attack involving one of the six category-A bio-agents (anthrax, smallpox, botulism, plague, tularemia and viral hemorrhagic fevers),[27] against a major passenger transportation node (airport, rail and transit terminal, cruise port terminal)? How effective are these methods in treating smooth and rough surfaces, carpeting, large volumes of air, "hotspots" in equipment, or in air ducts where dispersed aerosols can accumulate? To what extent have validation techniques been applied to all materials and methods used in the cleanup of bacterial and viral bio-agents, and toxins? Are both chemical and physical (radiation, UV light) sterilants effective? How does one decide what sterilant material to use, when, where, how much of it, and how many times to apply it? Should facility cleanup and restoration methods be tailored to specific bio-agents, or are there generic, all-purpose sterilants? Who certifies the effectiveness of sterilants, and how does the certification process work? What are the recommended options for decontamination readiness, e.g., the sources and availability of cleanup materials, hazmat-qualified workers, and means of disposal of contaminated materials? What are remaining knowledge gaps concerning the effectiveness of cleanup methods and outstanding research and development needs?

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[27] Available at www.bt.cdc.gov/agent/agentlist-category.asp Category A bio-agents are considered to be the most damaging, the most likely to be used, and of the highest priority for bio-defense preparedness.

How well do we know the health and safety margins for residual contamination with the bio-agents and toxicants used in remediation? Should OSHA industrial hygiene cleanup methods and sampling standards be used as adequate for contaminated workplaces, or are the stricter EPA environmental standards necessary? Are safe thresholds for the concentration of spores or viral agents known for all Category A bio-agents? Do existing bio-detectors reliably measure very low level, but still harmful, contaminants?

5. Stockpiles and logistics of decontamination equipment and supplies

What are the current plans for response, recovery, and cleanup at the national, regional and state, and local levels of jurisdiction? Are there national or regional stockpiles, or must each transportation authority stockpile its own supplies of equipment and sterilants? What are the logistics of distributing and transporting large amounts of decontaminants, during a shutdown or when the transportation system is crippled by a bio-attack?

6. Lessons learned from case studies and response exercises

What are the lessons learned for transportation facility owners and operators from the anthrax bio-attacks in 2001 regarding readiness to deal with contaminated people and facilities? What are the lessons for the future learned from full-scale bioterrorism emergency preparedness and response exercises, such as TOPOFF (in 2000 and 2002)? In which agencies (e.g., EPA, DOD, other) is there expertise in bio-contamination cleanup and recovery? Is the U.S. Army SBCCOM expertise applicable in and transferable to a civilian and urban transportation facility? Which firms can supply cleanup materials and hazmat workers experienced and competent to deal with bioagents, rather than pesticides and toxic industrial chemicals (TIC)?

7. Recovery plans as part of bio-emergency preparedness

Can traditional system safety program plans and emergency preparedness plans cover bio-terrorism? What plans and preparedness measures concerning the cleanup and recovery from a bio-attack have been developed by DOT, other federal agencies, and state emergency management agencies? In order to ensure the availability of materials on-demand (e.g., hazmat suits, antidotes, medicines, and sterilants stockpiles), what relationships have developed between transportation facility owners and operators and first responders, service providers and contractors?

8. Economic impacts and resource availability issues

What would be the transportation system-wide consequences of a bio-attack on a major national airport, a multi-modal transportation node (e.g., South Station linking subway, bus and rail modes), or a cruise port of a ferry terminal? What are the estimated economic impacts for bio-attack on a major facility, including: disruption of operations locally and system-wide, business loss, replacement costs for equipment, furniture, air filtration system, and health cost estimates for exposed workers and travelers? What is the likely cost and duration of facility remediation, by size and type? How do such costs scale (by volume, area, complexity, etc.)? Which agency has the primary fiscal responsibility for the cleanup of federal, state, or local transportation facilities? Are there designated national contingency or emergency funding resources for such a cleanup? Is

there any risk or disaster insurance coverage (DHS/FEMA)? Who should pay for decontamination? Who can afford it? What cost-sharing arrangements for potential cleanup of transportation facilities exist, or are planned at federal, state, and local levels with the private sector? What are good models? Is terrorism risk insurance feasible for major transportation facilities? What are the key liability issues related to cleanup and restoration of facilities to safe work and public places?

9. Responsibility, ethics and trust

Who determines when the facility is sufficiently clean and safe for people to return? "How clean is clean enough," in order to declare the recovery phase complete and to resume transportation operations? Is the residual risk to workers and the traveling [public keyed to the average individual or to the most vulnerable? How can employees' concerns over exposure to both trace levels of bio-agents, and to potentially toxic decontamination chemicals, best be managed?