EPA Safe Buildings Program: Update on Building Decontamination Waste Disposal Area

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ABSTRACT

Significant quantities of waste are generated during building decontamination operations resulting from terrorist attacks using biological weapons (BW), chemical weapons (CW), or toxic industrial chemicals (TICs). These waste streams may include aqueous solutions, furniture, ceiling tiles, wall hangings, carpeting, HVAC filters, and personal protective equipment from the cleanup crews. These materials may be contaminated with CW, BW, or TICs at varying, possibly unknown levels. The safe disposal of these materials will involve a combination of packaging, transporting, thermal treatment, and landfilling, either of the materials directly, or of the thermal treatment residues. This paper gives a status update on the US EPA's program of laboratory-, bench-, and pilot-scale research and guidance document development in regards to the safe disposal of these materials.

INTRODUCTION

As a result of the anthrax attacks on various government and news media buildings in 2001, the EPA instituted the "Safe Buildings Program" to address issues related to building decontamination. After a building has gone through decontamination activities following a terrorist attack with chemical warfare (CW), biological warfare (BW) agents, or toxic industrial chemicals (TICs), there will be a significant amount of residual material and waste to be disposed. This material is termed "building decontamination residue" (BDR). Although it is likely that the BDR to be disposed of will have already been decontaminated, the possibility exists for trace levels of the toxic contaminants to be present in absorbent and/or porous material such as carpet, fabric, ceiling tiles, office partitions, furniture, and personal protective equipment (PPE) and other materials used during cleanup activities. There could also be wastes from the decontamination process itself, such as scrubber slurries or activated carbon from scrubbers used to remove fumigants such as chlorine dioxide (ClO_2) from the buildings. In addition, there may be additional contaminated materials such as carbon adsorption beds and high-efficiency particulate air (HEPA) filters from the building's heating, ventilation, and air conditioning (HVAC) system. It is likely that much of this material will be disposed of in landfills or high-temperature thermal incineration facilities, such as medical/pathological waste incinerators, municipal waste combustors, and hazardous waste combustors.

This research program is moving forward under the assumption that the disposal of all the BDR will be done in accordance with existing regulations. This would include: proper transportation to the disposal site as defined in U.S. Department of Transportation (DOT) rules; proper packaging and handling of the materials as per the Occupational Safety and Health Association (OSHA), and the operational permits of the disposal facilities as governed by RCRA and the Clean Air Act.

The primary clients for this program will be: 1) emergency response authorities who have to decide the most appropriate decontamination methods and disposal of the resulting residues; 2) state and local permitting agencies, who have to make decisions about which facilities will be allowed to dispose of the materials; and 3) the waste management industry, that needs to safely dispose of BDR without affecting the operation of its facilities and without violating any of its environmental permits.

PROGRAM DETAILS

The issues related to disposal of BDR are being investigated using experimental and theoretical approaches as well as by gathering available information from publicly available sources. The goal of this effort is to develop a decision-support tool from which the available information can be used to help relevant parties plan for disposal activities, evaluate alternatives, and make preliminary decisions during the crisis management phases of a response activity, and to aid in the decision-making process in the consequence management phase of the response activity.

The information needed for the decision support tool and anticipated sources for that information are listed in Table 1. Some of the information can be found in parts of the U.S. Environmental Protection Agency such as the Office of Solid Waste (OSW) or the Office of Air Quality Planning and Standards (OAQPS). Other government agencies such as the Department of Transportation (DOT), the Centers for Disease Control (CDC), or the National Institute of Occupational Safety and Health (NIOSH) may have some of the information. Other valuable information sources may include industrial stakeholder groups such as the Integrated Waste Services Association (IWSA), the National Solid Waste Management Association (NSWMA), the Solid Waste Association of North America (SWANA), or the Coalition for Responsible Waste Incineration (CRWI), groups of state regulators such as the Association of State and Territorial Solid Waste Management Officials (ASTSWMO), or professional organizations such as the American Society of Mechanical Engineers (ASME) or the Air and Waste Management Association (AWMA). Some of the critical information is not available from any source. This information will be developed through an experimental and theoretical approach.

Table 1. Information needed for decision support tool and likely sources of that information

Information	**Source**
Regional capacity/locations of disposal facilities	EPA/OSW, EPA/OAQPS, ASTSWMO, IWSA, NSWMA, SWANA
Incinerator design/operation criteria	ASME, AWMA , CRWI, IWSA
Landfill design/operation criteria	EPA/OSW, NSWMA, SWANA
Transportation and packaging	DOT, CDC
Environmental regulatory issues	EPA/OSW, EPA/OAQPS, ASTSWMO
Worker safety issues	CDC, NIOSH
Thermal destruction behavior of CW/BW contaminants in BDR	In-house experiments, modeling
Landfill behavior of CW/BW contaminants in BDR	In-house experiments, modeling

Guidance document development

As an emergency response activity unfolds, the emergency responders will be confronted with decisions that will impact the cost and timing of the restoration of the building to normal operation, perhaps in a significant manner. Unnecessary delays in the disposal process due to inconsistent, confusing, or inappropriate permitting requirements are not in the best interests of the contaminated site, the various stakeholders, and the public. This program will prepare an integrated guidance document and decision support tool that will be developed in partnership with industry, state and local government, and federal agencies.

Data will be collected from the open literature, from state and federal regulatory agencies, and from landfill and incinerator manufacturers and operators, to develop operating guidelines for disposal of BDR and related residues. The goal of the project is to develop technical guidance for facility selection, feed preprocessing, packaging and transportation issues, thermal treatment system requirements and time/temperature profiles, pollution control system designs and operating conditions, landfilling requirements, disposal worker safety, and other parameters, as well as permit implications. The project will address the following questions:

- How can the BDR be inventoried and categorized to simplify the disposal process?
- Can the BDR be tracked from the site to the disposal facility and its ultimate disposition?
- What available disposal options are there for the different categories of BDR?
- What disposal capacity is available in the general area where the event occurred?
- What is the expected behavior of the BDR in the selected facility (incinerator or landfill)?
- What type of preprocessing of the BDR on site must be performed in order to make the material more amenable for disposal in a given facility?
- What types of packaging are necessary to minimize risk to workers handling the BDR, to the disposal facility workers, and to people along the transportation route to the disposal facility, and to minimize potential for contaminating the disposal facility?
- Are there other special waste types (e.g., asbestos?) that already have well-developed recommended operating practices that could be adapted for BDR?
- What are the issues related to transporting the BDR?
- How is the need for waste disposal reconciled with the need to maintain integrity of forensic evidence?
- What are the minimum and optimum time and temperature requirements needed to destroy contaminants to ensure an adequate margin of safety to the public and to disposal personnel?
- What are the minimum and optimum requirements for post-combustion treatment of incineration flue gases to ensure that containment of contaminant incineration products is adequate to protect the safety of the public and decontamination personnel?
- What are the characteristics of residues formed during the incineration process, and what are the requirements for their disposal in a safe manner?
- What are the potential harmful byproducts of the incineration processes and how can systems be designed to ensure minimal formation of these byproducts?
- What are the current capabilities of portable incineration systems, and can they be used or modified to meet the newly developed requirements mentioned above?
- What permit implications will there be for facilities disposing of these materials?

The information will be accumulated into a web-based application that will be centrally updated as new information becomes available and old information (such as contact information for key personnel) changes. This tool will create flow charts and checklists to simplify the complex interrelated decisions that come into play as a building is restored.

Experimental Efforts

Some of the information needed to complete the decision support tool is not currently available. This includes information such as the behavior of CW/BW agents bound on BDR in a landfill or incinerator environment. Table 2 lists the various components of BDR material that will be examined during this R&D program and the surrogates that will be used in the event that it is not practical or possible to perform experiments with live agents. Contaminants will consist of various TICs (as simulants for CW agents) and simulants for spore-based pathogens like anthrax, such as *bacillus globigii* (BG). Spore-based pathogens represent the most thermally resistant classes of pathogens, and BG was found to be the most thermally resistant of those simulants (1).

Table 2. Potential Substrates and Contaminants to be Tested

BDR Substrates	**CW agent simulants**	**BW agent simulants**	**TICs**
Carpeting Ceiling tiles Fabric Wallboard Wood Activated carbon	Dimethyl methyl phosphonate (DMMP) Chloroethyl ethylsulfide (CEES) Ethylene glycol	*bacillus globigii* *bacillus thuringiensis*	Monochlorobenzene

Bench-scale landfill survivability and transport studies

The fate and transport of BW and CW agents in landfill environments is not well established. Experiments are planned to evaluate movement and survivability of biological and chemical agents in the landfill environment, and confirmatory field studies of the fate and transport of chemical and biological agents in commercial landfills. Initial experiments will examine whether BW agents are inactivated or exhibit growth in leachate samples taken from actual landfills, and to assess the potential for transport of BW and CW agents into landfill gas. The leachate survivability studies will be performed using live agents at a DoD facility, whereas the landfill gas transport studies will be performed using surrogate materials. These studies will answer the following questions:

- What is the likely mode of transport (air, waste, leachate) for chemical and biological agents from a landfill?
- How well will the landfill environment reduce the survival time of active agents and protect against survival of active agents?
- Can BW and CW agents be transported into landfill gas?

Bench-scale thermal treatment studies

The thermal destruction of building materials contaminated with CW and BW agents is complicated by matrix effects associated with the contaminant and the material it is bound on. It is important to know the relative difficulty of destroying these toxic agents when bound on different materials to assure that minimum solid phase residence times will be achieved and residual solids (such as fly ash and bottom ash) and gaseous emissions leaving the system are free of contaminants. To provide guidance on minimum solid phase residence times, a fundamental knowledge must be gained of the combustion behavior of CW and BW agents bound on common building materials, and the desorption behavior of CW agents and TICs from filter media such as activated carbon.

Bench-scale research will be conducted to examine the destruction of surrogate chemical/biological (CB) agents that are present on or within several common building materials including carpeting, furniture and drapery fabrics, ceiling tiles, and wallboard. A laboratory-scale reactor will be used to examine the effects of substrate material, time-temperature profiles, and furnace conditions on the destruction of several surrogate CB contaminants.

The results from these studies can be used to evaluate incineration technologies for appropriateness for disposal of contaminated building materials.

Pilot-scale incineration studies

Pilot-scale testing will be performed to provide some scale-up to the bench-scale testing, and to investigate issues related to operational difficulties that might result from burning large quantities of building decontamination residues. The pilot-scale testing will be performed in the EPA's rotary kiln incinerator simulator (RKIS), a rotary kiln equipped with a secondary combustion chamber (SCC), each with a nominal firing rate of 73 kW (250,000 Btu/hr). The RKIS, shown in Fig. 1, is capable of burning solid materials (through a manual charging mechanism) and liquid fuels (directly injected into the burner[s] or sprayed into the transition section between the kiln and SCC). Emphasis will be placed on minimum time/temperature environments required to assure adequate destruction of the contaminants, so that technical guidance may be given to facilities and permitting entities regarding proper incineration of waste materials recovered from building decontamination activities.

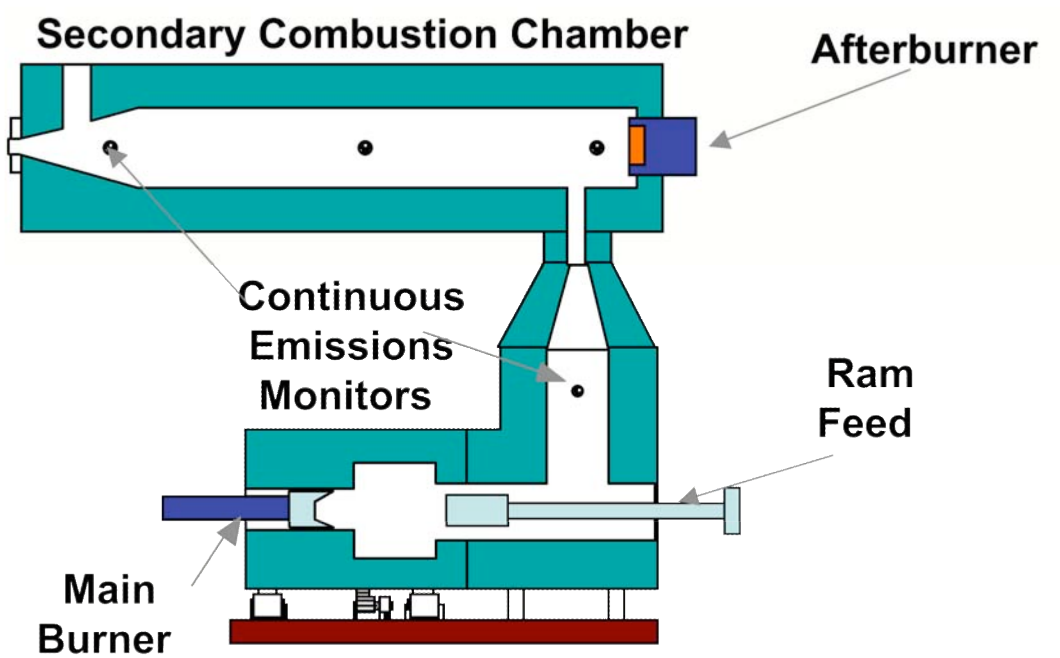

Fig. 1. EPA Rotary Kiln Incinerator Simulator

Initial pilot-scale testing will focus on issues related to combustion of uncontaminated carpeting and impacts of the products of combustion on air permits granted under the Clean Air Act. These tests, to be done in collaboration with the ASME and the Carpet and Rug Institute (CRI), will examine potential operational issues that result from the combustion of uncontaminated carpeting. The CRI is interested in the potential for using waste carpeting (with heating values approaching 8,000 Btu/lb) as auxiliary fuel in cement kilns. Most carpeting is made from nylon and has a high nitrogen (N) content and could potentially cause excess emissions of nitrogen oxides (NO_x). Issues related to sizing the carpeting for cement kiln application are being examined. Tests are also planned to address issues related to the impact that different sized carpet pieces have on burnout times and emissions, both transient and steady-state.

Modeling of BDR in Incineration Systems

In order to minimize problems associated with thermal destruction of CB-contaminated BDR, modeling will be performed to examine potential incinerator failure modes that might arise. This modeling, using an approach developed for the U.S. Army chemical demilitarization program (2), couples computational fluid dynamics (CFD) with complex chemical kinetics to predict concentration distributions of contaminants and their combustion byproducts within the incinerator. Two common incinerator designs will initially be modeled: a modular starved-air incinerator design similar to that used for medical waste incineration; and a rotary kiln incinerator similar to those used for hazardous waste combustion. The bench- and pilot-scale experimental studies will be used to help develop the pieces of the model and to calibrate the models.

Sampling and analytical methods development

Since the mobility of biological contaminants within landfills and thermal treatment devices has not been well-explored, it is critical that sampling and analytical methods be available to determine efficacy of destruction and permanence of land disposal. Preliminary sampling and analytical methods (3) for some microorganisms have been developed for potential use on medical waste incinerator stack gases and ash residues, but these methods have not been validated, and moreover, have not been tested for some of the primary biological warfare (BW) agents of concern (e.g., anthrax). This project will adapt and expand upon existing sampling and analytical methods for BW agents in combustor stacks and ash residues.

The primary goals of this project are:

- Investigate relevant sampling/analytical measurements issues such as sample collection efficiency, stability, preservation, etc;
- Investigate/determine potential method detection limits;
- Develop a draft procedure suitable for field testing.

SUMMARY

The U.S. EPA initiated the Safe Buildings Program to address issues related to decontamination and restoration of buildings after a terrorist attack with CB agents or TICs. Part of this program will investigate technical issues related to the disposal of wastes generated during the decontamination of buildings. The target audience for this program will be: 1) the emergency response personnel who have to make decisions about decontamination methods and disposal of the resulting residues; 2) state and local permitting agencies, who have to make the decisions about which facilities will be allowed to dispose of the materials; and 3) the waste management industry, that needs to be able to safely dispose of the building decontamination residues without affecting the operation of its facilities and without violating any of its environmental permits. The goal of this research program is to produce, in two years, technical information, decision support tools, and guidance documents that will enable the safe and effective disposal of these materials.

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