

Landfill Fire Response Guide for Surface and Subsurface Fires at Solid Waste Facilities

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The goal of this document is to provide a quick resource guide for waste fires at solid waste landfill facilities. Although many of these issues are present at waste fires, the strategies and tactics will depend on the waste type, type of fire, available fire resources, water and foam supply, environmental impacts and surrounding communities. All health and safety decisions should be made by a qualified professional health and safety officer. This guidance document is intended for fire resources, environmental response agencies, health departments, and media outlets. Some of these recommendations may not be applicable or practical. Fighting a solid waste landfill fire involves a high degree of risk and not all risks or exposures can be mitigated. This guidance document was designed to provide initial information similar to the Emergency Response Guide and does not cover all situations or risks.

Waste Fires

In the United States each person generates about 5.68 pounds of solid waste each day. Using the 2018 World Bank rate and a total urban population of 241,972, 393 people, in the US, we generate over 1.3 billion pounds of trash each day. To handle this volume of solid waste, over 2,000 landfills operate in the US. When a large waste fire erupts, the local responders find themselves overwhelmed and understaffed.

Fire departments are often unaware of the risks in fighting landfill fires and are generally not equipped safely suppress them. Even relatively small waste fires (e.g., 2 acres) can require a significant commitment of community fire resources. Costs to manage and suppress these waste fires can exceed the fire department operating budget. To understand the risks, cost, and environmental consequences of a landfill fire, a pre-incident plan needs to be developed. At a minimum, this plan should discuss emergency contacts, types of incidents, known hazards and potential exposures, types of waste accepted, available equipment and resources, general facility layout, water system, and site training with the landfill owners and operators. Not all types of incidents can be anticipated. Even the best preplan may change depending on the type of emergency, available resources and personnel, fire type, weather, and other conditions. Note: The fire service should recognize that solid waste landfills and compost facilities frequently ignite; however, these operational fires are usually extinguished by landfill personnel and equipment within 15 minutes and typically do not require emergency response by the fire service.

Categories of Waste Fires

To properly communicate the risks and exposures to emergency responders and landfill personnel, one must understand the nature of the incident. Typical incidents that occur at a landfill, recycling, and composting facilities can be broken down into three main categories.

The first category includes standard medical, vehicle fires, building fires, wildland fires, and hazardous material (hazmat) incident at the waste facility. Depending on the nature of the call, the response may include establishing elements of the incident command system (ICS), determining if a water supply is available, determining exposures, assessing a patient, or responding to a hazmat incident. The second category includes a surface fire in the active waste, recycling processing, or composting areas. These types of fires can require large fire flows to contain the spread of the fire or may be burning in water reactive materials such as sodium, potassium, lithium, or magnesium and beryllium borings, trimmings, grindings, and shavings, which pose a set of unique set of hazards and challenges. The third category is unique to the waste industry. This type of fire smolders underground for long periods of time before showing signs of combustion. Smoldering fires in construction and demolition or solid waste can pose a unique set of issues. These incidents may need a significant number of fire and heavy equipment and health and safety resources. The key to underground fires is to understand these incidents require a planned response between the landfill operators and the fire service. While there may be a need for an initial emergency response to contain the incident, for example if the subsurface fire ignited a surface fire, the fire service must understand the nature of the incident and develop an incident action plan (IAP) and

safety plan. Some subsurface fires may be contained by placing additional low permeability soils over the area of concern, while other may require fire resources for up to 30 days to extinguish.

Surface fires – 911 Response

Surface fires generally involve recently buried or uncompacted refuse, stored recyclables, or composting material that may have self- heated during aerobic decomposition and spontaneously ignited or ignited due to other causes. Active waste fires can be intensified by the presence of landfill gas (methane), which may cause the fire to spread throughout the landfill's working face. Generally, surface fires burn at a relatively slow rate of spread unless pushed by winds. Surface fires in solid waste and construction demolition and wood debris can be characterized by dense, white to dark smoke, depending on the amount of plastics and other hydrocarbons present in the waste. Fires at recycling centers tend to have thick black smoke due to the high plastic content. The emissions from all waste fires are toxic and may contain hazardous levels of carbon monoxide (CO), hydrogen sulfide (H₂S) and other carcinogenic compounds such as benzene. Common sources of surface waste fires include dumping of hot loads from BBQ ashes, chemical reactions, and human activity such as smoking, vehicles driving in waste, or arson.

Subsurface Fires – Non-911 Response-IAP Required

While not common to the waste industry, subsurface fires can develop at depths of 5 to 45 feet and deeper. These types of fires below ground pose a unique set of risks and hazards. The response to a subsurface fire must be strategically developed in an incident action plan (IAP) to minimize the exposure and risk to all personnel. These types of fires are difficult to extinguish and may create large voids in the landfill, which can cause cave in/sink holes at the landfill surface. In smoldering events, the subsurface fire can produce CO, H₂S and known carcinogenic compounds.

Common signs of a subsurface landfill fire include:

- Visuals Indications
 - Venting of gases, smoke, and/or steam emanating from the sub-surface
 - Dead vegetation
 - Snow melt
- Ground Indications
 - Surface cracks or fissures
 - Sink holes or depression

Do not excavate into the landfill or construction demolition pile without an IAP and safety plan, general knowledge of the waste area and type, discussion with the facility operator and appropriate resources. Excavation will expose the hot waste material to the air and introduce oxygen which will increase the fire severity. Excavation can only be used if it is a planned firefighting activity with knowledge from the waste operator and appropriately equipped (i.e., personnel in supplied air with fire protection clothing) heavy equipment. This type of incident requires a significant amount of time, resources, and planning. It is recommended the incident management team considers engaging subject matter experts to design the suppression plan.

Hazardous Material Incident

While the Emergency Response Guide nor the hazard classification system (National Fire Protection Association (NFPA 704) does not provide first responders with a specific page or section that discusses solid waste fires, waste fires must be treated as a hazardous material incident due to the chemical composition from burning solid waste and plastics, asbestos, water reactive materials, industrial wastes, and other unknown contaminated waste.

Safety Zones

Appropriate hazard safety zones (i.e., hot, warm, cold) must be established in a written safety plan to reduce exposures from hazardous substances. The safety zones should specify:

- The type of operations that will occur in each zone;
- The degree of hazard at different locations within the release site; and
- The areas at the site that should be avoided by unauthorized or unprotected employees.

The bottom line is that smoke exposures should be avoided by all fire ground personnel.

Known Hazards and Potential Exposures

Solid waste landfills produce flammable and toxic gases, and liquid known as leachate as part of the biological decomposition process. Environmental control systems at landfills are designed to manage these gases and liquids; however, these facilities and systems have their own unique risks and hazards. Facilities such as flare stations, where the landfill gas is collected and burned, may have confined space requirements due to potentially explosive landfill gases. If the emergency incident requires fire personnel to enter the facility, a site liaison should always be present.

Surface fires in solid waste can produce toxic gases such as benzene and other known carcinogenic compounds. During smoldering events, the sub-surface fire can produce immediately dangerous to life or health (IDLH) levels of CO and H₂S and known carcinogenic compounds. Proper personal protective equipment (PPE), respiratory protection, and a four-gas meter (i.e., CO, H₂S, O₂, LEL) should be worn at all time in the hot/exclusion zone. Additionally, if the landfill accepts asbestos containing waste and wastes that may pose a hazard if mixed, blended, or compacted then additional safe guards must be in place. A summary table of the potential level of contaminants is provided below.

Bottom line is that small quantities of unknown toxic, hazardous, poisonous, reactive, or radioactive materials may be disposed of without the waste operator's knowledge. Proper PPE must be worn at all times and first responders must follow decontamination protocols.

Table 1: Potential Level of Contaminants for Surface and Subsurface Waste Fires.

Environmental Contaminants	Surface Fire	Subsurface Fire
Carbon Monoxide (CO)	High	High
Hydrogen Sulfide (H ₂ S)	Low	High
Benzene	Low	Medium/High
Other volatile organic compounds (VOCs)	Low/Medium	Medium/High
Semi-Volatile Organic Compounds (SVOCs)	Low/Medium	Low/Medium
Dioxins and Furans	Low	Low
Heavy Metals	Low/Medium	Low/Medium
Polycyclic aromatic hydrocarbons (PAHs)	Low/Medium	Low/Medium

Note: This is only a quick guide and does not indicate the toxicity or hazards of each contaminant. The potential may change depending on type of waste the fire is burning in. For example, if the fire is burning in sheetrock, H₂S gas may be present at Immediately Dangerous to Life and Health (IDLH) levels and if the fire is smoldering underground, CO may also be over the IDLH.

Health and Safety Issues

All incident related activities should be conducted under a written Health and Safety Plan designed for a waste fire. Some of the key elements include:

- Site hazards;
- Safe working zones and environment;
- Chain of command;
- Communications;
- Heavy equipment operations;
- Rapid intervention team/crew (RIT/RIC);
- Personnel protective equipment;
- Decontamination;
- Respiratory Plan: supplied air, SCBAs, and other respiratory equipment;
- Air monitoring program for CO, H₂S, VOCs, dust, asbestos, etc.; and
- Compliance with appropriate governmental regulations (e.g., OSHA, US EPA)

Incident Command System

Depending on the size of the incident, additional agencies and resources will be needed to manage the incident. Local fire department should enter into a unified command with the landfill operator and/or environmental health official.

Resources and Equipment

Based on the type of incident, additional resources may be necessary to safely assess and suppress the fire. Types of resources available to the incident may include:

- Communication equipment
- Private consulting firms that specialize in landfill fire suppression
- Private construction firms that specialize in hazardous waste/fire suppression work
- Heavy equipment such as Cat 349 excavators with thumbs, articulating trucks, dozers, etc.
- Industrial hygiene services
- Safety equipment and supplies
- Water supply, pumps, HDPE water lines
- Water tenders
- Foam and other suppression agents

Additional Pre-Incident Documents

Fire Pre-Incident planning documents include the following:

- General Site Layout Map
- General Water Supply Map
- Fire Safety Plan

Suppression Agents

Applying Class A foams to waste fires has shown to be very effective. Class A foams when mixed with water in the correct proportion reduces the surface tension of the water and allows the water to absorb more heat and provide greater penetration into Class A fuels. By adding foam to the water, the mix clings to vertical or horizontal surfaces longer and is 3 to 5 times more effective on Class A fires than just water.

Depending on the size of the waste fire, multiple large appliances with high flow rate may be required. If this is the case, the unified command must account for amount of runoff and/or the weight of the water. If the landfill has an environmental control system such as a leachate collection system, then the amount water being used must be discussed with the landfill operators so the collection system is not overwhelmed by the fire flow. Additionally, the amount of water and resulting weight (e.g. one gallon of water weighs 8.34 pounds) need to be calculated so the fire flow does not result in a potential slope instability problem. Class A foams and other additives will shorten the suppression effort and reduce the amount of water required. As with all large-scale suppression incidents, you should not mix the suppression agents unless they are compatible according to their manufacturers. Class B foams have proven not to be effective in extinguishing waste fires and are not recommended.

Strategies for Fire Suppression

To quickly address some of the issues facing first responders during a waste fire, the following twenty-five strategies list has been compiled from past waste fires.

1. Locate landfill personnel and engage them on fire operations;
2. Landfill personnel have the site knowledge and resources you will need to be successful;
3. Ask landfill personnel what type of material is burning and what are the known hazards;
4. Treat the fire as a hazardous material incident and stay out of the smoke;
5. Establish a unified command system;
6. Set up for crowd control and possible evacuations;
7. Establish LCES (Lookouts, Communications, Escape Routes, Safety Zones) for the fire operations and limit heavy equipment operations to daylight hours;

8. Request radios for all fire ground personnel to ensure proper communication;
9. Develop a written IAP and health and safety plan;
10. All personnel should wear proper PPE and fire rate clothing in the hot zone;
11. Save your water for protection of equipment, personnel and structures until a proper water supply can be achieved. Most landfills do not have fire hydrants nearby. Water supply will be a concern to the fire operations;
12. Remember waste fires release an enormous amount of energy and emit all types of chemicals; fire fighters must be in full turnouts with supplied breathing air or at a minimum full-face respirator with organic vapor and acid gas protection and with CO/H₂S personal gas monitors depending on the safety zones (*Note: some compounds may exceed maximum-use concentration established by regulatory standards; hence, respirators may not be a viable option at times*);
13. Have a rapid intervention team/crew (RIT/RIC) available and know how to safely remove a heavy equipment operator from all equipment. Equipment operators should have supplied air along with an escape pack and outfitted in fire rated clothing;
14. Work up-wind and out of the smoke;
15. Beware of shifting winds – install a wind sock;
16. Request air monitoring support for both on-site and off-site;
17. Request heavy equipment (e.g., excavator, bulldozer, front end loader) and trained hazardous waste operators;
18. Select a Class A foam that is readily available in commercial quantities. The Class A foam should be a non-corrosive, non-toxic, biodegradable foam concentrate. Flow at the higher end of the application rate in the beginning of the fire fight. Reduce application rate once a baseline has been established. Do not mix foams from different manufactures
19. Consider using a low permeability soil to smother the fire if water and foam are not available;
20. Initial steps should focus on separating what is on fire from what is not on fire with the use of Class A foam;
21. Watch out for pooling or flowing runoff water from firefighting activities;
22. Be prepared to collect, store and/or transport a significant amount of contaminated water and account for the amount of water used for potential slope instability;
23. Do not make any definitive statements concerning the timelines to the media;
24. Shut down gas extraction wells in the area after consultation with landfill operators; and
25. Expect the unexpected.

Suppression Strategies for Surface Fires

The following is a quick summary of some of the suppression tactics that have been used in past fires.

- **Burn Out**- Allowing the waste fire to burn out or down to a smoldering phase before engaging.
- **Waste Segregation**- Separate the waste not already involved;
- **Soil Cover/Cap**- Bury waste with a low permeability (e.g., silt/clay) type soil;
- **Suppression Agents**- Use Class A foam to suppress the fire; and
- **Combination Method**- Part of all methods above to suppress the fire.

Emergency Response Notifications

During large scale waste fires, additional notification may be required. The notification might include local and state emergency management agencies, environmental quality agencies, health agencies, law enforcement, and the U.S. Environmental Protection Agency Emergency Response Teams (National Response Center 1-800-424-8802).

Evacuations

It is essential that the threat to the surrounding community be quickly evaluated. -If the community is in direct contact with heavy, dark smoke, then shelter-in-place orders or evacuations should be implemented by the local enforcement and health agencies. Follow your standard procedures for hazmat emergencies.

Guidebooks and Publications (Emergency Response Guide, Fire Scope, NFPA)

Information about waste fires in response guides is limited; however, given the occurrence and impact to communities and the environment more should be done to provide guidance to the fire service. Although many of the chemicals released during a waste fire are listed, a solid waste fire is not listed in the emergency response guide. To assist the first responder community, the following proposed label per National Fire Protection Association (NFPA) was created. The proposed label would read Health 2, Flammability 2, and Reactivity 1.



Reference Document:

- United States Fire Administration, Federal Emergency Management Agency, 2002. Landfill fires: their magnitude, characteristics, and mitigation, https://www.egovlink.com/public_documents300/colerain/published_documents/Rumpke/Landfill%20Fires.pdf