

# **LANDFILL GUIDELINES**

## **HAZARDS OF BURNING AT LANDFILLS**

**DECEMBER 1997**

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[Letter from Minister for the Environment to  
Chief Executives of all Local Authorities]

19 December 1997

Dear Chief Executive

### **Hazards of Burning at Landfills**

In 1995 the Ministry for the Environment carried out a survey of landfills in New Zealand. One of the disturbing findings of the Census, one that I was extremely concerned about, was that half of New Zealand's landfill operators reported that there had been fires at their landfills in the previous twelve months. Although many of the reported fires were likely to be accidental, or lit by people with malicious intent, it appears that some were lit deliberately by landfill operators.

Despite open burning being prohibited in many countries, it appears to remain a "traditional approach" to reduce the volume of waste in the landfill in many smaller communities in New Zealand. Such behaviour is simply not appropriate, especially in a modern, well-run landfill.

The Ministry for the Environment has, with the assistance of the consulting firm Woodward Clyde (NZ) Ltd, prepared the attached report: *Hazards of Burning at Landfills*. The report sets out in clear and straight forward terms the hazards of open burning and methods to reduce the likelihood of fires occurring. This is being sent to all councils as a further update to the 1992 Landfill Guidelines. I believe it clearly sets out why open burning needs to be stopped.

In particular I would like to bring to the attention of landfill operators and enforcement agencies that open burning is not permitted under the Resource Management Act without a consent. I am informed that no such consents have been granted. It can also be argued that open burning would be prevented by the Occupational Safety and Health Act because of the hazards it poses, both to workers on the site and to the community. It is therefore difficult to understand the high level of burning that was reported. Clearly action is needed by operators to reduce accidental fires and by enforcement agencies to take action where fires are deliberately lit.

I hope to see a much improved performance, using the advice in the attached report, when the Census is repeated.

If you have any queries about the content of the Report or the 1992 Landfill Guidelines, please contact the Ministry for the Environment directly:

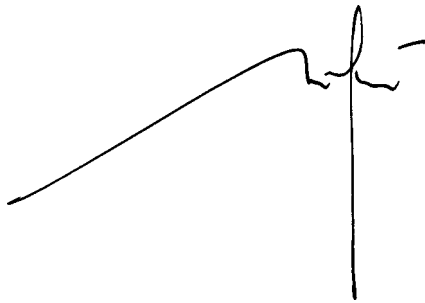
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Pollution and Waste Group  
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Please ensure that the copies of the attached Report are passed on to your Landfill Manager for inclusion in the 1992 Landfill Guidelines. A new contents page has also been provided and this should be inserted at the front of the original Guideline and the old page discarded. The report should be inserted after the Landfill Engineering Guidelines.

Further copies of the Report are available from the Ministry for the Environment's Publication Section at the same address, or from the Ministry's home page <http://www.mfe.govt.nz>.

Yours sincerely

A handwritten signature in black ink, consisting of a long, sweeping horizontal line that curves upwards and then drops vertically down to the baseline. The signature is stylized and appears to be 'S. Upton'.

Hon Simon Upton  
**MINISTER FOR THE ENVIRONMENT**

## **HAZARDS OF BURNING AT LANDFILLS**

The Ministry for the Environment has prepared this report for landfill managers to use to avoid the hazards of fires at landfills. The Ministry for the Environment is concerned at the high number of fires reported at landfills in the 1995 Landfill Census.

This report was prepared by Woodward Clyde (NZ) Ltd.

The report is being released as an addition to the 1992 Landfill Guidelines. Comments and questions about the report or on the 1992 Landfill Guidelines may be sent to the Ministry for the Environment.

All comments should be sent to

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## **Introduction**

## **Background**

A national census of all landfills in New Zealand was undertaken in 1995 by the Ministry for the Environment. More than half of the landfill operators responding reported that there had been fires at their landfills in the previous twelve months. Most burning was reported to be accidental, but 31% was intentional. Although burning occurred more at small landfills, there were a significant number of large landfills where burning occurred. (Brash 1996)

## **Purpose of this guide**

This operators guide is intended to provide guidance on landfill fires to landfill managers and operators.

## **Layout of the guide**

**Section 2, Types of landfill fires**, describes the different types of landfill fires and their causes.

**Section 3, Health effects and hazards of landfill fires**, describes the potential health effects and physical hazards of landfill fires.

**Section 4, Prevention of landfill fires**, describes means to prevent various types of landfill fires.

**Section 5, Control of landfill fires**, describes how landfill fires can be controlled if they do occur.

**Section 6, Alternatives to burning**, describes alternative means of managing refuse to reduce volumes in landfills and extend landfill life.

## **Types of landfill fires**

This section describes the types of fires encountered at landfill sites.

### **Surface Fires**

Surface fires are fires in recently deposited and uncompacted refuse in, or close to the landfill working face. Surface fires can also be fuelled by landfill gas, which can spread the fire through the landfill.

Surface fires are most commonly low temperature burning of general refuse and are typified by the emission of dense white smoke and the products of incomplete combustion. This smoke will also include irritating and odorous aldehydes and organic acids. During this process moisture in the refuse is driven off as steam, and other volatiles are lost by distillation. Temperatures may be high enough to release contaminants, such as arsenic from treated timber wastes.

Where fires burn quantities of flammable organic materials, such as tyres or plastics, temperatures may be very high in the burning zone. Combustion of the volatiles will not be complete, however, because of insufficient oxygen. High temperatures can break down volatile compounds, resulting in the emission of dense black smoke. Contaminants released are likely to include carcinogens such as polyaromatic hydrocarbons (PAHs), dioxins, furans and volatilised heavy metals. If plastics containing chlorine, such as PVC, are involved, acidic hydrogen chloride will also be discharged.

The common types of surface fires are:

- accidental fires started by the dumping of undetected smouldering materials;
- accidental fires associated with landfill gas control or venting systems;
- accidental fires caused by the behaviour of the site operator or landfill users;
- accidental fires caused by construction and maintenance activities;
- deliberate fires lit through malicious intent;
- deliberate fires lit by the landfill operator to reduce the volume of refuse or green waste; and
- fires from spontaneous combustion of landfilled materials.

### **Accidental fires due to incoming refuse**

Fires are often caused by the dumping of refuse which is already smouldering or burning on arrival at the landfill site.

## **Accidental fires associated with landfill gas control**

There is a potential for fires from landfill gas control systems due to:

- ignition of gas escaping from vents;
- leaks in gas collection pipework; and
- increase in oxygen level, caused by excessive pumping rates during landfill gas extraction, creating surface and deep-seated fires.

## **Accidental fires associated with site behaviour and operations**

Accidental fires on a landfill can be caused in several ways both by site operators, and by users, including:

- sparks from the exhaust systems of site plant or vehicles using the landfill;
- smoking on the landfill site by staff or users; and
- uncontrolled dumping of waste materials, including hazardous substances, which can ignite when mixed.

## **Accidental fires associated with construction and maintenance activities**

Accidental fires may be caused by construction or maintenance activities at landfills. Examples include:

- drilling, or driving, metal pipes or casings through refuse layers, resulting in sparks when other hard objects are struck;
- use of welding equipment on site; and
- use of electrical equipment on site.

## **Deliberate fires lit with malicious intent**

Landfills contain combustible material and produce ignitable gas. It is not uncommon for them to be targets for malicious fire lighting.

## **Deliberate burning**

Mixed refuse and/or green waste (green or dry garden waste, including grass, leaves and branches), is sometimes deliberately lit generally using a fuel such as diesel, to reduce refuse volumes, and reduce operating costs and increase landfill life.

**Deliberate burning should not be carried out** because of the risks to health caused by pollutants in smoke emissions, and by physical hazards. Alternative means of managing refuse to reduce volumes are described in Section 6.

The health effects of burning are detailed in Sections 3.1 to 3.3. The burning of green waste has a similar potential to damage health as the burning of mixed refuse.

Physical hazards of burning are detailed in Section 3.4 and include:

- burns to landfill operators and landfill users;
- explosions, due to:
  - build-up of landfill gas in enclosed spaces;
  - ignition of flammable or explosive material deposited in the landfill;
  - bursting of drums or other sealed containers deposited in the landfill;
- creation of hazardous products of combustion in the resulting ash and residue; and
- increased production of leachate when water is used to control burning.

## **Spontaneous combustion of landfilled materials**

Mixing of some materials in a landfill, or an increase in heat and oxygen level, can result in spontaneous combustion resulting in either a surface or a deep-seated fire. For example, if a small amount of hypochlorite (swimming pool chemical) comes into contact with a simple hydrocarbon oil or solvent it will spontaneously combust.

## **Deep-seated fires**

Deep-seated fires are found at depth in material deposited weeks, months, or years earlier.

Deep-seated fires can be major problems and should always be taken seriously. They have the potential to:

- create large voids, invisible from the surface, which can cause cracking or subsidence of the landfill surface, with a risk that landfill plant and personnel may be engulfed; and
- produce flammable and toxic gasses, for example, carbon monoxide;
- damage leachate containment liners and collection systems and landfill gas collection systems.

Deep-seated fires are often only detected by the presence of smoke emanating from some part of the site or by the presence of carbon monoxide in landfill gas.

Many deep-seated fires are starved of oxygen and produce carbon monoxide as well as carbon dioxide. Carbon monoxide is a colourless, odourless gas and in combination with

carbon dioxide will behave as a dense gas. Particular care must be taken in confined areas.

Carbon monoxide is a toxic gas and is also extremely flammable. It is flammable when mixed with air at concentrations between 12 percent and 75 percent.

Carbon monoxide is not commonly produced by bacteria in landfills and so if it is present in concentrations of more than 1 or 2 parts per million it may indicate underground combustion. It is not always produced by deep-seated fires and so its absence does not necessarily indicate the absence of a fire.

The common cause of deep-seated fires is an increase in the oxygen level within the landfill, which increases aerobic bacterial activity causing a temperature rise. This can then ignite methane in the presence of the oxygen.

Increased oxygen levels are usually caused by sucking air into a landfill through over-extraction of landfill gas.

## **Health effects and hazards of landfill fires**

This section details the following:

- health effects associated with emissions from landfill fires;
- toxic and hazardous wastes, and the effect of their presence in landfill fires; and
- physical hazards related to landfill fires.

## **Health effects of emissions from landfill fires**

Because of the low burning temperature and incomplete combustion of burning refuse, landfill fires emit a variety of pollutants that have the potential to affect the health of people exposed to the smoke. The risk of harm depends on a variety of factors including:

- type(s) of refuse burning;
- concentration of pollutants in emissions;
- individual sensitivity;
- duration of exposure; and
- the ratio of the products of combustion in the smoke plume.

## **Main pollutants of concern**

Although there are many harmful pollutants produced in a landfill fire the pollutants of most concern are:

- particulates;
- carbon monoxide;
- acrolein; and
- formaldehyde.

## **Particulates**

Smoke consists of the products of the incomplete combustion of the fuel source. All particles exist in either an aerosol or solid form at normal temperatures. The characteristics of smoke particles are influenced by the fuel being burned, and the characteristics of the fire.

It is often difficult to separate the effects of particles from gases that may also be present. Exposure to smoke particles can, however, reduce the ability to breathe, and reduce resistance to disease. Existing respiratory conditions may also be aggravated. Those with a greater pulmonary sensitivity, for example asthmatics, may show a much greater reduction in lung function than others.

## **Carbon monoxide**

Carbon monoxide (CO) is an odourless, colourless, and tasteless gas, that is poisonous to humans. Carbon monoxide is readily absorbed from the lungs into the bloodstream, where it is bound to the haemoglobin (Hb) molecules in the blood in preference to, and more strongly than, oxygen, forming carboxyhaemoglobin (COHb).

Carbon monoxide poisoning produces headache, weakness, dizziness, confusion, and changes to heart rhythm. It is a common by-product of the incomplete combustion of fuels such as paper, cardboard and wood.

## **Acrolein**

Exposure to low concentrations of acrolein can cause irritation of the respiratory system, nose and eyes, salivation, watering of the eyes (lacrimation), and mild intoxication (narcosis). Higher concentrations have been found to cause fluid on the lungs (lung oedema).

## **Formaldehyde**

Exposure to low atmospheric concentrations of formaldehyde causes irritation to the eyes, nose and throat, coughing, bronchial spasm and irritation of the lungs, and dermatitis. Discomfort increases rapidly with increasing exposure.

Asthmatic symptoms may occur due to the development of allergic sensitivity and kidney damage may occur with prolonged or excessive exposure.

## **Other pollutants**

The following pollutants may also be present in emissions from burning:

- ammonia;
- benzo ( $\alpha$ ) pyrene;
- hydrogen bromide;
- hydrogen chloride;
- hydrogen cyanide;
- hydrogen fluoride;
- isocyanates;
- nitrogen oxides;
- phenol; and
- sulphur dioxide.

These are all toxic to humans in some way, depending on the concentration and exposure. They can result in irritation to the eyes, nose and throat, and skin, respiratory problems, and some are cancer causing (carcinogenic).

## **Health effects**

The toxicity of the products of refuse combustion is far more complex than the effects of exposure to a single chemical. It is difficult to assess the relative concentrations of different pollutants that are likely to be present in the emissions from a landfill fire, and there is also a possibility that the effects of some pollutants will increase the effects of others.

Although short-term exposures (of around 10 minutes) to the air pollutants emitted by refuse burning are not expected to be lethal, even at short distances from the fire, the following describes some of the effects which can result.

At around 500 metres downwind of the fire, the presence of formaldehyde and other aldehydes, may result in a slight tingling sensation (formication) of the eyes, nose and throat.

At 200 metres, the smoke can be tolerated only briefly due to the aldehyde concentrations, with formaldehyde causing severe difficulty in breathing, burning of eyes, nose and trachea, intense watering of the eyes (lacrimation) and severe coughing.

At 100 metres from the fire the carbon monoxide concentrations are high enough that headaches, dizziness, weakness, confusion, nausea, disorientation and visual disturbance would be expected after a few hours exposure. However, the aldehyde concentrations would probably prevent anyone being exposed for long periods without a respirator.

Sulphur dioxide concentrations are unlikely to be a significant health risk, as the levels are not high enough to cause irritation and coughing further than 10 - 50 metres from the fire. At these distances, the concentrations of other pollutants are so high that exposure to the plume would be intolerable without protective equipment. However, if the fire included material with a high sulphur content, such as rubber tyres, exposure to sulphur dioxide would be higher.

The health risks of exposure to compounds from a landfill fire are equally likely to occur from exposure to smoke from the burning of green waste, a backyard burn-off or a bonfire. In fact, exposure to particulate emissions from a seemingly innocuous burn-off of leaves during the autumn months can be even higher than those from a landfill fire.

## **Toxic and hazardous wastes**

In addition to the exposure to the products of incomplete combustion already discussed, other more toxic compounds may be present in the smoke plume. This can occur when hazardous or toxic substances are disposed of in the general landfill area. In the case of liquids, although the fire will burn some of the material, a proportion may be volatilised (evaporated) by the heat of the fire, and people downwind will be exposed. Such compounds can include pesticides, herbicides, or solvents. Similarly, any toxic solids, such as pesticides or herbicides in the form of powders will be carried into the plume by the action of the rising fire gases resulting in potential exposure of people downwind.

Other potential adverse effects may arise from timber which has been treated with pentachlorophenol (used as a preservative until a few years ago). This can produce cancer causing (carcinogenic) dioxins when burned on an open fire.

If the wood has come from an older house, which may have been painted with lead-based paints, some of the lead in the paint can vaporise and be present in the smoke. Those inhaling the smoke may absorb additional lead into their bodies.

Re-constituted wood products such as particle board, chip board, medium density fibreboard, and strand board will emit higher than normal quantities of formaldehyde, adding to the irritant effects discussed above.

The New Zealand practice of co-disposal of toxic and hazardous materials with other refuse increases the likelihood of exposure to toxic and hazardous compounds during a landfill fire. Even more inert material can cause potentially hazardous exposures. For example, asbestos is usually disposed of in specially marked plastic bags. If these bags are burned in a fire, asbestos fibre may become airborne and anyone exposed to the smoke plume may inhale the potentially carcinogenic fibres. Similarly, linoleum removed from old houses often contains asbestos, and creates the same potential hazard if burned.

The products of incomplete combustion will include dioxins, furans and other potentially carcinogenic organic compounds. Although some of these compounds will be carried off into the atmosphere with the smoke plume, some will remain in the ash left behind after the fire has been extinguished or allowed to go out. These compounds may then find their way into ground water or other water courses, depending on how well leaching effects are minimised at the landfill.

## **Physical hazards**

Landfill fires can cause several hazards, in addition to those associated with the health effects of the products of combustion. These physical hazards can affect site operators and site users, including the public if the landfill site has public access.

The hazards associated with landfill fires can include the following, depending on site location, size, design and access:

- burns;
- explosions;
- surface cracking or subsidence;
- exposure to hazardous materials;
- exposure to hazardous by-products of combustion;
- damage to leachate, landfill gas and stormwater management systems;
- reduced visibility on surrounding roads; and
- discharges of contaminants into the environment.

Smoke also has a high nuisance value and a major source of complaints when present at a landfill.

## **Burns**

The most obvious hazard from burning, or fires, at landfills is burns (excepting the toxicological effects addressed in Sections 3.1 to 3.3), either to site staff or contractors or to the public if they have access to the site.

Fires can spread quickly on landfills because landfills contain combustible material. Wind gusts can also spread burning materials over a wide area. Highly flammable material can also be present where dumping is not well controlled. Anyone in close proximity to uncovered refuse can be at risk from a fire on the site.

In addition, landfill gas can migrate large distances and vent from cracks in the surface of the site, including those areas not filled with refuse. Landfill gas poses an additional risk as it can burn with an invisible flame. Particular care must be taken if a fire is present on any site, especially in or around any excavations or trenches.

## **Explosions**

If a fire is present on a landfill site, explosions can be caused by:

- ignition of highly inflammable material;
- ignition of landfill gas built up in enclosed spaces; and
- heating up of sealed drums, cans, aerosol containers or gas bottles.

Explosions can cause injury or death, due either to the physical force of the explosion or to flying debris and burning material.

There can also be a risk of violent steam eruption, resulting from:

- surface collapse or cracking in wet weather, allowing puddled surface water to flow into underground fire areas: or
- inappropriate water usage during fire-fighting.

### **Surface cracking or subsidence**

Deep-seated fires can cause cracking and subsidence over small or large areas of a landfill's surface. This can result in site plant or anyone on the landfill surface being engulfed.

### **Exposure to hazardous materials**

If areas of a landfill are excavated during control of a burning landfill or whilst extinguishing fires, hazardous materials may be exposed. This creates additional risks for site personnel and landfill users, either by their inherent nature or as an additional fuel source for the fire.

It is therefore important that the dumping of all refuse is closely controlled. Disposal areas for hazardous materials must be carefully selected and mapped (in three dimensions) so that the landfill operator knows exactly where hazardous materials are located.

### **Build-up of by-products of combustion**

Deep-seated fires can cause by-products of combustion to build up in confined areas such as site buildings. Like landfill gas, these products of combustion can migrate and create an asphyxiation hazard in an enclosed space.

### **Damage to leachate, landfill gas and stormwater management systems**

Deep-seated fires can damage materials used in the construction of containment liners and leachate collection systems. This can lead to increased discharge of leachate into groundwater or surface water.

Both deep-seated and surface fires can damage material used in landfill gas collection systems. This can lead to the spread of the fire.

### **Reduced visibility on surrounding roads**

Smoke from landfill fires can reduce visibility on surrounding roads and has the potential to cause traffic accidents. Visibility may be further reduced by low level temperature inversions in the surrounding atmosphere. Temperature inversions occur commonly in low lying areas or as a result of cold air drainage down valley slopes.

Temperature inversions delay the dispersion of the smoke and other contaminants, particularly in the case of a smouldering, low temperature surface fire.

### **Discharges of contaminants into the environment**

In addition to the instances described above, the use of water to control landfill burning or to extinguish landfill fires can increase leachate production and discharge into the environment, particularly if the site is unlined.

## **Prevention of landfill fires**

The potential for landfill fires can be reduced through good general landfill management including:

1. prohibition on all forms of deliberate burning;
2. staffing of the landfill site when open;
3. inspection and control of incoming refuse;
4. good compaction;
5. daily cover;
6. prohibition of smoking on site;
7. prohibiting or reducing public access; and
8. good site security.

This section details more specific issues related to preventing fires. It follows the causes outlined in Section 2, which have been repeated below for reference:

1. deliberate fires lit by the landfill operator to reduce the volume of refuse or green waste;
2. accidental fires started by the dumping of undetected smouldering materials;
3. accidental fires associated with landfill gas control or venting systems;
4. accidental fires caused by the behaviour of the site operator or landfill users;
5. accidental fires caused by construction and maintenance activities;
6. deliberate fires lit through malicious intent; and
7. fires from spontaneous combustion of landfilled materials.

## **Prohibition of deliberate burning**

Landfill design and operations should be planned so that burning is not necessary. All landfill staff should be trained in the risks associated with burning of refuse at landfills.

**Refuse should not be deliberately burnt** because of the hazards associated with landfill fires, as described in Section 3.

## **Clean Air Act 1972 and Resource Management Act 1991**

Before the introduction of the Resource Management Act 1991 the Clean Air Act 1972 effectively banned open burning at landfills.

Section 418 of the Resource Management Act allows only those activities which were legal under the Clean Air Act to legally continue until a Regional Plan determines

otherwise. In effect this means that open burning at landfills is illegal for most sites, unless allowed by a Regional Plan.

## **Health and Safety in Employment Act 1992**

A variety of hazards arise when burning occurs within a landfill site, and these may be significant risks to both the health and safety of site personnel and the public. The Health and Safety in Employment Act 1992 places specific requirements on employers and those in control of a place of work, to prevent harm to employees (Section 6 of the Act) and others (Sections 15 and 16 of the Act) who may be affected by activities at the workplace. All hazards must be systematically identified, the risk they pose to health and safety assessed, and significant hazards (those capable of causing harm) controlled. There would seem little doubt that fires at a landfill, whether planned or accidental, would be regarded as giving rise to a number of significant hazards, each of which must be appropriately controlled.

Sections 8 to 10 of the Act require that in controlling a hazard, it must, if practicable, be eliminated. If this cannot be done, the hazard must be isolated, or if this is not practicable, the hazard must be minimised. The potentially significant hazards produced by landfill burning, must be controlled. To comply with this requirement it can be argued, that as elimination is a practicable option in many situations, non-accidental burning should not be practised.

Whether or not burning is taking place at a landfill, many other activities that take place within the normal course of work have the potential to cause injury to the public, or other non-employees present, who may be unaware of the dangers they face. Because of this, non-employees should not be permitted to enter a landfill site unless properly managed by site personnel.

In most landfill sites in the USA, public access is banned for these reasons.

## **Accidental fires due to incoming refuse**

All landfill sites should have an emergency tipping area set aside from the immediate working area where incoming loads of material known, or suspected, to be on fire can be deposited, inspected and dealt with.

Waste that is burning on delivery should be doused with water or, more preferably, covered progressively with adequate supplies of damp soil or other cover followed by cooling and finally removal to its disposal point. Fire-fighting techniques should be appropriate for the waste type. Burning refuse should not normally be allowed to burn itself out.

The potential for fires due to incoming refuse that is alight can be reduced through vigilance and inspection of incoming loads.

## **Accidental fires associated with landfill gas control**

The potential for fires associated with landfill gas control can be reduced through;

- prohibiting open flames;
- installing flame arrestors and check valves on landfill gas vents;
- good design and maintenance of gas collection systems; and
- closely monitoring constituent gas levels when actively extracting landfill gas, to prevent over extraction.

## **Accidental fires associated with site behaviour and operations**

The potential for fires from these causes can be reduced by:

- prohibiting open flames;
- fitting all site plant with flame arrestors and requiring flame arrestors on vehicles entering operational areas;
- prohibiting smoking on the landfill site and displaying prominent “No Smoking” notices;
- prohibiting or restricting public access to operational areas of the landfill;
- staffing the landfill at all times when the public have access to the site, to ensure there is no uncontrolled dumping;
- prohibiting scavenging on the landfill site and placing warning and “No Trespassing” signs;
- prohibiting the dumping of hazardous materials; and
- inspecting loads entering the site.

## **Accidental fires associated with construction and maintenance activities**

The potential for fires from these causes can be reduced by:

- prohibiting open flames;
- monitoring for landfill gas between the hazard and the potential ignition source;
- undertaking a hazardous area classification in accordance with Australian Standard AS 2430.3-1991 and ensuring all electrical equipment complies with the hazard rating; and

- prohibiting welding on site or isolating the equipment to prevent it from becoming an ignition source.

## **Deliberate fires lit with malicious intent**

The potential for fires due to malicious intent can be reduced through;

- good site security;
- good compaction and daily cover;
- no stockpiling of large quantities of dry or combustible materials, such as paper or green waste, on the site;
- good shredding and windrowing of green waste; and
- secure storage for small quantities of hazardous wastes accepted at the landfill for later collection and off-site disposal.

## **Spontaneous combustion of landfilled materials**

The potential for fires due to spontaneous combustion can be reduced by;

- inspection of loads;
- close control over dumping of refuse;
- managed placement and mapping of hazardous wastes to prevent potentially combustible mixtures; and
- close monitoring and control of landfill gas extraction systems.

## **Deep-seated fires**

The potential for deep-seated fires can be reduced through:

- inspection and control of incoming refuse, particularly planned placement of hazardous wastes and mapping of areas where hazardous waste has been deposited; and
- close control and monitoring of landfill gas collection systems.

## **Control of landfill fires**

This section details ways to control surface and deep-seated fires and landfill management provisions for preventing and controlling landfill fires.

## **Control of surface fires**

The assistance and advice of the Fire Service should be sought when fighting landfill fires.

In most cases, the best way to control and extinguish a surface fire is to smother it with large volumes of wet or damp soil or other cover material. Work progressively inwards from the edges of the fire to slowly cover and compact the area. Then to allow it to cool before moving the material to its final resting place.

Such an operation can take some time, especially if the fire is a large one. It may be necessary to have the Fire Service attend initially to wet the area and extinguish any flames. Once the area is wetted and cooled, it should be covered as quickly as possible.

Vehicles and machinery on site for fire-fighting purposes should never be taken over areas of concern until the areas have been completely checked, by the landfill operator, for risk of surface collapse and engulfment.

## **Control of deep-seated fires**

Extinguishing deep-seated fires is usually beyond the capability of most common landfill plant, and to attempt to dig them out with inappropriate plant may make the situation worse by admitting air and exposing previously buried or encased hazardous substances.

In the event of a deep-seated fire, the area should be marked out and then surcharged with large volumes of clay or similar material. This minimises the number of outlets for gases to escape and reduces the influx of air to the area, thus containing the problem as far as is possible. The area must be checked daily by the landfill operator, for heat, smoke, cracking, subsidence and carbon monoxide in landfill gas wells. Fire fighting measures must be put into action before there is any significant fire breakthrough.

Where there is a deep-seated fire, landfill gas extraction in the vicinity of the fire should be stopped. Any nearby landfill gas vents should be temporarily capped as these will serve as chimneys for combustion products to escape or for air to be drawn in. Plugging all outlets will reduce combustion and assist in extinguishing the fire.

The impact of the suspension of landfill gas extraction on landfill gas safety should also be assessed and appropriate measures taken. These could include the provision of additional extraction wells and additional monitoring.

It is necessary to isolate the area to stop a deep-seated fire spreading further. Deep trenches should be excavated beyond the burning area and backfilled immediately with clay to create a barrier around the fire.

It may be possible to extinguish deep-seated fires by pumping an inert gas (for example, nitrogen) into the landfill. Specialist engineering advice, as well as advice from the Fire Service, must be sought if this option is to be investigated

## **Management provisions**

Management plans for landfill site operations should minimise the potential for fires and deal with surface and deep-seated fires, if they occur. These include:

- prohibition on all forms of deliberate burning;
- staffing of the landfill site when open for dumping;
- prohibition of smoking on site;
- inspection of incoming loads;
- close control over deposition of refuse; and
- good compaction and cover.

Fire fighting equipment should be maintained on-site, including:

- an adequate permanent water supply;
- water cart fitted with high pressure hose system;
- fire extinguishers; and
- protective clothing and breathing apparatus.

Staff should be trained and fire-fighting procedures established in consultation with the Fire Service. Training and procedures should include risks associated with landfill fires and methods for avoiding fires. First aid training should also be given to site staff.

Under no circumstances should any individual ever tackle a landfill fire alone due to the potential for burns, explosions or engulfment of machinery.

An example of appropriate landfill management plan provisions for landfill fires is given in Appendix A.

## **Alternatives to burning**

This section briefly describes methods of managing waste arriving at landfill sites, to reduce volumes and extend landfill life.

## **Alternatives methods of management**

As described in Section 2.1 deliberate burning of mixed refuse and/or green waste, has, in the past, been used to reduce refuse volumes and increase landfill life.

Other means of reducing refuse volumes and increasing landfill life include:

- compacting;
- shredding of green waste;
- composting of green waste;
- recycling;
- banning disposal of some types of waste; and
- developing a transfer station.

### **Compaction**

Good compaction at landfill sites reduces the volume taken up by refuse. Although specialised equipment is necessary for maximum compaction at medium to large sized landfills, track loaders and bulldozers can be used to adequately compact refuse at smaller sites.

Spreading refuse in layers of no more than 300 millimetres and compacting with several passes of a tracked machine can achieve densities of between 500 and 600 kilograms per cubic metre (compared to 800 to 1000 kilograms per cubic metre for specialised compaction equipment).

### **Shredding of green waste**

Green waste typically makes up between 20 and 40 percent, by weight, of all refuse disposed of at a landfill. It is usually the single largest component of the total waste stream.

Shredding reduces the volume of green waste by approximately 20 to 40 percent.

Green waste can be shredded either to produce a mulch as a final product, or to reduce the particle size of the material prior to composting. There are several different types of shredding equipment, including:

- rotary shear shredder;

- tub grinder
- hammer-mill; or
- high speed chipper.

Green waste can be stockpiled on site and shredded periodically.

## **Composting of green waste**

Composting typically reduces the weight of green waste by 30 to 50 percent and the volume by 50 to 80 percent through volatilisation and evaporation.

Composting is becoming increasingly popular as communities look for ways to divert material from landfills.

The costs of composting are higher than using green waste as mulch, as further processing is required and it requires more land.

Composting can be done using varying levels of technology, requiring different types of machinery and inputs into process control. These will be chosen based on the following factors:

- the type(s) of material being composted;
- the size of the composting site;
- the isolation of the composting site with regard to nuisances;
- the desired duration of the composting process, from raw material input to final product;
- the resources available to develop the composting facility.

## **Reuse and recycling**

Separation of incoming materials for reuse and recycling can reduce waste volumes. The success of reuse and recycling programmes, however, depends on markets for the collected material.

Materials commonly separated for reuse and recycling include:

- whiteware;
- furniture and other household items;
- paper and cardboard;
- glass;
- metals; and
- plastics.

## **Banning disposal of some types of waste**

Banning the disposal of some types of waste, for which there are alternative disposal or recycling facilities available, can reduce the volume of refuse arriving at landfills. Items and materials which may be suitable for banning include:

- whiteware;
- green waste; and
- recyclable paper and cardboard.

## **Development of a transfer station**

If a landfill is nearing capacity and there are no alternative local sites available, the development of a transfer station and transport of some or all of the refuse arriving at the site to another landfill should seriously be considered.

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APPENDIX A

LANDFILL MANAGEMENT PLAN PROVISIONS

## **FIRE**

Objective: To prevent or to effectively control any outbreak of fire at the landfill.

Comment: No burning of refuse shall be permitted. If a fire breaks out, immediate action shall be taken to extinguish the fire. The Fire Service should be contacted immediately. No person shall try to extinguish a landfill fire alone.

Basic fire-fighting equipment shall be kept at the site and maintained in a serviceable order.

The Landfill Operator shall ensure that regular fire fighting training is provided to the landfill operations personnel. Annual training sessions shall be used for this purpose, with input from New Zealand Fire Service personnel as appropriate.

Good refuse compaction and cover will restrict the potential spread of any outbreak of fire through the landfill.

Smoking shall not be permitted on the landfill site and “No Smoking” signs shall be erected in public areas.

If any incoming refuse truck contains burning or smoking material, the load shall immediately be dumped at an appropriate designated location or an area in which refuse has not been placed, and thoroughly hosed down and drained off. A similar procedure shall apply for any minor outbreak of fire at the working face.

In all other cases the landfill operator shall call the N.Z. Fire Service immediately a fire becomes evident.

Procedures: Smoking shall not be permitted.  
Dump and douse any burning/smoking loads.  
Call the Fire Service (dial 111) in the event of fire.