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| Fires at waste and resource recovery facilities  Causal factors and Victoria's legislative framework |
|  |
| December 2022 |

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| Acknowledgment  We acknowledge and respect Victorian Traditional Owners as the original custodians of Victoria's land and waters, their unique ability to care for Country and deep spiritual connection to it. We honour Elders past and present whose knowledge and wisdom has ensured the continuation of culture and traditional practices.  We are committed to genuinely partner, and meaningfully engage, with Victoria's Traditional Owners and Aboriginal communities to support the protection of Country, the maintenance of spiritual and cultural practices and their broader aspirations in the 21st century and beyond. |
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**December 2022**

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Executive summary

This report examines the causes of fires at waste and resource recovery (WRR) facilities and the available legislative tools and frameworks that can address these causes. The purpose of the analysis is to inform and identify opportunities to prevent fires.

While data is limited, the report finds that lithium-ion batteries (LIBs) are likely the leading cause of fires at WRR facilities. Mechanical and electrical faults, combustible or smouldering material and spontaneous combustion are also identified as significant causal factors. The chain of events that lead to ignition is discussed.

Analysis indicates that the legislative frameworks, especially general duties to minimise risks of harm under the Environment Protection, Occupational Health and Safety and Dangerous Goods Acts, cover these risks appropriately. However, more time is required to fully assess the impact of the *Environment Protection Act 2017,* which commenced on 1 July 2021.

There is a range of behaviours and other factors, such as market drivers, that influence the likelihood of ignition from these factors, which cannot be readily addressed through regulation alone. These include waste disposal practices and the industry’s willingness and capability to implement fire risk controls.

Lastly, the report identifies opportunities for further investigation to better understand and target the behaviours that are believed to contribute to the causal factors identified in this report, as well as potential areas for regulatory and compliance improvement. These include addressing the incorrect disposal of batteries and other combustible materials, improving data collection, and industry guidance materials and supporting the Battery Stewardship Scheme. Further policy analysis and consultation with agencies and industry are required to better understand the drivers of problematic behaviours to ensure appropriate interventions are identified and prioritised.

# Introduction

## Fire Prevention Program

Since 2017, improved industry awareness, joint agency compliance and enforcement action have led to a reduction in the severity and consequences of fires for the waste and resource recovery sector. However, fires continue to occur at waste and resource recovery (WRR) facilities.

Fire incidents present various risks, such as environmental pollution and the potential loss of resources, facility infrastructure and contractual partners.

The Department of Energy, Environment and Climate Action (DEECA) and the Environment Protection Authority Victoria (EPA) established the Fire Prevention Program in January 2021 to actively reduce the number and consequence of fires at WRR facilities across Victoria. Delivery of the Fire Prevention Program is continuing.

## Purpose of this report

The purpose of this report is to identify (within the limits of the available data) the factors causing the ignition of fires at Victorian WRR facilities. Further, it discusses the behaviours related to the identified causal factors that increase the likelihood of ignition. It also assesses the coverage of Victoria’s current legislative framework to identify possible legislative gaps.

By understanding the factors leading to fires, stakeholders, including Government, the waste industry and the general public, will be better placed to address them. Potential opportunities are suggested for consideration to further reduce the risk of fires at WRR facilities.

The report does not analyse factors that exacerbate the severity of fires at WRR facilities, such as stockpiling. Also, due to the lack of available data, the report did not investigate fires that occur during waste transport, albeit some of the recommendations in this report are expected to reduce the risk of fire in waste transport as well as at facilities.

## Approach

A range of information sources supported this analysis:

* 16 fire investigation reports from 2016-2021 from FRV on fire incidents at WRR facilities (Table 7 of Appendix 1)
* engagement with government and industry stakeholders
* literature review of peer-reviewed journal articles and government-commissioned reports
* Feedback and findings from inspections undertaken by EPA.
* Examination of 208 FRV and CFA recorded fire incidents from 2017-2021 suspected to have occurred at WRR facilities at the time of analysis.

### Stakeholder engagement

Key stakeholders across government and industry were consulted (see Table 1). Targeted conversations were held to test initial findings, gain further information, analyse, discuss, and finalise conclusions.

Table 1 Industry and Victorian Government Stakeholder Engagement

| Government | Industry |
| --- | --- |
| Environmental Protection Authority (EPA) | Victorian Waste Management Association (VWMA) |
| Sustainability Victoria (SV) | Waste Management and Resource Recovery Association (WMRR) |
| Fire Rescue Victoria (FRV) | Waste Industry Alliance (WIA) |
| Country Fire Authority (CFA) | Visy Recycling |
| WorkSafe Victoria (WSV) | Envirostream |
| Australian Battery Recycling Initiative | Battery Stewardship Council |

### Data Limitations

Data on ignition causes of fires at WRR facilities is limited in reliability and quality. Where causes have been identified, the circumstances leading to ignition are often unclear. The cause of fires is often hard to determine (e.g., when the evidence of the cause is destroyed in the fire). The data recorded about fires at WRR facilities also lacks specificity and does not capture all fire incidents. Identifying individual fires at WRR facilities is difficult as the location of fires is recorded based on the location of fire fighting vehicles rather than the property address. Of the 208 fire incidents suspected to have occurred at WRR facilities from 2017-2021, as many as 50% may have been misattributed to a WRR facility. A large number of these fires may have occurred at other businesses or residential structures close to a WRR facility.

Discussions with stakeholders revealed that many fires at WRR facilities don’t require calls to fire agencies as they are extinguished quickly. These incidents are not captured in FRV and CFA records. Therefore, consultation with the industry has provided a more complete understanding of fire incidents.

Engagement with the Victorian fire agencies (FRV and CFA) indicated that the cause of many fires is reported as ‘undetermined’, and this may affect as many as one third of all reported fires. Other fire agencies, found in references from New South Wales (Fattal, Kelly, Lui, & Guirco, 2016), the United States (Fogelman, 2019), the United Kingdom (Brown, et al., 2021) , Sweden (Ragni Fjellgaard, Lonnermark, Glansberg, McNamee, & Karolina, 2021), Germany and Austria (Nigl, Rübenbauer, & Roland, 2019), also report a significant number of undetermined fires. To better understand ‘undetermined’ fire incidents, 16 detailed FRV incident reports have been acquired to explore ‘probable causes’, supporting a better understanding of causal factors.

As a result, the interpretations in this report are not definitive. However, numerous international reports and anecdotal evidence from waste industries and fire agencies support the findings in this report.

# Causal factors

Our analysis identified four primary ignition causes of fires at WRR facilities: lithium-ion batteries; electrical, mechanical or vehicle faults; smouldering or combustible material; and or spontaneous combustion. Engagement with FRV, CFA and key industry stakeholders highlighted the commonly held view that lithium-ion batteries are likely the most common cause of fires. This is supported by detailed fire incident reports by FRV (Table 7 of Appendix 1).

This analysis outlines the available data to support these claims and discusses the chain of events that lead to ignition.

## Lithium-ion batteries (LIBs)

End-of-life lithium-ion batteries (LIBs) may retain significant energy which can act as an aggressive ignition source if damaged. Fire authorities and the waste industry alike report that waste LIBs are a significant contributing factor to many fires in waste collection, transportation, disposal, and recycling.

### The Victorian context

As noted, representatives from both the waste industry and the fire authorities in Victoria suggest that waste LIBs are a significant contributing factor to many waste fires. However, of the 208 fires suspected to be at WRR facilities, none indicated that batteries were the cause fire incidents in Victoria. This speaks to the *Data Limitations* section above, whereby the *circumstances leading to ignition are often unclear.* Despite incidentssuspected to be caused by batteries, they are often not officially recorded as the causal factor. This difference between the experience of the waste industry and fire agencies and available fire data is mirrored in international reports. An Austrian study on waste fires notes *‘the rising relevance of batteries as sources of ignition (fire cause) did not reflect in this study, although, experiences of individual plant operators suggest exactly the opposite’* (Nigl, Rübenbauer, & Roland, 2019).

However, whilst LIBs are often not ‘officially classified’ as the causal factor, 6 of 16 detailed FRV incident reports[[1]](#footnote-2) from 2016-2021 (Table 7 of Appendix 1) suggest LIBs as a ‘probable cause’. For example, one report states *‘Investigators considered that it was most likely that the fire causation was the abnormal activity of a battery within stockpile of commingled waste. However, in the absence of physical evidence, the cause is undetermined’*.

### Supporting evidence: International studies

Internationally, LIBs are also considered a key contributor to many waste fires, with some reports claiming that up to 48% of fire incidents at WRR facilities can be attributed to LIBs[[2]](#footnote-3) (Brown, et al., 2021). In a report by the United States Environmental Protection Agency *an Analysis of Lithium-ion Battery Fires in Waste Management and Recycling*, 64 of 245 fires between 2013 and 2020 were caused by, or likely caused by, lithium metal or LIBs (United States Environmental Protection Agency, 2021).

In 2018, the Californian Product Stewardship Council surveyed waste facilities across California and found that 83% of the 26 respondents experienced a fire in the last two years, with 65% of fires believed to be caused by batteries (Californian Product Stewardship Council, 2021). Similarly, according to a report “Cutting Lithium-ion Battery Fires in the Waste Industry” published by Eunomia and the Environmental Services Association (ESA) in the UK, 201 fires each year are caused by LIBs (Brown, et al., 2021). According to the report, of the 670 fires recorded by ESA waste management members across the UK in 2019-2020, 38 per cent were either recorded as caused by LIBs or “suspected” to have been2. Lastly, a study of waste fires in Sweden and Norway highlights that the waste sector sees battery-induced fires as a significant threat. Figure 2 of appendix 1 outlines the causes of waste fires in Norway and Sweden, with ‘self-ignition’ causing 271 fires. Self-ignition was commonly used by the industry to refer both to self-heating and thermal runaway in LIBs and for friction-started fires(Ragni Fjellgaard, Lonnermark, Glansberg, McNamee, & Karolina, 2021).

Compared with other batteries, LIBs have a thin internal casing separating flammable chemicals. This makes them susceptible to damage through mechanical handling (inherent in waste management processes), providing an environment where internal chemicals can mix, leading to a rapid heat release process called thermal runaway (Junxian, et al., 2020). Further, LIBs are often embedded in consumer products, such as phones and laptops, making them difficult to separate.

Various types of batteries exist in the consumer market, the most prevalent of which are lead-acid batteries (LABs) and (LIBs). In recent years, lead acid batteries have been replaced by lithium-ion batteries in many applications. This is a result of lithium-ion batteries having a greater energy density, efficiency, and lifespan as compared to lead acid battery chemistries. These batteries, however, due to the chemistry of LIBs, are significantly more prone to exploding and catching fire. From a review of incidents and fire testing data involving lead acid batteries, it had been determined that lead acid batteries do not pose significant inherent fire risks as compared to lithium-ion batteries (Parker, Obeng, & Wang, 2020).

### Increasing prevalence of LIBs

Research shows an increase in the production, use and availability of LIBs found in consumer products. It is expected that 81.8% of rechargeable battery market growth between 2019 and 2024 will come from LIBs (Zhao, Ruether, Bhatt, & Staines, 2021). The increased use of LIBs by consumers has led to a significant increase in the number of LIBs disposed of in recycling and landfill bins by households and businesses alike (Colmar Brunton, 2020). Ultimately, this is driving the amount of waste LIBs in WRR facilities. The problem is expected to worsen as LIB consumption increases, therefore, understanding the behaviours associated with households and businesses disposing of LIBs is important.

The Battery Stewardship Scheme (BSS) is a promising solution to address the increased risk LIBs are posing to WRR facilities. The BSS, which commenced in January 2022, is an industry-led initiative to provide free battery recycling to consumers across Australia. This nationalised scheme will include a suite of initiatives and communications to address incorrect battery disposal. The Scheme is supported by the Commonwealth and all State and Territory Governments and authorised by the Australian Competition and Consumer Commission (ACCC). Further information on opportunities to leverage the BSS is outlined below in the ‘Opportunities to address causal factors’ section.

## Electrical, mechanical and vehicle faults

Approximately 29% of the 208-suspected waste facility fires recorded by FRV and CFA from 2017-2021 were reportedly caused by various mechanical or operational issues. These incidents indicate that fires are likely caused through machinery malfunctions (including leaks and lack of maintenance), hot works (welding), combustibles being close to heat/friction or other operational deficiencies.

The types and number of machines, vehicles and equipment present at WRR facilities vary, depending on their size and the waste streams that they receive. Machinery and equipment require maintenance, often via hot works, and if poorly maintained, are predisposed to overheating or contributing to fire incidents. Most vehicles and machines have moving components that create heat, and fires can occur if fuel (i.e., waste) is exposed to these components.

Common issues relating to operational, mechanical or vehicle issues that can result in fires are identified in Table 2 below. The issues described have been linked to fire incidents outlined in Table 7 of Appendix 1.

Table 2 Common mechanical and operational issues identified through industry consultation and FRV incident reports

|  |  |  |
| --- | --- | --- |
| Cause | Common events leading to ignition | Fire incident # (Table 7 Appendix 1) |
| Wheel loaders & forklifts | Exhaust systems from wheel loaders and forklifts create heat and can ignite surrounding fuel sources (e.g. waste piles) or the front end of the wheel loader scraping concrete can create sparks. | 14 & 16 |
| Shredding machines | The heat created by components in the machine can be enough to ignite surrounding flammable material. Waste shredders routinely operate unmanned for prolonged periods, allowing the build-up of material in proximity to heated components. | 4, 7 & 11 |
| Conveyor belts | Conveyor belts have components called ‘rollers’ that create high frictional force. Bearings in conveyor belts can wear out and create friction and heat surrounding waste. Material, particularly long pieces of material such as hose pipe, conduit, or string, can get caught in these rollers resulting in failure, friction, and ignition. | 2 & 15 |
| Faulty wiring | Exposed or old wiring can short-circuit and overheat. | 12 |
| Hot works | Hot works, such as welding, are generally required when maintaining equipment and machinery at WRR facilities and can ignite fuel sources if appropriate protections are not applied. | None |

Data from 285 fire incident cases from 2007 to 2017 in Austria and Germany, reveal detailed information about locations, across the waste value chain, where fire incidents occurred. Shredders accounted for a total of 30/285 cases. The study reports that, according to the experience of individual plant operators, the relative number of fires associated with ‘crushing processes’ is significantly higher, even up to 50% of fires. A full list of these locations of fire incidents can be found in Table 6 of Appendix 1.

## Smouldering or combustible material

Combustible or smouldering materials in waste streams, according to industry, cause a significant number of fires.

Victorian fire agency data from 2017-2021 identifies 13 of 208-suspected waste facility fire incidents were caused by discarded smouldering material such as cigarettes and cigars. It is probable that more incidents, classified as ‘undetermined’ or ‘other’, were caused by combustible or smouldering materials. Table 3 presents a summary of common combustible or smouldering materials found in waste streams.

Table 3 Summary of common smouldering or combustible materials found in waste streams

|  |  |
| --- | --- |
| Material Type | Description |
| Butane gas canisters | Small non-refillable gas butane canisters are pressurised cans filled with highly flammable butane gas. They can be found in mixed waste streams and if they contain residue gas or are not empty, carry a significant fire risk. |
| Flares | Flares can be found in general mixed or recycling waste streams. These may come from fishing vessels where the flares have expired and been discarded into general waste bins. |
| Cigarettes | Cigarettes that are thrown out whilst smouldering can ignite waste materials downstream at waste facilities. |
| Aerosols | Aerosol cans tend to contain flammable material (such as hydrocarbons in deodorants and adhesives etc) and are pressurised. When not emptied and subsequently compacted; they can explode(Kukfisz, 2018). |

## Spontaneous combustion

Spontaneous combustion occurs via a process in which materials break down and release heat. If the heat created reaches temperatures beyond the ignition point of the surrounding materials, the surrounding materials will combust (Moqbel, Reinharta, Chenb, & Ruey-Hung, 2010). All combustible recyclable waste material will burn if its temperature exceeds its ignition point (Environment Protection Authority Victoria, 2021). Availability of oxygen and moisture, time that waste is stockpiled, and types and size of material all influence how quickly materials break down, and thus the likelihood of spontaneous combustion. Further evidence of this can be found in Table 4 below.

Spontaneous combustion is identified as the cause of 16 of 208-suspected waste facility fires from 2017-2021 in Victoria. These fires likely occurred across multiple waste streams. This is consistent with findings in other jurisdictions, including NSW, the United States and Norway (Fattal, Kelly, Lui, & Guirco, 2016) (Fogelman, 2019) (Ragni Fjellgaard, Lonnermark, Glansberg, McNamee, & Karolina, 2021).

From the available data, it is not possible to identify how the spontaneous heating events occurred. Industry and fire agencies also have an incomplete understanding of the causes of spontaneous ignition events. A reason for this may be that spontaneous combustion fires tend to be ‘deep seated’ (fires deep in waste piles) (Moqbel, Reinharta, Chenb, & Ruey-Hung, 2010). Therefore, understanding the factors leading to spontaneous heating is limited by difficulties in observing these events. However, waste operators stockpiling material for long periods may increase the risk of fires caused by spontaneous combustion.

Table 4 Factors affecting spontaneous heating

|  |  |
| --- | --- |
| Factor | Outline |
| Availability of oxygen & moisture | The increased presence of moisture and oxygen facilitates the physical, chemical, and biological breakdown of materials. The breaking down process releases heat that may create ‘heat pockets’ in waste stockpiles’ (Environment Protection Authority Victoria, 2021) |
| The time that waste is stockpiled | Material stored for long periods creates a higher chance of ignition due to spontaneous heating. Rising temperatures in heat pockets may cause different materials, depending on their point of ignition, to flame or smoulder which may lead to larger fires. The minimum temperature required to potentially cause the ignition of nearby materials could be as low as 65°C (Moqbel, Reinharta, Chenb, & Ruey-Hung, 2010) |
| Types & sizes of material | The molecular makeup of different materials influences how quickly different materials will break down. This is dependent on such things as the density and water content of the material. There is an increased risk of combustion in long-term storage from rust, treated materials and shredded materials (Environment Protection Authority Victoria, 2021) |
| Food organics and garden organics (FOGO) | FOGO decompose through microbial and chemical action, which can generate considerable heat. They will spontaneously combust when the heat generated is higher than that lost to the surrounding environment. Allowing a pile to get to an internal temperature of over 90°C can trigger rapid self-heating and eventual combustion. FOGO undergoing composting typically ignite between 150°C and 200°C (Environment Protection Authority Victoria, 2021). | |

# Legislative tools to address causal factors

Victorian legislative frameworks regulating the causal factors identified in this report are comprehensive, with very few gaps. Specific elements of these frameworks and their application to the causal factors of fires identified in this report are outlined below.

## Environment Protection Framework

The newly commenced environment protection framework includes the *Environment Protection Act 2017* (Vic) and *Environment Protection Regulations 2021.* This framework aims to protect human health and the environment by reducing the harmful effects of pollution and waste.

The general environmental duty (GED) is the cornerstone of the Act. The GED is directly relevant to the causal factors identified in this report as it requires duty holders to eliminate or minimise the risks of harm from their activities to human health and the environment so far as reasonably practicable. This includes the risks that may result in fires at WRR facilities.

This means that risks of harm arising from all types of waste, including LIBs and other combustible waste, spontaneous combustion, and risks from electrical and mechanical equipment failures, must be minimised by the operators of WRR facilities. Greater penalties attach to the GED where material harm is caused intentionally or recklessly. The risk of harm caused by a failure to maintain a plant is a specified breach of the GED under the environmental protection framework.

### Priority Waste Duties

Priority waste is a subset of industrial waste. A person in control or management of priority waste must classify the waste and take all reasonable steps to ensure that the priority waste is managed appropriately. This includes containing waste in a manner that prevents its escape and isolating it in a manner that ensures resource recovery remains practicable. A person must also take all reasonable steps to identify and assess alternatives to waste disposal.

LIBs are classified as a priority waste. E-waste, tyre pieces, and shredder floc are classified as priority waste as they are “waste of an explosive nature not subject to other legislation” (such as the Dangerous Goods framework). The waste duties, therefore, require the separation of these wastes for resource recovery.

### Reportable Priority Waste

Waste LIBs are not classified as reportable priority waste (RPW). RPW streams attract additional obligations including record-keeping duties and transport requirements.

### State of knowledge

The GED is underpinned by the ‘state of knowledge’ – which is what the person concerned knows or ought reasonably to know about the harm or risks of harm from the activity they’re undertaking.

Guidance plays an important role in building the state of knowledge and supporting an understanding of the risks of harm from particular activities and what controls may be proportionate to eliminate or minimise those risks. Key pieces of guidance informing the state of knowledge for WRR facilities include:

* *Management and storage of combustible recyclable and waste materials – guideline*. This guideline focuses on minimising risks from combustible recyclable and waste materials on a site. It outlines a process for fire risk assessment, identifies controls to prevent and mitigate fires at WRR facilities, sets out CRWM storage guidance and outlines emergency management plan requirements for fires at WRR facilities. The guidance advises on the separation of combustible non-waste materials from CRWM storage by removing gas cylinders, dangerous goods, electrical devices, batteries, flammable substances, etc. from areas where CRWM is stored. It also advises on risks and available controls for spontaneous combustion.
* *Managing industrial waste: your duties as a producer.* This guidance explains the waste duties that apply to different types of industrial waste and aims to help businesses understand how the waste duties apply to their business activities and what reasonable steps a waste producer needs to take to comply with these duties.
* *Battery Guidance. EPA* recently published the *Storage and management of waste batteries* guideline that outlines expectations for the storage and management of waste batteries for duty holders. This provides a state of knowledge relating to the safe management and storage of batteries onsite and adds clarity as to what the General Duty requires in this situation.

### Permission Scheme

Conditions applied by EPA to all waste and recycling facilities under the new Act may reduce risks of fire from the causal factors outlined above.

All WRR facilities except those storing very low volumes[[3]](#footnote-4) are required to apply for an EPA licence, permit, or registration. These are collectively referred to as ‘permissions’. Permissions support the GED and waste duties by ensuring certain standards and conditions are met across a range of activities. Permission holders must comply with the GED, their waste duties and any conditions prescribed in their permission. The conditions stipulated on permission for a WRR facility depend on a variety of factors.

Licence applications for larger-scale WRR facilities will be assessed and may attract licence conditions that require them to have a fire risk assessment and emergency management plan, as well as volume limits. A potential condition for WRR facilities applying for an A13[[4]](#footnote-5) licence or permit includes keeping the temperature of waste piles below 90℃, which is intended to reduce the risk of fire from spontaneous combustion. Smaller facilities that require a registration (A13c) will be required to minimise fire risk.

Except for small organics facilities and small landfills, all WRR facilities will be assessed for a condition that requires them to appropriately maintain machinery and equipment.  This supports the reduction of fire risk mechanical failures.

## Occupational Health and Safety Framework

The *Occupational Health and Safety Act 2004* (Vic) and Occupational Health and Safety Regulations 2017 (OHS framework) also include a general duty. Duty holders must eliminate risks to health and safety, so far as reasonably practicable, or reduce risks if elimination is not reasonably practicable. This requires the risk of fire to be minimised given fire is a major safety risk. There are also specific obligations to maintaining the plant.

The general duty under the OHS framework is similarly informed by the state of knowledge. Compliance codes explain how to comply with duties under the OHS Act.

The *Compliance Code: The plant* guides duty holders about how to comply with their duties under the OHS Act and Regulations about plant. Though the guidance provided in the Code is not mandatory, a duty holder who complies with it will - to the extent it deals with their duties or obligations under the OHS Act and OHS Regulations – be taken to have complied with those duties or obligations.

Employers also must ensure, so far as is reasonably practicable, that persons other than employees are not exposed to risks to their health or safety. This creates an obligation on employers to consider risks flowing from their activity, for example, residents who live near the site who may be impacted should a fire occur.

## Dangerous Goods Framework

The *Dangerous Goods Act 1985 (Vic)* and *Dangerous Goods (Storage and Handling) Regulations* 2012 set out the requirements for safely storing and handling dangerous goods and ensuring associated risks and security concerns are properly managed. Dangerous goods include LIBs, explosives, combustible liquids, and high-consequence dangerous goods as well as those defined in the Australian Dangerous Goods Code (ADG Code).

Anyone who is normally or occasionally in the supervision of premises storing dangerous goods (the occupier) is required to eliminate, or if cannot eliminate, then minimise as far as reasonably practicable the risks associated with managing and storing a dangerous good.

Where a WRR facility is processing a dangerous good, then the design of the premises, plant, process, or systems of work needs to eliminate or minimise risks associated with the storage of dangerous goods. This requires that any hazards or risks are identified, and a record of the risk assessment is made and kept for as long as that assessment is current. The occupier also needs to ensure that dangerous goods do not inadvertently become unstable, decompose, or change to create an additional hazard or increase risk.

There are also obligations to manage risks that could harm people that are located outside the site. Risks need to be managed through isolation of the dangerous good to ensure that it does not create a chemical and physical reaction with another substance at the premises.

Manufacturers and/or the first supplier of dangerous goods are required to determine if something is a dangerous good as soon as possible if they have reasonable grounds for suspecting the goods are dangerous. If it is a dangerous good, they must supply receivers with a safety data sheet (SDS) and apply package markings and class or hazard class information on the dangerous goods, to assist occupiers to identify what’s in a product, precautions for use, and safe storage and handling requirements.

## Building Legislation

The *Building Act 1993* (Vic) and the *Building Regulations 2018* (Building Legislation) set the legal framework for the regulation of building construction, building standards and maintenance of specific safety features.

Under Building Legislation the building owner is required to maintain essential safety measures (ESMs) installed in that building so that they operate satisfactorily, keep ESM routine service records for the building and prepare an annual ESM report and produce these upon request.

ESMs include fire alarm systems, extinguishers, hydrants and hose reels, fire detection and alarm systems, fire-rated materials, fire windows, smoke alarms, smoke control systems and sprinkler systems.

The types of ESMs installed within an individual building, as well as the intended performance of each measure, is determined based on the class and size of the building by the National Construction Code. The National Construction Code is applied in Victoria by incorporation through the *Building Regulations 2018*.

Whilst these measures do not prevent fires, they will assist in suppressing and controlling the fires if they ignite.

## Planning and Environment Act 1987 (Vic)

The *Planning and Environment Act 1987* (Vic) has the purpose of planning the use, development, and protection of land in Victoria. Planning approval may be required to operate a WRR facility, depending on the proposed location of the facility and the provisions of the applicable planning scheme. In some cases, the relevant local government will refer a permit application for a WRR facility to the EPA as a determining referral authority. This can result in some WRR facilities having conditions around waste stockpiles as part of their planning permission.

While the tools under the planning framework do not address the specific causal factors raised in this report, they can put in place controls to ensure that some risks from a fire at WRR facilities are mitigated by ensuring they are appropriately situated, depending on the applicable planning scheme.

# Addressing the causal factors

This report has identified several factors that are causing the ignition of fires at WRR facilities. These factors, such as LIBs or plant malfunctions, are driven by behaviours, such as incorrectly disposing of LIBs upstream and failing to maintain plant. To address the causal factors, an understanding of the associated behaviours is required. These behaviours are diverse and complex and require action across Government, industry and the general public.

## Better understanding of contributing behaviours

Although Victoria’s legislative frameworks offer relatively comprehensive requirements to prevent or reduce the risk of fire at WRR facilities, compliance with those obligations is not consistently observed across the industry. Further, industry efforts towards the improved waste collection and processing systems may be undermined by incorrect disposal of LIBs and other combustible materials upstream.

### Supporting compliance

Whilst Victoria’s legislative frameworks offer relatively comprehensive requirements to control the risk of fire at WRR facilities, compliance with those obligations is not consistently observed across the industry. This finding indicates that further action is required to increase compliance with legislative requirements.

Understanding the reasons for non-compliance across the waste value chain is an important step in identifying appropriate opportunities to effectively drive positive change. With an understanding of barriers to compliance, Government and industry can take action to ensure duty holders comply with the law. Complying with the law and controlling fire risk can prevent fires from occurring in the first place.

Actions to support the prevention of fires can include awareness raising, education, compliance and enforcement. For the waste and resource recovery sector, compliance starts with understanding the fire risks associated with each premise and putting controls in place. Of the sites EPA has visited, the EPA has observed that many duty holders do not understand their fire risk, and many more do not have adequate fire prevention or suppression controls in place. It is the duty holder’s legal obligation to understand and control the fire risk associated with their operations. This means taking proactive action to control the risk. It is important that controls implemented follow the hierarchy of control (starting at elimination), that they are fit for purpose, and they are maintained in good working order.

It is important that all Victorians dispose of their waste at a lawful place; this means at a place that is authorised to accept that waste type being disposed of. Fire risks can be created by inappropriately disposed of waste; for example, disposing of lithium-ion batteries in household recycling bins can result in fires in garbage trucks or down the line at resource recovery centres not designed to accept this waste type.

### Addressing upstream waste disposal behaviours

Industry fire prevention efforts may be undermined by contamination of waste streams caused by upstream disposal behaviours. This aligns with industry feedback that suggests that the prevalence of certain causal factors is impacted by waste generators upstream– for example, batteries being put in rubbish bins by households or businesses. Batteries are arriving in the mix of recycling at WRR facilities, and they may not be appropriately identified, separated, or managed when they arrive. Under the new *Environment Protection Act 2017* (EP Act), waste duties do apply to a business and require them to separate wastes such as batteries for resource recovery. The same does not apply to individuals at home, as rubbish disposed of in household bins is not classified as priority waste. LIBs only become priority waste once they are picked up from households to be taken to a WRR facility.

While the GED applies to everyone, it is not enforceable against individuals – only where the activity is part of a business or undertaking. Arguably, it would be far too difficult to enforce even if the legislation did apply to individuals and their domestic waste. A more appropriate avenue for dealing with this issue is likely to be through awareness raising, behaviour change initiatives, and programs to support resource recovery. It needs to be clear to consumers how specific types of waste, such as LIBs, should be disposed of and easy access provided to appropriate collection points. Different approaches may be required for business waste generators to encourage compliance with requirements to separate and reduce risks. All of these are discussed in the following section.

Lastly, it is important to consider that the EP Act requirements were only recently introduced. Businesses may require support to understand and comply with new requirements. The Victorian Government should engage with industry in the WRR sector to support compliance and better understand the behaviours driving the causal factors.

## Opportunities to address the causal factors

The Victorian community and businesses involved in generating and reprocessing waste have a key role to play in preventing fires in the WRR sector. Opportunities to minimise the prevalence of fires at WRR facilities are discussed in this section.

### Reducing the volume of combustible materials, such as LIBs, incorrectly disposed of by households and businesses

Improving rates of correct disposal requires changing the behaviours of households and businesses. To achieve this, further work is required to address the levels of awareness of both how to dispose of combustible materials correctly and the dangers of disposing of them incorrectly; and the barriers impacting the use of the drop-off points.

EPA and WSV may also inform and educate the commercial and industrial waste producers’ generators on managing waste batteries and other combustibles in line with the priority waste duties and Dangerous Goods requirements.

Additionally, key opportunities include supporting the BSS which began in early 2022. The BSS is a voluntary product stewardship scheme that will collect a levy from battery importers to fund accredited battery collectors, sorters and processors. It will involve a suite of initiatives to support the safe management of batteries across Australia. The scheme has recruited industry partners including Duracell, Energizer, Coles and Woolworths to fund recycling and provide collection services for end-of-life batteries.

As the BSS develops, there is an opportunity for the Victorian Government to leverage this scheme to reduce fire incidents from waste batteries in Victoria by improving their separation, handling, storage, and processing.

### Supporting compliance performance with fire risk requirements at WRR facilities.

While our analysis found that Victorian legislation appropriately requires fire risks to be addressed, improvements could be made to increase compliance with the new EP Act and regulations, including through awareness raising and education, targeted efforts to support compliance, and compliance monitoring and enforcement. Understanding the reasons for non-compliance across the waste value chain is an important step in identifying appropriate opportunities to address them.

When considering interventions, it is important to note that the full suite of tools in the EP Act and regulations have only recently come into effect. It will be important to monitor how effective these tools are in reducing fire risk and understand that the industry is currently going through a transition period to comply with the new requirements of the Act and regulations.

### Improving the quality of fire incidence data

As discussed, data on ignition causes of fires at WRR facilities is limited in reliability and quality. Fires are not always reported to fire services, and when they are the ignition cause is often undetermined. Regulators (EPA and WSV), fire agencies, industry and the Australian Fire Agency Council could work together to improve the capture of data on fire incidents and could also leverage the duty to notify in both the EP Act and OHS Act. This could include investigating options to:

* align or combine reporting processes under both duties
* standardise data capture on fire incidents, including developing a standard list of ignition causes with definitions
* develop processes to ensure this data is regularly reported (including to agencies and authorised officers), to inform continuous improvement and behaviour change programs.

Additionally, the Victorian Government could explore ways in which intelligence can be shared with the industry to improve its visibility of trends and enable more proactive risk management.

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# Appendix 1 – Supporting information

This appendix contains supporting evidence to complement the Fire Prevention Programs *causal factor and legislative analysis* report.

**Tables and Figures**

Figure 2 Summary of ignition sources for fires in waste facilities based on official Swedish fire statistics 2012–2015 (Ragni Fjellgaard, Lonnermark, Glansberg, McNamee, & Karolina, 2021)

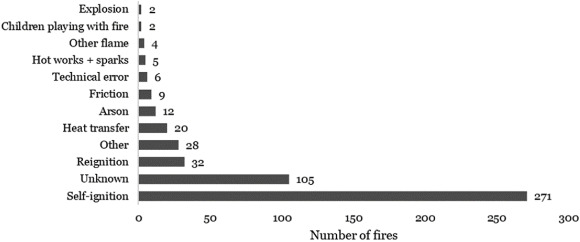


Table 6 Distribution of fire incidents across waste facilities in their areas/sections in Austria & Germany from 2007 - 2017 (n=285) (Nigl, Rübenbauer, & Roland, Cause-orientated investigation of the fire incidents in Austrian waste management systems, 2019)

|  |  |
| --- | --- |
| Specific location of fire origin 227 | |
| Aggregates / facility areas 54 | |
| Waste bunkers | **6** |
| Delivery halls | **2** |
| Feeding/intake hoppers | **1** |
| Exhaust extraction and filtration systems | **3** |
| Conveyors | **9** |
| Shredders, shredding facilities | **30** |
| Waste turner, waste mixer | **3** |
| Storage areas | **108** |
| Outdoor storage areas | **31** |
| Storage (boxes) | **31** |
| Storehouses | **29** |
| Bales, bale storages | **3** |
| Waste piles | **6** |
| Baler, press containers | **8** |
| Transport areas | **65** |
| Collection and transport vehicles | **18** |
| Waste containers | **47** |
| Unspecific locations of fire origins | **43** |
| Recycling facility | **10** |
| Waste treatment facility | **8** |
| Waste sorting plant | **8** |
| Waste recovery facility | **2** |
| Composting plant | **1** |
| Municipal waste collection centre | **6** |
| Landfill | **8** |
| Unknown location of fire origin | **15** |
| Total sum | **285** |

**Fire Rescue Victoria incident reports**

The table summarises key information relating to causes of fires across 16 incidents across Victoria from 2016 – 2021. Details of the incident, along with and official causes and description of a probable cause has been included.

Table 7 summary of Victorian fire agency fire incident reports (n=16)

| **Fire Incident** | **Official classification** | **Probable cause** |
| --- | --- | --- |
| Date: 11/01/2021 | Accidental – Electrical | Battery  *Explanation:* Area was scrap steel; staff utilise mobile material to move scrap steel from smaller piles into larger piles which has the potential to mechanically damage batteries. “Compromised battery would introduce ignition source into combustible fuel package. |
| Date: 07/02/2018 | Accidental | Conveyor belt  *Explanation:* “I conclude that the resulting friction caused by the bearing failure on the head drive pulley of flock conveyor No.4 caused sufficient enough heat to ignite the flock mixture on and around the pulley”. |
| Date: 11/01/2016 | Electrical | Battery  *Explanation*: Explanation Ignition source concluded as battery fault ‘short circuit’ in an older wheel loader vehicle at scrap tire facility. |
| Date: 18/02/2021 | Accidental | Shredding machine  *Explanation:* It is likely that fine residual waste particles were left attached to a heated metal exit shoot of a shredding machine and consequently heated and dried and ignited |
| Date: 19/01/2019 | Accidental – electrical | Battery  *Explanation:* Likely cause was batteries short circuiting due to improper storage and batteries being stored that still have charge in them. |
| Date: 09/08/2020 | Undetermined | Battery  *Explanation:* Stored energy battery cells experiencing catastrophic failure resulting in the development of heat increasing to a thermal runaway reaction and the ignition of available combustible materials. It was too unsafe to do a proper investigation. |
| Date: 18/02/2021 | Accidental | Shredding machine  *Explanation:* Residual waste from a shredding machine ignited follow high temperature from the outshoot part of the machine. |
| Date: 07/07/2020 | Undetermined | Lithium-ion battery or another shredding machine fault  *Explanation:* A shredding machine either shredding a lithium-ion battery OR material getting stuck in the machine and causing friction. |
| Date: 01/10/2017 | Smoke/steam arising from pile of mixed recycled rubbish | Undetermined  *Explanation:* None given, could not be determined. Unlikely to be spontaneous combustion but to rubbish being moved daily. No further evidence to suggest any other causal factor. |
| Date: 04/01/2021 | Undetermined | Battery  *Explanation:* Investigators considered that it was most likely that the fire causation was abnormal activity of a battery within stockpile of comingled waste. However, in the absence of physical evidence, the cause is undetermined |
| Date: 28/02/18 | Undetermined | Shredding machine  *Explanation:* Red hot metallic object from the breaking down process of a shredding machine ending up in flock stockpile igniting other combustibles |
| Date: 13/01/2020 | Accidental / electrical | Electrical  *Explanation:* Unspecified electrical event occurring in a light switch electrical componentry |
| Date: 13/07/2017 | Undetermined | Spontaneous combustion  *Explanation:* Spontaneous heating of decomposing organic material in glass material igniting combustibles of the adjoining recycled waste heap is the most probable cause. Due to the extent of damage of the fire, ignition is officially undetermined. |
| Date: 07/07/2018 | Undetermined | Vehicle accident  *Explanation:* Vehicle accident - Whilst there are several possible ignition causes, the most likely is a spark or hot object igniting combustibles during the process of using forklifts to remove comingle bales. |
| Date: 28/02/2017 | Accidental | Conveyor belt  *Explanation:* The cause is classified as accidental and was due to mechanical error in a conveyor belt. |
| Date: 28/07/2020 | Accidental | Vehicle accident  *Explanation:* A forklift had been parked near spilt petrol. When the forklift started it ignited the petrol. |

1. Detailed incidents reports are not completed for every fire, only those where a more detailed investigation into the cause of the fire is necessary. [↑](#footnote-ref-2)
2. This UK estimate of 48% was based on waste industry reporting for 2019-2020 of fires both known and suspected to have been caused by LIBs (38%), plus as “*an assumption that 25% of 'Unknown' cause fires are actually due to LIBs*. [↑](#footnote-ref-3)
3. Less than 5 m3 of any waste is stored on the site at any time. [↑](#footnote-ref-4)
4. A13 is the activity code for general waste and resource recovery under the *Environment Protection Regulations 2021*. [↑](#footnote-ref-5)