Presentation Title: A Holistic Performance-based Framework to Address Fire Safety in Waste Management Facilities

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1.0 Abstract

The Australian Federal Government introduced the Recycling and Waste Reduction Act [1] in early December 2020, banning the export of unprocessed waste overseas. In 2022, the NSW Government introduced the Remanufacture NSW Grant Program to recycle items such as paper, plastic, cardboard and tyres that were subject to the export of unprocessed waste overseas (NSW Government, 2022). This legislation and grant along with the COVID 19 pandemic have provided a stimulus to reconfigure local waste infrastructure to reprocess and re-manufacture recyclables onshore within Australia.

Waste Management and Treatment Facilities (WMF) come in various shapes and sizes, each processing different types of waste products ranging from household chemicals to organic waste. The nature of these facilities and the materials stored within present a unique set of risks, in relation to site and building fire safety.

Many of these WMF operate in a manner that allows a large deposition of waste material to be collected and piled up. The waste collected here is then sorted into various segments for further treatment including recycling or disposal. Such segregated waste is then held on site until collection, transfer or further treatment is viable.

WMFs may also operate based on exclusively accepting certain waste streams, such as chemical waste, paints, solvents, and e-waste products. Such facilities present a unique set of risks where both, the building and process risk need to be considered along with the installed fire services.

WMF fire risks are not readily covered by the prescriptive Deemed-to-Satisfy (DtS) provisions of the Building Code of Australia (BCA) necessitating a Performance-based approach. The application of BCA Clauses E1.10 (E1D17) and E2.3 (E2D21) referring to Special Hazards, states that additional provision must be made if problems of fighting a fire could arise because of certain aspects, i.e. nature or quantity of materials stored, displayed, or used in a building or on the allotment; or water supply needed for fire-fighting purposes.

2.0 Historical Fires in Waste Management Facilities

With the ever-increasing amount of waste produced, it is common for many existing warehouse buildings and related sites to be converted into WMFs. This often results in a gap between prescriptive Building Code requirements, existing Performance Solutions on the building and the various waste management guidelines applicable in respective Australian States and Territories. A brief historical perspective is provided in this section to detail some waste management facility fires with varying severities across Australia.

2.1 Bellevue Hill, Western Australia 2001

The 2001 Bellevue Hill waste management facility incident in Western Australia (Australian Institute for Disaster Resilience, n.d.), can be considered the first major waste facility incident in Australia that led to a change in legislation and development of a set of guidelines to address the fire risks

[1] Recycling and Waste Reduction Bill 2020

associated with WMFs. The facility at the time contained half a million litres of chemicals and toxic solvents that contributed to the combustion process resulting in toxic smoke being produced.

2.2 Coolaroo, Victoria 2017

The 2017 Coolaroo recycling facility fire incident in Victoria (Environment and Planning Committee, 2019) highlights that the nature of materials need to be considered as part of fire safety provisions. The fire originated in a pile of cardboard stored on site. The facility functioned as a materials recovery centre with a focus on household recycling and waste for numerous Councils in Victoria.

2.3 South Guildford, Western Australia 2019

The 2019 South Guildford recycling facility fire incident in Western Australia (Government of Western Australia, 2019) is another example which highlights that the nature of materials need to be considered as part of fire safety provisions. The subject fire originated from a spark created when a gas cylinder was crushed. The facility functioned as materials recovery centre where waste would be stored on site prior to being sorted. Figure 1 is a photo taken post incident noting that the storage area was at 80% capacity.

Figure 1 – Photograph taken post incident with the storage capacity of the building at 80% (Government of Western Australia, 2019)

Hence, understanding the type of waste being received, the storage duration, storage layout, processing plant, building characteristics and site layout is vital in developing a holistic fire safety strategy.

3.0 Types of Waste Stored on Site

Prior to developing a holistic fire safety strategy for WMF's, a good place to start is identifying the type of waste that will be stored or processed on site. This will provide a baseline for the most critical design fire scenarios as well as feeding into measures required to address BCA E1.10 and E2.3 compliance.

The various types of waste that are commonly encountered on sites are outlined below.

3.1 Municipal Waste

Defined as “waste other than sewage and air emissions generated in and usually collected by a municipality” (International Finance Corporation, 2005). Figure 2 provides a guidance on what is considered municipal waste across the various sectors.

Table 1 - Sources and Types of Municipal Solid Waste

Source	Typical Waster Generators	Types of Solid Waste
Residential	Single and multifamily dwellings	Food waste, paper, cardboard, plastic, textiles, leather, yard waste, wood, glass, metal, ash, special waste (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires) and household hazardous waste
Industrial	Light and heavy manufacturing, fabrication, construction sites, power and chemical plants	Housekeeping waste, packaging, food waste, construction and demolition materials, hazardous waste, ash, special waste
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastic, wood, food waste, glass, metal, special waste, hazardous waste
Institutional	Schools, hospitals, prisons, government centers	Same as commercial
Construction and Demolition	New construction sites, road repair, renovation sites, demolition of buildings	Wood, steel, concrete, dirt, etc.
Municipal Services	Street cleaning, landscaping, parks, beaches, other recreational areas, water and wastewater treatment plants	Street sweepings; landscape and tree trimmings; general waste from parks, beaches and other recreational areas; sludge from water and wastewater treatment plants
Process	Heavy and light manufacturing, refineries, chemical plants, power plants, mineral extraction and processing	Industrial process waste, scrap materials, off-specification products, slag, tailings

Source: World Bank (2005)

Figure 2 – Sources and examples of municipal waste (International Finance Corporation, 2005)

3.2 Recycling Waste

Recycling waste could range from plastic bottles to Aluminium cans which are typically processed at material recovery centres. Typically, such materials are stored onsite for long durations prior to bulk collection and transfer to other sites as shown in Figure 3. However, the risk afforded by items such as plastic stored in bulk piles in the building need to be considered in the fire safety strategy.

Figure 3 – Sorted plastic bottles stored in piles at a recycling facility awaiting transfer

3.3 Chemicals

Certain chemicals may be classified as Dangerous Goods as per AS 1940 (Standards Australia, 2017) and the storage of such items presents additional risks that need to be factored into the assessment. As outlined in the Bellevue Hill fire incident in 2001, a fire originating in a chemical waste facility may result in a much more serious incident and have more severe impacts. Hence, the risk afforded by items such as chemicals stored in bulk piles need to be considered as part of the fire safety strategy for the development.

Figure 4 – Bulk storage of chemicals on site awaiting to be processed

3.4 Batteries

Batteries present a unique set of risks much like chemicals. However, due to their size are much harder to detect in general municipal waste. An article published by the BBC in 2022 (Gill and Stephens, 2022) noted that batteries were the most common cause of waste fires in the UK. It is likely a very similar case for Australia where incorrectly disposed batteries have the potential to lead to serious fires.

4.0 Applicable Waste Management Guidelines

Whilst there are numerous Australian guidelines for the fire safety in Waste Management Facilities, the most commonly referred are outlined below:

1) Fire Rescue New South Wales (FRNSW) waste management guideline (Fire and Rescue NSW, 2020).

2) The prevention of Fires in waste stockpiles Queensland Guideline (QLD Government, 2020)

3) The Environment Protection Authority Victoria guideline (EPA Victoria, 2021).

4) The Australasian Fire Authorities Council waste management guideline (Australasian Fire Authorities Council, 2022).

Whilst the waste management guidelines have been publicly available for some time now, adhering to them does not warrant a building or site can adequately address the fire hazard and minimise the consequences. There have been numerous fires originating in waste management facilities since the advent of the guidelines, highlighting that a piece of the puzzle is still missing.

It is noted that none of the aforementioned address the potential risks associated with the waste management process itself, highlighting a possible gap in the overall assessment of fire safety in a WMF.

4.1 Fire Rescue NSW Guideline

The Fire and Rescue NSW (FRNSW) guideline first drafted in 2019 was the seen as the first attempt by an Australian fire brigade to develop a set of fire safety design considerations when developing a WMF. The Guideline provides a top-down approach for when applied for new waste management facilities. These range from the type of fire services required to assist with firefighting to the size of stockpiles of combustible waste stored on site. It is noted that retrospective applications to existing facilities may not be practicable due to existing building and site constraints.

4.2 Queensland Government Guideline

The Queensland Environmental Authority developed the prevention of fires in waste stockpiles in 2020 with the aim of reducing the risk of fires at waste facilities. This introduced many of the design concepts outlined in the FRNSW Guideline to Queensland. The primary intent was to provide a guideline that may be enforced for Queensland WMF's to ensure an adequate level of fire safety is provided.

4.3 Environment Protection Authority Guideline

Following a WMF fire incident in Victoria, the Environmental Protection Authority (EPA) introduced the Environment Protection Authority Victoria guideline for waste management facilities in 2021. This introduced many of the design concepts outlined in the FRNSW Guideline to Victoria. The primary intent was to provide a guideline that may be enforced for Victorian WMF's to ensure an adequate level of fire safety is provided.

4.4 Australasian Fire Authority Council Guideline

The most recent guideline that was introduced 2022 was the Australasian Fire Authorities Council (AFAC) that captured many of the requirements of the FRNSW and Victorian guideline and placed it into a document that can be referenced by fire brigades in all Australian jurisdictions.

5.0 Overall Building Fire Safety

With reference to Figure 5, the overall fire safety strategy for a WMF is governed by a combination of the following design subsets, as discussed in further detail below:

- Dangerous Goods Compliance;
- Process Risk Assessment;
- Fire Safety Study; and
- Building Code Compliance;

Figure 5 – Design subsets that contribute to a holistic WMF fire safety strategy

5.1 Dangerous Goods Assessment

Undertaking a Dangerous Goods (DG) Assessment in accordance with AS 1940 (Standards Australia, 2017), and other relevant DG legislation / standards would be the primary step in the holistic assessment of WMFs. As noted in Section 3.3, the presence of chemicals at WMFs increases the overall hazard and potential fire intensity.

A Dangerous Goods assessment would be proposed to encapsulate the potential risks and provide a means of complying with the DG standards for onsite storage. This stage is vital as locations of the DG goods would impact on the overall fire safety and the process risk assessment in the following stage. Whilst DG's are not all combustible or flammable, due consideration still needs to be given to them and the impact they have when exposed to high temperatures experienced in fires.

Hence, careful consideration of the Dangerous Goods must be undertaken as part of the holistic approach to fire safety in WMF's to ensure that all the potential fire risks are captured.

5.2 Process Risk Assessment

This stage comprises a risk assessment of the entire process utilising the risk management framework presented in ISO 31000:2018 and Figure 6 below. Following this framework allows various hazards unique to the site to be identified and captured.

Whilst, the various waste management guidelines provide a very good starting point, this approach provides a more site-specific assessment that allows the overall fire safety strategy to be developed in a manner that better suits the site. A first principles ground up risk assessment of the site is likely to facilitate a comprehensive understanding of the potential fire hazards and likely consequences. This contrasts with the traditional top-down approach in the WMF sector where many of the emerging hazards may be missed.

Outcomes from the risk assessment directly feed into the Fire Safety Study (NSW Department of Planning, 2011) assessment in which additional mitigation measures may be specified depending on the outcomes of the assessment, as discussed further in the next section.

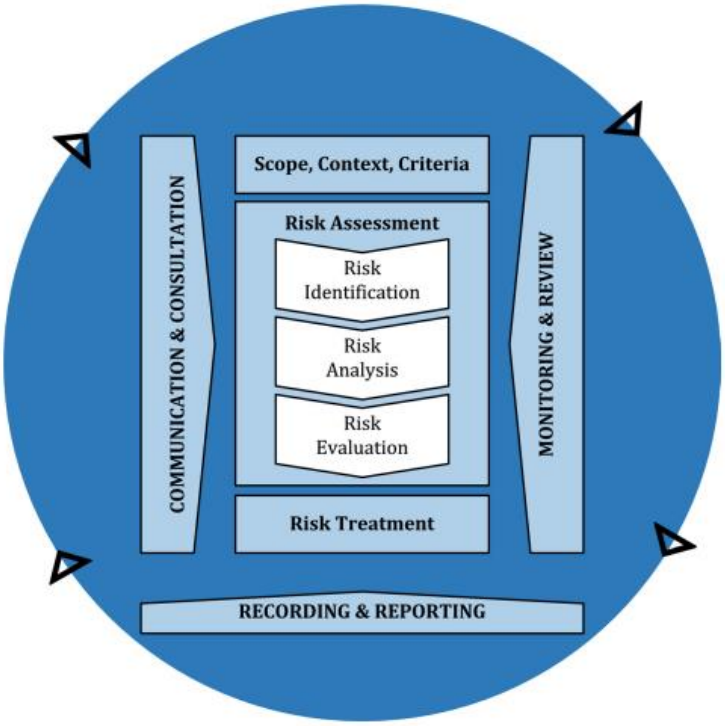

Figure 6 – Risk management process as contained in AS ISO 31000:2018 (International Organization for Standardization, 2018)

5.3 Fire Safety Study

Whilst not regulated in all states in Australia, NSW Hazardous Industry Planning Advisory Paper (HIPAP) No. 2 (NSW Department of Planning, 2011) provides the framework for assessing hazards that were flagged from the risk assessment. Figure 7 outlines the relationship between the risk assessment (hazard analysis) and the Fire Safety Study.

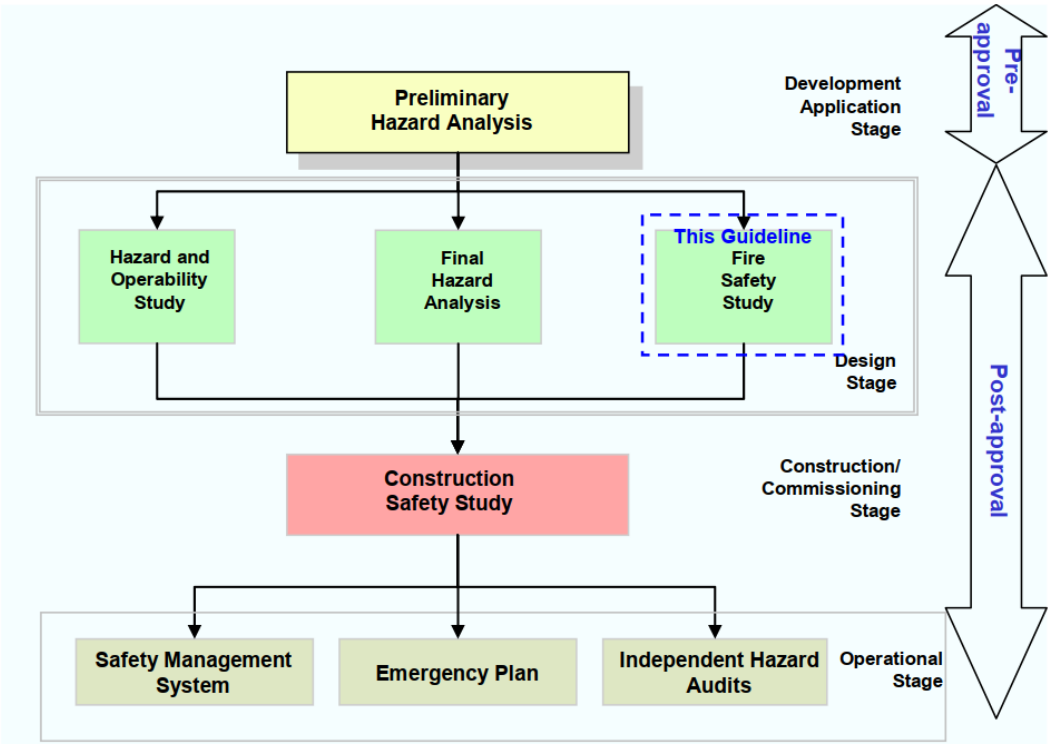

Figure 7 – Hazard assessment process as nominated in HIPAP 2 (NSW Department of Planning, 2011)

The Fire Safety Study provides tangible design outcomes to be implemented to address the likely consequences from a fire incident and bring the fire safety level in a WMF to an acceptable level.

The Fire Safety Study outcomes not only feeds into the overall WMF fire safety assessment as shown in Figure 6, but also the Building Code Compliance Assessment for BCA E1.10 and E2.3, as outlined below.

5.4 Building Code Compliance

Outside of the normal prescriptive clauses for Class 7b or 8 building use which WMFs fall under, the prescriptive BCA Deemed-to-Satisfy (DtS) Provisions do not provide any guidance on addressing the unique fire hazards in a WMF. All four (4) fire brigade guidelines discussed previously nominate that BCA Clauses E1.10 and E2.3 need to be considered for WMFs.

The Guide to the BCA provides limited background on addressing BCA E1.10 and E2.3 and is very much open to interpretation. Hence, as part of the holistic assessment, standard fire safety benchmarks will be developed utilising the Fire Brigade Guidelines to address BCA E1.10 and E2.3 in WMF's.

6.0 Holistic Site Wide Design

A holistic performance-based fire safety strategy is essential to address BCA Performance Requirements and Fire Brigade Operational Requirements for modern WMFs. The management of waste stockpiles in relation to fire hazard, fire detection efficacy and smoke hazard management are some of the key considerations for WMF fire safety design.

A 'tailor-made' site specific fire engineering approach is recommended for each WMF considering the processing/ treatment functions being undertaken, intended various operational modes and the type of waste being processed/ stored.

With the aid of case studies, this presentation will outline a framework for addressing the fire hazards associated with waste management facilities based on a holistic site wide approach. This includes a rigorous fire hazard assessment and consultative design consultation process led by the Fire Safety Engineer with relevant input by various project stakeholders including the WMF Operator, Fire Protection Designer, Building Certifier, Building Insurer, Fire Brigades and other regulatory authorities such as the Environmental Protection Agency. Techniques to specifically address fire safety in WMFs using a first-principles risk management approach based on the ISO 31000 Risk Management Framework and the Fire Safety Study methodology from the NSW HIPAP 2 (Planning NSW) Guidelines will also be covered in this presentation.

7.0 References

Australasian Fire Authorities Council, 2022. Fire safety in waste management facilities (No. 3095).
Australian Institute for Disaster Resilience, n.d. Industrial - Bellevue hazardous waste fire [WWW Document]. URL https://knowledge.aidr.org.au/resources/industrial-bellevue-hazardous-waste-fire/

Environment and Planning Committee, 2019. Inquiry into recycling and waste management (No. Interim Report). Parliament of Victoria, Victoria, Australia.

EPA Victoria, 2021. Management and storage of combustible recyclable and waste materials – guideline (No. 1667.3).

Fire and Rescue NSW, 2020. Fire Safety in Waste Facilities.

Gill, V., Stephens, K., 2022. Batteries linked to hundreds of waste fires [WWW Document]. BBC News. URL https://www.bbc.com/news/science-environment-63809620

Government of Western Australia, 2019. Structure Fire Investigation Report (Fire Investigation Report No. 460022). Department of Fire and Emergency Services, Western Australia.

International Finance Corporation, 2005. Environmental, Health, and Safety Guidelines for Waste Management Facilities.

International Organization for Standardization, 2018. ISO 31000:2018 - Risk Management Guidelines.

NSW Department of Planning, 2011. Hazardous Industry Planning Advisory Paper No. 2 (HIPAP 2) - Fire Safety Study Guidelines.

NSW Government, 2022. Remanufacture NSW [WWW Document]. URL https://www.environment.nsw.gov.au/funding-and-support/nsw-environmental-trust/grants-available/remanufacture-nsw

QLD Government, 2020. Prevention of fires in waste stockpiles.

Standards Australia, 2017. AS 1940:2017 - Storage and Handling of Flammable and Combustible Liquids.