WISH fire guidance and tests

Reducing fire risk at waste management sites

- WISH Forum
- Fires 2013 – turning point
- WISH waste guidance 2014 and 2017
- WISH waste fire tests phases I, II and II
- Future activity and revisions

Waste Industry Safety and Health Forum

What is WISH?

WISH (Waste Industry Safety and Health Forum) was formed 20 years ago:

- Cross-industry organisation (not an industry trade body organisation), and independent
- Steering group: HSE (Health and Safety Executive), ESA (Environmental Services Association), CIWM (Chartered Institution of Wastes Management), WRAP (Waste Recycling Action Programme), EU Skills (sector training body), Local Authorities, Unions + wider WISH membership
- Main areas of activity:
  - Identifying critical health and safety and related issues for waste management
  - Providing strategy and direction on issues
  - Producing industry guidance (19 formal guidance documents + other documents)
- WISH web site: https://wishforum.org.uk, all guidance etc downloads free

2013 fires – a turning point

In 2013 a series of high-profile waste site fires occurred in the UK – homes were evacuated, motorways closed etc

- The issue became political, resulting in pressure for action and guidance
- WISH was tasked with producing guidance
- First step was a global literature search by HSL (Health and Safety Laboratories) for available research and guidance on waste fires – some, but nothing structured or comprehensive
- WISH waste fires working group set-up to progress guidance and research, consisting WISH members, plus NFCC (National Fire Chiefs Council), environmental regulators and Public Health England
- Involvement of main insurer risk engineers in some aspects, such as on fixed fire systems

WISH fire guidance

The original WISH waste fires guidance (*WISH28 reducing fire risk at waste management sites*) was released in October 2014, and then revised and reissued in April 2017:

- Revised version required because of the results of the WISH waste fire tests phases I and II (of which more later), developments since 2014 and a need for more guidance for waste operators on fixed fire systems
- Current 2017 version is 166 pages long, split into the main body of guidance and a series of appendices
- Likely the most comprehensive guidance available on waste management fires
- Formally supported by various organisations, including the National Fire Chiefs Council, Environmental Services Association and the Chartered Institution of Wastes Management

WISH Waste Industry Safety and Health Forum

REDUCING FIRE RISK AT WASTE MANAGEMENT SITES

This guidance is good practice guidance. Parts of it may go further than is needed to achieve legal and regulatory compliance. Waste management operators must first comply with applicable law and regulation, regulatory standards, and the requirements of their permits, licences and similar permissions.

This is the second edition of the WISH 'Reducing Fire Risk at Waste Management Sites' guidance, the first edition having been released in October 2014. As for its predecessor, this revised guidance is aimed at providing waste management operators with the advice and information required to:

- Reduce the likelihood and frequency of fires at solid waste management sites
- Where fires do occur, reduce the potential safety, health, environmental, property damage and business interruption impacts

Production of this guidance was facilitated via the WISH Waste Fires Working Group. Representation on the working group included the following organisations:

- CIWM (Chartered Institution of Wastes Management)
- CFOA's (Chief Fire Officers Association) National Fire Chiefs Council (NFCC)
- ESA (Environmental Services Association)
- EA (Environment Agency)
- HSE (Health and Safety Executive)
- PHE (Public Health England)
- WRA (Wood Recyclers Association)
- TRA (Tyre Recovery Association)

Other organisations were also consulted on specific aspects, such as some of the main insurers involved in waste management on fire engineering issues, and other bodies were corresponding participants.

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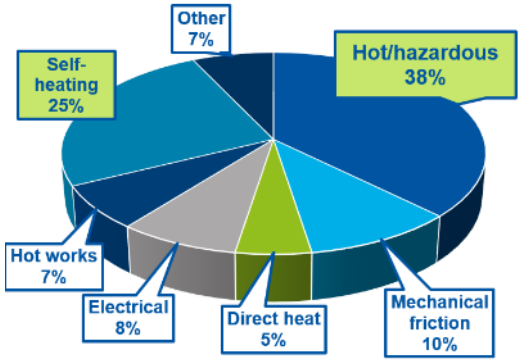
WISH fire guidance

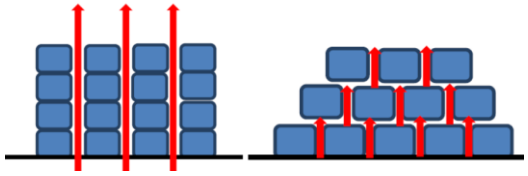
Main body of guidance:

1. Introduction and scope
2. Whole site considerations: Causes of waste fires, hot works, housekeeping, mobile plant etc
3. Waste reception: Hot and hazardous items in wastes, reception management etc
4. Waste treatment and processing: Electrical faults, risks by type of machinery/item (shredders, balers, conveyors, picking cabins, de-dusting systems etc)
5. Waste storage general: Storage capacities and times, self-heating, use of bunkers etc
6. External waste storage: Vandalism, arson etc
7. Internal waste storage: Use of bunkers in internal storage, application of separation distances etc

Focus on fire prevention and management, not on life-safety (plenty of guidance already available)



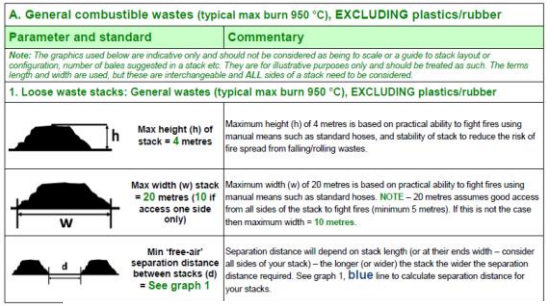
Type of FRS appliance	Min width of road (metres)	Min width of gateway (metres)	Min clearance height (metres)	Min weight restriction (tonnes)
Water tender	3.7	3.2	3.7	12.5
High reach vehicle	3.7	3.2	4.0	24
Weight of vehicles may need to be confirmed with your local FRS as various types of vehicle are in use				



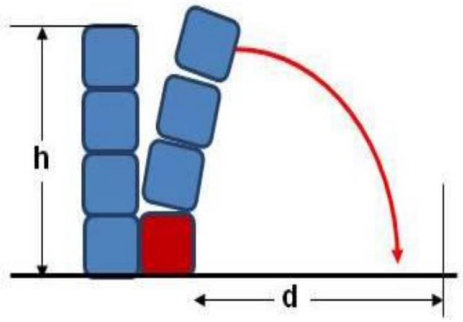
WISH fire guidance

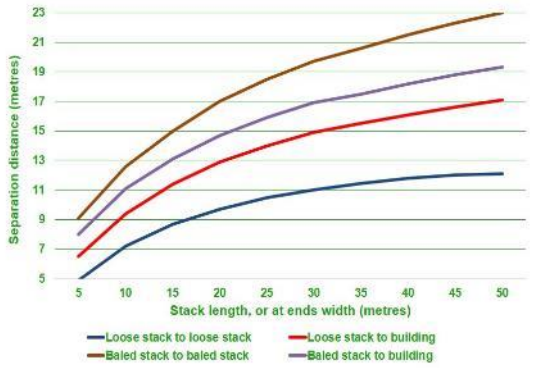
Appendices

1. External storage of wastes: Fire spread mechanisms in waste storage stacks, free-air separation distances to prevent fire spread, storage stack dimensions, site layout etc
2. Emergency planning: Guidance on producing emergency plans and their contents, liaison with the emergency services etc
3. Checklists: For use by waste site operators to check their fire management provision
4. Fire/risk engineering and waste management plants: Design issues, detection, alarm and fire suppression systems, fixed system options for waste plants, water supplies and demand, what works for waste management and what not
5. Links and further reading
6. Glossary



A. General combustible wastes (typical max burn 950 °C), EXCLUDING plastics/rubber	
Parameter and standard	**Commentary**
Note: The graphics used below are indicative only and should not be considered as being to scale or a guide to stack layout or configuration, number of bales suggested in a stack etc. They are for illustrative purposes only and should be treated as such. The terms length and width are used, but these are interchangeable and ALL sides of a stack need to be considered.	
1. Loose waste stacks: General wastes (typical max burn 950 °C), EXCLUDING plastics/rubber	
h — Max height (h) of stack = 4 metres	Maximum height (h) of 4 metres is based on practical ability to fight fires using manual means such as standard hoses, and stability of stack to reduce the risk of fire spread from falling/rolling wastes.
w — Max width (w) stack = 20 metres (10 if access one side only)	Maximum width (w) of 20 metres is based on practical ability to fight fires using manual means such as standard hoses. NOTE – 20 metres assumes good access from all sides of the stack to fight fires (minimum 5 metres). If this is not the case then maximum width = 10 metres.
d — Min 'free-air' separation distance between stacks (d) = See graph 1	Separation distance will depend on stack length (or at their ends width – consider all sides of your stack) – the longer (or wider) the stack the wider the separation distance required. See graph 1, blue line to calculate separation distance for your stacks.





WISH waste burn tests

One of the main gaps in knowledge identified in 2013 was a lack of good fire science and testing on real wastes. This gap was filled (at least partially) 2015 - 2017 by a series of waste burn tests:

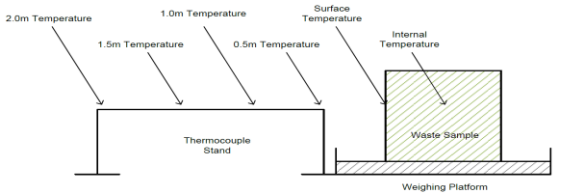
- Phase I: Smaller scale tests conducted at the Fire Prevention Association's research premises
- Phase II: Larger scale 'mass burn' tests at Pollington in Yorkshire and Barling in Essex
- Phase III: Fire-fighting and confirmatory tests at the National Fire Training College
- Most extensive series of burn tests on wastes ever conducted, globally
- Total cost of the tests exceeded £180,000 (funded by NFCC and industry)
- Provided a mass of data, some of which is still being analysed in detail

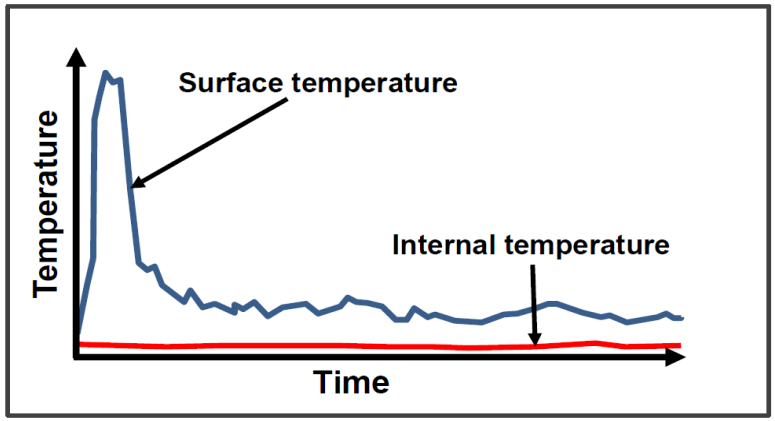
A non-technical summary of these tests is available free of charge from WISH

WISH waste burn tests

Phase I tests:

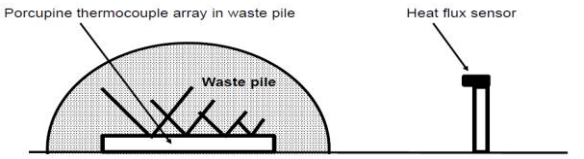
- Smaller scale: Sample size 42 kg – 1350 kg
- Nine different types and configurations of waste tested, loose and baled wastes
- Heat outputs over time measured, plus mass loss and CO emissions
- Thermocouples inserted in samples for internal temperature measurement
- In general, results were as expected, but did not reflect fire services or industry experience regards how real waste fires burnt





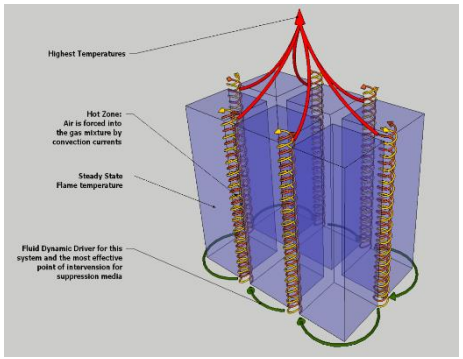
Most wastes ‘charred-over’ quickly restricting the fire and steady state burn temperature

WISH waste burn tests



Phase II tests:

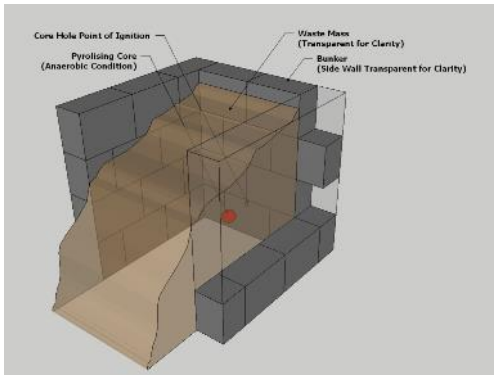
- Larger scale: Sample size up to 30 tonnes
- 13 different types and configurations of waste tested, loose and baled wastes
- Temperature outputs measured, and for loose waste stacks ‘porcupine’ of thermocouples used to measure internal temperature
- Results aligned much more with fire service and industry experience of waste fires
- For loose waste stacks, two distinct fire mechanisms were revealed: Inside-out burns and outside-in burns
- For baled wastes the chimney effects between bales were significant – not seen in the smaller scale tests as only single bales burnt
- Burn temperatures were in some cases much higher than expected



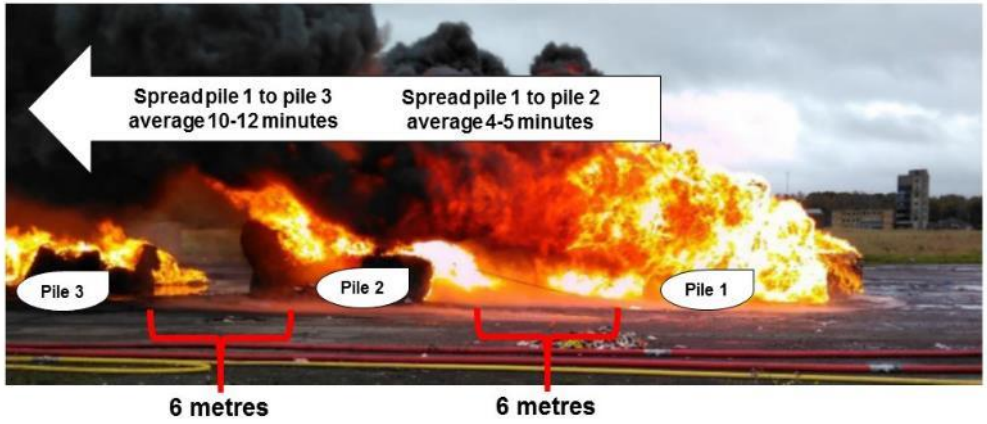
WISH waste burn tests

Phase III tests:

- Principle aim to test different fire-fighting techniques and media (CAFs, water and water plus wetting agent) on waste fires
- Loose wastes in bunkers and open stacks of baled wastes used (plastics as worst case)
- Also used to confirm results from phases I and II relating to free-air separation distances, and effectiveness of interlocking block bunker walls
- Results will be used to inform fire brigade training and national operational guidance



Photograph of actual tests. Note, bale stacks in partial collapse and extensive flames result in pre-burn distances not being clear in photograph. This test repeated four times to ensure consistency.



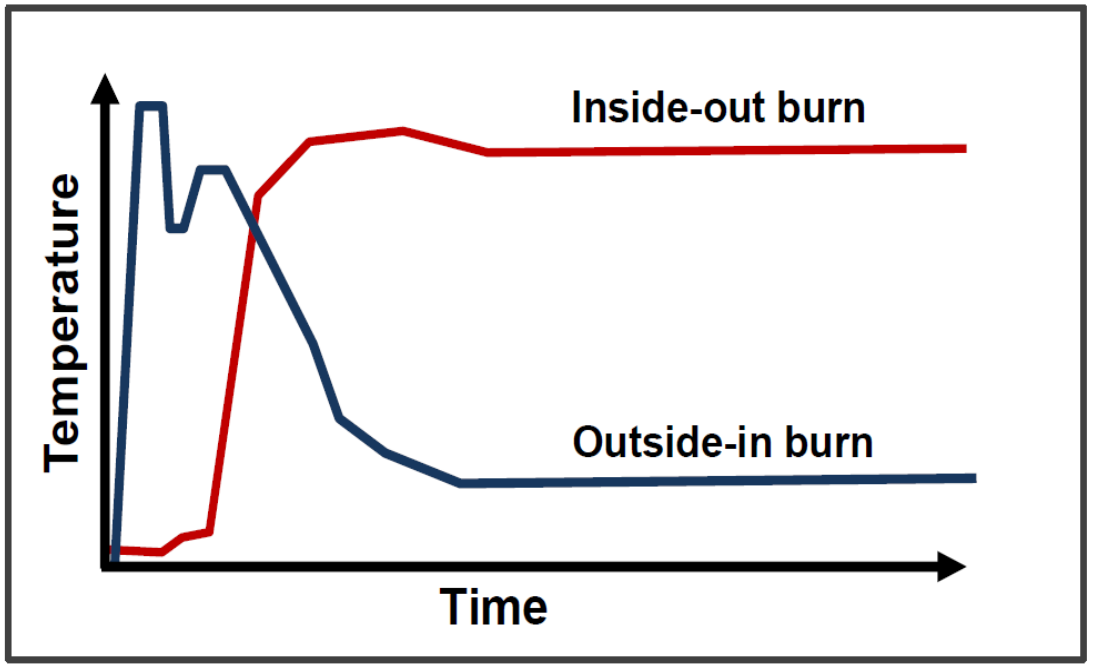
The phase III tests confirmed that free-air separation distances to prevent fire spread between stacks and stacks and buildings are much wider than previously thought

WISH fire tests
Example results

For loose waste stacks, two distinct fire mechanisms were revealed:

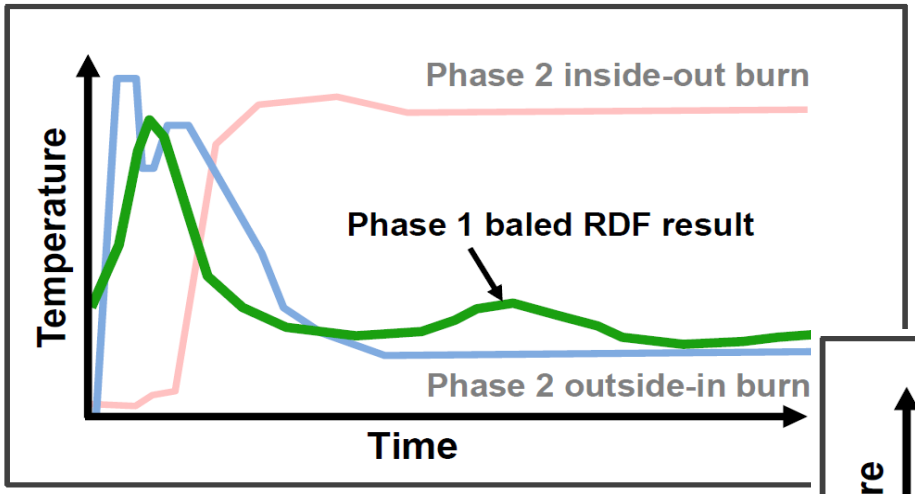
- Outside-in burns where the fire starts on the outside of a stack, such as from arson, hot mobile plant exhausts etc
- Inside-out burns where the fire starts within the waste stack, such as from self-heating or a discarded lithium battery

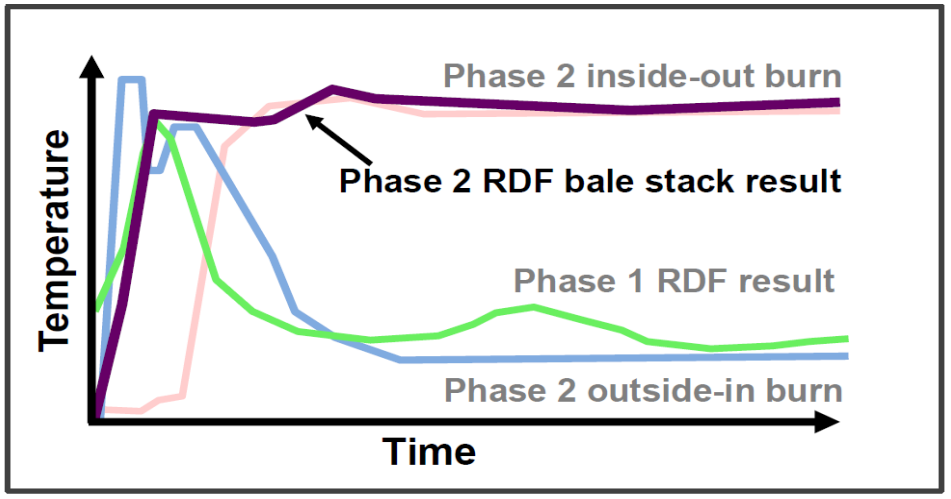
For outside-in burns temperature rises, but then reduces as the surface of the stack 'chars' producing a layer which restricts the fire from finding more fuel. For inside-out fires, the fire takes longer to develop, but when it does temperatures rise and stay high



WISH fire guidance
Example results

For baled waste stacks outside-in burns are the most common by far (too dense for inside-out burns), but when bales are stacked together the chimney effects between bales were significant:



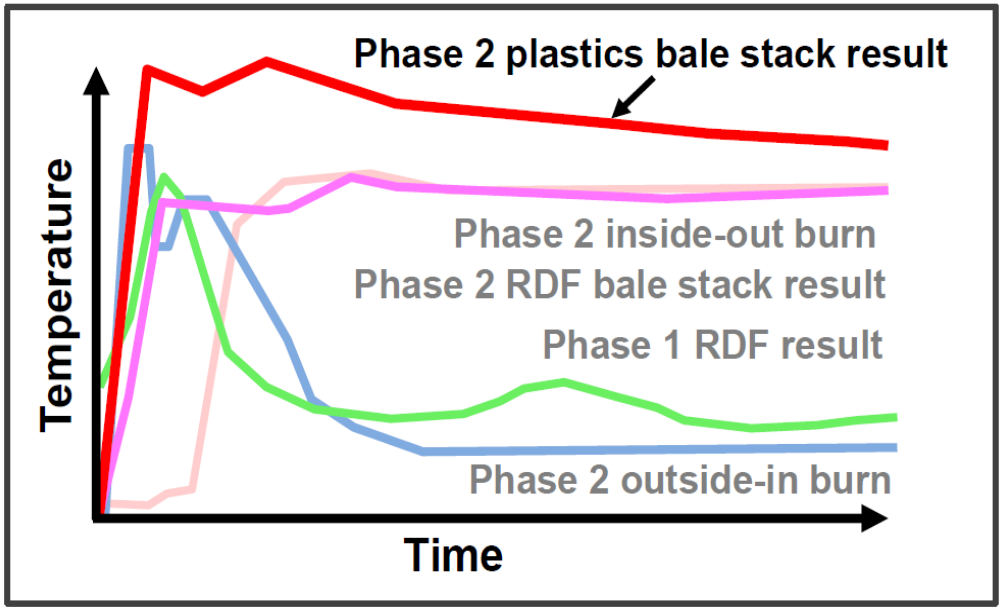


WISH fire guidance
Example results

The type of waste also had an effect, perhaps not surprisingly:

Waste type	Surface temperature (typical maximum)
Pre-crush wood waste (un-screened)	840^{0}C
Raw wood waste	850^{0}C
Paper/ card baled	850^{0}c
Pre-crush wood waste (screened)	860^{0}C
Refuse derived fuel (RDF) loose	900^{0}C
Refuse derived fuel (RDF) baled	900^{0}C
Solid recovered fuel (SRF) loose	950^{0}C
Solid recovered fuel (SRF) baled	950^{0}C
Shredded rubber	1,127^{0}C
Plastic HD baled	1,200^{0}C
Plastic LD baled	1,200^{0}C

In practical terms, wastes can roughly be split into two categories: Plastics/rubbers with burn temperatures of 1200 degrees (or more), and 'the rest' with lower burn temperatures (850 – 950 degrees)



WISH fire guidance
Example results

The phase III tests showed marked differences between different types of fire-fighting media (tests on baled plastic waste stacks):

Media	Detail	Volume water used	Time to extinguish
Water	2 x 45 mm jets at 7 bar	20,000 litres	20 minutes (not extinguished)
Foam (CAFs)	Class A wet solution CAF, 2 x 128 litre/minute jets	1,800 litres	7 minutes
Water + wetting agent	2 x 45 mm jets at 7 bar, with wetting agent at 0.3% by volume	1,800 litres	2 minutes

But, also that interlocking block walls are generally effective at restricting fire spread, within limits such as flame height

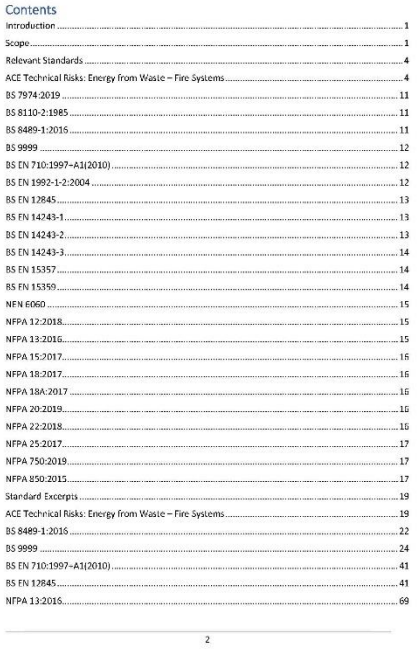
Material in bay	Duration	Max temperature	Comments
RDF (refuse derived fuel)	50 hours	400 – 500 °C	Slight heating through block, but still able to hold bare hand on the outside edge of blocks. Some flame penetration through gaps in blocks down wind of the fire
Loose plastic wastes	2 hours	1,100 °C	Slight heating through block, but still able to hold bare hand on the outside edge of blocks
Pre-crush wood	20 hours	950 °C	Post fire spalling of the inner face of block but remained stable

WISH fire guidance and tests
Available documents and the future

- The full results of the WISH waste fire tests will be published as a research paper, but is awaiting academic peer review (likely publication 2019)
- A non-technical summary of the tests was produced after phase II, and has recently been revised to include a summary of phase III (publication November 2018)
- Further testing is planned, and is being scoped
- The implications of the waste fire tests are still being considered. For example, it seems likely that some/many fixed fire systems at waste management plants may be under-specified
- This will be a developing and changing field, but at least a start has been made and our understanding of waste fires is far advanced than it was a few years ago

WISH fire guidance and tests
Available documents and the future

- The current 2017 WISH waste fires guidance will be revised to take account of the phase III tests (likely publication date Late 2019-early 2020)
- The guidance has now been translated into 3 languages and is used as a regulatory reference standard across three continents
- The next version of the WISH waste fires guidance will include a appendix listing all of the fire standards relevant to waste sector fire prevention, with the relevant sections extracted and included.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Questions

The WISH waste fires guidance 2017, and a non-technical summary of the waste burn tests, is available on the WISH web site:

https://wishforum.org.uk

Waste Industry Safety and Health Forum