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## Examination of the Practice for Protection against Landfill Fires

*The scientific examination of residential waste management has become an increasingly important scientific problem nowadays. Waste disposal and incineration are the most important elements of the modern waste management system. The handling, disposal and burning of residential wastes have significant fire safety risks. In this article, the authors examine the fire protection characteristics of landfills, the legal background of their operation, the causes and circumstances of the individual fires that have occurred, the measures to increase the efficiency, as well as the technical and technological possibilities of fire safety operations.*

*Keywords: waste, waste management, landfill, fires, fire prevention, safety*

### Introduction

Waste management as a global environmental problem is a consequence of humanity's survival process.<sup>5</sup> It can be said as a general rule that in nature waste does not exist. It is also well known that matter is not lost, only transformed.<sup>6</sup> Waste is material that is formed in the built environment by the economic activity of society, which can no longer be used at the place of origin.<sup>7</sup> An example for the advantage of waste generation is that many archaeological findings have become important historical values thanks to the preservation of "waste".

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<sup>5</sup> WILSON–VELIS 2015: 1049–1051.

<sup>6</sup> DARVAY et al. 2016: 88–104.

<sup>7</sup> SOLYMOSI 2016: 171.

The composition and quantity of modern waste is significantly different from what was customary in earlier centuries. Waste generation and related treatment methods – as a result of human production that became more intense – became a social issue after the industrial revolution and then became a global environmental problem after the boom in machine manufacturing and the plastics industry.<sup>8</sup>

Currently, it is necessary to move in the direction of zero waste from the point of view of the disposable world.<sup>9</sup> However, as a result of the currently experienced population growth, the related dynamic urbanisation process, and changes in consumer social habits, society and modern civilisation can no longer coordinate the increasing waste production at the place of origin.<sup>10</sup> Therefore, there is a need for solutions such as the application of waste-free or low-waste technologies, the separate collection, utilisation, recycling of the generated waste, the disposal of waste not used as secondary raw materials, the temporary storage, disposal of non-reusable waste.

Among the domestic legislation Act. CLXXXV of 2012 on waste management (Act on Waste Management) is the primary applicable legislation source in Hungary. The Act on Waste Management defines that during the prevention activities of waste generation and waste management, the following activities must be applied in order of priority:

- prevention of waste generation
- preparation of waste for recycling
- waste recycling
- utilisation of waste in other ways, especially energetic utilisation, as well as disposal of waste at waste landfill sites

In this article, the aim of the authors is to assess the legal regulation and law enforcement practice of waste disposal activities in accordance with fire protection. In the course of this evaluation process, in addition to the analysis of the effective international and domestic legal regulatory environment and the technical guidance materials we will analyse the causes and circumstances of the occurrence of major fires, the measures to increase the efficiency of fire safety operations, and technical and technological possibilities for intervention procedures and methods.

## The role of landfills in waste management

Based on the examination of the so-called waste hierarchy,<sup>11</sup> it can be concluded that final landfill disposal of waste as a waste management procedure is used to a significant extent in Hungary. Based on data received upon our request from the Ministry of Energy, the rates of waste processing procedures in our country at the end of the year 2021 were as follows:

<sup>8</sup> FARAGÓ 2013: 43–76; SUPKA 2020.

<sup>9</sup> Directive (EU) 2018/849 of the European Parliament and of the Council.

<sup>10</sup> UNEP 2015.

<sup>11</sup> Directive 2008/98/EC of the European Parliament and of the Council; National Waste Management Plan (2021–2027).

- proportion of waste used in its own material: 36.6%
- proportion of energetically utilised waste: 12.4%
- proportion of landfilled waste: 51%

Waste disposal (landfilling, incineration without energy recovery, illegal dumping) is a common and relatively cheap solution for waste management.<sup>12</sup> When choosing waste management methods, it is important to apply the higher levels of the elements of the waste hierarchy. In addition, a technical solution suitable for the given conditions must be selected as well. The last procedure – and at the same time the least favourable way according to the hierarchy – is the dumping of waste.

The elements of the regulations related to landfills – based on European Union legislation – are the followings:

- Act CLXXXV of 2012 on Waste
- Decree 20/2006 (IV.5.) of the Ministry of Environment and Water on certain rules and conditions relating to the landfill of waste and the landfilling of waste

Additional useful legal and technical information can be obtained from the National Waste Management Plan prepared by the Environment Authority.

In line with the relevant regulation, landfills can be categorised in the following ways:

- Category A – inert waste landfills
- Subcategory B1b and B3 non-hazardous waste landfill sites
- Category C hazardous waste landfill sites<sup>13</sup>

Waste disposal methods include landfilling, thermal disposal and chemical, biological or physical processes. Waste disposal can be done by cumulate waste in a prismatic, frontal, circular system, or by mound construction accumulation. In relation to the latter treatment method, we can state that it requires a large area, increases the load and pollution of environmental elements and cannot provide a solution to the global waste problems of the society. Landfilling waste is actually a "superficial" treatment, as it does not reduce the growing amount of waste, nor does it have the motivating force to reduce waste in an institutional, legal, administrative or technical sense.

Hungary has not increased its waste incineration capacity in recent years. However, the modernisation process of the existing facilities is currently underway, with the aim of creating closed material cycles by increasing reuse and recycling, as well as reducing the amount of waste to be disposed of.

Waste should be considered a material flow in the cycle, which is part of the green transition processes according to the National Energy and Climate Plan, and a determining part of reducing greenhouse gas emissions strategies. This is also an environmental protection objective of the European Union, within the framework of which Hungary has made significant voluntary commitments.

<sup>12</sup> Act CLXXXV of 2012 on Waste.

<sup>13</sup> Decree 20/2006 (IV.5.) of the Ministry of Environment and Water on certain rules and conditions relating to the landfill of waste and the landfilling of waste.

Overall, the trend is towards reducing the role of landfills, and in the waste hierarchy, zero waste and waste generation at the point of origin come to the fore. Based on the current social processes, the secondary objective of waste management is the reintroduction of waste into production as a resource of civilisation activities.<sup>14</sup> It can be concluded that the operation of landfills has no return benefit, regardless of this, even today, the importance of landfills is still considered decisive. Among the types of waste accumulated in landfills, we can find many combustible materials, which pose a significant fire safety risk and have the potential to pollute the surrounding environment.

The analysis and evaluation of waste disposal activities from the point of view of fire protection and environmental safety aspects is the main objective of this article, the results of which will be presented in the following section.

## Evaluation of legal regulations concerning the fire protection of landfills

Directive 1999/31/EC of the Council of the European Union on landfills<sup>15</sup> specified in its Annex I some fire protection requirements concerning the installation and operation of landfill facilities. Among the general measure requirements, the directive lists a fire incident among the events with a disturbing effect or danger to the landfill facility. Regrettably, it can be stated that the European Union regulations dealing with the safety situations of landfills leave some room for improvement as the regulation only defines the main standards of waste disposal and acceptance. However, disaster prevention or fire prevention aspects are not examined in this legislation. In addition, the cited legislation in its Article 5 paragraph (3) b) point classifies flammable and explosive substances as waste that cannot be accepted in landfills. However, it does not make recommendations or technical prescription regarding the implementation of this legislation. It also does not have recommendations for filtering out flammable or explosive substances from waste. Unfortunately, this burden ultimately falls only on the operator's discretion. As a result, the operator determines internal norms within his own competence, which can be supplemented with the professional recommendations of the fire prevention authority or the specialised fire protection service organisation. Of course, this significantly can reduce the security level of the facility.

It can be concluded that no process or technology is currently available to filter out flammable substances entering the territory of the landfill's site. Perhaps the only option is to draw the public's attention on the public awareness to collect waste selectively. In the capital city of Budapest, for example – within the framework of the annual garbage collection program – the collection of small-sized hazardous waste, such as paints and thinners, takes place at a separate collection point from municipal waste. In this way, the Capital City Public Area Maintenance Office, which organises

<sup>14</sup> BEREK et al. 2021: 87–96.

<sup>15</sup> European Council Directive 1999/31/EC (26 April 1999) on landfills.

the garbage collection, strives to improve the level of recycling and to reduce the possibility of fires and work accidents during the collection process.

We can also cite a precedent for an accident related to flammable substances mixed with waste. In November 1996, a spark and then an explosion occurred in the cargo hold of a garbage truck in Rákospalota Budapest presumably from the mixing and shaking of the paint solvents and metal shavings. The explosion opened the rear wall of the garbage truck and the waste stored there caught fire. Fortunately, there were no personal injuries.<sup>16</sup>

It is also worth mentioning that the previously mentioned European Union regulation also prohibits the dumping of used transport vehicle tires. According to the main rule, it is not possible to deposit these materials in the landfill site. Filtering out tires is no longer an easy task, as residential waste collection machines do not transport them either. However, practical experience shows that tires still appear in several landfills, therefore, during their burning a significant amount of toxic combustion products are produced that can endanger the surrounding environment and the population.



*Picture 1: Consequences of a large amount of accumulated car tire fire*

*Source: Facebook page of the Zalahaláp Volunteer Fire Department.*

In Hungary, the general regulation of waste management is contained in the Act on Waste Management. In addition, Decree 20/2006 (IV.5.) defines the exact rules for the establishment and operation of landfill facilities. The two mentioned legislations do not discuss the safety aspects of the facilities in a separate provisions. The establishment criteria for the fire protection of landfills are stipulated only by the National

<sup>16</sup> Hajdú-Bihari Napló 1996.

Fire Protection Regulations (NFPR) introduced by the decree of the Ministry of the Interior (hereafter: NFPR)<sup>17</sup> in its point 6 of paragraph 72. According to the regulations "the outdoor storage area of the municipal waste dump must be provided with an intensity of 1,800 litres/minute of extinguishing water for one and a half hours".

Practical experience shows that the nearest fire hydrant is usually at a significant distance of 1 to 3 kilometres from the facilities. It is therefore only possible to provide extinguishing water from specially installed axillary fire protection reservoirs.<sup>18</sup> According to domestic regulations, the requirement is to keep a minimum of 162 cubic meters of extinguishing water ready per facility. Pursuant to paragraph 274 of the NFPR, reservoirs must be reviewed on an annual basis. In addition, a pressure test is also performed every five years during the fully implemented review. Typically, the response forces of the regionally competent professional firefighting organisation take part in the pressure test.

It is worth noting that professional fire departments carry out relatively few local preparation visits or practical exercises in the area of landfill sites. However, it would be advisable to increase the number of visits, as the terrain conditions in the area of the landfills change frequently. There may be other variable factors including changes in ground conditions, access roads, also the quantity and location of other stored flammable substances, as well as the number and operational readiness of the operator's machines that can be involved in extinguishing activities.

The legislation in force has relatively few practical prevention regulations regarding the fire safety landfill sites. In case of most facilities, the fire protection policy is drawn up by the plant's owner or commissioned employee with fire protection qualification. However, these fire safety regulations mostly only provide guidance on the placement of fire extinguishers and their readiness to usage. In our opinion, the development of a general sample fire protection policy can be one of the solutions that the landfill operator can adapt to the conditions of the local facility. In accordance with our practical experience, operators often give general verbal instructions to their workers. Among them we can also find prevention and practical firefighting advice.

Operators may also have protective devices that are not specifically required by law to be kept in readiness. As an example of this, some operators utilise the so-called mobile, i.e. fire extinguishers with a large charge mass.

## Evaluation of fire-hazardous activities of landfills

### *Risks posed by landfilled waste materials*

We can determine from the heterogeneous composition of the deposited waste that many substances are capable of causing fire or other accident hazards stored in the landfill areas.

<sup>17</sup> Decree 54/2014 (XII.5.) of the Ministry of the Interior on the National Fire Protection Regulations.

<sup>18</sup> ÉRCES-VASS 2019: 131–161.

Fires that occur in landfill facilities can be divided into two large groups according to their cause of occurrence. There are fires caused by human activity or natural decomposition of waste materials. Human activities include primarily the use of open flames, typically smoking. This also includes the ignition of combustible substances due to the hot surface of work machines in case of relatively hot weather conditions. Similar cases can lead to “flying fires” and then fires involving large territories.

Another large group is fires resulting from the decomposition of deposited materials. A significant part of the waste that ends up in landfills comes from biodegradable, typically household waste. Biologically degradable wastes significantly form flammable methane gas during the decomposition process. Methane trapped in waste can easily ignite from a spark or other heat source. The gases produced during decomposition are called landfill gas. Of course, methane can also be used in energetic solutions. We can understand that within the disposal body, different layers are formed from the deposited waste. The individual layers are mostly covered with geotextiles and then covered with earth, which minimises the amount of landfill gas reaching the surface level. Before covering with geotextiles and earth, drain pipes are installed horizontally to pump out the landfill gases. In some cases, the less efficient vertical piping is also used instead of horizontal piping. In this case, the pipelines pass through the waste layers, as a result of which regional extraction can be less effective. Vertical piping is typically recommended for landfills with small areas, as well as for disposal below the ground level.

### *Fire hazard of waste selected for recycling*

On the basis of official data from 2021, the Hungarian population produced nearly four million tons of waste. As we have already mentioned, about 51% of that amount was landfilled in storage facilities. Based on the so-called circular economy aspirations of the European Union, it intends to bring the rate of landfilling below 10% by the year 2035. In accordance with the data collected between 2017 and 2021, it can be seen that the landfill rate in Hungary is stagnating based on the data requested from the Ministry of Energy. The trend can therefore be clearly perceived that the operation of landfills will remain a particularly important task for decades to come.<sup>19</sup>

The majority of landfill sites operate manual sorters, where the waste is grouped according to its material. In this way, paper, glass, metal and plastic waste are sorted separately. Plastic waste is compacted and baled on site of the territory of the landfill facility. At the end of the process, the waste becomes a saleable commodity ready for recycling. However, the landfill operator cannot sell the goods until he receives permission from the authority to do so. In some cases, it can take weeks or months to grant permission. As a result, the amount of baled waste increases continuously, often until the end of the plant's storage capacity. All these can increase the risk of the occurrence of fire and the severity of the possible consequences to the environment.

<sup>19</sup> KIROVNE RÁ CZ 2021: 21–36.

The following photo clearly shows the significant amount of bales of plastic waste accumulated in the area of one of the landfill sites in Hungary.



*Picture 2: Baled plastic waste is considered a significant source of danger*

*Source: Google Maps. Edited by Benjámín Hózer.*

Similar waste accumulation activity significantly increases the risk of fire, as well as the speed of fire spread between bales in the event of a fire situation.

Recently, a fire broke out on the territory of a waste disposal and processing company, which took three days to completely extinguish. The fire affected a nearly 5,000 square metres territory. Units from several local fire departments were sent to the scene of the major fire. After requesting data from the local waterworks, we found out that the responders used a significant amount of nearly 1,500 cubic metres of firewater during the three days of response work. In the area, as mentioned in the previous example, a large amount of sorted, baled waste ready for transportation was accumulated. The facility is located in a natural wind tunnel, so the fire spread quickly. The waste was surrounded by concrete retaining walls, so the fire did not significantly spread to the protective forest lane just beyond the fence.<sup>20</sup> The intensity of the heat effect is well characterised by the fact that the protective wall made of concrete elements was significantly damaged.

<sup>20</sup> Decree 20/2006 (IV.5.) of the Ministry of Environment and Water on certain rules and conditions relating to the landfill of waste and the landfilling of waste; Attachment 1, point 3.2.

### *Hazards of biowaste and compost processing*

In addition to the problem of baled waste, damage often occurs from the treatment of biowaste. Biowaste is typically composted in the landfill area. Biowaste is usually brought to the plant in bags. To produce compost, the raw material gets removed from the bags, it gets grinded and then the bio-stabilisation process begins. The resulting mixture is sorted into so-called "prisms", after which the mixture is composted for several weeks. During the process, biochemical decomposition starts, which is accompanied by the intense heat development of decomposition bacteria. Despite regular rotation, self-ignition can often occur.



*Picture 3: Compost caught fire in the landfill area*

*Source: Picture made by Benjámín Hózer.*

The fire hazard potential of stored compost can be easily minimised in case of regular technological procedures. The deposited compost can be stored almost indefinitely by covering it with a layer of earth. There is no legal obstacle to the latter.<sup>21</sup> In addition, biochemical decomposition stops at the end of composting, so further gas production and heat generation are significantly reduced.

<sup>21</sup> CIMER-VARGA 2015: 209–218.

## Conclusion

In the Hungarian waste management system, the general goal – in addition to increasing the amount of recycled waste – is to reduce the amount of landfilled waste. The main reason for this is the transition to a circular economic model and the fulfilment of the European Union's related obligations. Landfill sites remain of a great importance. Depending on the types of waste treated, landfill facilities can have a significant fire safety risk.

Although fires at landfill sites occur frequently worldwide, there are still no commonly used prevention and firefighting protocols at the international or domestic level. As a result, most operators and intervening organisations follow the procedures applied within their own jurisdiction. Most of the operating rules applied in landfills are considered sufficient; however, unexpected fires do occur in large numbers, concerning which the necessary fire prevention and mitigation measures must be introduced widely.

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