VÉDELEM TUDOMÁNY
KATASZTRÓFAVÉDELMI ONLINE TUDOMÁNYOS FOLYÓIRAT

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FIREFIGHTING IN CASE OF FLASHOVER EVENTS

Abstract

In an event related to the flashover phenomenon. Even though fire safety regulations are becoming stricter constantly (heat and smoke venting, built-in smoke detectors and extinguishing equipment, etc.), modern construction and building engineering processes (e.g. perfectly closing plastic doors and windows) as well as wood furniture treated with plastic based chemicals are favorable for extreme fire spreading. In fact, in today's buildings flashover spreads eight times faster than 50 years ago. According to the studies by the American Underwriter Laboratories (UL), while 50 years ago on average it took 29 minutes to reach the condition of complete flashover, today it takes less than 5 minutes.

Keywords: fire departmens, firefighter, flashover, backdraft, rapid fire progress, rfp

TŰZOLTÓI BEAVATKOZÁS FLASHOVER JELENSÉGGEL ÖSSZEFÜGGŐ ESEMÉNYEKBEN

Absztakt

A tűzoltókat sújtó halálesetek között kiemelt helyen találjuk a flashover miatt bekövetkezett halálesetek. 2003 és 2012 között 63 tűzoltó halt meg flashover jelenséggel összefüggő eseményben. A tűzvédelmi előírások folyamatosan szigorodnak (hő és füst elvezetés, beépített tűzjelző és oltóberendezések stb.) ugyan, de modern építési, épületgépészeti eljárások (pl. tökéletesebben záró műanyag nyílászárók) valamint a műanyag alapú és vegyszerekkel kezelt fa bútorok kedveznek az extrém tűzterjedéseknek. Tény, hogy a mai épületekben a flashover nyolcszor gyorsabban terjed, mint 50 évvel ezelőtt. Az amerikai

Underwriter Laboratories (UL) tanulmányai szerint, míg 50 évvel ezelőtt átlagosan 29 perc kellet a teljes lángba borulás állapotának eléréséig, addig ma kevesebb, mint 5.

Kulcsszavak: tűzoltóságok, tűzoltó, teljes lángbaborulás, szúróláng, hirtelen tűzterjedés

1. THE DEFINITION OF FLASHOVER

It is the phase of fire development, when all objects and surfaces in a room are heated to their auto-ignition temperature and the flame erupts from them almost simultaneously.

According to another definition, flashover is the ignition of flammable materials as a result of heat radiation or heat flow or both, when objects in a room are heated to their auto-ignition temperature and their almost simultaneous ignition occurs.

During fire development, the close-to-ceiling gas layer's temperature approaches 900 ° F (c.a. 480 °C), thus increasing the intensity of heat radiation to the flammable materials in the room. The surface temperature of the flammable materials rises, pyrolysis gases are created and heat up to their ignition point. When the temperature of the upper layer reaches 1,100 ° F (c.a. 590 °C) then the pyrolysis gases of the flammable materials ignite together with the bottom of the close-to-ceiling gas layer. This is the phenomenon known as flashover [1].

2. THE TYPES OF RAPID FIRE PROGRESS

Hot rich flashover

In Hungarian literature hot rich flashover is the classic type flashover.

It means the rapid ignition of smoke and combustion gases in a room. After the top part of the room fills with heat, it radiates downwards onto every flammable material of the room, as a result of which they reach their ignition temperatures almost simultaneously. After this flames erupt, and the entire room is filled with flames. So the detection is very important before firefighting [2] [3].

Rich flashover

In Hungarian literature it is known as backdraft. Backdraft is the explosive or rapid burning of combustion gases, which develops when oxygen enters an under-ventilated room [4] [5]. In the latter phase of the fire with the high temperature the room becomes oxygen-poor. The fresh air entering at this time (oxygen) suddenly mixes with the combustion gases and ignites explosively [6].

Delayed flashover

Delayed flashover happens when colder smoke ignites after congregating outside of its room of origin. This phenomenon often occurs very violently and explosively, thus it is also known as smoke explosion.

Lean flashover

In Hungarian literature it is known as rollover. The rollover often precedes complete flashover. The ceiling flames seem to ‘roll over’ the entire ceiling. It is frequently called a snake in the smoke. The phenomenon causing this is in reality combustion gases reaching their ignition temperature.

Increasing the chance of survival in rooms that are exposed to potentially Rapid Fire Progress

Intervention safety related to flashover

The chance of survival for civilians and firefighters exposed to flashover is practically zero. So, these events can be called extreme [7]. The only possible solution to increase our chance of survival is if we recognize the evolving danger in time and react to it [8]. The signs of a developing flashover may be high temperature, the color, density and movement of smoke, and the appearance of a rollover. Consistently executed entry into the room affected by fire can greatly increase the survival chance of the firefighters. We can draw conclusions by a short ‘shooting’ of water into the ceiling gas layer. If the ‘shooting’ immediately and completely expands into steam, it suggests extraordinarily high temperature. If some water drips back down, the temperature is under 100 °C. Dense, yellowish-brown smoke erupting with pressure often suggests an under-ventilated fire. This is when the possibility of backdraft development is the highest. Since in the case of hot rich flashover the oxygen supply to the room is sufficient, here dense, black, upward twisting can be a telltale sign. Frequently, the

smoke coming from the building's openings are followed by shots of flame [9] [10]. As it was described above, the rollover often precedes complete flashover. After the appearance of rollover only seconds remain till complete flashover.

According to studies, a firefighter working under a neutral plane in complete gear is able to move at the speed of about 0.5-1.0 m/s. This means that if in an ideal case he will recognize the signs suggesting danger 2 seconds before the development of the flashover and withdraws, he can still only cover 2 meters. Accordingly, in a room without water spray covering, he can only progress a maximum of 1.5 meters from the entrance. Outside of this range he probably has no chance of escape!

If the water spray is appropriately applied, we can delay or completely prevent the development of flashover. In the course of this we cool the walls and the ceiling, thus slowing heat radiation.

Aggressive gas cooling technique

In the course of aggressive gas cooling we cool and dilute the ceiling gas layer to prevent burning. This technique is for the purpose of approaching the fire's nest, it is not sufficient to extinguish the fire. With this technique, on the one hand we steam water that results in heat withdrawal, on the other hand in a closed rooguidem that shows vertical temperature layering, we mix the different temperature layers, thus bringing the whole system under the ignition temperature.

Steam generation results in an increase of volume. From 1 liter of water at 100 °C 1,700 liters of steam develop, which is equivalent to 1.7 m^3. At 600 °C (which is the ignition temperature of carbon-monoxide, thus in the case of flashover risk we must count on nearly this temperature), from 1 liter of water 4,200 liters, meaning 4.2 m^3 of steam develops. Conversely, cooling gases contract, thus their volume is reduced. If we choose the amount of entering water correctly, the cooled smoke/steam mixture will have a smaller volume than the initial hot smoke's volume. Conversely, if we enter too much water, we may upset the thermic balance. As a result of this the neutral plane may collapse, turning the room into and overheated 'steam-bath' with zero visibility.

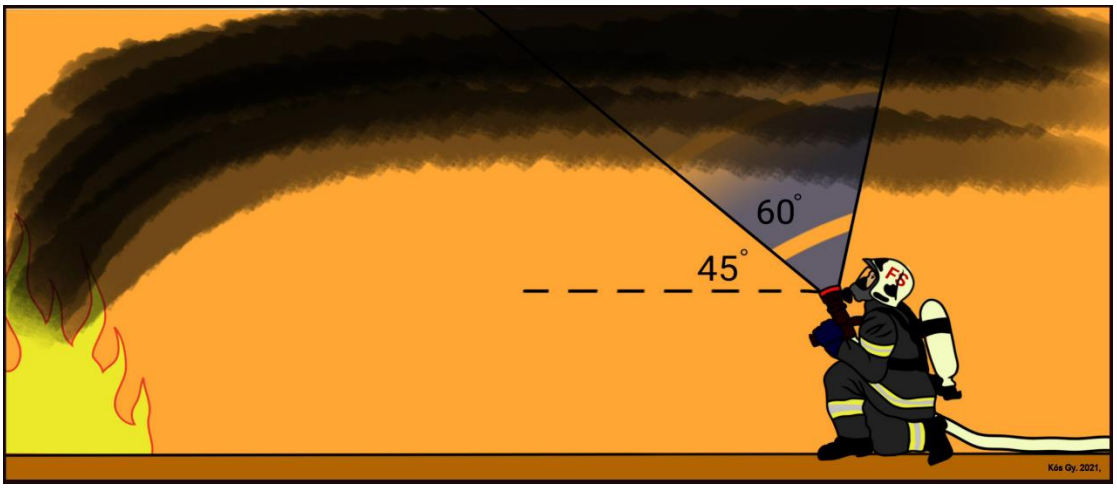

Figure 1 – Examination of the nozzle for spray. Source: Authors

During the intervention we set the nozzle for spray with about 60° cone angle. This nozzle spray should be at an angle of 45° to the floor. Progressing toward the fire's nest, it is important to cover the room with nozzle spray application in its entire width. This is important because the smoke generally progresses toward the firefighters, thus we can achieve that uncooled flames cannot move beside them. We apply short shots, thereby we do not upset the thermic balance. It is advisable to close the door after entry, so the cooled gases cannot leave the room and they can function as a buffer. Laboratory tests have proven that the ceiling gas layer reaches its initial temperature again after about 5 seconds. By keeping the cooled smoke there, this effect can be reduced [11].

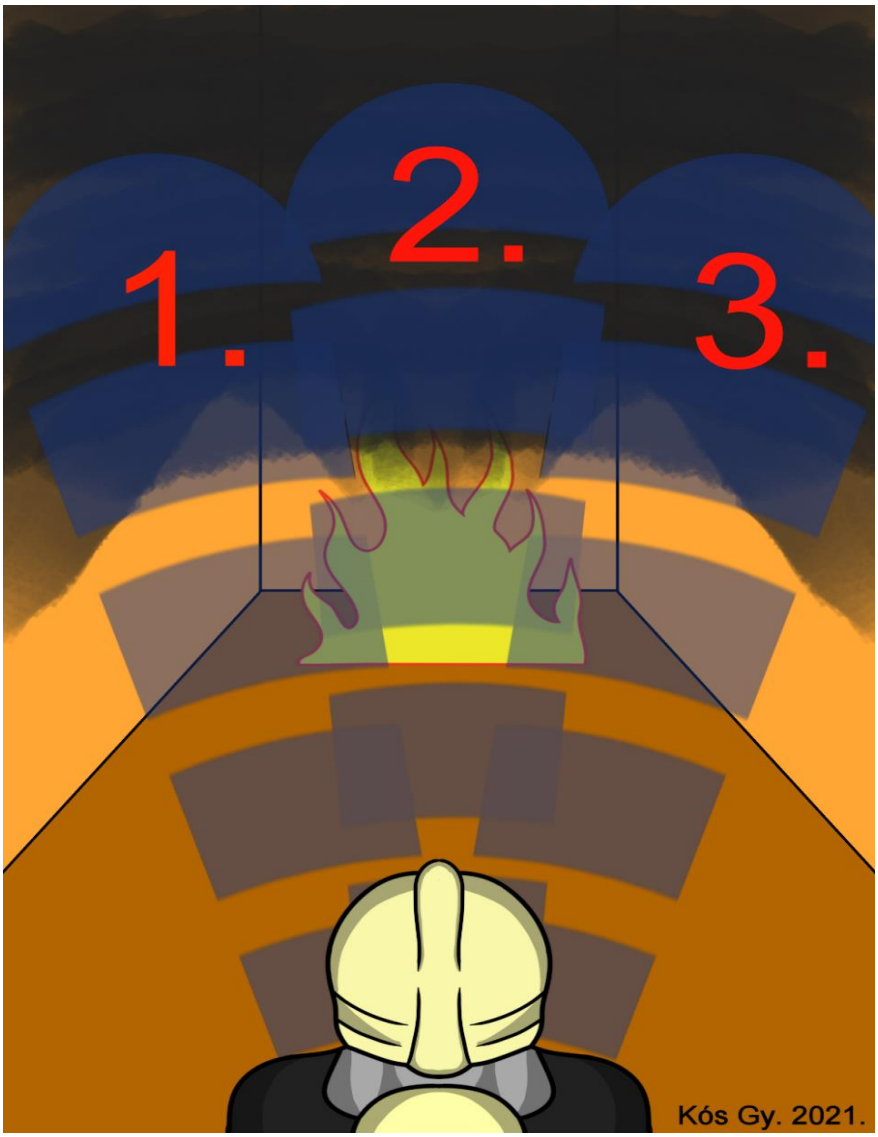

Figure 2 – Firefighter on site. Source: Author.

With the so-called ‘penciling’ technique the safety of the firefighters can be further increased. With incorrectly chosen nozzle spray we will not be able to achieve sufficient cooling effect in the hot gas layers. As a result of this, we only achieve a swirling flow, which may increase the chance of flashover. We can apply the penciling technique to prevent this. In the curse of this, we apply short, bound shots. This nozzle spray is useful for cutting through different temperature layers and achieving a cooling effect even in the uppermost and hottest layers. By combining the aggressive gas cooling and the penciling technique, the development of flashover can be delayed, thus allowing safer withdrawal for the firefighters. By applying the above guidelines the chance of flashover can be significantly reduced. If it still happens the

chance of survival for firefighters is drastically reduced. In the case of flashover, if the firefighter remains capable, he should stay as low as possible. Open the entire nozzle spray without delay, switch to fog setting, hold the nozzle above his helmet and make circular movements, thus striving to cool the largest possible area. Withdraw immediately.

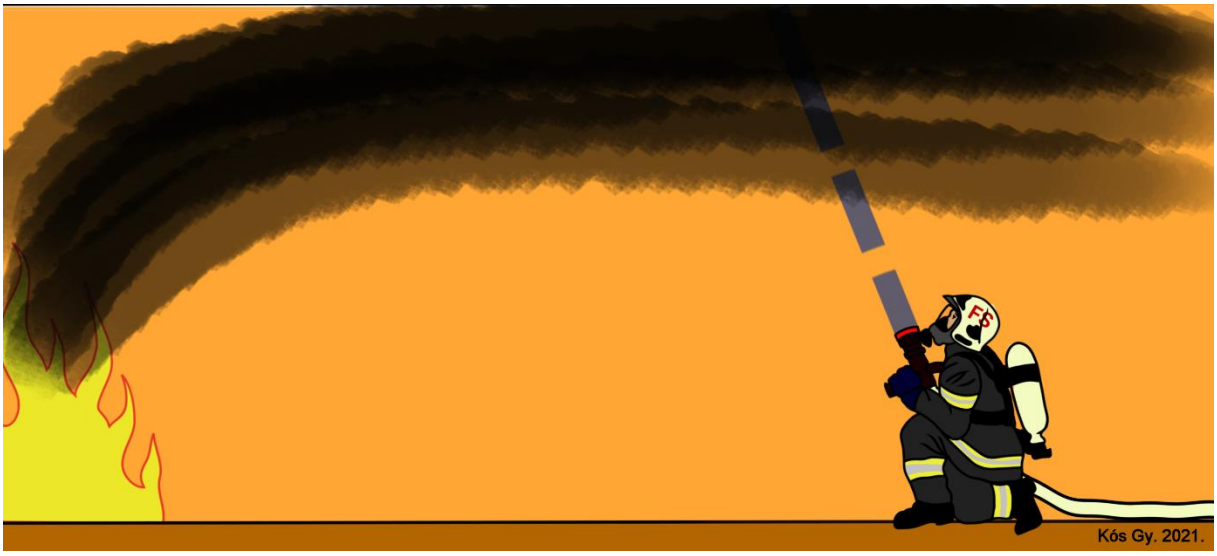

Figure 3- Firefighter safety related to backdraft. Source: Authors.

3. SUMMARY

As we have discussed above, the difference between flashover and backdraft is that the former is a temperature dependent phenomenon, where sufficient oxygen is present for combustion, while the latter is an oxygen dependent effect, meaning that combustion cannot be completed because of a lack of oxygen. As a result of this flammable steams/gases accumulate in large quantities. Large volume of yellowish-brown, dense smoke coming from the openings of a building with high pressure may suggest a backdraft. Further telltale sign may be if the windows are blackened from the inside but have not been broken. Wear complete protective gear. Before entry, check the temperature of the door. A hot door may be a telltale sign. In this case always have the nozzle spray ready that is suitable for intervention, and do not stand in front of the door (in the case of outward opening doors), open it upon ourselves using it as a shield against the erupting flames.

In summary it can be stated that the chance of survival in Rapid Fire Progress (RFP) can be primarily increased by recognizing the early signs that suggest dangerous situations. Appropriately used personal protective gear and the prepared nozzles applied together with the above discussed techniques can considerably increase firefighter safety. In the future it will be necessary to maintain preparedness trainings in the topic [12] and formulate the conclusions in education [13] [14] and work [15].

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