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Authorial exposition and official criticism of PhD essay by Ferenc Zoltán, fire-fighter lieutenant colonel

RESEARCH OF ACTIVE AND PASSIVE FIRE PROTECTION SYSTEMS FOR NEW GENERATION HALLS

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COMPOSITION OF THE SCIENTIFIC PROBLEM

Fire behaves differently in halls than in general small spaces. Due to the large internal height and airspace, the evolution of the fire in the beginning is more like in a windless open-air environment, rather than in small, conventional rooms surrounded by building structures. Therefore, the dispersion and behaviour of fire differs from usual fire models. Considering these factors, it is necessary to develop a specific fire protection and technical criteria system. Applicability of active fire protection systems must be regarded because of the obstacles in rooms of such large interior height. These can be the sensors of built-in fire-alarms or areas protected by sprinkler apparatus, described in a later chapter. Thus, it presents a new challenge.

New generation halls started to spread in Hungary from the beginning of the 1990s. Then the fire protection requirements were quite unregulated for these types of buildings in the country. The first fire protection regulation was legally standardised in 1994 (MSZ 595/8:1994 Fire Protection of Buildings: Heat and smoke eduction in single-airspace halls). At the end of 2001, fire protection standards stopped being compulsory and they became included in the 2/2002. (I.23) BM regulation, almost with the same content: "Determination of technical requirements for fire and civil protection; Technical requirements for fire protection of buildings, chapter I. Fire protection of buildings, chapter I/8: Heat and smoke eduction in single-airspace halls".

In Hungary, there is little experience with fires in halls yet, but regarding planning and expertise, there is already great necessity for new regulations (e.g. smoke eduction sizing, heat and smoke eduction operating simultaneously with sprinklers, opening heat and smoke-exhauster on time etc.).

With the economical and social changes in the early 1990s in Hungary, suddenly a developed, modern technology engulfed the fire protection field as well. Today many experts are able to handle these subsystems (automatic fire alarms, automatic fire extinguishers, heat and smoke exhausts, including passive fire protection systems as well) at a good level.

I am convinced that it is not enough to know these appliances by their system or subsystem, as they might "start an independent life". Effective fire protection (totality of active and passive fire protection subsystems) is based on how these subsystems are interconnected, how they depend on and complement each other. It means that we have to define the effectiveness of these systems in a complex system, always taking local specialities into consideration.

I believe that all active and passive fire protection systems complement each other and in a particular situation, it is necessary to find those subsystems, which support each other best without preventing each other's effective operation. My other motivation to choose this subject as my research topic is that from the early 1990s, the number of one-airspace hall-like shopping centres (CORA, AUCHAN, METRO etc.), warehouses and logistic centres have been increasing dynamically.

Previously, buildings of such type and size had existed in a relatively small number in Hungary. In these buildings, due to their sizes, an occurring fire behaves in a different way. Mainly the large internal space, the big quantity of air (gas that feeds fire) and the tall shelf system (usually 10-12 m, using the high headroom) explain that fire load per square meter is several times bigger compared to ordinary buildings.

15 years ago neither the Hungarian fire protection law, nor the technical regulations were prepared for such cases yet. Thus, effective smoke and heat extraction and other conditions of related fire protection regulations were not elaborated for halls.

Today the Hungarian legal system regulates these parts and tasks in detail. However, I assume that better results could be reached by considering the aforementioned factors and attuning them more to the other active and passive fire protection systems (fire protection of building structures). Unfortunately, even this current system regulates only the heat and smoke eduction. In Hungary, there is no regulation in operation about complete halls yet. Because of the special problems, it would be justifiable to regulate halls independently and to define several technical requirements individually.

RESEARCH GOALS

As I mentioned it earlier in the brief problem definition, fire behaves differently in single-airspace halls from rooms encircled by ordinary building structures. Therefore, in the case of this type of building, I find more thorough research and regulation justified.

Accordingly, my aims are the following:

1. I wish to prove by experiments that with harmonising active fire protection systems and with early, effective heat and smoke eduction, a faster and safer fire-fighter intervention will be realised.
2. I wish to prove by experiments that in single-airspace halls the formation of a smoke-free air layer is only possible with depletion devices that immediately open to fire alarm, simultaneously with air supply induction-pipes.
3. I wish to prove by experiments that increasing the number of heat and smoke-exhauster mouths to an optimal level (location of fire and exhausters meet at an angle of maximum 18°-20°), the sideward spread of fire can be reduced.
4. I wish to prove that by the synchronisation and integration of active fire protection system requirements with the passive ones (such as fire resistance and combustibility requirements for building structures, fire compartment sizes etc.) more favourable rates could be reached without a decrease in the fire protection efficiency.

RESEARCH METHODS

While preparing this essay, I greatly relied on Hungarian and international (EU) literature, technical measures, and on the analysis and effectuation of experiments. The literature exploration included significant research in the topic and their Hungarian adaptations. I especially paid attention to the exposition of practice that has been accepted or recommended in the European Union. I did my own fire experiment to accomplish a successful research goal. I analysed the aforementioned data collection and the results of the experiments. I drew universal conclusions from the results of the analysis. Developing the theme, I used my over 17 years of professional experience and achievements in specialist control and architect-fire protection.

BRIEF DESCRIPTION OF THE FINISHED ANALYSIS

In the first chapter, during the interpretation of the research, I collected and organised basic definitions, defined new concepts in relation with my work as necessary.

I expounded the complex physical and chemical process of fire in time and space as well as the features of these changes. I focused on phenomena that give guidance to the earliest fire signals. I examined the procession of fire as release of energy and as material alternation.

I analysed fire as an exothermic burning process, according to the three basic forms of heat transport (conduction of heat, heat-radiation and convection).

I presented how the features of fire (heat and smoke) affect human body; what burning and the resulting smoke can cause separately.

In chapter two, I examined the characteristics of fire in halls, including how such fire behaves. Fire behaves completely differently in a room encircled by building structures than outdoors, since the conditions are also different. I analysed the conditions of escape, people's rescue and fire-fighter intervention in halls with and without heat and smoke eduction. After that I investigated the effective fire-fighter intervention's conditions in halls. Within that, I observed the circumstances influencing the effective intervention and also the conditions of safe and effective involvement.

Chapter three covered the fire-protection features of new generation halls. I analysed passive fire-protection systems and the fire-technical attributes of building materials. I examined the combustibility, smoke-producing ability and dripping qualities of building materials as supporters. Within this, I studied the following building structure materials according to their components:

- wood and wooden based structures
- metal structures
- silicate based structures (burnt clay, rough ceramics, concrete, reinforced concrete, light-weight concrete and mixed structures)
- plastics

Furthermore, I explained active fire-protection systems' relations in halls. In that part of the chapter I amplified active systems' (inbuilt automatic fire-alarm, heat and smoke-exhauster, inbuilt automatic extinguisher) applicability and effectiveness in halls.

In chapter four I reviewed the feature of heat and smoke-exhausting and sprinklers, considering international and Hungarian fire experiments. I analysed the experiences of the fire experiment that took place in Gent, Belgium. In this part of the chapter, I researched the co-operation of the heat and smoke-exhauster and the automatic water extinguisher (sprinkler), taking international experiments into consideration.

I did my own experiment, where I observed efficient heat and smoke-exhausting in halls. This was partly similar to the Gent experiment, except that I analysed the following aspects:

1. The case when heat and smoke-exhauster and fresh air supply gates open right to fire signal.
2. The case when heat and smoke-exhauster opens after the decision of the incident commander (approx. 15 minutes from signal to exploration) along with the fresh air supply gaps.
3. The case when smoke-exhauster gaps open immediately to fire signal, and simultaneously we open the neighbouring heat and smoke-exhauster domes instead of the fresh air supply.

Following that I summarised the experience of the two experiments and drew conclusions, which I used to prove my theses.

Chapter five covered fire-protection and technical regulation of halls. I analysed and explained the current and the planned fire-protection regulations of halls in Hungary. I displayed the fire-protection and technical regulations used in the European Union regarding halls. I presented the connections of heat and smoke-exhausting and sprinkler and how they are regulated in a particular country (France). I compared these with the Hungarian regulation, analysed them and I drew conclusions.

SUMMARISED CONCLUSIONS

Active fire-protection systems have an important role in architectural fire-protection.

It is quite obvious that because of the special features of halls the task is not easy. For safe evacuation and efficient fire-fighter intervention, besides early fire signal, it is very important to keep the lower part of the hall smoke free. This can be achieved by heat and smoke-exhausting. The sooner we can indicate the fire or the circumstances referring to fire, the more efficiently we can apply heat and smoke-exhausters. Early fire signal is only one criteria of effective fire-protection of halls. Using the large internal height we can realise a smoke free air layer in the room. Furthermore, an inbuilt extinguisher is essential, which intervenes automatically and might decelerate the damage to property.

The other advantage of a smoke-free air layer is that the interfering fire-fighter is able to see the building structure and can assess whether it is safe to fight fire inside the building. The pocket of fire is visible, therefore they can start fire fighting quickly and expediently, there is less damage caused by the water. This way fire fighting is more effective and the people remaining inside can escape safely. The conclusion from the experiments shows that 15 minutes after the domes opened, the cavity barrier cannot hold the smoke anymore and the hall will be filled with smoke.

The smoke in the bordering smoke sections has no thermal energy supply, so it cools down and approaches the floor. With the domes opening, the difference in temperature will not be enough to raise and educe the smoke through the dome gates. This is why besides early fire alarm it is necessary to open smoke-exhausters simultaneously.

I have proved that with the synchronisation and integration of active fire-protection systems into one system, better results could be achieved regarding passive fire protection system requirements (such as fire resistance and combustibility requirements for building structures, fire compartment sizes etc.) without a decrease in the fire protection efficiency.

PRACTICAL USE OF RESEARCH RESULTS, RECOMMENDATIONS

In the last few years, a significant number of new halls have been established in Hungary. The 2/2002. (I. 23.) BM. sz. decree, an expansive regulation about buildings' fire-protection is currently under reconstruction. Therefore, new scientific results might be useful for the creators of the law.

There is no fire-protection and technical regulation for halls in Hungary yet, only for one part: heat and smoke eduction. These buildings are in a special fire-protection category since the fire's process is different from ordinary rooms of short internal height and small ground-space. Fire-protection strategies need to be planned and realised differently as well. The decree reconstruction is very precise because since the EU accession, Hungarian regulations have to be attuned to European Union regulations. This field has not been investigated before; this is why it meant a significant professional challenge for me.

The results have been successfully integrated in the new draft, in which halls will get a prominent role, regardless of their function. With this, the Hungarian economy – using our transit routes - has the possibility to become Central-Eastern Europe's logistic basis. At the moment, Hungarian regulations do not really support this if we look at the authoritative fire section areas. Until now it can be 2500 m2, considering more than 3000 MJ/m2 fire loading with complete active fire-protection equipment (inbuilt automatic fire alarm and extinguisher, effective heat and smoke-exhauster). In the draft, it is 1600 m2 now up until 6000 MJ/m2 fire loading. This was only accepted harmonising the results of my Hungarian and international research, experiments and professional experience. These results helped acknowledge the special features of halls. With early fire signal, heat and smoke-exhausting and with the extinguisher's operation, fire loading can be minimised. With the synchronisation of active and passive fire-protection systems in halls, we can achieve significantly better results.

I gained important experience and results throughout my research work, which I would like to recommend to experts who prepare decisions and laws and co-ordinate the activities related to this theme. Furthermore, I would like to recommend them to those who do designing or design authorising activities. I also recommend them to the intervening fire-service complement and instructors.

SCIENTIFIC RESULTS

Based on my research, I phrase the following scientific results:

In the case of single-airspace halls, my experiments proved that with harmonising active fire-protection systems and with early, effective heat and smoke eduction, a faster and safer fire-fighter intervention is realised.

I proved with experiments that in single-airspace halls the smoke-free air layer's formation is only possible with exhausts that immediately open to fire alarm, simultaneously with air supply induction-pipes.

I proved with my own experiment that with the heat and smoke-exhauster mouths' compression the fire's sideward spread could be reduced.

I have proved that with the synchronisation and integration of active fire-protection systems into one system, better results could be achieved regarding passive fire protection system requirements (building structures' fire-company and combustibility requirements, fire section sizes etc.) without a decrease in the fire protection efficiency.

Considering the new scientific results, I developed the authoritative fire section sizes, the new heat and smoke protection rules and the fire-protection requirements for halls.

PUBLICATIONS

1., Ferenc Zoltán: A passzív tűzvédelem és a hő- és füstelvezetés hatásai csarnok épületekben = VÉDELEM 2005/2 sz. p.:24-25.

2., Ferenc Zoltán: A hatékony hő- és füstelvezetés és a sprinkler berendezés összefüggései csarnok épületekben = VÉDELEM 2003/6 sz. p.:25-27.

3., Ferenc Zoltán: A tűzjelző berendezés és a hatékony hő- és füstelvezetés összefüggései csarnok épületekben = VÉDELEM 2004/1 sz. p.:34-35.

4., Ferenc Zoltán: A hatékony hő- és füstelvezetés vizsgálata csarnok épületekben = VÉDELEM 2005/3 sz. p.:10-13.

5., Ferenc Zoltán Logisztikai központokban a biztonságos tűzjelzés és a hatékony hő-és füstelvezetés összefüggései, www.ZMNE.hu/tanszékek/vegyi/docs/fiatalkut. 10 pages

6., Dr László Földi - Ferenc Zoltán: A hatékony tűzoltói beavatkozás feltételei csarnok épületekben = AARMS 2005/ sz. p.: 553-560.

7., Ferenc Zoltán: Csarnok épületek építészeti tűzvédelmében a hő- és füstelvezetőké a főszerep = VÉDELEM 2005/4 (under publication)

8., Ferenc Zoltán: Csarnok jellegű bevásárló központokban keletkezett tűzesetek pszichológiája www.ZMNE.hu/tanszékek/vegyi/docs/fiatalkut (under publication, 12 pages)

9., Ferenc Zoltán: Csarnok jellegű épületek hő- és füstelvezetése ZMNE 2002. university thesis

10., Dr. Oszkár Cziva – Ferenc Zoltán Katasztrófa elhárítás folyamata Hungarian conference seminar. Lecturer Ferenc Zoltán Balatonfüred 2003. December 04.

11., SzIE YBLM Biztonságtechnikai szak 4 lectures Csarnok jellegű épületek hő- és füstelvezetése 2004. April 19. and 26.

12., .SzIE YBLMF Biztonságtechnikai szak 4 lectures Csarnok jellegű épületek hő- és füstelvezetése és az aktív tűzvédelmi berendezések összefüggései 2005. April 14. and 21.

13., Tűzvédelmi Szolgáltatók és Vállalkozók Szövetsége and GTE Tűzvédelmi Szakosztálya joint Hungarian conference 2006. February 23. „Hő- és füst elleni védelem, épületgépészeti berendezések és villamos berendezések”.

CURRICULUM VITAE

QUALIFICATIONS

Ybl Miklós Technical College, Fire-protection Engineer Faculty – ***Fire-protection engineer (1994)***

Inbuilt fire-protection equipment designer *(1997.)*

Architectural fire-protection expert *(1999.)*

Zrínyi Miklós Nemzetvédelmi Egyetem Vezetés és Szervezéstudományi Kar Védelmi Igazgatási Szak -Vegyi és Környezetbiztonsági szakirány - ***Certified protection directing manager (2002)***

PROFESSIONAL EXPERIENCE

1988 Mar. 01-1989 Feb. 01 Budapest XI. District Fire-service Headquarters – ***Fire fighting department/firefighter***

1989 Feb. 01 – 1989 Nov. 01 Budapest XI. District Fire-service Headquarters – ***Fire prevention department/ fire prevention executive***

1989 Nov. 01 – 1990 Apr. 01 Budapest XI. District Fire-service Headquaters – ***Fire fighting department /engine commander***

1990 Apr. 01 – 1992 Oct. 01 Budapest XI. District Fire-service Headquarters – ***Fire prevention department/ fire prevention executive***

1992 Oct. 01 – 1995 Apr. 01 Budapest XI. District Fire-service Headquarters – ***Tűzoltási és Műszaki Mentési Osztályvezető***

1995 Apr. 01 – 1998 Dec. 01 Budapest XXII. District Fire-service Headquarters –***Head of fire prevention department***

1998 Dec. 01 –2002 June 30 Budapest XXII. District Fire-service Headquarters – ***Tűzoltóparancsnok***

2002 July 01 –2006 Jan. 31 Budapest IX. and XXII. District Fire-service Headquarters – ***Fire-chief***

Since 2006 Feb. 01 Budapest Fire-service Headquarters South-Buda Fire fighting and Rescuing Headquarters (XI:, XXI. And XXII: districts) – ***Fire-chief***

LANGUAGE SKILLS

Russian - Intermediate „C" professional (martial) exam (2002)

English - Elementary „C" exam (2004)

AWARDS

Fire-service councillor (1998)

OTHER

Hungarian Fire Prevention Competition individual and team 1st prize (1997)

Budapest Fire Prevention Competition individual II. prize (1998)