# American Journal of Research, Education and Development

# RED

ISSN 2471-9986

# American Journal of Research, Education and Development

IMPRESSUM

American Journal of Research, Education and Development
ISSN: 2471-9986

Publisher: DEVLART LLC
250 Camelback Ridge Ave. Henderson, NV 89012
red@devlart.hu

# Comparative analysis of the new traditional methods for the plastic casing of fire-resistant cables

*Éva Gyöngyössy, PhD student (University of Public Service), Junior designer of Fire Alarm System, Schrack Seconet Kft. E-mail: evi.gyongyossy@gmail.com Orcid: 0000-0003-2058-8780*

**Abstract**

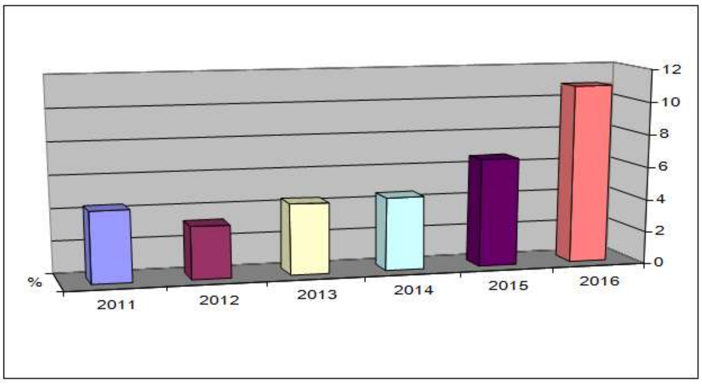
Nowadays electrics, and as parts of them, electrical cables are all around us. They are of great importance from the aspect of fire prevention policy. On the one hand, they are a part of fire control systems, however, on the other hand they can also be a cause of fire, thus assisting its spread. In apartments, offices, industrial plants, healthcare institutions, agricultural buildings and in almost all types of buildings the major cause of fire is of electrical origin. In our thesis I examine the existing legislation and standards as what tests electrical cables must undergo and what requirements they must meet in order to obtain a fire- resistant rating. I intend to test various plastic-covered cables by exposing them to heat and flame, meanwhile observing their reaction and behavior. Results: We would like to determine how the current regulatory systems reflect the real requirements' also investigate if cables certified fire-resistant really correspond to real-world conditions. Finally, we propose some possible solutions to the problems.

**Keywords**: fire protection, fire-resistant cables, standards, certification, testing

*Corresponding author: Éva Gyöngyössy*, *E-mail: evi.gyongyossy@gmail.com*

**Introduction**

Nowadays, electrical equipment - and electrical wires as part of it - surround us in all areas of life. They have a dual role: on the one hand, they are part of the fire protection systems, they help escape and rescue, and they can also be the cause of the fire, increase the spread of the fire, and contribute to the occurrence of greater damage. Electricity as a cause of fire is the most frequent problem, causing injuries, death, property damage, downtime and very often the complete destruction of equipment in half of all fires worldwide, including developed countries. [1] As can be seen in the diagram, among the established causes of fire in Hungary, electrical energy as the cause of fire has shown an increasing trend in the percentage of investigated cases in recent years, and is also the second most common cause of fire in Hungary. (Figure 1) [2]

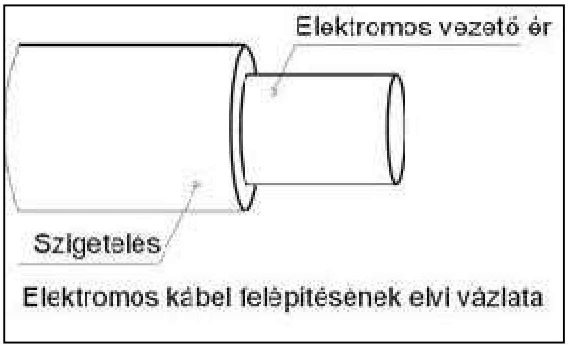



*1. Figure: Proportion of causes of fires investigated in Hungary as a percentage of electrical causes. 01.01.2011-2016.05.23 (Source: BM OKF)*

It can be seen that the role of conduit systems is very complex, as they have both a risk-reducing and increasing role and their use cannot be ruled out; therefore, we must strive to reduce their dangerous risks, in addition to allowing them to retain their role in fire protection. In the following, we examine whether the current regulations meet today's expectations. Those electric cables that have been certified as fire-resistant by the standards, under given conditions, with given test methods, whether they behave properly under real stresses, in the event of a real fire. We consider it important to draw attention to the former, because if we comply with outdated or incomplete regulations, considering that everything is done in accordance with the regulations from planning to construction, then we may think that we have reduced the risks to a minimum and this may give a false sense of security, if we comply with the inadequate regulations themselves.

**Structural and material structure of fire resistant cables**

The structure of today's modern electric wires consists of two essential elements: the inner so-called conductor, which is made of copper or aluminum, or other materials used, and the surrounding outer insulation, which can be single or multi-layered (Figure 2). The conducting material of indoor electricity is usually copper.



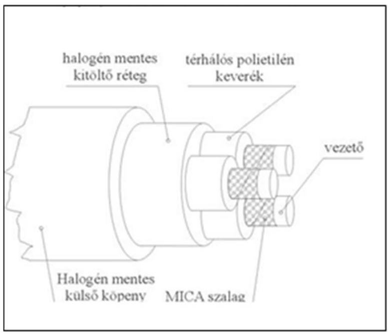

2. *Figure: Structure of electric cables Source: www.partnercabel.hu*

It is very important that we always use cables suitable for the purpose and the possibilities, or what is even more important, that the given network is loaded and used only to the permissible extent, since the fire can not only originate from external fire, but also from the inside of the cables due to overloading. . In our study, I will only focus on resistance to external fire. Depending on the task, countless wire structures can be created, the two basic types are the solid and the twisted version, which largely determines the subsequent flexibility of the cable. The choice of insulation method is almost entirely determined by the circumstances of use. Therefore, manufacturers use appropriate insulation for various tasks. The insulation layer of cables and wires is usually formed by one or more insulating materials or a combination of insulating materials. The most common insulating materials are: paper and insulating compounds, fibrous materials, varnishes, air, PVC (polyvinyl chloride), PE (polyethylene), rubber insulation. Nowadays, the most widely used insulating materials for the insulation of wires and cables are PVC, Polyethylene (PE) and rubber, or their various variants. Products insulated with special materials account for a smaller proportion of wire and cable production, but their use is becoming more and more essential. One of the special tasks that traditional insulations can no longer fulfill is fire resistance.

It is very important that we always use cables suitable for the purpose and the possibilities, or what is even more important, that the given network is loaded and used only to the permissible extent, since the fire can not only originate from external fire, but also from the inside of the cables due to

overloading. . In our study, I will only focus on resistance to external fire. Depending on the task, countless wire structures can be created, the two basic types are the solid and the twisted version, which largely determines the subsequent flexibility of the cable. The choice of insulation method is almost entirely determined by the circumstances of use. Therefore, the manufacturers' fireproof insulation of the various Fireproof cables can only be solved with an "insulation system". The design varies by manufacturer. In our country, the vast majority of products are manufactured according to the German standard, the basic design of which is as follows (Figure 3):

- Solid copper conductor
- MICA tape
- Cross-linked polyethylene mixture
- Halogen-free filling layer
- Halogen-free outer jacket




3. *Figure: Construction of fire-resistant cable [3] www.partnercabel.hu*

Flame resistance is, of course, a basic requirement for PVC insulation, and other materials also have this property, such as halogen-free materials.

The fire-resistant cable, when exposed to an external burning effect, also starts to burn like its traditional counterparts, so the only question is how long the cable can maintain its function under the influence of the external flame, i.e. supply power to the connected equipment. The MICA tape surrounding the copper conductor and the cross-linked polyethylene insulation burn into a ceramic-like material when burned, which remains closed and ensures the insulation of the blood vessels for a considerable period of time. [3] [5]

Other special tasks are high mechanical stress, resistance to chemicals, water resistance/pressure resistance, adequate shielding, armor. [5] [6]

**Effective requirements for fire resistant cables**

The requirements for fire-resistant cables are set out in Regulation 54/2014. (XII.5.) BM Ordinance, the National Fire Protection Regulations, which stipulates that during the establishment, installation and design of fire consumers, it must be ensured that their functionality in the event of a fire

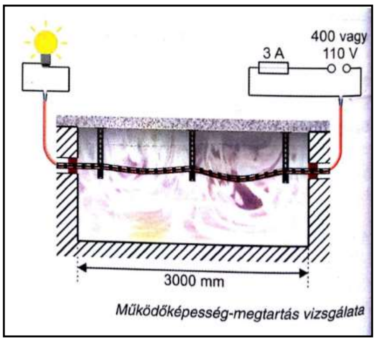
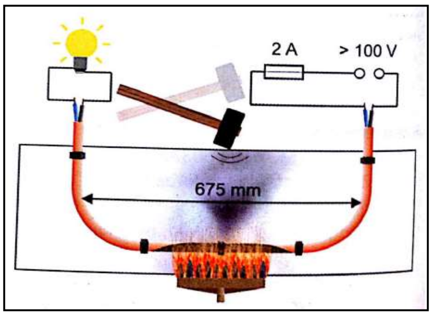
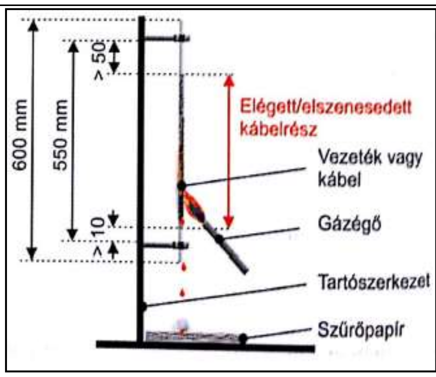
They may be kept for the shorter period of time according to Table 1 contained in Annex 11 and the duration of the fire resistance performance requirement for the load-bearing wall. Functionality is maintained if, in the event of a fire, the electricity necessary for the operation of the consumer in the event of a fire is available for the prescribed period of operation, and the fire protection, operation and control of the wiring system is ensured. It also stipulates that the cables, as part of the built-in fire protection equipment, must resist fire for at least 30 minutes or must be protected for such a period.

Part 7 of the Fire Protection Technical Directive entitled "Electrical equipment, lightning protection and protection against electrostatic charging" offers solutions to fulfill the legal requirements. The security level defined in the OTSZ can be achieved with the solutions described in the TvMI or in a different way, if the achievement of the same security level is proven. According to the TvMI, a fire-resistant cable system suitable for ensuring the protection of wires and wire systems against fire, the functionality of which has been verified by testing and is included in the Fire Protection Compliance Certificate; laying the line, line system in the ground; or routing the line or line system in a concrete slab, if it has been covered with concrete covering at least 30 mm thick. The maintenance of functionality can be verified with a standard test, during which the cable and the cable support structure are tested together. The equipment used to conduct the test is a 2 m wide, 3 m long and 2.5 m high chamber, in which a 3 m long piece of the cable system installed according to practice is placed. The cores of the cables placed on the cable support structure are connected to a voltage (400 V in the case of high-current cables, 110 V in other cases) through a 3A overcurrent protection device, so that the circuit formed in this way indicates if a short circuit or wire break occurs. During the test, the chamber is heated according to the so-called standardized temperature curve, thereby simulating the temperature rise process of an average fire, while the current-conducting capacity of the cables is continuously checked. The recommended duration of the test is 30, 60 or 90 minutes, depending on the fire resistance class to be certified. The condition of fire-resistant certification is that no wire breaks or short circuits can occur in the cable system. Fire resistance can only be interpreted within a specific time range.

Accordingly, DIN 4102-12 distinguishes the following fire resistance classes: E30, E60, E90. In the absence of a generally accepted standard, many European countries have adopted the German DIN 4102-12 requirement system into their national standard system. This practice was also followed by Hungary with the introduction of MSZE 24102 as a pre-standard, which is practically a translation of DIN 4102-12 into Hungarian, which dates back to 1998. Since then, not only has the use of electricity increased, but the types of cables have also evolved along with the devices, while our standards are constantly becoming outdated.

As time progresses, modern cables take the place of the old ones, and in the future it can cause big problems if they are not properly qualified and are used in many places with uncertain properties. Given that there is no way to test the support structure assembled on site (i.e. whether the cable system will work even in the event of a fire), fire resistance can only be ensured if a support structure that has passed the DIN 4102-12 test is reproduced at the time of construction. The question arises as to whether the standards should be developed separately for fire-resistant cables and separately for the structures supporting and fixing them in the future, or whether they should be examined together, as is the case with the current standard.

*1. Table: Summary of relevant standards [1]*

| Retention of functionality | Retention of insulating ability | Flame spread |
|---|---|---|
|  |  |  |

| | | |
|---|---|---|
| MSZE24102, DIN4102-12 | MSZ EN 50200,<br>MSZ EN 50362, IEC 60331 | MSZ EN 60332-1/2/3 |
| Cable with holding system | Only cable | Only cable, or more pieces of cables together |
| Rating: Exx<br>E30/ E60/ E90<br>xx: minutes | Rating: PH xx/ FE xx | Rating: appropriate/ not appropriate |

Additional standard tests: retention of insulating ability (FE marking; only the cable test), flame spread test, flammability test, year drip test, etc. MSZ EN 50200 examines the insulation retention capacity of small cross-section cables, and this test method has several problems. On the one hand, it is not suitable for testing large-diameter cables, on the other hand, the constant temperature of 850°C is lower than the value expected in the case of developed fires, and the test does not contain any indication of what kind of cable support structure the cable should be placed on in practice. The effects resulting from the deformation of the support structure have a strong influence on maintaining the functionality of the cable, which is also not taken into account in the test. [7] [8]

It follows from the former that our current standards are outdated and do not reflect real conditions, requirements, and are also inadequate from a practical point of view. (The implementation of the systems is difficult, time-consuming, uncontrollable and expensive.) Another problem arises as to whether the flame spread test or the operability test in itself qualifies a material, or whether it would be possible to better reduce the risks that pose a danger, the fire protection in addition to keeping functions necessary for measures?

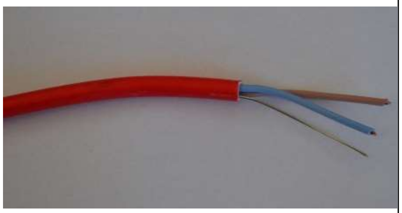
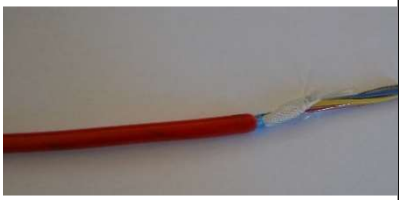
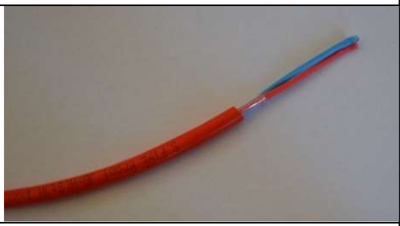
**Combustion methods, tests**

The comparative flammability test of my samples was carried out by measuring the oxygen index using a suitable standard measurement method (MSZ 10200-1989 or ISO 4589) with a FIRE type testing device. The flammability of materials can also be characterized by the minimum oxygen concentration at which they still burn. Most of the combustible materials can burn with normal oxygen content (21 tf %), but there are some materials that cannot. The determination of the oxygen index (LOI, Limited Oxygen Index) is an important material parameter in assessing the flammability of combustible materials, and can be used in principle for any combustible solid material. This is the only parameter that can be used to quantitatively characterize the flammability of poorly burning plastics in air. It is also excellent for assessing the effectiveness of flame retardants. According to the LOI definition, the lowest oxygen concentration of a flowing oxygen-nitrogen mixture, expressed in volume percentage (0-100% tf%), in which the test specimen continues to burn independently for at least 3 minutes after ignition (capable of flame propagation), or is sufficient in a length of at least 5 cm. The exact conditions of the measurement are recorded in standards. The principle of the test is that the material to be tested is placed in a transparent glass cylinder, which is connected from the bottom to the device that ensures the set air composition, and is open from the top for the removal of combustion products. By adjusting the oxygen concentration characteristic of the material, the tested sample becomes ignitable and shows a burning phenomenon. The percentage content of nitrogen and oxygen in the test equipment can be adjusted as desired. The sample holder is a vertical 6x15 cm U-shaped, two-layer metal frame. The ignition source is also a standard 1.6 cm long propane-butane gas flame. Light the sample on the upper edge, holding the flame there for 30 seconds. Combustion starts downward in countercurrent with the preset air mixture flow. The oxygen index is the value when the burn reaches 8 cm on the sample. The value of the oxygen index depends very strongly on the temperature: as the test temperature increases, the oxygen index decreases. Another test is the observation of flame spread. One piece of the cable, or several types of it, was tested and fixed in the desired position. The lower part of the cable is exposed to a flame with a heat output of 1kW for 30 seconds. After that, we measured the section of the cable where the fire had spread. We also examined the behavior of the bent cable, the fire effect, and I also exposed my samples to mechanical effects during the test, thus simulating the real conditions. [9]

**Test patterns, tests and results**

I tried to choose my test samples in such a way that they were of different types and qualifications. We made 16 cm pieces from each sample type, at least 10 pieces per type. First, I examined the casing separately, then I looked at the behavior of the internal components both alone and in pairs, as well as in the case of multiple cables being placed together.

*2. Table: My test results.*

| Specimen type | | Main features | Oxigen-index (LOI) | Combustion phenomena |
|---|---|---|---|---|
| 1<br>PH 30 |  | **NOBURN 2X1,9MM2 300/500v**<br>With fire resistant ceramic silicone conduit insulation. Sheath with low smoke emission, preventing flame propagation, halogen-free, with 2x1.9 mm2 solid conduits.<br>1.0 mm2cross-section,conduit made of Cu, halogen-free coating (sheath) | 33,7% | Burning with flame |
| 2<br>FE180, E90 |  | ***KABTEK JE-H (St.)H.Bd 2x2x0,8***<br>Halogen-free, flame resistant, safety technology cable. Structure: solid copper conduit, halogen-free conduit insulation, aluminum foil-shielded, mounted on plastic, fire retardant external sheath made of halogen-free material. Cu conduit, halogen-free coating (sheath) | 33,4% | Burning with flame, smoking below and above, melting and dripping while burning |
| 3<br>PH 120 |  | ***S.FIRE PROOF JB-H(ST.)H 1x2x1***<br>Fire retardant cable with solid copper conduit, halogen-free polyolefin insulation and external sheath.<br>0.5 $mm^2$cross-section conduit made of Cu, halogen-free coating (sheath) | 37,7% | Burning dripping, melting |
| 4<br>No PH marking |  | **BRANDMEL DEKABEL**<br>***10 wired multicore cable for fire alarm system***<br>Assumably, with non- fire retardant PVC sheath, a 4-conduit fire alarm cable. | < 36% | Burned out completely at 36%, very quickly. With heavy smoke, flying fibrous materials and combustion products. |
| 5.<br>PH 180, E90 |  | ***EUROSAFE 2x1 SQMM SHIELDTO BS 638***<br>Fire resistantcable, 3-hour fire retardance, shielded, EN54. Aluminated, synthetic foil, red flame retardant PVC sheath.<br>1.0 mm2cross-section conduit made of Cu, halogen-free coating (sheath) | 27,5% | When burned, it drips, melts, smokes |

From my results, it can be seen that although none of the 4 types (I did not consider type 6, as it is assumed to be non-flammable) is capable of self-sustaining combustion based on the oxygen content of the air, we can still distinguish them according to their flammability. Whichever type has the lowest oxygen index is the one closest to the oxygen in the air, i.e. it will burn the most easily. This type needs the smallest heat rise so that its oxygen index drops to 21% and is capable of self-sustaining combustion even in air. For me, this became the 5th sample type, with 27.5%. It was a two-core Eurosafe fire alarm cable. The inner cores of the cables were self-extinguishing due to the oxygen content of the air when exposed to a small flame, but when we raised the oxygen content to 33%, they burned completely with smoke and flame. The foils that make up the cables burned quickly even in air, with a lot of smoke and flame. During the tests, it became clear that the samples should be tested alone if the goal is to determine the exact oxygen index, because the adjacent flame has a great influence on the burning of the tested cable. Surely this can be related to the previously mentioned temperature dependence of the oxygen index. It was observed during the flame propagation tests that where the cables were bent, they were damaged more easily in all types. First, it caught fire, and then within a few seconds the cover cracked, and the fire also caused damage to the internal vessels. The external mechanical effect also greatly affects the performance of the cable, because the burnt coating is ceramicized on the cable and this causes the insulating effect, but if it falls off the cable due to an external force, it remains unprotected.

**Conclusions, recommendations**

The increase in the rate of electrical fires is clearly visible from statistical data [10]. Therefore, based on our measurements and experiments, I would recommend the grouping of fire-resistant cables based on the oxygen index, because it is not possible to really compare different cables on the basis of standard flame spread tests, nor does it give a complete picture of the complex properties of the cables. If the LOI of a substance is greater than 21%, but less than 28%, it can be considered slow burning. If the oxygen index (LOI) of the substance is greater than 28, then it is considered self-extinguishing (SE: self-extinguishing). I would recommend that the classification be based on the oxygen index, divided into four categories:

- (BA) LOI<20.95- burning in air (BA: burning in air)
- (NBA) 20.95-28.00- non burning in air (NBA: non burning in air)
- (SE) 28.00-100.00 - 'self-extinguishing' materials (SE: self-extinguishing)
- (NB) LOI>100.00 – 'non-burning' materials (NB: non burning).

For this reason, I tested the cables for oxygen index, because this tells a lot more about the combustion. Testing the oxygen index gives us an immediate result, it is relatively simple, fast, and last but not least: more economical. From August 2017, a system will be introduced to classify the sheathing of fire-resistant cables, which is based only on standard tests related to flame spread, several expensive tests. It would be more expedient to group them based on the oxygen index and then, if necessary, carry out further tests, for example, we can see if a burning drip test is needed.

Flame spread can only be characteristic in air, but we cannot distinguish between materials that are not combustible in air, while according to the oxygen index, materials that are not combustible in air can also be ranked easily, and it can also be determined to what extent the oxygen index would decrease to 21% as a result of a temperature increase, i.e. for the amount required for self-sustaining combustion in air. This can be an important question in the case of spaces with high operating temperatures, where due to the high temperature, even with a lower oxygen content, self-sustaining combustion can occur, and the fire resistance of the wires is reduced. (For example, factory kitchens.) A suitable basis for the correlation between further structural research and fire resistance is a thermoanalytical test, which indicates the direction of further tests. [11] [12]

The examination of flame spread and usability covers the system and the cable as a whole, even though it is possible that only the internal wires deteriorate the property. I would recommend that the cable makers should be qualified separately, and the flammability parameters of the plastics and the cables assembled from them should also be examined, because they can behave differently. Even though the exterior may be flame-retardant, current load experiments prove that the fire hazard can come from the inside as well, not just from the outside.

It would also be worthwhile to include in the construction regulations to avoid the use of hot-melting, drip-covered cables on escape routes, even with suspended ceilings, their use is not advisable due to their high risk. From the point of view of manufacturers and contractors, separate test standards would be more beneficial. It would give designers more freedom if they were not forced into systems by the fact that the support structure and cable system are certified together, so they can only be used in a restricted manner, as it has undergone the test. They could freely pair the wires and support structures if they were separately qualified parts of the system.

**References:**

1. KRUPPA A.: Villamos vezetékrendszerek tűzvédelme. OBO Bettermann Kft., Bugyi, Magyarország 2013
2. http://www.katasztrofavedelem.hu/- A villamos energia által okozott tűzesetek megelőzése, letöltés: 2016-10-30, search: google.hu, keywords: tűz, elektromos kábel
3. Partner Cable: http://www.partnercable.hu/hu/szolgaltatasok/hirlevel/szakmai- hirlevelek/kabelgyartas-1-4-resz (Letöltve: 2017.06.30.)
4. Ezermester: http://ezermester.hu/cikk2181/Villamos_vezetekekhttp://94.199.180.149/html

/dpi/efeladat/szetankonyv/tankonyv.php?p_id=80642 (Letöltve: 2017.08.30.)

5. Docplayer: Luciano Borghetti, Hughes Associates Europe SRL http://docplayer.hu/ 1221831-Elektromos-tuzek-es-tuzolto-anyagok-mivel-celszeru-oltani.html (Letöltés ideje: 2017.05.05.)
6. Electro_Cord: http://electrocord.hu (Letöltés ideje: 2017.05.05.)
7. KRUPPA A.: Tűzálló kábelrendszerek VÉDELEM [2007] 345-47. oldal
8. KRUPPA A.: Tűzálló kábelrendszerek létesítésének elméleti háttere VÉDELEM [2011] 1. 7-17.
9. KEREKES ZSUZSANNA Doktori (PhD) értekezés: Oxigén index szerepe az oxidált- és szénszálak éghetőségében (SZIE Gödöllő 2012)
10. HESZ J.: A műveletirányítás tapasztalatai; Tűzoltó Szakmai Napok 2016. Szentendre, Magyarország, 2016.03.02 Budapest: BM OKF, 2016. pp. 88-91. ISBN 978-615-80429-0-1
11. KEREKES ZS.- LUBLÓY É.- RESTÁS Á.: Az oxigén index (LOI) alkalmazásának lehetőségei a tűzvédelmi minősítésekben. Védelem Tudomány, I3 (2016) 16-27.oldal
12. KOPCSEKÓ K: Derivatográfia és Rtg-diffrakció mérnöki feladatok megoldásában, In: Köllő G (szerk.) ÉPKO 2002 Nemzetközi Építéstudományi Konferencia. Budapest, Magyarország

# Questions of firefighter intervention in radiological incidents

*Viktória Finta, Associate Professor, University of Public Service, Faculty of Law Enforcement, Institute of Disaster Management, Department of Fire Protection Technical, Email: akoris.vikta@gmail.com ORCID: 0000-0002-2032-8623*

*Sándor Rácz major assistant professor, University of Public Service, Faculty of Law Enforcement, Institute of Disaster Management, Department of Fire protection and Rescue Operations Management, Budapest, Hungary, E-mail: racz.sandor@uni-nke.hu, ORCID: 0000-0001-9955-924X*

*Corresponding author: akoris.vikta@gmail.com*

**Abstract**

Radiological emergencies (RE) are those emergencies which involve radioactive material that is not nuclear but emits ionizing radiation. Although such sources are usually kept and transported closed, their shielding or packing can be damaged in case of accident or fire. If the source becomes unshielded environmental exposure can increase or even radioactive contamination can occur. Depending on type and dose ionizing radiations can cause morbidity or even mortality, while they can only be detected with special instruments but not our senses. That is why first responders are the most endangered in a RE and their radiation protection is imperative. Thus, even at the initial stage of the intervention, the incident commander (IC) has to tackle several urgent tasks and a huge responsibility. Alarm level classification and on-spot reconnaissance take on a crucial role here. The paper provides help to clarify hazards and make decisions on taking the risks.

**Keywords:** radiological emergency, ionizing, radiation, protection, decision-making

## Introduction

Effective firefighting intervention in the event of a fire is, in fact, the professional execution of activities carried out in parallel, which essentially consists of saving life and property, extinguishing the fire, eliminating risk factors, and performing related tasks. Each of these elements is based on pre-practiced protocols, the application of which is detailed by law and organizational regulatory instruments, but the diversity of the location and the various risk factors that occur may hinder their implementation.

Regarding the topic of the article, the examination of the dangers of interventions in the scene of radiation sources. The Hungarian legal system basically distinguishes between nuclear and radioactive material [5], thus nuclear accidents can be separated from other radiological events. A radiological event is any dangerous situation related to ionizing radiation, where fissile material capable of a self-sustaining chain reaction is not present; for example, an accident or fire in an industrial or medical facility that uses radioactive isotopes, a transport accident, a terrorist act, an incident related to an abandoned, lost, or stolen radiation source [10].

Since ionizing radiation can be harmful to health or even fatal, depending on the type and dose, radiation protection of those who intervene is essential. In order to do this, it may happen that the options during the rescue are limited in terms of space, time, number of personnel, or in other ways.

## Formulation of the problem

Incidents related to radioactive materials occur relatively rarely, but they can have more serious consequences.

This can occur, on the one hand, due to the late identification of the radiation hazard, the lack of personal protective equipment, and the underestimation of the hazard.

In the optimal case, those managing the firefighting intervention have sufficient information at their disposal to make appropriate decisions in order to create safe work [1]. The investigated firefighting intervention also stands out among the dangerous firefighting activities, since when approaching the scene of the incident, the available information only informs the commander of the type of danger, but its magnitude and its impact on the environment can only be assessed on the spot. In Hungary, the legislation defines the tasks that the leader of the intervention must perform [2], and they also provide appropriate authorization [7]. In the event of a firefighter's intervention in the presence of an open source of radiation, the evacuation and closure of the endangered area, the involvement of the appropriate partner agencies, and public information are of particular importance.

We speak of an open source of radiation because isotopes that are basically safely stored or transported can be affected by such an external influence during a fire or road accident that we can assume that they become open, i.e. damage to the shielding/packaging, or that radioactive material is released into the environment [8]. The fire chief must therefore assume this until he is convinced otherwise, since firefighters do not have protective equipment that would safely protect against harmful effects [9].

In Hungary, disaster prevention mobile laboratories (KML) can be alerted to radiological, biological and chemical accidents, which have staff and measuring instruments suitable for radiological detection. In addition, Disaster Prevention Radiation Detection Units (KSE) are available in the border counties, which are equipped with additional instruments specially suitable for radiation detection. The instruments are used to map the radiation situation in the area, depending on the measured data, the danger zone (100 μSv /h) and the safety zone (20 μSv /h) are designated, the time to be spent in the damaged area is determined, the radiation source is found and data is collected regarding the probability of becoming open or spreading out [6, 10]. It is foreseeable that if the commander of the first arriving unit is not assisted by the KML/KSE in the initial stage of the intervention, he will have to make difficult decisions without important information [3].

In such a case, the leader of the intervention must definitely think beyond the routines of general firefighting work and include additional variables in his decision-making mechanism.

## Scientific background

Most of the ionizing radiation that affects humans is of natural origin (we ourselves are radioactive), and a significant proportion of artificial radiation also comes from voluntary medical applications (e.g. lung filtration). That is, radioactivity is part of our normal life, most of our fears about it are unjustified. At the same time, it is important to point out that the ***dose*** is an extremely important feature, and radiation with a dose much higher than the natural background radiation has a health-damaging effect, and in extreme cases can even be fatal. In order to be able to deal with this topic properly, it is essential to have adequate background knowledge. Sufficiently deep acquisition of radiation protection knowledge is also essential because in a critical situation, unjustified excessive fear can cause even more damage than carelessness.

The most important physical quantity is the absorbed dose, which indicates the energy released by the radiation in the material per mass unit in Gray ( Gy ). From this, we derive the effective dose, in which, in addition to the absorbed energy, we take into account the different radiosensitivity of individual organs, as well as the different biological effects of each type of radiation. This is already a biological dose concept, its unit is Sievert , Sv . In Hungary, the value of natural background radiation is 2.4 mSv per year. [12]

Among the quantities that can be measured in practice, the dose rate, which is the dose per unit of time, is extremely important. By measuring this, it is possible to calculate the length of stay for the interveners in a given damage area.

In terms of radiation sources, it is important to know which isotope of which element it is, what type of radiation it emits, and how active it is [1]. [12]

In terms of the type of radiation emitted by the source, it can be alpha, beta, gamma or neutron radiation, at least in practice these occur most often.

consisting of helium nuclei with high ionizing power but low penetration, which can be absorbed by a sheet of paper or a few centimeters of air. However, in terms of its biological effect, it is 20 times more harmful than beta or gamma, which is why it is particularly important to be incorporated into the body by ingestion or inhalation, in other words , protection against incorporation . [12]

Beta radiation is a particle radiation consisting of electrons and positrons with medium ionizing and penetrating power. A thin metal sheet, 1-2 cm thick plexiglass or 1-2 meters of air can be absorbed. [12]

Gamma radiation is electromagnetic radiation, i.e. it consists of photons. It is electrically neutral, highly ionizing and highly penetrating, and can be defended against with high-numbered batteries, lead, and concrete. [12]

Neutron radiation is also particle radiation, but it is electrically neutral and has the particular danger of triggering nuclear reactions. You can protect yourself against it with batteries with low registration numbers (water, boric water, paraffin). [12]

The most commonly used isotopes in industry, research, and medical diagnostics and therapy are the following: sodium-24 (β), cobalt-60 ( γ), selenium-75 (β), iodine-131 ( β), cesium-137

[1]activity: number of radioactive decays per time unit; unit: Becquerel, Bq

( $\gamma$ ) , iridium-192 ( $\beta$-$\gamma$ ), plutonium(beryllium)-239 ($\gamma$-$n^0$ ), americium-241 ( $\alpha$-$\gamma$ ), americium(beryllium)-241 ($\gamma$-$n^0$ ). [12]

Ionizing radiation can have deterministic and stochastic effects on the human body. The characteristic of the stochastic effect is that in the case of small doses, the probability of cancer and genetic disorders increases in the long term. The deterministic effects mask the symptoms of acute radiation sickness, which do not occur at all below a certain threshold dose, and above that, the severity of the symptoms increases as the dose increases. Typically, below a whole-body dose of 200-500 mSv , there are no noticeable symptoms, at 1000-2000 mSv , mild radiation sickness occurs, with some latent period. Symptoms are headache, fever, nausea, vomiting, diarrhea, fatigue, weakness, increase in the number of white blood cells . As the dose increases, the latency period decreases, the symptoms worsen, bleeding, nervous system symptoms, fur loss, and infections may occur due to the weakening of the immune system. The so-called half-lethal dose ($LD_{50/60}$ ), at which half of the irradiated individuals die within 60 days, is 3000 mSv , depending on individual sensitivity . Approximately 6,000 mSv is almost always fatal, but these limits are roughly doubled with medical treatment, so a patient has been recorded who survived a whole-body dose of 12,000 mSv with medical treatment (without permanent health damage). [11]

**Issues of firefighter protection in radiological incident management**

A fire in the presence of a radiation source does not differ significantly from that in the absence of radioactive material. At least in the sense that the spread and properties of the fire are not affected. The difference is that, due to the presence of radiation, there may be methodological differences during the intervention in order to avoid unnecessary or excessive exposure of the interventionists. The essence of the protection of primary responders in radiological emergency situations is to eliminate the occurrence of deterministic effects of ionizing radiation reaching them during the intervention, and to minimize the probability of stochastic effects. [10]

It is also necessary to apply the three most important principles of radiation protection for firefighting and technical rescue in radiation-hazardous areas: justification, optimization, and dose limitation. The first is definitely the principle of justification, according to which the benefit associated with the intervention exceeds the risk. For the interveners, the risk can usually be greatly reduced by complying with the reference levels defined in the law. In

Hungary, the law distinguishes between planned radiation situations and emergency situations. The general worker dose limit is 20 mSv /year, reference levels for emergency situations have been determined. Efforts must be made to ensure that the effective dose received does not exceed 20 mSv in this case, but in a serious situation, depending on the scope of the possible consequences, 50 mSv or 100 mSv may also be permitted. Moreover, in case of life saving, it can be up to 250 mSv , but during the entire emergency intervention it cannot exceed 500 mSv . Furthermore, in the case of an expected effective dose of over 100 mSv , the interventionist must be informed of the risks in advance, and can only participate voluntarily in the prevention. In addition, if the effective dose received during the prevention actually exceeded 100 mSv , the law also requires the employer to do additional tasks regarding the health follow-up of the employee. [4]

If, on the other hand, the dose is not known, because there is no personal dosimeter available, or there are no measured data from the area, then it is the task of the firefighting leader or the disaster site commander to weigh the ratio of risk and benefit. Here, among other things, it is necessary to take into account whether life saving is necessary, how much further escalation of the emergency situation is expected, and how much property and environmental damage may occur if the intervention is not taken.

The information required for risk assessment must be obtained during the reconnaissance, including the physical properties of the radiation source (what isotope, how much activity), how damaged the packaging is, what is the probability that it has really been opened or scattered on the site. In the absence of measurement data, the dose can be estimated by calculation, knowing the type and activity of the radionuclide, as well as its location on the damage site. In the case of a transport accident, the type and activity of the isotope is indicated on the bar, but of course in a real situation it is not at all certain that the inscription will be read on a burning vehicle, and it is possible that the specialist or documentation required for identification will not be available either.

In this case, if, despite the unknown radiation situation, some kind of intervention is necessary based on the commander's decision, the principle of optimization (ALARA) must be kept in mind [2].

This can be implemented in practice in three ways: for the shortest possible time, as far as possible from the assumed location of the radiation source, and if possible, perform the most

[2]ALARA: Yes Low Dig Reasonably Achieveable , keeping radiation levels as low as reasonably possible

necessary operations using shielding. In addition, it is recommended to pay attention to registering the stay time of the interveners, which facilitates the subsequent estimation of the dose suffered, thereby determining the expected health effect, if measurement data is already available in the future. [10, 12]

**Example**

Take, for example, a class 7 shipment according to ADR, which contains a sealed radiation source of $^{137}$ Cs. The transport vehicle suffers a road accident, in which the vehicle, its driver and the goods are also damaged. The car catches fire, the driver is unconscious, the packaging of the radiation source is damaged to such an extent that it is assumed that it has become open or scattered. A passer-by notifies the emergency services, but the report does not reveal that the car has a radioactive material marking. According to the information of the primary intervention units, a truck is on fire and one person is trapped and injured. In this case , it depends on the preparedness, thoroughness, and prudence of the fire -fighting leader or accident site commander that the on-site investigation covers whether there are marks on the vehicle indicating any hazardous substances. If this is not done, it may happen that only afterwards, even during the fire investigation, it becomes clear that the intervening staff was exposed to ionizing radiation.

The next question is what the fire chief does if he is aware that radioactive material is present and life saving is necessary, but there are no specific measurement data available on the radiation levels. A completely different radiation environment is formed when the radiation source is closed and when it is open, or even if spillage has occurred. The radiation levels, the time available for the intervention, and even the methods are different. For this reason, radiation detection and the instrumental survey of the site have a cardinal role in the planning and implementation of the intervention, and it is practically not recommended to start saving lives without it.

**Other issues of intervention**

Because of the above, performing an intervention in the presence of an unknown radioactive substance also raises professional ethical and moral questions. According to Hungarian legislation, those who intervene in the prevention of a radiological hazard above a certain dose can only perform these tasks on a voluntary basis, and the dose received by them is registered [4]. The personnel of the professional disaster protection agency carry out their work in a legally regulated manner, even risking their lives and physical integrity, which primarily serves the protection of life and property of the population [13]. At the same time, it is worth highlighting the term "risk taking". It must be clearly seen that a situation may arise where, due to the presence of radiation, the intervention can no longer be considered a mere risk. Illustrated by example: while taking out a gas cylinder from a burning house is considered a risk, since depending on the circumstances and the intervention, if the firefighter is quick, skillful and lucky enough, the cylinder will not explode prematurely, whereas in a transport accident radioactive material that has become open and scattered Fire fighting or life saving carried out in the presence of a given dose is certainly harmful or fatal.

In addition, in Hungary, the personal dosimeter is not part of the personal protective equipment, so determining the dose suffered can be difficult.

## Conclusions

Due to the number of variables, a detailed elaboration of the outlined problem is not possible in such a scientific publication, but we can make a firefighter's intervention safer with the partial answers and guidelines given to the problems that have arisen. The complexity of the danger source, its familiarization, the development of possible tactical steps, and their training with the participants in the intervention can be done with the help of a complete methodological guide developed in every detail, which must continue to be prominently featured in the training topics of the firefighting units of the Disaster Management.

The biggest issue when such an event occurs is to recognize in time that we are facing a dangerous situation that cannot be eradicated solely with the firefighting units of the Disaster Management. However, since they are the first to arrive at the scene, they must carry out the primary detection of the source of danger. During the time that has passed until the arrival of the KML/KSE unit suitable for radiation detection, the fire chief cannot be inactive, especially in the case of saving lives, but the interveners can do this without the use of a personal dosimeter, as explained above, only by directly risking their lives. Equipping firefighters with individual dosimeters, as well as related training, is definitely justified, even if radiological incidents rarely occur. In addition, it is very important to accurately define the event , which helps to assign the required amount and purpose of tools and resources already at the initial stage of the intervention.

**References**

[1] Ágoston Restás : Applied firefighting; University note, National Public Service University, 2015; ISBN 978-615-5527-23-4

[2] Act XXXI of 1996 on fire protection, technical rescue and the fire brigade

[3] Á. Restás : Special Decision Making Method of Internal Security Managers at Tactical Letter . In . NISPAcee , Government vs. Governance tendon Central and Eastern Europe: From Pre-Weberianism lake Neo-Weberianism ? Presented Papers from the 22nd NISPAcee Annual Conference , 2014. p.1

[4] 2/2022. (IV. 29.) OAH decree on protection against ionizing radiation and the related licensing, reporting and control system

[5] CXVI of 1996 law on nuclear energy

[6] 6/2016 . BM OKF instruction on the publication of the Firefighting Tactical Regulations

[7] 39/2011. (XI. 15.) BM Decree on the general rules of firefighting and technical rescue activities of the fire department

[8] Lajos Kátai-Urbán: Development of industrial safety laws, institutions and instruments related to hazardous plants in Hungary , Budapest: National Public University, p. 89 of 2015.

[9] Péter Pántya : Is the intervention of firefighters a dangerous business? BOLYAI REVIEW 23:(3) pp. 36-42. 2014. ISSN 1416-1443

[10] Manual for First Responders to a Radiological Emergency , IAEA, 2006

[11] Jerrold T. Bushberg : Radiation Exposure and Contamination , Merck Manuals , 2013

[12] György Köteles (ed.): Radiology, Medicina, 2002

[13] XLII of 2015 Act on the employment relationship of the professional staff of bodies performing law enforcement tasks

**Historical background on the diagnosis of mental disorders until the establishment of modern psychiatry, and its links to law enforcement**

*Johanna Farkas*

*Heim Pál National Pediatric Institute, Department of Child and Adolescent Psychiatry, Üllői út 86, Budapest 1089, Hungary*

*University of Public Service, Faculty of Law Enforcement, Department of Criminal Psychology, Ludovika square 2, Hungary*

*https://orcid.org/0000-0001-6376-4209*

**Abstract**

In this paper, we look at the history of the treatment of mental patients from prehistory to the development of modern psychiatry. Due to ideological and scientific developments, knowledge of mental illness has emerged in different contexts and its development can therefore be described as neither linear nor progressive. In the early 1950s, a 'scientific explosion' occurred with the formation of the World Psychiatric Association and the American Psychiatric Association, the publication of the first psychiatric diagnostic manual, and the discovery of the first antipsychotic. We present the Bertillon method for identifying criminals, which is based on the nosological systems of medicine.

**Keywords:** Diagnostic and Statistical Manual of Mental Disorders (DSM), History of Psychiatry, International Statistical Classification of Diseases and Related Health Problems (ICD), Mental illness, Mental health

*Corresponding author: farkas.johanna@uni-nke.hu*

## Introduction

The emergence of mental illness is thought to be ancient to humanity, and there are numerous references to it in historical sources (Segal et al., 2019). Different ideologies and aspects of scientific development have emerged in different historical periods, giving rise to different contexts and perspectives on mental disorders. In our study, we look at the characteristics of thinking from prehistory to the mid-20th century. Up to this point in time because in 1952 there was a kind of 'scientific explosion' in psychiatry. The American Psychiatric Association (APA) was formed, the first Diagnostic and Statistical Manual of Mental Disorders (DSM) was published, and modern psychopharmacology was born with the first antipsychotic (Wallace - Gach, 2008). Doctors diagnosed patients based on their individual observations and specific treatments. In the pre-psychiatric era, their theories and treatment methods were applied in isolation from each other, based on different diagnostic methods (Bogousslavsky - Moulin, 2009). Training centers and so-called Schools were set up in the most prestigious hospitals (e.g. Salpêtrière, Bedlam), which attracted the doctors we now call psychiatristsres. However, it was only in the early 19th century that the science of psychiatry became differentiated from other medical fields. The German physiologist Johann Christian Reil was the first to coin the term psychiatry in 1808 (Schochow - Steger, 2014).

**Normality versus abnormality**

During mental disorders, normal life patterns are disrupted and symptoms appear. Today, based on estimated statistics, about 10% of the total population is or has been treated psychiatrically with a diagnosis of some form of mental disorder (Nussbaum, 2013). Normality is defined as mental health, which can be described by the following criteria (APA, 2020).

(a) freedom from incapacitating internal conflicts;
(b) the capacity to think and act in an organized and reasonably effective manner;
(c) the ability to cope with the ordinary demands and problems of life;
(d) freedom from extreme emotional distress, such as anxiety, despondency, and persistent upset; and
(e) the absence of clear-cut symptoms of mental disorders, such as obsessions, phobias, confusion, and disorientation.

The definition of normality is that „normality is not abnormality". However, the normality of behavior depends on the environment and culture in which a person lives. As the definition of normality has changed over historical periods, so has the perception of mental illness. Persons who do not conform to the social norms and expectations of culture have in many cases been controlled and isolated from the majority of society so as not to upset the stability of the community.

**Treatment of mental disorders in different historical periods**

In prehistoric times (before 3000 BC), mental illness was interpreted as a manifestation of supernatural powers, which archaeologists have suggested is likely based on cave paintings and skull scans. The earliest trepanned skull finds date back to 6500 BC (Restak, 2000). It is assumed that seizures of people with chronic headaches and epilepsy were attributed to evil forces and cured by skull trepanning (Faria, 2013).

Trepanation, which was practiced in prehistoric times, remained a common treatment in antiquity, as confirmed by one of the most important archaeological sources from Jericho (circa 2200-2000 BC) in Bronze Age Palestine. Another important ancient find was acquired by the German Egyptologist Georg Ebers (1837-1898) in Luxor in 1873. The 20-metre-long Ebers Papyrus', dating from around 1550 BC, is the oldest known medical document (Rogers, 2011). The chapter entitled 'Book of Hearts' describes symptoms of depression and dementia, while other papyri describe symptoms of hysterical personality disorder. In ancient times, psychiatric pathologies were explained by demonic forces or divine will. There are also references to psychiatric illness in the Bible. For example, the melancholy of Saul, the first king of Israel, was a depressive episode, followed by manic episodes (Stein, 2011). The death of his three sons in a battle against the Philistines left him melancholic and, in despair after his capture, he committed suicide. Ancient Greek physicians sought to separate religion and medicine and therefore looked for the causes of disease in the functioning of the body. Hippocrates (c. 460-377 BC) and Galenos (c. 130-200 AD) explained mental illnesses by the disturbance of bodily fluids (Thumiger - Singer, 2018).

Following the fall of the Roman Empire (476), the ideological takeover of the Catholic Church in the Western world was typical. The fundamental view was that suffering was a just punishment for man and witchcraft was the work of the devil. Witches should therefore be persecuted, tortured, and executed. Because many people with mental disorders were presumed to be witches, many of them ended up at the stake. The mentally ill easily stood out in the community for their odd behavior and quickly became targets of the Inquisition. In the middle Ages, mental illness was also attributed to supernatural forces, reinforced by the many natural disasters that swept across Europe (e.g. plagues, famines). Although they could not explain the destruction scientifically, it was considered to be the work of the devil. In the 14th century, hospitals for the mentally ill began to be established in parallel with witch hunts. The first asylum for the insane opened in Florence in 1377 as St Boniface's Hospital, and in the same year, St Mary of Bethlehem Hospital (Bedlam) in London began to receive the mentally ill (Scull, 2016). These hospitals, however, housed not only the sick but also the poor, the homeless and the criminals, and therefore cannot be considered as mental hospitals, but as their precursors. Most patients were mostly confined against their will to these institutions, where they lived in squalor, chained to walls and in squalid conditions. Increasingly, somatogenous causes were suspected as the cause of mental illness, and so physical treatment (e.g. cutting of blood vessels, vomiting, purging, trepanation) was given priority. Witch-hunts peaked in the 16th and 17th centuries, but in isolation, the voices of those who saw the symptoms as a disease rather than a diabolical plot were heard. Reginald Scot (1538-1599), a member of the British Parliament, was one of the first to try to convince the community that the accused witches were in fact mentally ill (Kors & Peters, 2001). In 1621, Robert Burton, an Oxford mathematician, first wrote about mental illness in his "Anatomy of Melancholy". In this book, he details the causes, symptoms and treatment of mental illness based on the somatogenetic model of illness. The mid-17th century saw the start of a wave of institutions for the insane, including the Hôpital Général (La Salpêtrière) in Paris, founded in 1656, where Sigmund Freud later studied. And in America, the first mental hospital opened in Philadelphia in 1753 (Sudak, 2017). In today's terms, patients lived in inhumane conditions. They were treated as people unable to think, unable to behave according to the norm, prone to violence and tolerating pain, which was reflected in the treatment they received.

The humanist approach that emerged in the 18th century was a great improvement on the medieval approach, although there were some glaring counter-examples (Farreras, 2017). In 1692, a series of witch trials began in the town of Salem, spreading like a contagion from town to town, all the way to Boston. Two of the reverend's daughters were behaving strangely (writhing on the ground, speaking unintelligibly), which the Puritan community considered to be possessed by evil spirits. A wave of forced confessions followed, and the number of accused grew. A total of 80 people (including a policeman) were brought before the court, 20 were eventually sentenced to death and the rest imprisoned. It was only at the end of the 18th century that a change in approach to the treatment of the mentally ill occurred. In 1785, Italian physician Vincenzo Chiarughi (1759-1820) removed chains from patients, improved hygiene, separated men and women, and introduced recreational activities (Dowbiggin, 2011). Philippe Pinel (1745-1826), a French doctor, introduced similar reforms at the Salpêtrière Hospital. The changes in medical treatment in the 19th century led to the ’moral treatment’, where humane dominated care.

By the end of the 19th century, the reform movements had stabilized and the somatogenetic approach was strengthened by major discoveries, to which the work of many researchers contributed (Wallace, 2008).

**Classification of mental disorders and its links to law enforcement**

The introduction of nosology has enabled medicine to diagnose diseases, including psychiatric illnesses, according to a uniform set of criteria. Initially, the "great professor principle" was used, which was replaced by the "expert consensus principle". The latter was a scientific synthesis of medical experience and is still used today to define diseases. Both research data and clinical experience are used and diagnostic criteria are regularly reviewed by expert groups in controlled conditions. Mental disorders are classified according to two systems:

- Firstly, the International Statistical Classification of Diseases and Related Health Problems[1] was published in 1893 by World Health Organization (WHO), which includes mental and behavioral disorders among other diseases.
- On the other hand, it is based on the classification system used specifically for mental disorders since 1952, known as the Diagnostic and Statistical Manual of Mental Disorders[2] published by APA.

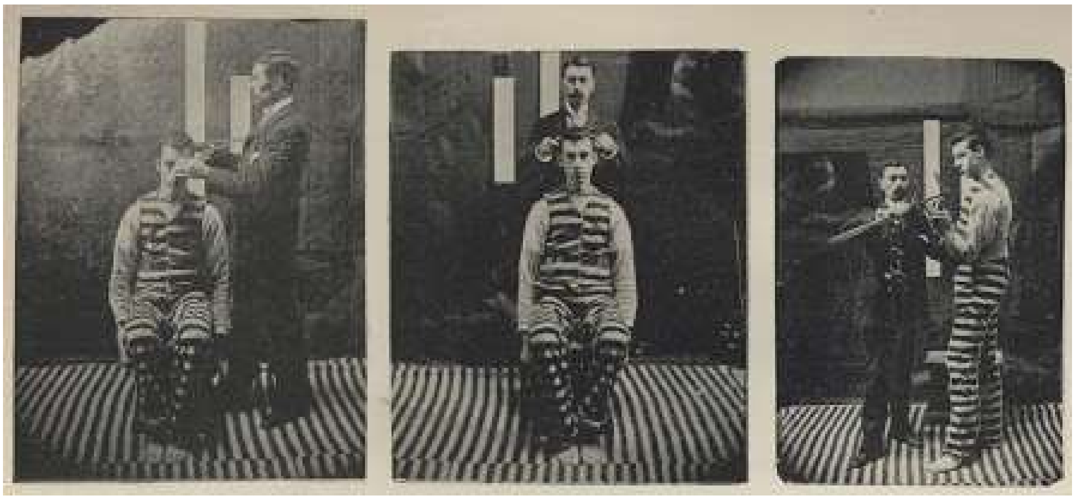
The following are the characteristics of the development of ICD in relation to law enforcement. The ICD is based on the classification developed by Alphonse Bertillon in 1893. By the end of the 19th century, there was a growing need to classify criminals according to certain categories. On the one hand, it was intended to make the identification of criminals more efficient and, on the other hand, to support the law enforcement of imprisonment (Figure 1).


*1. Figure The first anthropometric profile of Henri-Léon Scheffer, a french criminal from 1902. González-Rodrígez - Baron (2020)*

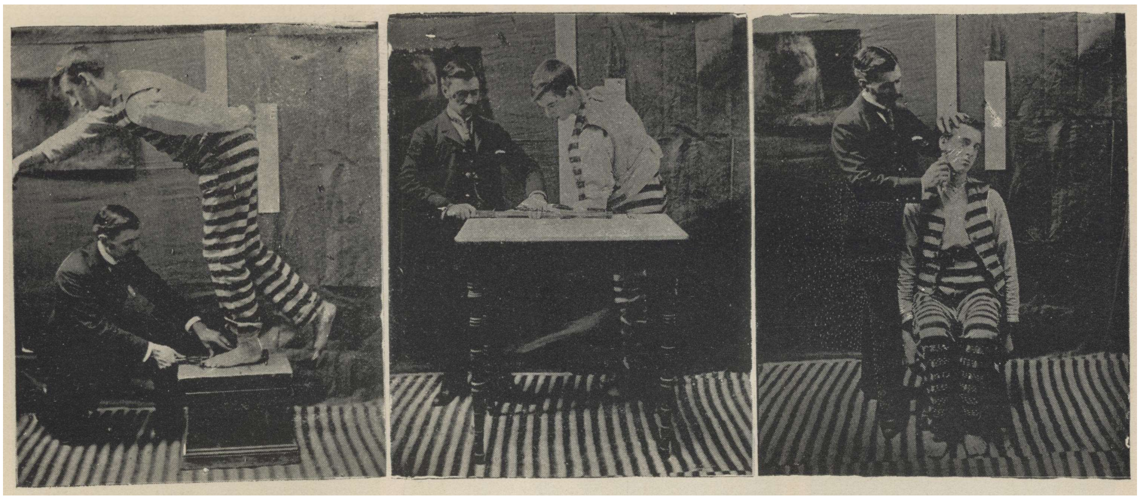
Bertillon made accurate measurements. For example, he measured the bony parts of the body, the width of the skull, the length of the leg, the size of the trunk and the left middle finger (Figure 2; Figure 3), described the colour of the hair, the colour of the eyes, and took photographs in profile and

[1] Currently the ICD-10 is in force, which is continuously revised.
[2] Currently the DSM-5 is in force, which is continuously revised.

from the side, which he recorded on cardboard. Based on the classification, he placed an offender into one of 243 different categories and further grouped the offenders based on eye and hair colour.



*1. Figure Measurement method introduced by Bertillon for the identification of criminals: method of recording the dimensions of the head and the left middle finger*
*Cleve (2014)*



3. Figure *Measurement method introduced by Bertillon for the identification of criminals: method of recording the dimensions of the left foot, left forearm, and right ear*
*Cleve (2014)*

The information written on the files helped to identify the offenders, and when they committed a repeat offence, their files were completed. This made the police's investigative work much easier. France introduced the Bertillon classification in 1882, and the State of Illinois was the first overseas to adopt it in 1887 (The New York State Division of Criminal Justice Services, 1997). The system spread rapidly, with regular training sessions organized by the French police (Figure 5). The method developed by Bertillon is still used worldwide today.

This system became the basis for the classification of diseases, and in 1893 the first ICD was created on this basis, which was overseen by the WHO in 1948, and the sixth version was published by the international organization in that year. Mental disorders were listed under the so-called "F codes", collectively known as "Mental and behavioral disorders" and numbered from F00 to F99. These F codes have also been included in the DSM-5 for ease of reference, showing the interoperability and interconnectedness of the two systems. Although the criteria in the ICD are looser and less specific for mental disorders, they are mostly used for statistical, funding, and research purposes.

## Conclusions

The introduction of nosological systems has led to the diagnosis of diseases (including mental disorders) according to uniform criteria. It has allowed for a smooth discourse between professionals, a common basis for education and research, and the implementation of scientific research. Research is still ongoing today and nosological systems are constantly being revised. Certain diseases are being "incorporated" into the system, certain diseases are being given different names and the description of symptoms is becoming more precise. For this reason, we cannot look back over the various historical periods with the knowledge we have today without any reservations, since our ancestors did not even know the causes of many diseases, let alone their existence. And the Bertillon system has reformed the way the civilized world deals with crime, applied not only by the police but also by medicine.

## References


APA (2020). *Dictionary*. Available: https://dictionary.apa.org/normality Downloaded: 2020.04.23.

Bogousslavsky, J., Moulin, T. (2009). From Alienism to the Birth of Modern Psychiatry: A Neurological Story? *European Neurology,* 62:257–263. DOI: 10.1159/000235594

Cleve, S. (2014). *The Bertillon System*. Minneapolis: American Land & Title Register Association, 1899.Available: http://historyapolis.com/blog/2014/04/23/the-bertillon-system-science-and-crime-in-the-global-information-age/ Downloaded: 2022.08.29.

Dowbiggin, I. (2011). *The Quest for Mental Health*. Cambridge: Cambridge University Press. DOI: https://doi.org/10.1017/CBO9780511993411

Faria, M. A. (2013). Violence, mental illness, and the brain – A brief history of psychosurgery. *Surgical Neurology International*. 4: 49. DOI: 10.4103/2152-7806.110146

Farkas J. (2017). A fejlődéslélektan történeti vonatkozásai. *Határrendészeti Tanulmányok*. 14(3): 117-135.

Farkas J. (2020): Mentális betegek kezelése és ellátása – hazai intézménytörténeti vonatkozások. *VIII. IRI Social Science Conference*, Štúrovo

Farreras, I. G. (2017). *History of mental illness*. In. Biswas-Diener, R. & Diener, E. (Eds), Noba textbook series: Psychology. Champaign, IL: DEF Pub. Available: http://noba.to/65w3s7ex

González-Rodrígez, J. – Baron, M. G. (2020). Forensic science in UK. Regulation of Forensic Science in England and Wales. The role of the Forensic Science Regulator. *Forensic Science Review*, 32 (1): 2-6. ISSN: 1042-7201

Kors, A. C. & Peters, E. (2001). *Witchcraft in Europe 400-1700*. Pennsylvania: University of Pennsylvania Press. ISBN: 9780812217513

Nussbaum, A. (2013). *A DSM-5 diagnosztikai vizsgálat zsebkönyve*. Budapest: Oriold és Társai Könyvkiadó. ISBN 978-963-9771-95-6

Restak, R. (2000). *„Fixing the Brain". Mysteries of the Mind.* Washington: National Geographic Society. ISBN: 0-7922-7941-7.

Rogers, K. (2011). *Medicine and Healers Through History.* New York: Encyclopaedia Britannica. ISBN: 1615303677

Segal, A. F. – Winfree, L. T. & Friedman, S. (2019). *Mental Health and Criminal Justice*. New York: Wolters. ISBN: 978-1-4548-7745-5

Schochow, M. & Steger, F. (2014). Johann Christian Reil (1759–1813): Pioneer of Psychiatry. *American Journal of Psychiatry*, 171(4): 403. DOI: https://doi.org/10.1176/appi.ajp.2013.13081151

Scull, A. (2016). Madness in historical perspective. *Canadian Medical Association Journal*, 188(10): 756-758. DOI: https://doi.org/10.1503/cmaj.151418.

Stein, G. (2011).The case of King Saul: did he have recurrent unipolar depression or bipolar affective disorder? *The British Journal of Psychiatry,* 198(3): 212. DOI: 10.1192/bjp.198.3.212

Sudak, H. (2017). *Pennsylvania Hospital' Influence on the Fields of Psychiatry*. Available: http://www.uphs.upenn.edu/paharc/features/psych.html Downloaded: 2020.04.23.

The New York State Division of Criminal Justice Services (1997). *The Bertillon System.* Available: https://www.criminaljustice.ny.gov/ojis/history/bert_sys.htm Downloaded: 2022.08.29.

Thumiger, C. - Singer, P. (2018). *Mental Illness in Ancient.* Medicine. Series: Studies in ancient medicine, 50, 38. ISBN: 978-90-04-36226-0

Wallace, E. R. & Gach, J. (2008). *History of Psychiatry and Medical Psychology*: With an Epilogue on Psychiatry. USA: Springer ISBN-13: 978-0-387-34707-3

RED

7234 5610 33

ISSN 7234561-6