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Efficient usage of hybrid hose packs during interior firefighting

Hibrid tömlőcsomagok hatékony használata zárt téri tűzoltás során

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Absztrakt:

A tűzkár csökkentése érdekében kiemelten fontos, hogy a tűz oltása minél hamarabb megkezdődhessen. A tűzoltás előkészítése során jelentős idő takarítható meg sugárvezetékek kiépítése során a szerelési módszerek változtatásával. A cikkben a szerző megvizsgálja, hogy ez a tömlőcsomagok segítségével hogyan érhető el. A szerző a szakirodalom és saját tűzoltói tapasztalatai alapján megvizsgálja, hogy milyen követelményeknek kell megfelelnie a sugárszereléseknek. Bemutatja a különböző, már használatos tömlőcsomagokat, valamint egy új, saját fejlesztésű hibrid tömlőcsomagot, valamint hogy azokat hogyan lehetne használni a magyarországi körülmények között, majd ezeket gyakorlati kísérletekkel vizsgálja. Több szcenárióban összevetve a jelenlegi magyarországi tömlőszereléseket a tömlőcsomagos szerelésekkel megállapítható, hogy az utóbbiak gyorsabbak, hatékonyabbak és kevesebb hibalehetőségre adnak lehetőséget még úgy is, hogy fele annyi személyzetet igényel.

Kulcsszavak: zárt téri tűzoltás, tömlővezeték menedzsment, tömlő csomagok

Abstract:

In order to mitigate fire damage, it is of the outmost importance to start the extinguishing of fires as soon as possible. In the process of preparing hose lines, significant time can be saved by changing the methods of laying them. In this article the author examines how this can be achieved with the use of fire hose packs and the requirements of hose line preparation by processing scientific literature and his own firefighting experience. The author also presents various hose packs already in use, as well as a new hybrid self-developed hose pack, their possible applications within the Hungarian fire service, and finally examines their use in practical experiments. By comparing the current, standard Hungarian hose line preparation methods to the use of hose packs in multiple scenarios, it can be determined that the latter are faster, more efficient and are less prone to errors, even though they require only half the manpower.

Keywords: interior firefighting, hose line management, hose packs

1. INTRODUCTION

Firefighting operations are extremely time-sensitive. Fire extinguishing measures have to be started as soon as possible to save lives and goods. This can be achieved not only by reducing the time needed for dispatching and approaching the scene, but also by speeding up the preparation of the initial attack. Therefore, it is the duty of the fire service to find all the methods by which this can be achieved.

Besides speed, efficiency needs also to be taken into account. Firefighting is physically demanding, which is why unnecessary tasks have to be reduced, so firefighters can reserve their energy for the actual intervention. At the same time, preparing for fire intervention does not only cause physical but also extreme mental stress [1, pp. 86-94]. By simplifying the methods to build up the hose lines and eliminating the chances of making mistakes, it is possible to reduce the pressure of decision-making, so firefighters can focus on other tasks.

2. HOSE LINE MANAGEMENT REQUIREMENTS

The location of the fire should be approached with an uncharged attack line as far as it is safely possible, since this is less strenuous to move with than a fully charged hose line. It always depends on the current situation when to charge the line, but this should happen at the latest before opening and entering the burning room, or ascending/descending to the floor that is on fire [2, p. 80].

But once the hose line is charged, the nozzlemen have to be able to pull in the required hose length on their own. This is less demanding when the hose reserve is well prepared, with one or two hose length (one standard hose length is 20 m) dependent on the situation. The hose reserve is best prepared before charging the line, with "U" shaped bays in the direction of entry, as this way the point of entry does not break the line. If possible, multiple bays should be implemented, so only part of the line needs to be dragged in the beginning. In stairwells, it is worthwhile to lay the hose reserve upwards on the stairs above the point of entry, so the pressurized hose will need to be pulled downwards, thus gravity will assist with advancing the line [3, p. 62]. The reserve has to be prepared with great care, it has to be taken into account how the line will behave upon charging it.

It is necessary to avoid the entanglement of one or multiple hose lines. Otherwise, the lines can be a tripping hazard, they will be difficult to pull forward and make the fire scene hard to overview [3, p. 59]. By mixing up different hose lines, the wrong line could be shut off, endangering the nozzlemen. Furthermore, loops and kinks in the hose line pose a big threat to firefighters navigating along the line, who can get lost during a retreat and run out of air. This unfortunately has already happened at the Technical University of Budapest, when three firefighters died in the line of duty on August 8th 2006 [4, p. 10]. Entanglement can be prevented by the conscious placement of the hose lines. During interior firefighting this can be achieved with the correct preparation of the hose reserve.

3. THE REGULATION OF HOSE LINE PREPARATION IN HUNGARY

The tactical and practical methods of preparing attack, base and supply hose lines in the Hungarian fire service are regulated by the General Rules of Firefighting and Technical Rescue (Tűzoltás és Műszaki Mentés Általános Szabályai) [5] the Firefighting Tactics Regulation (Tűzoltás-taktikai Szabályzat) [6] and the Equipment Preparation Regulation (Szerelési Szabályzat) [7]. Viewed as a system, these regulations should make up the standard operating procedure for firefighting operations. The General Rules of Firefighting Tactics and Technical Rescue and the Firefighting Tactics Regulation are of a theoretical nature and do not regulate the basics of interior firefighting tactics and do not set practical standard operating procedures. This would not pose a problem if

the Equipment Preparation Regulation would extensively cover this field, but this is not the case. The Equipment Preparation Regulation rigidly prescribes the preparation of hose lines in too great detail without being founded in practice, and many parts can be derived from the CTIF (Comité Technique International de prévention et d'extinction du Feu) competition regulation [8]. Most sections have not been changed in decades, only adapted to the current structure of the Hungarian fire service. Instead of defining a general frame for firefighting interventions, certain tasks of firefighters are specified in too much detail, while not giving solutions to often arising problems. For example, the increasingly used "half-squad" is only mentioned twice [7, pp. 4, and 85] without giving concrete solutions for equipment preparation by them. The biggest problem, though, is that interior interventions are only covered by two sentences [7, p. 4] while their characteristics completely differ from the hose line preparation covered in the Equipment Preparation Regulation.

4. HOSE PACKS

Besides the individually equipped rolled hoses, many countries around the world are also using pre-connected and folded hose lines, which can have a significant tactical advantage if used correctly [9]. This practice is most common in the United States of America, but there have already been examples of this in the Hungarian fire service as well [10, pp. 106-107].

Hose packs were originally developed in the United States of America for firefighting in high rise buildings, so an attack line could be easily prepared from a standpipe. This method raised the attention of many fire departments in Europe as well, as an easily manageable hose-reserve could be formed when building off a base hose line [2, p. 83].

One hose pack consists of one or two "C" sized hoses held together by straps secured with adjustable buckles or Velcro. Size should be limited to 1.3 to 2 m [11, p. 3]. It can easily be transported by laying it over the shoulders or the SCBA (self-contained breathing apparatus) air tank, while the latter solution leaves the hands open for ladder climbing [12, p. 427]. It is recommended to already attach the nozzle to the hose, as this way it is impossible to forget it.

1. Figure Hose pack carried over the shoulder and the SCBA Air tank, source: picture by the author

4.1 Folded hose pack

In this variant, the hose is folded back and forth onto itself, leaving the couplings outside on opposite sides. Before charging the lines, the straps need to be removed and one or two folds need to be stretched out, so water can easily fill the hose line. To make this easier, these folds should be left a few centimeters longer, as that makes grabbing them for stretching easier [3, p. 63]

2. Figure Folded hose pack and preperation as hose reserve, source: picture by the author

4.2 Coiled hose pack

A coiled hose pack is folded into a spiral, where the pre-connected nozzle is on the inside of the coil. The great benefit of this solution is that after removing the straps, the line can be charged without the need of further stretching of the hose line. Water will fill the line and form loops that fit into a relatively small area. This makes it ideal to use in narrow corridors and tight stairwells, where 20 or even 40 m of hose-reserve can fit with this method [11, p. 3].

3. Figure Charging a coiled hose pack [3, p. 63]

Pulling the pressurized line takes less effort than a traditionally prepared charged hose line, as the distance for dragging is shorter. While pulling the hose line, it will twist, therefore it is not recommended to do so with an uncharged line, but it does not pose problems when it is charged. The formed loops can be leaned onto the wall to be kept out of the way, and they can be rolled like a wheel to the other end of the line [3, p. 63].

4.3 Hybrid hose pack

The hybrid hose pack was developed by the author by combining the folded and the coiled hose pack into one bundle. The straps with which the individual hose packs are secured are sewn together into a harness system. Depending on the tactical needs, either of the two or both hose packs can be removed from the harness and be prepared for charging the hose line. If only one hose pack is used, the other is still secured by the harness and can be used at a later point. If both hose packs are used, the single piece harness is less likely to be lost than individual straps.

4. Figure Hybrid hose pack assembled, source: picture by the author

This hose pack combines the advantages of both types of hose packs, maintaining maximum flexibility by adjusting to different tactical needs, while it can be handled by a single firefighter.

5. Figure Harness for the hybrid hose pack, source: picture by the author

5. EXAMINATION OF POSSIBLE USE IN THE HUNGARIAN FIRE SERVICE

Per the Equipment Preparation Regulation, the first and second firefighter each take one rolled hose, as the standard length of the first attack line consists of two hoses. Swapping out the individual rolled hoses for hose packs, the preparation of hose lines in an interior environment could potentially be simplified. The effectiveness of using hose packs can be determined by comparing them in timed experiments to the standard methods of hose line preparation described in the Equipment Preparation Regulation.

5.1 Use of two hose packs instead of two individually rolled hoses

To maximize the tactical advantage, a folded and a coiled hose pack should be used. Using two coiled hose packs restricts using them only at the point of entry, while using two folded hose packs does not offer a significant advantage over using individually rolled hoses. After attaching it to the distributor at the end of the base hose line, the folded hose pack can be stretched uncharged to the point of entry, or it can be used as a hose-reserve. At the point of entry, the coiled hose pack can be attached to the hose line and is ready to be charged. If the distributor is at the point of entry, and it can be safely determined that 20 m of hose is enough (for example a small apartment), the coiled hose pack can be directly attached to the distributor.

5.2 Practical experiments using two hose packs

In his prior research, the author conducted timed experiments at the 2nd District Fire Department of Budapest, comparing the individually rolled hose and hose pack preparation methods three times with two firefighters participating in each method [13, pp. 79-90]. According to the scenario, the distributor was on the floor below the point of entry into the burning compartment. The hose line has to be built up using two hoses, bringing the total length to 40 m, and the hose-reserve has to be laid onto the stairs and the corridor before the burning room. In both methods, two firefighters each prepared one of the two hoses before connecting them together. In all the experiments, extra care was taken to appropriately prepare the hose-reserve without kinks in order to be easily dragged even if charged. Time was measured from giving the order until the line was ready to be charged upon request.

	2 individually rolled hoses	1 folded and 1 coiled hose pack
1. experiment	58 s	35 s
2. experiment	67 s	29 s
3. experiment	53 s	26 s
Average	59.3 s	30 s

1. Table Timed results of two individually rolled hoses and two hose packs, source: edited by the author

Using hose packs takes almost half the time – 50.6% – compared to preparing the hose line with individually rolled hoses. This is mostly achieved because the coiled hose pack does not have to be arranged before charging the line, but arranging the folded hose pack is also easier and less prone to error than preparing a rolled hose.

5.3 Use of a hybrid hose pack instead of two individually rolled hoses

When using a hybrid hose pack, a single firefighter is able to carry and prepare the hose line. This frees up the second firefighter to assist the rest of the fire crew with preparing the base hose line or the water supply, while the first firefighter is preparing the attack hose line. This is especially advantageous with "half-squad" sized crews in the beginning of firefighting before other fire crews arrive at the scene to assist.

For the biggest time savings, it is recommended to pre-connect the two hoses in the harness. After removing the harness, connecting the open coupling to the distributor, and arranging the folded hose pack, the hose line is ready to be charged. If the point of entry (where the line needs to be charged) is further away from the distributor, the firefighter removes the straps from the folded hose pack and attaches it to the distributor. Both hose packs are then placed over the shoulder with the unsecured segment inside, held in place by the neck and the other, still secured hose pack. During advancement to the point of entry, the hose will fold unhindered onto the ground, laying itself into the hose line. Once the point where the line should be charged is reached, the firefighter arranges the rest of the unsecured hose, unties the other hose pack and asks for the line to be charged.

It needs to be noted, that for safety reasons the second firefighter has to rejoin the first firefighter before entering smoke-filled areas, so that they can safely carry out reconnaissance, operate and drag the attack line, as well as locate and extinguish the fire together.

5.4 Practical experiments using a hybrid hose pack

In his current research, the author conducted timed experiments at the 10th District Fire Department of Budapest, comparing the preparation of two individually rolled hoses by two firefighters to the preparation of a hybrid hose pack by a single firefighter in two different scenarios. Each method and situation was tested three times. In all the experiments, extra care was taken to appropriately prepare the hose reserve without kinks in order to be easily dragged even if charged. Time was measured from giving the order until the line was ready to be charged upon request.

In the first scenario, the distributor was placed at the top of the stairs, right in front of the point of entry. A hose reserve consisting of a 40 m hose line had to be prepared for charging and entry by laying the hose on the stairs or the small space in front of the door. In the traditional method, two firefighters rolled out two hoses, connected them, the nozzle and the distributor and arranged the hose line for charging. With the hybrid hose pack method, the harness was removed, the hose line was connected to the distributor and was arranged by a single firefighter.

	2 individually rolled hoses	1 hybrid hose pack
1. experiment	48 s	33 s
2. experiment	43 s	30 s
3. experiment	44 s	29 s
Average	45 s	30.6 s

2. Table Timed results of two individually rolled hoses and two hose packs, source: edited by the author

The use of the hybrid hose pack was faster by 31.9% than the traditional method. This is mostly achieved because only one connection needs to be made, the coiled hose pack does not have to be arranged, and the folded hose pack is easier to arrange.

In the second scenario, the distributor was on the floor below the point of entry into the burning compartment. The hose line has to be built up using two hoses, bringing the total length to 40 m and the hose reserve has to be laid onto the stairs and the corridor before the burning room. In the traditional method, two firefighters rolled and laid out the hoses, connected them, the nozzle and the distributor, and arranged the hose line for charging. With the hybrid hose pack method, the point of entry was approached with the folded segment unsecured and attached to the distributor, then the harness was removed from the coiled segment and the firefighter called for the line to be charged.

It has to be noted that the location at the 10th District Fire Department was more complex, so the measurements cannot be directly compared to the ones conducted at the 2nd District Fire Department.

Figure 6: laying of the hoseline with the hybrid hose pack, source: picture by the author

	2 individually rolled hoses	1 hybrid hose pack
1. experiment	93 s	61 s
2. experiment	100 s	50 s
3. experiment	82 s	58 s
Average	91.7 s	56.3 s

3. Table Timed results of two individually rolled hoses and hybrid hose pack (scenario 2) Source: edited by the author

The use of the hybrid hose pack was faster by 38.6% than using two individually rolled hoses. This is mostly achieved because only one connection needs to be made, the coiled hose pack does not have to be arranged, and the folded hose pack laid itself during advancement without the need for further arrangement.In both scenarios, the hybrid hose pack proved itself to be significantly faster than the standard preparation methods described in the Equipment Preparation Regulation. This faster preparation time was achieved by half the manpower, while also being simpler, more practical, and less prone to error than using two rolled hoses.

6. CONCLUSIONS AND FURTHER RECOMMENDATIONS

In this article the author summarized the requirements and regulations of hose line management in the Hungarian fire service. Hose packs were presented as an alternative to the standard hose line preparation using individual rolled hoses. Additionally, the hybrid hose pack developed by the author was also introduced as a combination of two hose pack variants. After examining how these hose packs could be used within the tactics of the Hungarian fire service, testing was conducted comparing the use of hose packs to standard preparation methods in different scenarios. The tests proved that a significant, an almost 50% improvement could be achieved using two hose packs instead of two individually rolled hoses. Using the hybrid hose pack offers an improvement of 31.9% to 38.6% over the standard method while only using half the manpower. Furthermore, practical experience shows that using hose packs is less prone to error and the created hose lines are easier to handle.

Although according to the test results the benefits of using hose packs are clear, these can only be achieved if they are prepared thoroughly. While they can be assembled manually, this process can

be tedious and complicated for some firefighters. Purpose-built jigs can alleviate these problems by ensuring that the hose packs are always the right size and by speeding up the process. This makes reassembling the hose packs right after use on the fire scene not ideal, so the easiest solution is to collect the hoses in traditional rolls and rebuild the packs back at the firehouse.As the hose packs are a new introduction to the Hungarian fire service, there is no solution yet for storing them on a standardized fire engine. They should be easily accessible for the nozzlemen, so keeping them either in the cabin or in a right side compartment is ideal. Since the assembled hose packs are still flexible, they can either be draped over the safety bar in the cabin, laid flat on the cabin floor or folded into a compartment, but in either case they have to be secured against unwanted displacement in some form to prevent injuries and damages.Further testing is recommended to test hose packs in even more scenarios. In addition, it has to be examined how the use of hose packs can [9] be introduced into the Equipment Preparation Regulation and into the training program of the Hungarian fire service, as well as the most optimal solutions to assemble and store them. To achieve this, the author seeks cooperation with the Disaster Management Training Centre.

7. REFERENCES

[1] Á. Restás, „Police, Soldier, Firefighter in Emergency: Decision Making Method is Special," *Security Dimensions: International & National Studies,* 2014, vol. 12, no. 12, pp. 86–94.

[2] B. Lüssenheide and H. de Vries, "Hula Loop", *Feuerwehr-Magazin*, 2010, vol 8, pp. 80-85.

[3] S. Faulstich and J. Helpenstein, "Verhalten im Innenangriff", F*euerwehr-Magazin Sonderheft,* 2008, vol. 1, p. 62.

[4] Önkormányzati és Területfejlesztési Minisztérium, Országos Katasztrófavédelmi Főigazgatóság, "*This unfortunately already happened at the Technical University of Budapest, when three firefighters died in the line of duty on August 8th*", 2006, p. 10.

[5] *39/2011. (XI. 15.)* BM rendelet a tűzoltóság tűzoltási és műszaki mentési tevékenységének általános szabályairól, [Online]. Elérhetőség: https://njt.hu/jogszabaly/2011-39-20-0A (2023.10.27.)

[6] BM Országos Katasztrófavédelmi Főigazgatóság, 6/2016. (I. 24.) *Tűzoltás-taktikai Szabályzat és a Műszaki Mentési Szabályzat kiadásáról,* 1. Appendix. BM Országos Katasztfavédelmi Főigazgatóság, 2016. [Online] Elérhetőség: BM OKF Intranet normatár (2023.10.27.)

[7] 3/2015. (VI. 8.) BM OKF utasítás, *A tűzoltóságok Szerelési Szabályzatáról,* Appendix 1. 2015, p. 4, 85. [Online] Elérhetőség: BM OKF Intranet normatár (2023.10.27.)

[8] CTIF, „Wettbewerbsordnung," 2011, vol 7, [Online]. Elérhetőség: https://www.feuerwehrverband.de/app/uploads/2020/05/Wettbewerbsordnung_Trad_IFWB_2011_2012_Teil_1.pdf, (2023.10.27.)

[9] P. Pántya, „Fire, Rescue, Disaster Management. Experiences from Different Countries," *Academic And Applied Research In Military And Public Management Science,* 2018, vol. 17, no. 2, pp. 77–94.

[10] Belügyminisztérium Tűzrendészet Országos Parancsnoksága, *Szerelési szabályzat,* Budapest, 1969, pp. 106-107.

[11] B. Lüssenheide, „Verbesserung des Schlauchmanagement - Lösungsvorschlag Schlauchpakete. 2007. [Online]. Elérhetőség: https://slidex.tips/downloadFile/verbesserung-des-schlauchmanagement-lsungsvorschlag-schlauchpakete, (2023.10.27.)

[12] G. Corbett, Fire Engineering's Handbook for Firefighter I and II., 2009, p. 427.

[13] P. Tomka, „A tömlőcsomagok magyarországi alkalmazásának lehetőségei zárt terű tűzoltás során," *Védelem Tudomány: Katasztrófavédelmi Online Tudományos Folyóirat,* 2018, vol. 3, no. 3, pp. 79–90.