HOW WE ACT IN THE HELSINKI RESCUE DEPARTMENT IN THE CASE OF UNDERGROUND METRO FIRES

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ABSTRACT
Helsinki, the capital of Finland has a metro transport system. It is all together 26 km long including tunnels about 10 km. The tunnel system is so called twin tube but has openings to next tunnel every 150 – 200 metres which makes smoke ventilation very complicate to operate during underground fire. Tunnels and metro stations are situated very deep underground. The system has been built mainly in the 80’s and 90’s so there is a lot of technical safety equipment to help City of Helsinki Rescue Department manage in large operations. Progressive computer-guided assistance for fire officer gives him a real time information about what is happening in the tunnel.

Although a lot of money and time has been invested to the safety of metro it is possible that the worst can happen. Also the human behaviour can either cause the accident or make the situation worse. That is why the Helsinki Rescue Department has to prepare to the accidents in metro.

Operationally speaking it is essential that all rescue forces are well trained and equipped with suitable tools. Leading many rescue units in a rapid accident effectively is a very challenging task for fire officers. They must be familiar with underground surroundings and the importance of smoke ventilation. Planning beforehand all standard operational procedures and testing those in reality are the key of success.

Keywords: Metro, underground fire, smoke ventilation, standard operational procedures, technical safety equipment

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1. GENERAL INFORMATION ABOUT THE METRO OF HELSINKI

The Helsinki metro transport system is 26 km long. Tunnel sections are about 10 kilometres long build in hard rock and going quite deep, the deepest point is over 30 metres underground. Tunnels are so called twin tubes but the openings and exit ways between those tunnels are open every 150-200 metres so for example smoke can fill both tunnels easily. That is so because earlier we thought that it is better for passengers to have a short exit way to next tunnel in the case of emergency. Tunnels are quite wide. You can walk beside the metro car easily. In the narrowest point is 0,7 metres free space but generally over 1,5 metres.

The Helsinki metro system was mainly planned in the 70´s and built in the 80´s and 90´s. The traffic started 1982 so it is a quite young system. In the oldest parts of metro tunnels there were no official regulations about safety. All has been built after discussion between Communal Traffic Company and the Rescue Department. In the last ten years there has been a lot of improvements in the metro and its safety systems.

Metro trains are quite large. Nowadays the traffic company is using combination with four cars so the capacity is about 800 passengers. The maximum capacity with six cars is 1200 passengers. The metro trains are running with three minutes interval in rush hours but in the next August it will be changed to 2,5 minutes. Last year there were about 53 million passengers using the Helsinki metro.

There have been only few real fires in the Helsinki metro during the recent years. There are about 30 alarms yearly in the metro. Most of them caused by maintenance staff. Ambulances are visiting metro stations daily.

2. TECHNICAL SAFETY EQUIPMENTS

2.1 Metro stations

Every metro station has automatic fire alarm system connected to the Rescue Departments alarm centre. Smoke detectors or heat detectors are situated in platforms and all places where passengers can go. Also all technical rooms are equipped with automatic alarm system. Sprinkler system is in all exit ways in stations. Traffic control centre has cameras which allows visual detecting. All underground stations have guards with radios so they can do a lot in case of fire, too. They are trained by the Rescue Department.

2.2 Tunnels

In tunnels there are nowadays no fire detecting system but it is under construction and will be ready until July this year. The system will be based on new cable technology and will be connected to computer aided smoke ventilation system so that firemen can easily see from the computer monitor in every metro station what is the current wind speed and direction in the tunnel and where is the fire. That has been the most difficult thing to detect for the rescue personnel who is trying to use smoke ventilation right because of several tunnel openings going to the surface and air temperature difference specially in wintertime between the tunnel and open air.
2.3 Smoke ventilation

The smoke ventilation system is based on all information we can get mentioned before. After detecting the situation it is possible to use smoke fans situated in metro stations and in every shaft (at least one between two metro stations). It is also possible to use smoke doors to shut down the running tunnels. Every underground metro station is equipped with four smoke doors.

The purpose of smoke ventilation is on the other hand to save the passengers and on the other to improve possibilities to firemen to do their job.

2.4 Communication systems

The communication systems have always been the weakest point when emergency personnel has operated in underground circumstances if they don’t have special systems with them.

All underground tunnels and stations are equipped with so called leaky feeders giving rescue personnel two channels to their radios. The radio system is the same as metro trains and guards are using. Metro has given those radios to the Rescue Department so the only use for these radios is in metro not anywhere else.

Now they are building a new digital radio system to the metro. It is based on TETRA technology. The Helsinki Rescue Department starts using that system 1.4.2002. That system is going to be a new authority radio system to whole Finland during this year and few next years.

To be on the safe side there is also so a called field phone system and ordinary phones planned to use by firemen if there are some problems with the radio systems.

2.5 Water mist

In the tunnel there is situated 110 mm water pipe line with 6 bar pressure for the rescue personnel. It is insulated (non-flammable and coated with plate) and warmed by electricity because of our winter time. Hydrants are situated in every 100 metres.

3. STANDARD OPERATIONAL PROCEDURES IN THE CASE OF METRO FIRE

3.1 City of Helsinki Rescue Department

The Rescue Department has a decentralised unit system. It has facilities and bases in various districts of Helsinki. The operative section of Helsinki Rescue Department is responsible for daily fire, rescue and medical stand-by duties. Operational staff is about 400 men in addition there are also 200 volunteer firemen divided in 15 volunteer fire brigades. In Helsinki there is eight rescue stations. Each rescue station has two basic units and at least the capabilities required for all first-aid measures, i.e. a rescue unit capable of independent extinguishing and rescue duties and medical and damage control, and an ambulance unit for medical rescue duties.
If we have the information of fire or smoke in underground section of the metro we will alarm immediately so called second grade. That means:

- 2 fire officers
- 4 fire engines
- 2 heavy rescue tenders
- 1 tender with 10 000 litres water
- 1 heavy control unit
- 1 emergency medical services
- 1 medical supervisor
- 5 ambulances

Altogether that means about 50 men. When it is clear that it is a question of a big accident the system will automatically alarm more units on scene. All underground metro stations are situated very near to the rescue stations so the driving time to the nearest station is only 1-3 minutes.

Main forces goes to that metro station where the fire is but in the same time at least two units divides up to the next stations too (Figure 1). That is because we are afraid of the rapid smoke movement to the next metro stations.

**STANDARD OPERATIONAL PROCEDURE**

Having gathered further information the rescue leader perhaps have to make a new grouping of rescue forces depending on the real situation so that we have enough strength in the right place. In the same time he has to create capable leading organisation on the scene (Figure 2). That is very demanding task in the most urgent period of the rescue operation. In the same time he must order more units and men to scene (3. Grade, 4. Grade, 5. Grade) and be aware of the possible collapse of the tunnel if the fire is threatening and lasts too long.
3.2 Smoke ventilation

One of the most important things during the rescue operation is how to handle the smoke removal so that passengers can come out from the tunnel and metro stations. Without successful smoke ventilation it is almost impossible for firemen to enter in the tunnel. The whole idea is to create wind speed in the tunnel to 2 m/s and then enter downwind to the fire.

It is essential to know what is the normal wind speed and direction before you try to begin control the smoke. The normal wind in the tunnel can be up to 3 m/s after the metro trains has stopped. The influence of wind starts after one minute after the trains have stopped. The normal wind speed varies a lot depending of the season. In the winter time nearly all trellises and doors are shut down because of the cold air so the influence is smaller. We tried to find out the relationship between the weather on the ground and tunnel but did not manage to analyse the correlation.

Our solution was to build a system in the tunnels and metro stations where in the case of emergency the rescue leader can have the real time information about the situation underground. The system is based on wind detectors which are situated in the tunnels and stations. All information can be seen from computer screen in every metro station. The view is simple: tunnel map where coloured arrows shows the speed and direction of wind.

- light blue arrow = no wind or less than 0,5 m/s
- blue arrow         = you can fight against the current wind, 0,5 – 1,5 m/s
- red arrow           = you cannot fight against the wind, over 1,5 m/s

In the same map is also shown all smoke fans, smoke doors and water pipe lines etc. Every metro station has especial room for the Rescue Department where all safety information is gathered.

With that system we can have reliable information for decision-making very quickly. Also a very good point is that by this system we can place our own units easier and make faster decisions about our tactics. We call this system Computer Guided Assistance for rescue leader.
The system is planned so that if in the case of fire heat damages some gables or wind sensors it does not break the whole system. Now when we know the wind direction the only thing is to find out where the passengers are and where are they going and what are they doing. Where are injured people and how many are they? That must be known very rapidly. Our principle is that we do not start smoke ventilation before we have enough information about the whole situation going on in the tunnel.

3.3 Special rescue equipment

Because of the metro our rescue units have special equipment with them all the time. Also in metro stations there is stored some more necessary equipment. We are prepared for long distance smoke diving with pressured air breathing apparatus (2 x 6,8 litres, 300 bar), and we have the possibility to use guidance rope (700m) so that firemen can not get lost. Because of the metro train is using 700 V electricity system it is very important to ground it as soon as possible. That is the first task when firemen are entering the rails. We have also special jack for lifting the metro train. The reliable radio system for metro tunnels and other communication systems makes modern leadership possible to rescue leaders and fire officers. It also helps firemen occupational safety in a very demanding circumstances.

However the best equipment for firemen is training in metro environment before the fire or accident. Our training is based in several forms:

- individual training of special rescue equipment
- unit training and familiarise to stations and tunnels including smoke ventilation
- large scale training with real units and men and passengers three times per year
- theoretical lessons about metro and the tactics of rescue operations

3.4 Emergency medical service

All firemen in the Helsinki Rescue Department has the education and practical knowledge of taking care injured people. Firemen are working in 24 hour shifts. From that they are 12 hours in rescue units and 12 hours in ambulances. That makes our operations easier to handle because we can flexibly use all multiskill firemen in right place when needed. For example if there is need for more ambulances we can use rescue units instead because our rescue units are equipped with the same medical instruments as ambulances only stretchers are missing.

Fire in the underground part of metro is always very severe situation. On the other hand of course for the passengers but also for firemen. Even if the Municipal Traffic Company and the Rescue Department are working together to increase the safety in metro all the time it is still possible that something unexpected can happen. It is not enough if all basic safety systems are working well (exit ways and signs, safety lighting etc.) because with the passengers there are always disable and old persons or children who needs extra help to get out. Also the human behaviour in the case of fire is very often very surprising in safety meaning. That is why rescue operations must be planned and trained often. In the operational situation firemen do seldom mistakes, all the mistakes have been done before if the preparation of difficult situation has been underestimated.