Fire fighter Training in enclosed spaces- Experiences of Hagerbach Test Gallery, Switzerland

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ABSTRACT

Tunnel accidents are challenges for all rescue services specially fire fighters. Fire fighters have to rescue persons and extinguish fires in a situation with partly unknown boundary conditions. This report is concerned with a comprehensive integrated training programme for the fire brigades covering tunnel insets.

At the trainings the participants first will be introduced to emergency situations and the arising dangers and risks through various exercise scenarios. Training starts with basic procedures, such as communication whilst in tunnels and reconnaissance of emergency scenes involving unspecified - possibly even toxic - substances, whilst in artificially smoky tunnels.

With real fires under controlled conditions, the response units were introduced to dealing with rising temperatures and an increase in smoke in the tunnel. To this end realistic tunnel accidents were created in the 400m fire test gallery of VSH Hagerbach Test Gallery Ltd. The exercises carried out clearly demonstrated the necessity of such courses, since even fire fighters behave differently working under stress in a tunnel environment, than in the open. By the same token, questions which above ground do not arise in the same way take on added significance. Examples of this are communications, reconnaissance of the accident site and saving people at a great operational depth.

FIRE FIGHTER, TRAINING, TUNNEL

INTRODUCTION

Underground construction has been on the increase across the world – there is huge demand for good quality transport infrastructure, both road and rail, and it can often only be met with extensive subterranean construction: in heavily populated areas the only remaining room for infrastructure is underground. In many new industrializing countries, new infrastructures can only be achieved through tunnels or underground galleries on account of the topographic circumstances.

Along with the technical challenges of construction, the demands on emergency services are constantly growing: the infrastructure and the electro-mechanical equipment involved in underground travel routes are becoming ever more complex, and the decision-making processes are increasingly supported by electronic aids (eg control structures). The expectations of society and road users for speedy and optimally successful rescue operations are growing rapidly, and this places emergency services under additional pressure.

Despite all of the technical advances made in recent years, the empirical component still plays a major role in rescue operations. Nor will this change in the future: the interpretation of events, their development, and the introduction of special rescue and protection measures not only requires solid theoretical knowledge, but also a good measure of experience – a quality which can only be acquired

through practice. It is impossible to imagine rescue services in underground construction without practical experience.

This practical experience demands that the training process must at a given point involve real fires. Only in this way can the rescue forces expose themselves to the special demands and properties of underground fires, and learn how to deal with them.

The majority of events in tunnels which require the presence of rescue and response forces is fortunately not connected with fire. The training for such occurrences under real conditions is thus at least as vital as the basic fire brigade training, and that means there is also an increasing necessity for training and education in crisis management. But even for rescue services time aspects are essential and have to be trained.

When considering the training of rescue forces for tunnel operations, it must always be borne in mind that the rescue operation represents the last link in a chain of protective measures which must be taken to prevent an accident or to minimise the effects of one. In the following we will not concentrate any further on the protective measures based on construction and organisation.

TRAINING CONCEPT

For all trainings some basic rules have to be trained and which have to be applied to all situations of the insets. These are:

- self protection of the rescue forces
- protection of the tunnel construction
- searching every square meter for injured persons

The above mentioned rules sound simple. Experiences of trainings have shown that in reality it will be difficult to obtain the rules when fire fighters are under stress of an accident. Especially the first point of self protection has to be reminded to the very ambitious rescue forces.

Looking at the tasks for the rescue forces' operations in a tunnel probably constitute some of the most demanding tasks with which fire brigades are confronted. The great difficulties result from the special circumstances of the tunnel environment such as

- the distance to the combat zone
- the duration of the operation
- high temperatures, since the heat cannot escape freely
- intensive smoke and reduced vision
- unknown freight on the vehicles
- restricted communication

This makes the training for tunnel operations specialist training which builds on basic extensive fire brigade skills. The training is focussed on the response team as a whole, not on the individual members, as the only way to deal with a tunnel operation efficiently and safely is by means of seamless cooperation.

With this as a given, it is advisable to fit the training programmes to the needs of each response situation. These are, for example:

- the tunnel system (single or double line)
- duration of the alarm

- organisation of the response
- depth of the operation
- water supply (distance from hydrants, amount of water)
- communication capacities
- protection targets

The points above should already be taken into account in the planning and design phase of a tunnel, so that the construction and any rescue operations complement each other.

Temperatures of 1000°C and above, as set out in the specifications for the fire protection in construction, are not bearable for humans and also for fire fighters. Should such temperatures arise in the centre of a fire, the site must be cooled from the sidelines, so that the response forces can work their way to the source of the fire through temperature of no more than 300 °C.

TRAINING PROGRAMME

During training the participant is led through the problems of tunnel operations in several steps, and develops the correct behaviour patterns.

A first module – providing the bases for all further activities and also the safety of the rescue forces - deals with the identification and assessment of the accident scene. In an accident scenario involving a delivery vehicle, the composition of the contents must be judged in order to ascertain what further rescue measures are appropriate. It is particularly important to assess whether poison or any other noxious substances which would place the rescue teams in danger are present.

This reconnaissance proceeds through a preliminary control, which is carried out immediately after the alarm is raised. Already at this stage the safety of the response forces is to be guaranteed by way of appropriate protective measures, such as taking along an extinguisher. As with all other operations, communication with operation command is to be constantly maintained. This can be an additional problem just by going through a transversal tunnel if the tunnel's radio communication system has been damaged in the accident.

People in the accident zone must be rescued while at the same time ensuring the safety of response staff and patients.

In a further module people at great operational depths and in smoky areas are to be rescued. In this situation orientation and communication pose the greatest problems. The performance of the response forces can be significantly improved with the help of a thermal imaging camera. If the picture from the camera is directly transmitted to the response unit's command, the latter can respond quicker to the evolving situation. There are however limits to the use of thermal imaging cameras, if parts of the room are invisible due to structural features, or if the room is all at the same temperature so that no contrasts can be seen.

Operational exercises in sections of tunnel artificially filled with smoke serve to help recognise the difficulties of tunnel operations and to teach the correct response. The confined conditions of a tunnel system, with cross-connections and secondary areas such as ventilation and transformer stations, etc. make communication considerably more difficult. Radio contact can be maintained no more than two branches into the tunnel system at best, and must be maintained by means of appropriate measures such as relay posts. Once the significance of the communication problem in underground facilities is recognised, it is basically possible to bring about improvements by installing appropriate equipment.

With air supply restricted to breathing equipment the range of movement of the fire services is greatly reduced. Even if every 250m in the tunnel there are cross-connections which give access to the other

tunnels, there can in a worst case scenario be an operating depth of 250m, which is very difficult to cope with. The exercises in saving individuals whilst using breathing protection in real tunnel sections with artificial smoke made all participants very aware of this problem.

Simulated vehicle fires with real heat and smoke introduce course participants to the ancillary conditions of a fire in the tunnel. Unlike outside, most of the heat cannot disappear upwards. The heat is reflected by the roof and walls of the tunnel generating intense heat in the driving area. If the tunnel structure is not protected by a fire protection system, the response forces additionally have to reckon with concrete potentially cracking, massively damaging the structure of the tunnel. In extreme cases this can lead to the collapse of structural components.

In the final exercises the contents of all of the other exercises are combined and the response teams are confronted with a staged event which must be dealt with on their own, whilst under the supervision of the instructors. The crisis must be mastered in small teams and within a very confined space. The teams must simultaneously save individuals, fight fire, cool the structure and if needs be prevent noxious substances escaping.

The response techniques depend on the capabilities of each fire brigade. Thus foam and water extinguisher systems are used, but also special systems such as CAFS (Compressed Air Foam System). Only in practical use do the advantages and disadvantages of the different systems become evident. The decisive factors are:

- transport investment
- time required to get the equipment ready
- effectiveness in extinguishing
- cooling effect

Although these are “only“ exercises, the response forces are pushed to the limits of their mental and physical capacities. Experiencing the limits of their own tolerance in a realistic environment allows participants to be sure that they do not overstretch themselves in an emergency, putting themselves and their colleagues in unnecessary danger.

Briefings after each course lead to a discussion on the experience gained and how the fire fighting forces can optimise their approach.

CONCLUSIONS DRAWN FROM THE TRAINING COURSES TO DATE

The experiences gained from the different operational exercises have shown that it is vital for response forces to train under circumstances which are as realistic as possible. Working with breathing equipment always poses an additional difficulty. The smoke and heat conditions in tunnels are difficult to compare with experiences above ground, where operating depths are usually very limited. Only those who have known ”in peacetime“ what it means to maintain communication lines, to recognise their physical and mental limits, to use their equipment quickly and efficiently under difficult circumstances, will be successful in a crisis.

Exercises show participants the possibilities and the limits of fire fighting in tunnels and more often than not take the fire fighters to their personal limits. The personal experience gained from these realistic exercises is of significant importance to the fire fighters. It allows them to put the knowledge gained from their training into practice in a real emergency and bring it quickly under control.