



National
Operational
Guidance

Hazard

Tunnels under construction



NFCC
National Fire
Chiefs Council

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Hazard - Tunnels under construction

Hazard Knowledge

This guidance focuses on tunnels under construction, along with the refurbishment of existing tunnels. The information may be relevant to disused or decommissioned tunnels.

Fire and rescue services should ensure that all reasonable arrangements are made to liaise with those constructing the tunnel system and should review Site-Specific Risk Information (SSRI) and response plans so that they reflect the current situation.

As construction nears completion, it will be necessary to re-evaluate information previously collated and to work with infrastructure managers, tunnel user representatives, regulators and other multi-agency partners to ensure that the final emergency plan is validated. Plan validation should take place before commissioning exercises and the official opening, through exercises using the access and systems that are in place.

Many aspects of the construction of a below ground structure fall outside the knowledge and skills of fire and rescue service personnel. It is recommended that fire and rescue services liaise with experts to ensure that proposals fulfil statutory duties, legal requirements and specific construction standards and that the services required to support a fire and rescue service incident are established.

Tunnels under construction can present challenging and unusual hazards such as:

- Limited access and egress
- Extreme travel distances
- On-site machinery
- Presence of hazardous materials and explosives
- Complex layouts
- Compressed air working

Compressed air working

Work in compressed air relates to any activities within any working chamber, airlock or decompression chamber that is used for the compression or decompression of people. This includes a medical lock used solely for treatment purposes, where the atmospheric pressure exceeds 0.15 bar. Access to a pressurised working will involve an airlock. or air washing lock, also referred to as a manlock. Work in compressed air is regulated under:

- [The Work in Compressed Air Regulations](#)
- [Work in Compressed Air Regulations \(Northern Ireland\)](#)

These regulations apply to all people employed in tunnelling, pipe jacking and shaft and caisson sinking operations carried out in compressed air, including the use of tunnel boring or shaft excavating machinery and similar operations, as part of construction work.

Atmospheric pressure at sea level is fractionally above 1 bar pressure, pressure gauges are scaled to read zero at this at normal atmospheric pressure. In a pressurised atmosphere a reading of 1 bar refers to double that of atmospheric pressure. At 1 bar the equivalent volume of air at atmospheric pressure is halved, therefore inhaling the same volume of gas contains double the concentration of air.

Fires involving compressed air workings will involve an accelerated combustion process, due to increased oxygen levels in the pressurised atmosphere.

During construction, tunnels may be pressurised to prevent water ingress, particularly boring under a river or in very wet layer. Regulations under the Health and Safety at Work etc. Act are in place in respect of people employed in pressurised workings.

Further information can be found in [Tunnels and underground structures supplementary material - Work in compressed air \(Pressurised atmospheres\)](#)

Health risks

When working in a pressurised atmosphere, the body's internal pressures balance to match the external pressure; therefore, the amount of air inhaled at 1 bar pressure will be double that at atmospheric pressure.

There are various types of health problem (decompression illness) which can be caused by working in compressed air. According to the Health and Safety Executive (HSE) information, [About work in compressed air](#), the most common are:

- Decompression sickness, which predominantly occurs as a condition involving pain around the joints, or, more rarely, as a serious, potentially life-threatening condition that may affect the central nervous system
- Barotrauma, where a change in surrounding pressure causes direct damage to air-containing cavities in the body directly connected with the surrounding atmosphere, principally the ears and sinuses
- Dysbaric osteonecrosis, which is a long-term, chronic condition damaging the long bone joints, such as hips and shoulders

Breathing apparatus

The working duration of self-contained breathing apparatus (BA) is significantly reduced by increased pressure. The balance of the exhale valve and diaphragm controlling the demand valve are likely to be affected by the increase in the external pressure. In addition, the stress and exertion of working in these environments is likely to increase breathing rates.

Personnel need to consider the potentially limited intervention they can make at incidents in tunnels or other below ground structures under construction. The need to wait for additional core and specialist resources will inevitably add moral pressure to personnel and incident commanders to take life-saving action.



Control measure - Establish arrangements for tunnels under construction

Control measure knowledge

The notification of any tunnel or below ground structure project should be the starting point for engagement with the client, principal contractor and responders. There is a statutory requirement for the contractor to provide emergency and rescue capability in tunnels under construction.

The most hazardous phase of the project to be risk-assessed. The outcome of the risk assessment will inform the development of any special procedures, restrictions or limitations to be applied, well before the construction phase commences. The contractor's risk assessment outcomes and plans must be confirmed in writing.

Refuge chambers should be present in tunnels under construction. A refuge chamber is a place of relative safety in a shaft or tunnel where on-site staff can wait to be rescued or until it is safe for them to exit the tunnel. Refuge chambers should be easily identifiable and readily accessible by anyone at risk.

Special controls and procedures agreed by the contractor must be recorded in the emergency plan and communicated to all partners so they can be implemented quickly and without confusion. Special controls, restrictions or limitations will need to be applied to no through access conditions. These can be created when a tunnel boring machine (TBM) commences boring and the services required to support a fire and rescue service intervention cannot be established for a period of time. In a fire situation, this would mean that the fire and rescue service could only make a limited intervention, as a charged line of delivery hose cannot be dragged for long distances.

A normal control measure applied during these circumstances is for the TBM to be provided with a

water mist system to protect walkways, and a rear water curtain to protect the TBM crew, who would remain on-board.

The hand digging of cross passages and the need to enter the cutting head of the TBM both involve working in confined spaces. Such conditions will require the contractor to have special rescue teams available on-scene when work is being carried out, as this responsibility cannot be discharged to the fire and rescue service. Although some fire and rescue service personnel are trained and equipped to work in confined spaces, technical rescue teams are not normally mobilised as part of the fire and rescue service first attendance, resulting in a delay in intervention.

Compressed air working

There is a statutory requirement for fire and rescue services to be notified in advance of compressed air working. At that point, the opportunity should be taken to discuss the limited intervention capability the fire and rescue service can provide.

The task of firefighting or rescuing people employed in compressed air workings is principally the responsibility of the contractor on site. The fire and rescue service might respond to sites where compressed air workings are present and stand by to give advice and provide backup facilities as necessary.

However, subject to any prior arrangement between the contractor and the fire and rescue service, the contractor's responsibilities under the Health and Safety at Work etc. Act should make it unnecessary for personnel to deal with an incident within compressed air workings.

Subject to prior agreement and arrangement, it might be reasonably foreseeable that fire and rescue services could be requested to provide some element of a contractor's emergency arrangements. Breathing apparatus (BA) command and control procedures, appropriate to the risk, should be established along with any minimum provisions for a safe system of work.

Pre-planning and familiarisation

To ensure adequate emergency response, site inspection visits will be essential to familiarise and prepare all responders likely to attend and make an intervention in these environments during construction or when completed.

It may be beneficial to use joint on-site training to gain familiarisation of tunnels under construction.

For further information refer to [Tunnels and underground structures supplementary material](#).

Strategic actions

Fire and rescue services should:

- Establish emergency arrangements with the lead contractor and, where applicable, the compressed air work contractor for tunnels under construction
- Consider using joint on-site training to gain familiarisation of tunnels under construction
- Conduct regular site inspection visits to tunnels under construction to improve familiarisation

Tactical actions

Incident commanders should:

- Adhere to emergency plans for incidents in tunnels under construction
- Not commit personnel to tunnels subject to compressed air working
- Establish and communicate limits of operation in tunnels under construction, based on identified risks and available resources