

# BEATING THE BENDS

How hyperbaric tunnelling support keeps repair technicians healthy

BY ANDREW TOPF, EDITOR

**D**ivers must constantly keep track of their depth and dive time in order to prevent decompression sickness, otherwise known as the bends. Because divers are breathing air while they are pressurized by the surrounding water, the diver's tissues absorb gases (mostly nitrogen) from the breathing air. The deeper the diver goes and the longer he stays there, the more gas his body absorbs. When the diver returns to the surface and the pressure is relieved, these accumulated gases start to leave the body. If the pressure is relieved too quickly, bubbles can form. These bubbles in the diver's tissues are the cause of decompression sickness. Nitrogen bubbles can cause joint pain and in extreme cases, impaired brain, spinal cord and lungs function.

Most people don't think about diving when considering the actions of tunnelling workers below ground, but in fact the two activities can be quite similar. On tunnel boring machines (TBM's) that are in soft ground and below the water table, the machine is under pressure from the surrounding water, just as a diver would be. Any inspections or repairs to the machine, such as changing cutters or removing obstructions, must be done under pressure. On a tunnel boring machine this process of placing workers under pressure is called a "hyperbaric intervention".

To accomplish a hyperbaric intervention on the TBM, the machine is constructed with an air and water tight bulkhead immediately behind the excavation chamber that houses the cutting head at the very front of the TBM. An airlock is attached to this bulkhead.

During normal tunnelling operations the excavation chamber is filled with the ground-up mixture of mud, sand, and rock, usually called "muck", produced by the cutting head. When a hyperbaric intervention is needed, the muck level in the excavation chamber is lowered slowly and replaced by compressed air. The compressed air holds back the water and loose soil in the excavation chamber so qualified personnel can work there. Workers in the non-pressurized portion of the tunnel can enter the airlock,



A member of the hyperbaric intervention support team, inside the airlock. The workers are often certified commercial divers.

be pressurized to the same pressure as exists in the excavation chamber, and then, once the pressures are equal, enter the excavation chamber to work.

TBM's mining in solid rock don't need to worry about holding back loose soil with compressed air, so they don't need to do hyperbaric interventions. They can work on the cutterhead at normal, atmospheric pressure and use pumps to remove any water that enters the excavation chamber.

"Putting people in the TBM under pressure is exactly the same as putting divers underwater. Your body feels the same effects, so we run under the same laws of physics for diving. Even though you're not in the water, your body is still exposed to

## How it works

The working time of the intervention depends on the pressures involved. The amount of time compressed air workers can safely work under pressure is determined by the decompression table(s).

If a hyperbaric intervention is required, a hyperbaric tunnelling support team would be called in. The team working under pressure usually comprises three individuals: two repair technicians and a third attendant, who is responsible for communications and keeping an eye on the workers to ensure the pressurized environment they are working in is safe. At least two additional workers will stay in the non-pressurized portion of the tunnel and operate the manlocks for the workers under pressure.

The process of passing personnel from a regular atmospheric environment to a pressurized space requires an air lock chamber that equalizes the different air pressures through a system of valves and gauges. The air lock chamber is fitted to the front of the TBM, allowing access to the working chamber. The procedure requires workers to enter the air lock chamber where two sets of sealing doors are built in at opposite sides. Once they enter the air lock, the doors are closed and air is pushed into the air lock until the pressure matches the air pressure outside the machine. Once the pressures are equalized, the second set of doors can be opened and the workers can crawl out into the working chamber and begin performing their assigned duties.

Black, who started his dive career with the Australian Navy and has over 30 years of experience, said the procedure requires quite a bit of pre-planning.

"If there's going to be a hyperbaric intervention, it's all pre-planned," he said. "The machine will stop mining, and then we'll make all the preparations, and do all our calculations. It may be a simple inspection or it may be what they call a full tooling change up."

Hyperbaric tunnelling support typically takes place between 30 and 120 feet deep. Tunnels that go deeper than that may require TBM workers to enter a saturation habitat, where workers live and work under pressure, sometimes for weeks. Workers who perform in these conditions usually need several days of gradually adjusted pressure to decompress before they

**"Putting people under pressure in the TBM is exactly the same as putting divers underwater. Even though you're not in the water, your body is still exposed to that over-pressurization."**

SCOTT BLACK, GROUP MANAGER FOR COMMERCIAL DIVING AND HYPERBARIC TUNNEL SUPPORT, ASI GROUP

can be brought back up to the surface.

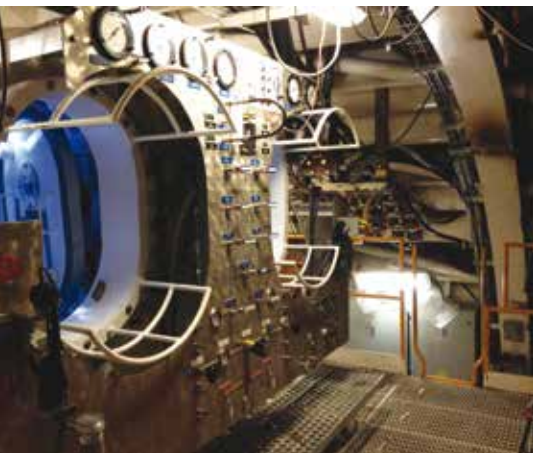
What could go wrong?

Along with the constant danger of decompression sickness, hyperbaric intervention support workers also face the usual risks that come with working with any large and complex machinery - including bone breaks, strains or lacerations. Specialized medical equipment is available in the airlock and the attendant, also called a diver medical technician, has a higher level of medical training. A hyperbaric physician is always on call, should more complex medical problems occur.

Black said being part of a hyperbaric tunnelling support team requires a set of specialized skills, including the mechanical qualifications needed to repair or inspect the TBM; and fitness to handle a pressurized environment. Often the workers are certified commercial divers who are already qualified to work under hyperbaric conditions. At ASI, team members are equally suited to commercial dive jobs or hyperbaric tunnelling:

"You're on a dive site today and tomorrow you're on a tunnelling site," said Black, adding that ASI has about 30 divers in their employ. "They come with all of the disciplines required and the mindset since it's a bit of a different work environment. So typically we pull straight from our divers."

"It's exciting. It keeps us coming to work every day." CUI



View of the airlock chamber, which is fitted to the front of the TBM, allowing access to the working chamber.