



Safety Orientation Course- Tunneling (Workers)

Learner Guide



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Information about the course

Course Overview

This course aims to introduce workers to recognize common safety and health hazards and take the necessary preventive measures to avoid injuries and diseases while working in the tunnels..

Who should attend this Course?

Workers who need to work in tunnels within a construction site.

Course Objective

- Understand general safety in Tunneling Works
- Identify hazards working in a Tunnel
- Practice safety procedures when operating Tunneling Equipment and Machinery
- Able to work safely in Confined Spaces
- Practice safety procedure when doing Hot Work and working in Compressed Air
- Competent in wearing Personal Protective Equipment (PPE)
- Know the dangers and precautionary measures associated with Tunneling Works

Course Duration :

4 hours (Including 15 minutes Assessment)

Assessment :

Written Test(MCQ)

Attendance Requirements : 100 %

Passing Mark : 60 %

Certification :

Upon successful completion of the course a certificate endorsed by EFG Training Services Pte Ltd will be issued the participants.

Training Methodologies

1. Learners are required to take part in group discussion and presentation
2. Training methodologies consists of :
 - Lecture with Q&A and sharing of workplace practices
 - Case studies
 - Videos and other e-resources and instructional media

Attendance Requirement: 100%

Duty of Care

- Above all, we are dedicated to ensuring your Health, Safety and Wellbeing.



- Risk management has been applied to all general and practical activities.
 - All staff are First Aid & Emergency Trained.
 - All Equipment is fully inspected.
 - All activities are voluntary. If you feel unwell, unfit, or unsure just tell us.
 - If any accident occurs, tell us.
 - No tolerance policy for intentionally endangering the health or safety of other students.
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Lesson 1

Introduction

Learning Objective

At the end of the Topic, learner is able to identify and explain:

- Common Safety & Health Hazards In Tunnel.
- Preventive Measures.
- Common Emergency Equipment and Procedures in Tunnel.
- Working in Compressed Air.

Tunnel definition

A tunnel is a Confined Space.

A Underground Passageway for MRT Trains; Cables; Sewage; etc.

"Tunnel" means a subterranean passage made by excavating beneath the over-burden into which a worker enters or is required to enter to work.

Types of Tunnel

- Bored Tunnel



Cut & Cover Tunnel



- NATM Tunnel



Compressed Air Tunnel



Lesson 2 Accident Case Studies

Learning Objective

At the end of the Topic, learner is able to identify and explain:

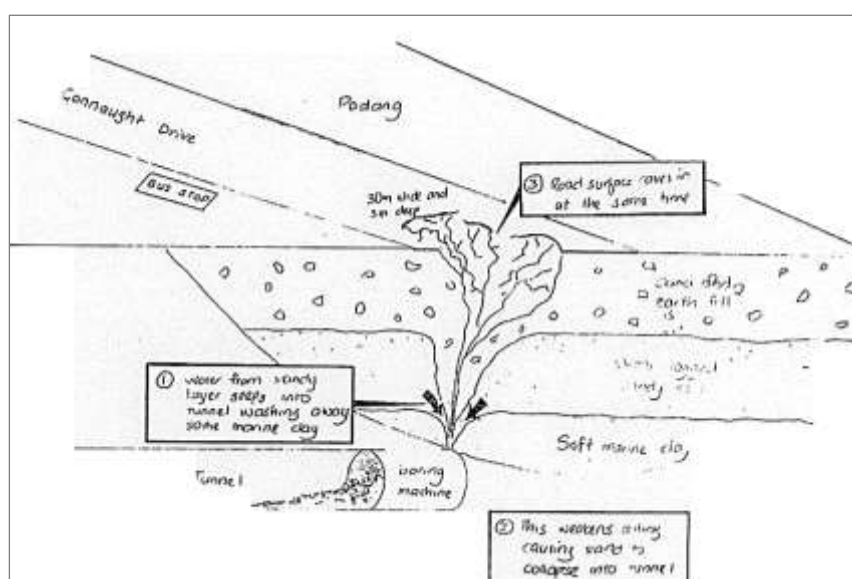
Identify cause of accident and recommend corrective and preventive measures

Accident Case Study 1

On 24/12/1985, a MRT project had a collapse of tunnel ceiling due to water from sandy layer seeping into the tunnel thru' sand patch in marine clay.

Collapse resulted cave-in along the road. A motorcyclist and his pillion plunged into hole and both were injured.

No worker in the tunnel were injured. But 8 workers had difficulties escaping from tunnel before the collapse..



Recommendations

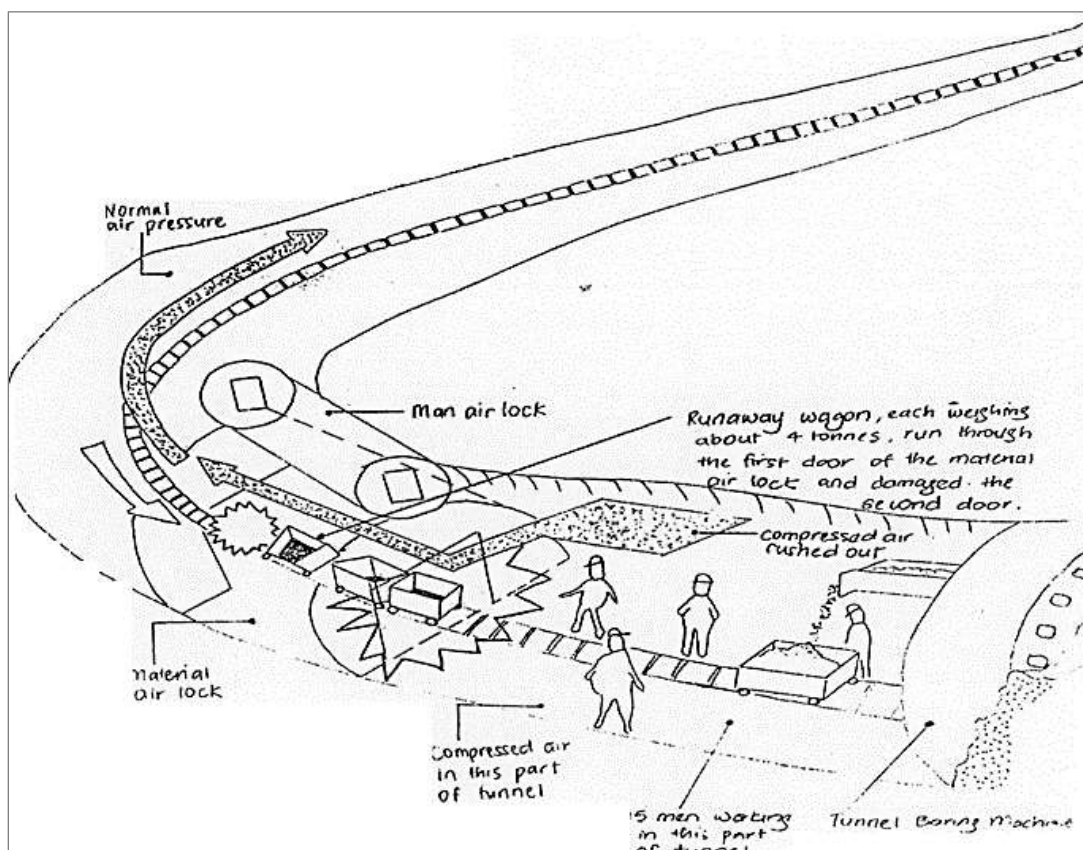
- Probing the soil condition well in advance should be done and carried out as accurately as possible.
- Grout the soil, if necessary.
- Pressure of compressed air should be increased when necessary.
- Experienced personnel should supervise the work and inspect the face of tunnel for undue soil changes.
- Workers not involved in the operation should keep clear of the danger zones, i.e. tunnel without shield protection or linings.
- Workers should be informed of dangers in the tunnel without delay i.e. by the use of alarms or other warning signals.

Accident Case Study 2

26/4/85, 15 men working in compressed air area when 3 wagons broke loose and hit the material lock door, causing compressed air to rush out from the pressurised portion of tunnel, and normal air rushed inwards.

Tools, pieces of ripped ventilation shafts, electrical fixtures and other things inside the tunnel were swept out.

Some workers vomited, felt dizzy and ears ringing. They felt very weak and had intermittent chill.



Recommendations

- The wagons should be properly secured to the catch and such catch has to be regularly inspected and maintained.
- Introduce a device that can stop the runaway of wagons or by means of buffers or stops which can be put into position when that portion of the rails is not in use.
- Disconnect the rails that are near the locks when the rail is not in use.
- Install an alarm on the wagons which would sound if the wagon move and the alarm could be deactivated by workers who are attending to the moving wagons.

Lesson 3 General Safety in Tunneling Works

Learning Objective

At the end of the Topic, learner is able to identify and explain:

- Training of personnel (SOC, Induction; etc.).
- Provision & Use of PPEs (Safety Helmet, Shoe, Reflective Vest; etc.).
- Tunnel Safety Rules (No Smoking; etc.).
- Safe Means of Access & Egress (Vehicles and Pedestrian).
- Control of Access & Entry of Personnel (Tally board; etc.).
- Permit-to-Work and SWP.

WSH (Construction) Regulations 2007 Reg. 88

Duty of the employer of any person who carries out any work in a tunnel or the principal to ensure that the person does not carry out the work unless the person has received adequate safety and health training to familiarize himself with the hazards associated with such work and precautions to be observed.

Warning Notices

Reg. 77. — (1)

Notices shall be put up at appropriate and conspicuous positions to warn about the excavation (tunnel) in a worksite.



Illumination Level in Tunnel

Reg. 83. —

- All areas in the tunnel shall be adequately illuminated: and
- Emergency Generators are provided to ensure adequate illumination of the tunnels and work areas in the event of a failure in the power supply.

Communication in tunnel

86. — (1)

Effective and reliable means of communication, such as a telephone network, shall be provided at intervals of 100 meters along the tunnel in the worksite, including outside the portal or at the top of the shaft, and maintained at all times

86. — (2)

Any code of audio and visual signals used shall be conspicuously displayed near the entrances to the worksite and such other locations as may be necessary to bring it to the attention of all persons concerned.

Tally Board System

Monitoring of person entering / exiting tunnel.

During any emergency, to account for every site personnel, a tally board must be displayed and updated with the names or employee code of person.



Types of hazards in a tunnel

- Materials movement in Tunnel
- Failure of lifting equipment / Gear / Appliance
- Personnel hit or crushed by machinery
- Hit by falling materials
- Collision of equipment / machinery
- Mechanical Hazards
- Fire and Explosion
- Electrocution
- Oxygen Deficiency and Enrichment
- Toxic Gases and Flammable Gases
- Poor Lighting
- Heat
- Noise
- Improper use of equipment and man-rider
- Unsafe access / Egress
- Slippery or uneven tracks / Rails



Materials Movement in Tunnel

- Use Designated Walkway
- Don't stand or walk along rail track

Failure of Lifting Equipment/Gear/Appliance

- Don't stand or work near danger zone
- Lifting Permit
- Qualified Lifting Team



Personnel Hit or Crushed by LOCO

- Use Designated Walkway
- Obey Warning Signs

Mechanical Hazards (Rotating or Moving Parts)

- Safety Guard
- Use of Lock Out Tag Out (LOTO) System
- Trained Personnel



Fire and Explosion

- No Smoking
- No Petrol Engine
- No In-compatible Works
- Hot Work Permit
- Forced Ventilation

Electrical Hazards



- Qualified Electrician
- Monthly LEW Check
- Warning Sign
- 110V Hand Tool

Oxygen Deficiency and Enrichment

- Gas Test by Confined Space Safety Assessor
- Tunnel Permit
- Proper Ventilation

Inadequate Lighting

- Adequate Lighting
- Adequate Emergency Lights

Noise

- Maintenance of Machinery and Ventilation duct etc..
- Use of Ear Plug/Muffler.

Heat

- Proper Ventilation
- Adequate Rest
- Drinking Water Facility
- Proper Clothing

The air in our natural environment contains 20.9 % oxygen.

An environment is considered oxygen deficient when the concentration of oxygen is **less than 19.5 % by volume**. The effects and symptoms of different levels of oxygen deficiency on humans are described below.

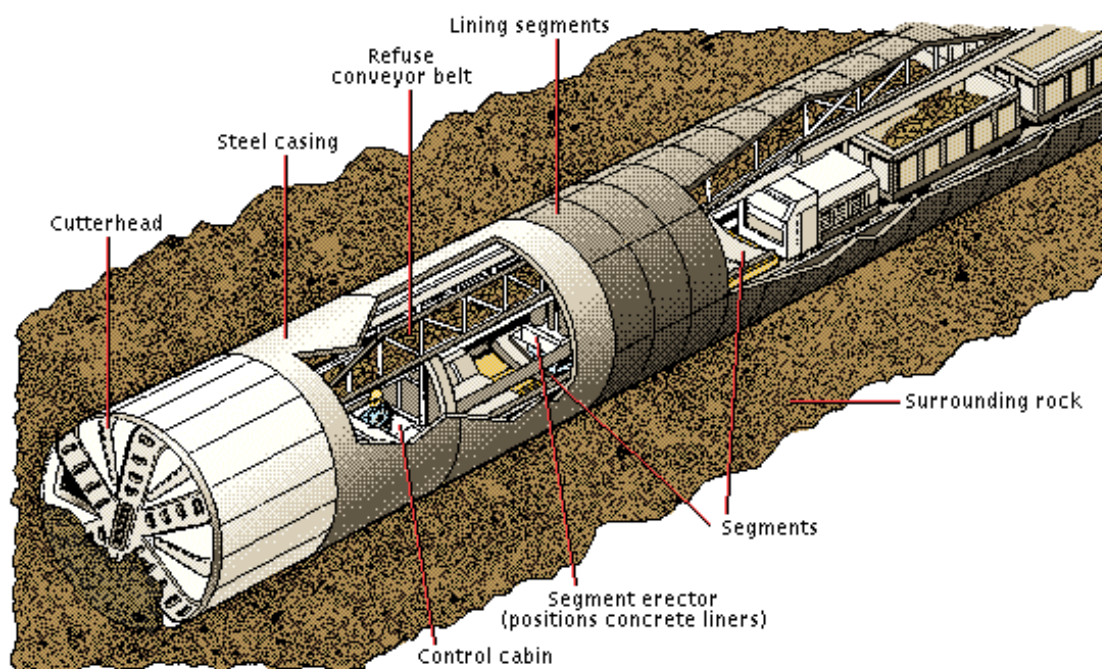
Oxygen concentration, volume %	Effects and symptoms
19.5	Minimum safe entry level
16 – 19	Poor coordination, fatigue
12 – 16	Rapid pulse, difficulty in breathing
10 – 12	Very fast and deep breathing, lips begin to turn blue, headache
8 – 10	Fainting, unconsciousness, nausea, vomiting
6 – 8	Fatal in 8 minutes; 50% fatal in 6 minutes
< 6	Coma in 1 minute, convulsions, respiratory and cardiac arrest, death

Table 1: The effects and symptoms of different levels of oxygen deficiency on humans.



Lesson 5 Tunneling Equipment and Machinery

Tunneling Machine



Authorised Person

- Only trained and authorised personnel are allowed to operate machinery.
- Forklift and excavator must be operated by only trained personnel.
- Daily checklist must be filled up before start work
- Operators of other machinery like skid loaders, overhead cranes, boom/scissors lift, must be trained by the manufacturer or supplier.

Safe operation

- NEVER use the forklift as a elevated working platform.
- Operator can be prosecuted if there is a mishap.
- Hose and couplings secured with proper clips / clamps and whip arrestor.
- Do not use Binding wire or nylon rope to secure .



Use of internal combustion engines 85 (g) (h).

- No petrol driven internal combustion engine shall be used underground.
- No diesel engine shall be used underground unless it is so constructed that —
- No air enters the engine without first being cleaned; and
- No fumes or sparks are emitted by the engine.

Temperature and Humidity 98 (1) (2) (3) (4).

- The temperature in any working chamber, man-lock or medical lock shall not exceed 29°C. and the relative humidity shall not exceed 85%.
- A wet and dry bulb thermometer, in good working order, shall be provided in every working chamber.
- A Lock attendant shall be appointed to record the readings of the thermometer in the lock attendant's register.
- The lock attendant in charge shall record the readings of the thermometer at least once in every 4 hours in the lock attendant's register.

Locomotive in Operation



Gantry Crane



Mechanical and Electrical Equipments



Electrical Safety

- Only trained electricians are allowed to perform repair works on electrical systems
- Use 110V Hand Tools

Operating Voltage (V)	Colour	examples
55	White	
110	Yellow	
230	Blue	
400	Red	

DB boxes must be locked at all times.



Electrical Cables should always be hung to avoid damage, tripping and falling hazard.

Lesson 6 Confined Spaces

Confined Space Dangers

- Oxygen Deficiency and Enrichment
- Toxic Gases
- Flammable Gases

Oxygen Deficiency and Enrichment

- Gas Test by Confined Space Safety Assessor
- Tunnel Permit
- Proper Ventilation

Toxic Gases

- Gas Test by Confined Space Safety Assessor
- Tunnel Permit
- Proper Ventilation
- Carbon Monoxide
- Hydrogen Sulphide



Flammable Gases

- Gas Test by Confined Space Safety Assessor
- Hot Work Permit
- Forced Ventilation
- No Smoking
- Methane Gas, LPG
- Solvents
- Petrol

Hazards in a confined space can be classified into the following types:

- Atmospheric Hazards
- Physical Hazards
- Mechanical Hazards
- Electrical Hazards

1. Atmospheric Hazards

- Oxygen Deficiency
- Oxygen Enrichment
- Flammable Gases
- Toxic Gases



Oxygen Deficiency

An oxygen deficient atmosphere is present when oxygen level in the atmosphere drops below 19.5%.

A person will die due to asphyxiation if he enters a oxygen deficient atmosphere.

Causes of Oxygen Deficient Atmosphere

- Oxygen displaced by other gases such as nitrogen, argon, carbon dioxide, etc.
- Oxidation process such as rusting.

- Oxygen consumed by bacteria such as in sewers.

Oxygen Enrichment

An oxygen enriched atmosphere is present when oxygen level in the atmosphere rises above 23.5%.

Oxygen supports combustion and high levels of oxygen can be a fire and explosion hazard.

Causes of Oxygen Enriched Atmosphere

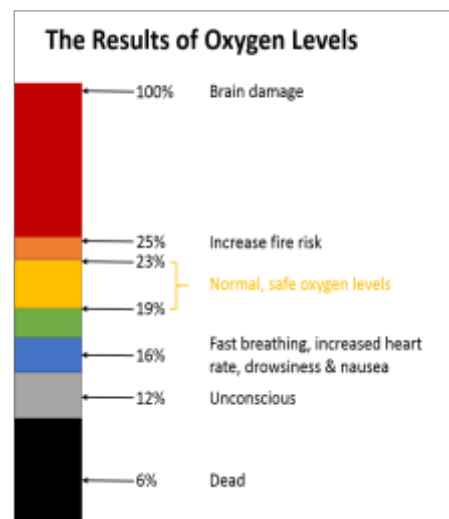
- Leakage of oxygen gas hoses in a confined space.

Oxygen Level

> 23.5% - Oxygen Enrichment

19.5% - 23.5% - Safe levels

< 19.5% - Oxygen Deficiency



Effects of Oxygen Deficiency

16 - 12% O₂ in Air	Deep breathing, fast heartbeat, poor attention, poor thinking, poor coordination
14 - 10% O₂ in Air	Faulty judgment, intermittent breathing, rapid fatigue (possibly causing heart damage), very poor coordination, lips turning blue
10% or less O₂ in Air	Nausea (vomiting), loss of movement, loss of consciousness followed by death
Less than 6% O₂ in Air	Spasmodic breathing, convulsive movement, death in approx. eight minutes
4% - 6% O₂ in Air	Coma in 40 seconds

Flammable Gases

- Methane.
- Petroleum vapours.
- Paints and solvent vapours.
- Leakage of fuel gases such as LPG and Acetylene.

Fire and Explosion

The accumulation of flammable gases in the confined spaces can result in fire and explosion.



Toxic Gases

Common types of toxic gases in confined spaces:

- Hydrogen Sulfide
- Carbon Monoxide
- Welding fumes
- Benzene, petroleum vapours

2 Physical Hazards

Noise

High noise levels can cause hearing loss.

Sources of noise in confined spaces are noisy operations such as powered hand tools, knocking.

Temperature Extremes

Temperatures in confined space can rise due to hot weather or hot works carried out in the confined space

Engulfment

Workers can be trapped or buried by dry bulk material or liquid such as: Grains, sand, flour, cement, etc.

Flooding while working in storm drain Water flow

3 Mechanical Hazards

Mechanical hazards are caused by unexpected movement of mechanical equipment such as:

- Blenders
- Stirrers
- Shafts
- Chain or belt drives

Ensure all mechanical equipment are locked out and tagged before entering the confined space.

4 Electrical Hazard

Electric Shock is also a possible hazard in Confined Spaces.

- Electrical Hazard Sources include:
- Broken lighting
- Frayed electrical wires
- Hazards from portable electrical equipment



Other Hazards

Falling Objects - tools and other objects may fall and strike workers.

Wet surfaces can cause slips and falls.

Obstructions such as pipelines in the confined space can cause trips and falls

Safety In Confined Space

The following safety measures must be implemented prior to entry into a confined space:

- Conduct Risk Assessment
- Testing of Atmosphere
- Confined Space Entry Permit
- Ventilation
- Lighting
- LOTO – Isolation
- Confined Space Attendant
- Provision of PPE
- Emergency Procedure

Lesson 7 Hot Work

Safety in Hot work

- No Smoking
- No Petrol Engine
- No In-compatible Works
- Hot Work Permit
- Forced Ventilation



Hot Works Safety

- Gas cylinders shall be stored at designated areas.
- Check gas hoses for leaks as leaking gas hose in tunnel can result in fire and explosion.'
- Hot work permit before starting hot work in tunnel.
- Daily checklist.
- Cylinder cage/trolley with chain.
- Fire extinguisher.
- Warning signs.
- Earthing for welding machine.
- No damage gauges.



- Cylinders shall be secured in proper gas cages for lifting to shaft bottom or transportation to the tunnel.
- Cylinders Must be removed from the or shaft immediately tunnel after use.



- Welding holders and Welding cables must be in good condition.



Lesson 8 Working in Compressed Air

Compressed air work is not new in Singapore and has been used in the construction of the Mass Rapid Transit (MRT) system, Deep Tunnel Sewerage System and other tunnelling works.

Examples of such works include inspection and replacement of tunnel boring machine (TBM) cutting tools.

Workers who enter and/or carry out work in a compressed air environment are exposed to health hazards if compressed air work is not managed properly.

Some associated health problems are decompression sickness and barotraumas.

Compressed air is used in the construction of a tunnel to prevent entry of ground water into the tunnel. It may be used in the working space in front of the TBM to allow maintenance work to be carried out on the machine face or allow workers to manually remove obstructions;

For example, boulders or old piles. Workers would be exposed to compressed air which can be intermittent in such cases

Compressed air may also be used in the tunnel itself where there are workers working and conventional TBM are being used. In this case, more workers would be exposed to the compressed air and its associated health risks.

Access to the compressed air portion of the tunnel is through a chamber called the 'man-lock'. Once inside the man-lock, the air pressure can be slowly increased to the desired pressure inside the compressed air portion of the tunnel (compression procedure).

When the desired pressure is reached, workers can then enter the compressed air working chamber.

When coming out of the compressed air working chamber, workers would be required to enter the man-lock again where the air pressure would be slowly reduced in stages to atmospheric pressure before they are allowed out of the man-lock (decompression procedure).

Preventing Compressed Air Illness and Barotrauma in Compressed Air Work

Work in a compressed air environment, such as tunnelling work may result in compressed air illness and barotrauma related to changes in air pressure.

Do you know

- What is compressed air illness and barotrauma?
- How to stay healthy?
- When to seek medical attention?

What is compressed air illness?

What happens when you pull open the cap of a can of fizzy drink? You can see air bubbles being released. The same happens when you move from a compressed air environment to the outside. Nitrogen bubbles dissolved in your bloodstream during compression may be suddenly released when the decompression is not carried out correctly. These bubbles can cause compressed air illness, resulting in pain in the joints and/or muscles (bends). In more serious cases, you may develop a heart attack or stroke and your bones may be damaged (dysbaric osteonecrosis).

What is barotrauma?



Ear Pain from Aural Barotrauma

You can also develop pain inside the air spaces of the ear, face or chest. This condition is called barotrauma and is caused by the expansion or contraction of air in these spaces. You are at greater risk of developing barotrauma if you have a cold, sore throat, ear or chest infection.

Personnel required to work in compressed air environment shall be certified by "Designated Workplace Doctor": Within 30 days before employment.

At least once every 3 months for working pressures below 1 bar and at least once every 4 weeks for working pressures at or above 1 bar.

In addition, you will need to be re-examined within 3 days before starting work if you have:

- Not worked in compressed air environment for more than 14 consecutive days.
- Suffered from a cold, chest infection, sore throat or ear ache.
- Suffered from any illness or injury requiring absence from work for more than 3 consecutive days.

Good Work Practices

A. During compression

- Breathe normally
- Follow the instructions of the man-lock attendant
- Pinch your nose and try breathing out. You should feel air leaving your ears (Valsalva manoeuvre)
- Always enter the man-lock with an experienced compressed air worker if it is your first time

B. During decompression

- Breathe normally, do not hold your breath
- Wait for the man-lock attendant's signal before leaving the man lock
- Change your position frequently to improve blood circulation

Always inform the lock attendant if you develop pain, discomfort or dizziness!

C. After decompression

- Remain at the worksite for at least one hour, if the working pressure is one bar or more
- Do not take too hot or too cold a bath/shower
- Do not fly, dive or engage in strenuous exercises (like jogging or swimming) for at least 24 hours

In addition, you should:

- Have adequate rest in between shifts
- Drink plenty of water to prevent dehydration



Do not:

- Work in compressed air if you have a cold, sore throat, earache or chest infection
- Drink alcohol or fizzy drinks before or when working in compressed air

When to seek medical attention?

Report to your supervisor and arrange to see the medical lock attendant or doctor if you:



- Feel unwell before, during or after compressed air work
- Develop aches, joint pains or skin rashes after decompression

Lesson 9 Procedure for Safe Work

Shoring and support

Where the depth of any excavation in a worksite exceeds 1.5 m or where the banks are undercut adequate shoring by underpinning sheet piling, bracing; or other means of shoring shall be provided to prevent collapse of the excavation; or any structures adjoining; or over areas to be excavated. Reg. 77(2)

PE Design

Where the depth of any excavation in a worksite exceeds 4m, adequate shoring by underpinning, sheet piling, bracing; or other means of shoring shall be made; or erected in accordance with the design; of a P.E to prevent collapse of the excavation; or any structure adjoining; or over areas to be excavated. Reg. 77(4)

Where the depth of any excavation exceeds 4m, no work (other than excavation or shoring operations) shall be carried out inside the excavation until after a certificate under WSH (Construction) regulation 78 (2) (ii) has been issued in respect of the underpinning, sheet piling, bracing or other means of shoring for that excavation. Reg. 77(5)

Safe Precaution

During any excavation work in a worksite, all reasonably practicable measures shall be taken

- To prevent any person being trapped by the collapse of the excavation.
- To prevent any person being struck by an object, such as excavating machine or by any material dislodged by the machine.
- To prevent any person falling into the excavation.
- To prevent any person inhaling or otherwise being exposed to carbon monoxide or another impurity of the air in the excavation. Reg. 77(6)

Excavated Material

Excavated material or other superimposed loads shall be so placed away from the edge of the excavation in a worksite to prevent the materials; or other loads from falling into the excavation; or cause the banks to slip; or cause the upheaval of the excavation bed. Reg. 77(7)

Open Side of excavation

The open side of any excavation in a worksite which exceeds 2 m in depth of shall be provided with adequate guard-rails to prevent persons from falling into the excavation. Reg. 77(8)

Notice shall be put up at appropriate positions to warn about the excavation in a worksite. Reg. 77(9)

Inspection

The excavation in a worksite and its vicinity shall be inspected by a designated person after every rain storm or other hazard-increasing occurrence. Reg. 77(10)

Safe access to and egress from the excavation in the worksite is provided where person are required to work in the excavation. Reg. 77(9a)

The access or egress is sufficient in numbers and installed in such locations so as to be readily accessible. Reg. 77(9b)

Stability of Tunnel

Reg. 81 (1) (a) (b)

Where tunneling works are being carried out in a worksite, all reasonably practicable measures such as shoring, shot-creting, supports by means of rock bolts, segments or steel sets or other measures shall be taken

- To ensure the stability of the tunnel: and
- To prevent any person being trapped by the collapse of the tunnel or being struck
- by a object falling into the tunnel.

Ventilation

Reg. 82 (a) (b)

In a worksite where tunneling works are carried out

- all work areas in a free air tunnel shall be provided with appropriate ventilation system to ensure adequate supply of fresh air.

- all reasonably practicable measures shall be taken to ensure that the air in the tunnel where person has to work is free from flammable gases and vapors and contains:
 - (i) At least 19.5% oxygen by volume; and
 - (ii) Not more than 23.5% oxygen by volume; and
- Air that has passed through any underground oil or fuel storage areas shall not be used for ventilation in the tunnel.

Illumination Level

Reg. 83 (a) (b)

In a worksite where tunneling works are carried out

- All areas in the tunnel shall be Adequately Illuminated; and
- Emergency Generator are provided to ensure adequate illumination of the tunnels and work areas in the event of a failure in the power supply.

Access to and Egress from tunnel or Shafts

Reg. 84 (1) (2)

- Safe access to and egress from any tunnel in a worksite where tunneling works are being carried out shall be provided where persons are required to work in the tunnel.
- Where persons have to descend in a shaft in a worksite, an alternate means of egress from the shaft shall be provided for emergency purposes.

Reg. 84 (5) (a)(b)(c)

- Proper control of ingress and egress of persons to and from any tunnel under construction in the worksite shall be exercised.
- A chart listing the names of persons working in the tunnel and their location of work shall be displayed at the main entrance to the tunnel and be regularly update.
- Notices to warn persons against unauthorized entry shall be displayed at all points of entry to the tunnel.

Communication

Reg. 86 (1)

Effective and reliable means of communication such as telephone network, shall be provided at intervals of 100 metres along the tunnel in the work site, including outside the portal or at the top of the shaft, and maintained at all times.

Reg. 86 (2)

Any code of audio and visual signals used shall be conspicuously displayed near the entrances to the worksite and such other locations as may be necessary to bring it to the attention of all persons concerned.

Rescue Team

Reg. 89 (1)

Where 25 or more workers have to work underground at any one time, It shall be the duty of the occupier of the worksite to ensure that at least 5 such persons who have been

trained in rescue procedures, resuscitation, the use, care and limitations of breathing apparatus and the use and maintenance of firefighting equipment.

Reg. 89 (2)

Where more than 4 but not more than 24 workers have to work underground at any time, it shall be the duty of the occupier of the worksite to ensure that at least 2 such persons are persons who possess the training on the rescue procedures, resuscitation, the use, care and limitations of breathing apparatus and the use and maintenance of firefighting equipment.

Reg. 89 (3)

It shall be the duty of the occupier of a worksite where tunneling works are carried out to provided and maintain sufficient breathing apparatus for use by persons employed to work in a tunnel in the worksite

Fire-Fighting Facilities and Procedure

Reg. 90 (1) (a)(b)

It shall be the duty of the occupier of a worksite where tunneling works are carried out:

- To provided adequate and appropriate fire-fighting facilities in every tunnel in the worksite including a fire alarm system connected to the ground; and
- To conduct at least one joint exercise for fire and rescue purpose together with the Singapore Civil Defence in the course of the tunneling works.
- A fire drill is held once in every 3 months in the worksite.

Fire Safety and other Emergency

- Familiariasie fire and other emergency response procedure.
- Participate quarterly emergency drill.
- Know the location of fire extinguishers and First Aid Box, Eye wash station.
- Know the emergency escape route and assembly point.
- Know how to wear breathing apparatus.

Emergency Preparedness

Emergency Equipment



▪ Fire Extinguisher



▪ First Aid Box



▪ Gas Detector

Fire Drills

Fire Drill in tunnel shall be conducted every 3 months.

It is important for every person to take part in fire drill so as to understand the emergency evacuation procedure.

Rescue Team with equipment

Self Contained Breathing Apparatus (SCBA)



General Worksite Safety

- A worker can enter the tunnel only when a valid entry permit is displayed at its entrance
- and supervisor tell him to enter.
- When you feel dizzy or unable to concentrate on your work while working under the hot work environment, you should take breaks in a cooler areas and drink more water
- Use designated walkway while walking in tunnel.
- Locomotive must be operated only by trained and authorized operator.
- Before you can start doing track repairing or maintenance work in a tunnel, you must obtain track work permit and notify locomotive operator.
- When you feel dizzy or unable to concentrate on your work while working under the hot work environment, you should take breaks in a cooler areas and drink more water.
- Use designated walkway while walking in tunnel.

Lesson 10 Other Safety Precautions

- Obey Warning signs.
- Don't walk on the tunnel track.
- Don't bring cigarette or cigarette lighters into tunnel.
- Report unsafe condition to the supervisor immediately.
- Don't operate machinery or equipment unless your are trained and authorized.
- Not to stand or work in the danger zone.

Appointment of competent person for compressed air works.

The main contractor shall appoint a suitably qualified and experienced person who shall at all times be in control of the air supply plant and be in attendance at the site when any person is employed in a compressed air environment.

Welding Sets in Tunnel

All Welding Sets shall be fitted with a Voltage Limiting Device or shock preventor. PCB (polychlorinated biphenyl) or a similar insulating medium shall not be used for such devices.

Identification Badges

WSH (Construction) Regulations 2007 Reg. 101 (1)(2)(3)

Identification badges containing relevant particulars shall be issued to any person who is employed in the CA environment in the worksite for the guidance of others should the person be taken ill after leaving work.

It shall be the duty of every person who has been issued an identification badge to wear the badge at all times while at work in the worksite.

Exit in case of Emergency

Provision shall be made to enable any person inside a man-lock or working chamber to control the doors of the man-lock or working chamber in order to leave the man-lock; or working chamber in the case of emergency.

Except in the case of an emergency, no person shall operate the controls for the opening and closing of the doors of man-locks and working chambers unless he has been authorised by the lock attendant.

Proper access way/staircase provided



Consumption of Alcohol and Smoking

No person shall consume alcohol or smoke whilst he is employed in a compressed air environment.

No person shall carry cigarettes, cigarette lighters, matches or other sources of ignition into a compressed air environment.

No person who has consumed alcohol shall be allowed to undergo compression in any lock other than in a medical lock.

Duty to follow instructions of lock attendant.

No person shall wilfully obstruct, delay, refuse to follow or carry out any instructions given by a lock attendant in the course of his employment

Persons Suffering from Cold, Chest Infection

Any person suffering from a cold, chest infection, sore throat or ear ache shall report his condition to the site superintendent who shall ensure that the person is not employed in a compressed air environment until he has been medically examined and certified fit.

Types of Safety Sign

There are basically 4 types of safety signs:

- Mandatory Signs
- Warning Signs
- Prohibitory Signs
- Safety Signs

Mandatory signs means signs that must be complied with.



Face Shield
Required



Eye Protection
Required



Hand Gloves
Required



Hearing
Protection
Required



Head Protection
Required



Foot Protection
Required



Fall Protection
Required



Respiratory
Protection
Required

Warning signs (Triangle with black pictogram on yellow background) warn about the hazards present at the work place.



Electrical
Hazard



Beware of
Forklift
Movement



Caution, Risk of
Fire/Flammable
Substance



Toxic Substance



Caution,
Risk of Explosion/
Explosive
Substance



Caution,
Risk of Ionizing
Radiation



Caution,
Overhead Load
Hazard



Caution,
Slippery Floor

Prohibitory Signs prohibits actions as described in the signs and must be strictly adhered to.



No Naked
Light/Flame



No Smoking



No
Unauthorized
Entry

Safety Signs indicate the presence and location of safety equipment/facilities.





Fire
Extinguisher
Signage



Emergency
Escape Exit

Training



Safety Information Centres



End

Aide Memoire – Safety Orientation Course (Tunneling) for workers (SOCTN)

Types of Hazards and Safety Precautions

Fire Hazard

If any one of these elements is not present (or is not present in a proper proportion) the fire or explosion will not occur.



- No Smoking
- No Petrol Engine
- No In-compatible Works
- Hot Work Permit
- Forced Ventilation

Types of combustible Materials



The various extinguishers

Available for the different Classes of fire

Electrical Hazards

- Qualified Electrician
- Monthly LEW Check
- Warning Sign
- 110V Hand Tool



Tally Board System(Monitoring of person entering/ exiting tunnel)



(Machine & Equipment must LOTO(lock out and tag out before maintenance or repairing)

- Only trained and authorised personnel are allowed to operate machinery
- Use Mechanical Handling methods instead of manual handling.
- Regular Housekeeping is important
- Use safety guards when operating machinery
- Use tools only for its intended purpose

Ventilation

Safe Level of oxygen 19.5 % to 23.5%

Wear your PPE



Recognize the signs

