TRAM ELECTRICAL AND TRAM TRACK SAFETY AWARENESS

Revision Status

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1.0 PURPOSE OF THIS COURSE

1.1 Working on and near tram lines can be extremely hazardous and the risks of severe injury and death are high. Trams and road vehicles are a major hazard but there is also the danger of electrocution from the electrical wiring. The dangers of slipping, tripping and falling when moving around the tram environment are ever present.

1.2 There is also the potential for works to interfere with components of the tram system and disrupt tram running.

1.3 This course will provide information on how and where trams move around the system, the hazards associated with working in the tramway environment and a basic knowledge of track, signals and electrical systems, that will help you work safely. In doing so, you will protect your life, that of other workers and members of the public and help prevent accidents.

2.0 LEARNING OUTCOMES

- When you have finished the course, you will be able to:
- Identify the basic types of track construction
- Determine the UP and DOWN tracks and understand why this is important
- Recognise the hazards associated with working in a tram depot
- Recognise components of the electrical system and the dangers associated with them
- Understand how close you can come to the electrical system before control measures need to be put in place
- Understand the fundamentals so that work can be performed safely in an electrical environment

3.0 LEGAL AND OTHER REQUIREMENTS

Workers on any site must:

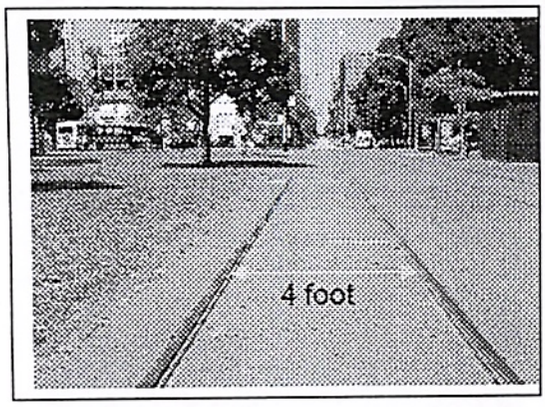
- Have a zero blood alcohol level in accordance with the Transport Act 1983.
- Not be impaired by prescription or over-the-counter medicines, herbal remedies or illegal drugs in accordance with the Transport Act 1983.
- Wear an approved Special Purpose Orange Safety Vest with silver reflective stripes.
- Wear lace up, ankle length, safety boots.
- Wear any other personal protective equipment as designated.
- Have undertaken and satisfactorily passed a medical examination including a vision and hearing test.

4.0 DEFINITIONS OF TERMS

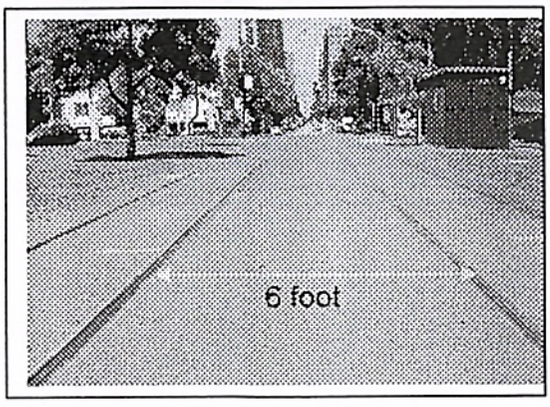
Power Centre	Tram Power Control Room **9610 3394, 9610 3395** (24 hours a day, 7 days a week)
Power Centre Supervisor	Supervisor of all Electrical Operations of the Tram Traction system **9610 3391**
FOC - Fleet Operations Centre	Tram Fleet Operations Centre **9610 3382, 96103383, 96103384, 96103385 & 96103389**
Workers	Persons who have completed the Tram Track Safety in the Field course and who are engaged in a work activity in the tram environment.
Spotter Or Electrical Safety Observer	A person whose who has attended a training course approved by the OCEI and sole task is to observe the movements of plant near live overhead wires and fittings.
OCEI	Office of the Chief Electrical Inspector.
Up Tram	Tram travelling to termini closer to the city.
Down Tram	Tram travelling to termini further from the city.
Mobile Plant	As far as PTW is concerned mobile plant is deemed to include the following equipment while in operating mode:- • Cranes • Concrete Placing Booms • Tipping Trucks • Backhoes • Elevating Work Platforms • Excavating Equipment or any equipment fitted with a jib or boom and any device capable of raising or lowering a load. Note: Operating mode is when the driver or operator is at the controls of the machine.
Vehicle	**'Vehicle'** means a truck (non tipping), car, utility, or other general purpose conveyance used for the carriage of persons or goods.
PTW	Permit to Work Adjacent to Electrical Apparatus.

5.0 TRACK SYSTEM

The track system consists of rails on which the tram runs and a supporting structure. The distance between the rails (the gauge) is 1436 mm and is known as the '4 foot' The distance between the tracks is greater than 1916 mm and is known as the '6 foot'.



Distance Between Rails – 4 foot

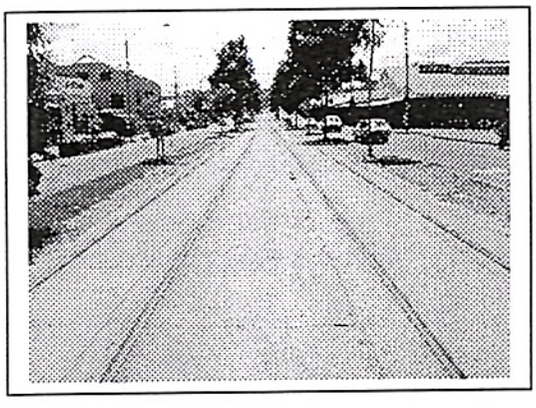


Distance Between Tracks – 6 foot

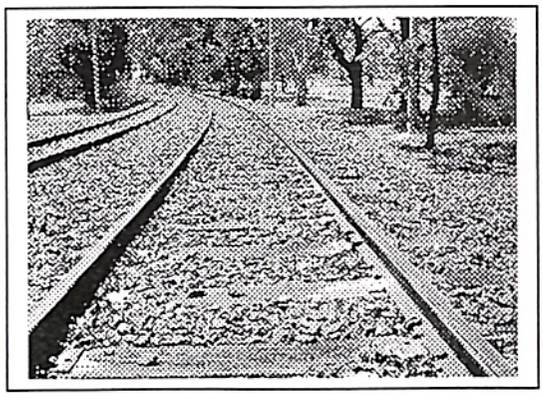
Warning

There is not sufficient room to stand in the 6 foot while trams are passing

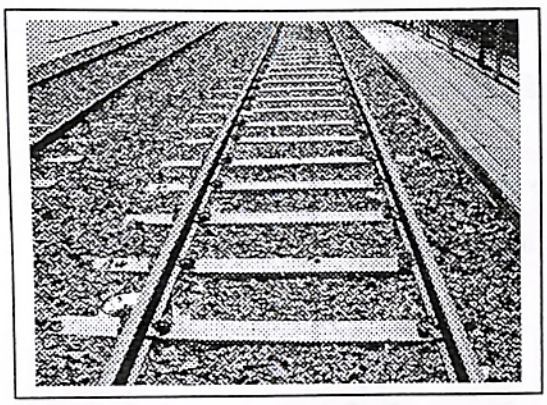
The supporting structure can consist of concrete, asphalt, timber tramway blocks as well as wooden or concrete sleepers with ballast. The track system can be laid in a tram only easement eg. Peel Street or in a public road eg. Epsom Road.



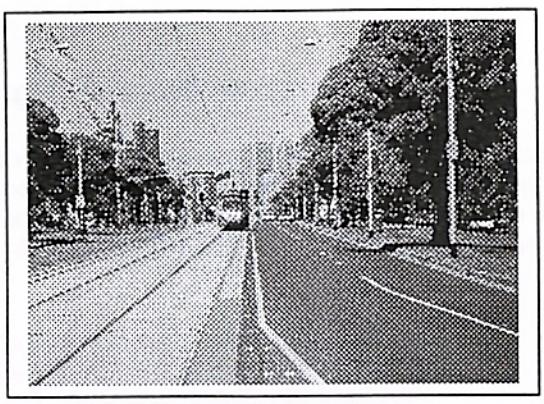
Concrete Track – Tram Only Easement



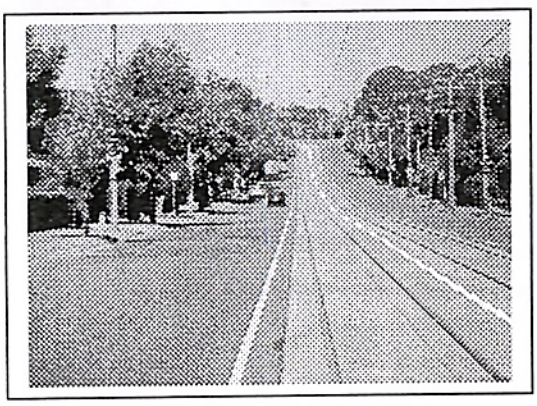
Timber Sleepers – Tram Only Easement



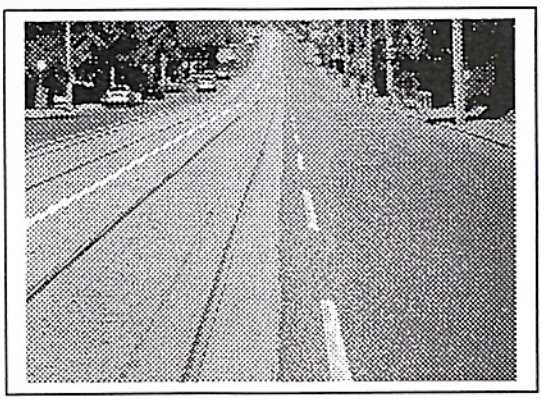
Concrete Sleepers – Tram Only Easement



Permanent Tram Lane



Part Time Tram Lane



Shared Lane - Tram has Priority

Public roads can have marked tram lanes as follows:-

- Full time or permanent tram lane - yellow line with reflectors
- Part time tram lane - continuous yellow line. Overhead signs indicate the times the tram lanes operate
- Shared lane, tram has priority - broken yellow lines

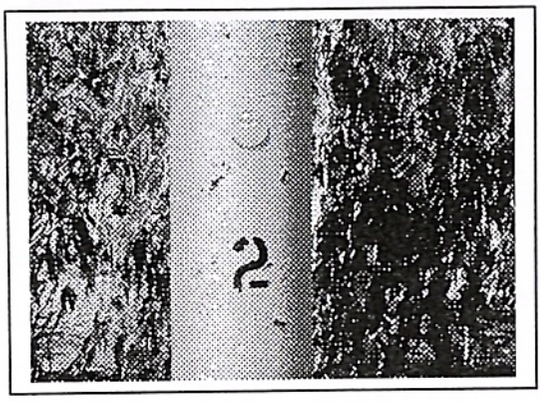
Warning

Take extreme care when crossing over ballasted tracks, especially in wet weather, to avoid slipping on the sleepers and to avoid injuries due to the uneven surface.

6.0 TRACK OPERATIONS

6.1 Track & Pole Numbering Conventions

6.1.1 Tram poles were installed when the various routes were electrified and unfortunately, there was not a uniform numbering system. However, all poles are numbered sequentially along a particular street. Poles are often numbered from the start of the street or corner rather than from the terminus.



Hint
Pole 2U would be on the UP side of the street adjacent to the UP track. Pole 2D would be on the opposite side of the street, adjacent to the DOWN track.

6.1.2 Up trams travel towards the terminus closest to the Central Business District. Poles adjacent to the Up track are known as Up Poles.

6.1.3 Down trams travel towards the terminus further from the CBD. Likewise, poles adjacent to the Down track are known as Down Poles.

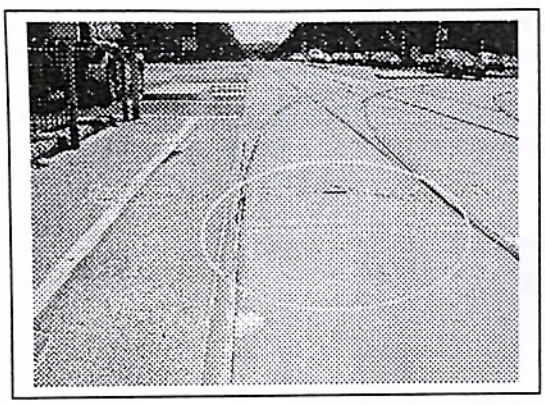
6.1.4 The numbers are normally painted on the pole in a contrasting colour.

Warning

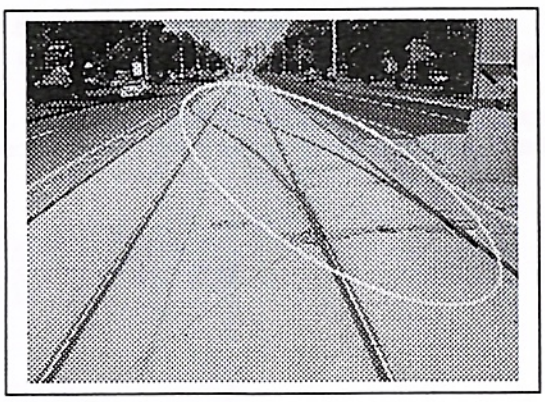
Be careful removing posters to reveal pole numbers. Discarded syringes may be concealed in the layers of posters.

6.2 Turnouts and Crossovers

Turnouts allow trams to turnout from one track to another



Turnout



Crossover

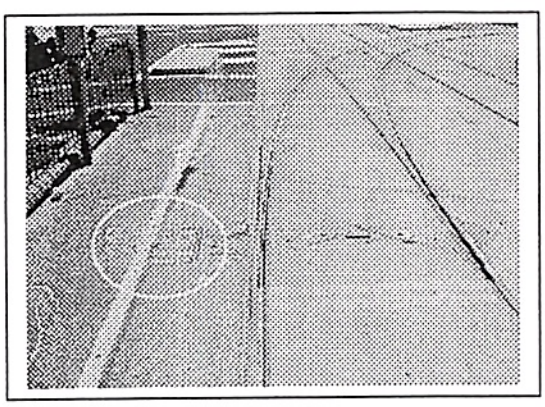
6.2.1 Crossovers are two turnouts linked together to let trams cross from one track to another

6.2.2 Points are the movable blade that allows the tram to change from one line to another

6.2.3 Points can be manually operated by using a point bar.

6.2.4 Points can also be operated automatically by the driver as the tram approaches the points.

6.2.5 The automatic points are powered from the 600volt overhead wiring. The cables to the automatic points are buried beneath the roadway.



Turnout with Automatic Points

Warning

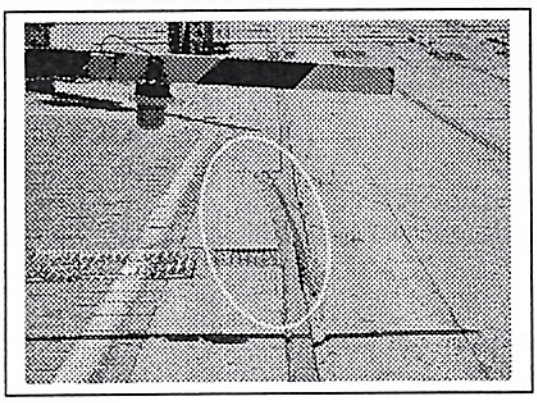
When digging or sawing in the roadway near automatic points an isolation of the supply cables is generally required.

6.3 TRAIN – TRAM LEVEL CROSSING

There are 4 train tram level crossings:-Glenhuntly, Gardiner, Kooyong and Riversdale.

Work within 3 meters of a railway line is covered by the train Book of Rules and Operation Procedures which take precedence over the tram General Operational Rules and Procedures.

To reduce the risk of a tram colliding with a train, tram catch points are installed on the approach side of the crossing. The catch points are designed to derail the tram to avoid collision. The train signal box has control of the catch points



Tram Catch Points at Level Crossing

Warning

Never place fingers, or tools and equipment between the blades of automatic points or catch points as they may operate with out warning.

6.4 DEPOTS

Trams are serviced, maintained, and stored during off peak times at a number of depots located around the metropolitan area. – Camberwell, Kew, East Preston, Essendon, Brunswick Malvern and Glenhuntly. Before entering a tram depot sign the visitors book and collect a "Visitors" name tag from the Depot Office.

Work to be carried out in tram depots must be assessed by the Power Centre Supervisor or his representative to determine if an electrical isolation or permit issue is required.

Warnings

Tram Depots have extensive overhead networks. Contact with tram overhead wiring may cause injury or death.

In depots, trams operate in both directions and may change tracks without warning.

Trams are often stabled over pits that form falling or tripping hazards.

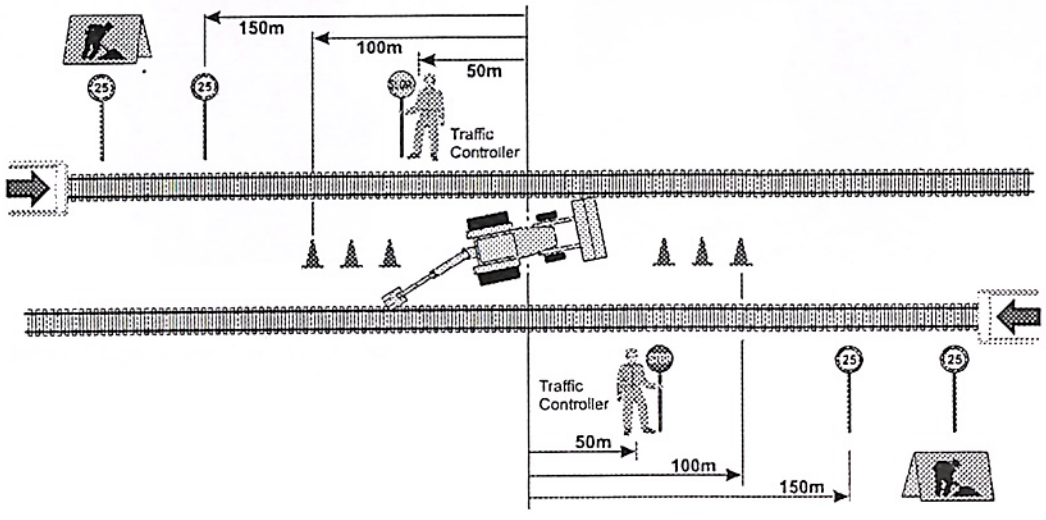
7.0 TRACK SAFETY

Where trams operate in a shared carriageway traffic management that meets VicRoads traffic management standards for road vehicles is normally adequate for trams.

Where trams operate in their own easement (eg. Royal Park) and the track is to be fouled or work to be within 1.42 m of the running rail then the "Safety Procedures for Light Rail / Tram Reserves" shall apply.

The protection includes :-

- 25 km/hr signs at the reserve entrance
- 25 km/hr signs150 m prior to the worksite,
- witches hats 100 m prior to the worksite and
- Traffic controllers 50 m prior to the worksite to instruct tram drivers.



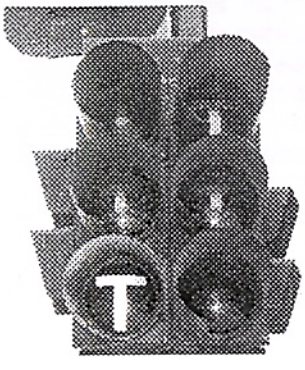
8.0 SIGNALLING SYSTEM

8.1 Traffic Signals

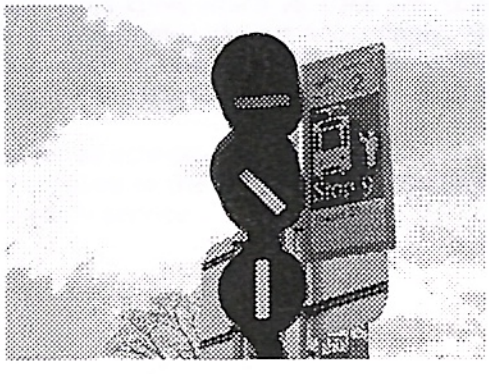
8.1.1 Trams generally follow road traffic signals but there are some special signals for trams only.

8.1.2 For trams only "T" lights take precedence over normal road traffic lights. "T" lights can be red, amber, green or white.

8.1.3 Automatic points have bar lights that indicate to the tram driver the position of automatic points.



White T Light allows tram to turn left



Bar Lights showing direction of Automatic Points

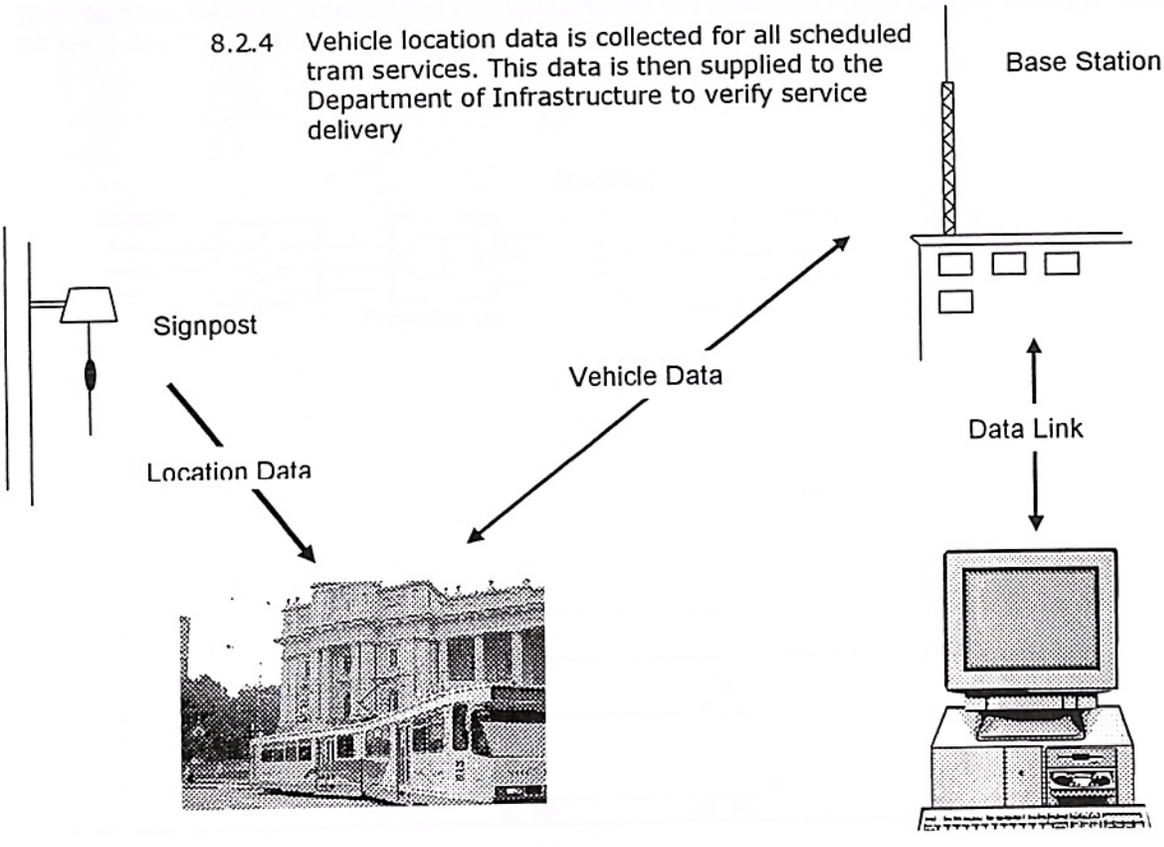
8.2 AUTOMATIC VEHICLE MONITORING

8.2.1 The Automatic Vehicle Monitoring (AVM) system uses a computer and radio technology to monitor tram operations. The system allows the position of trams across the network to be monitored by Fleet Operations.

8.2.2 Low power radio transmitters called signposts are located around the metropolitan area. Trams pick up signals as they pass these signposts and automatically relay this information back to the control centre. This information is processed by the central computer and presented to the tram network controllers on a number of computer screens.

8.2.3 With this information, Control operators know which vehicles are running ahead or behind schedule, or in an emergency can act accordingly. The system also allows the Control Operator to talk to the driver directly or issue a public address announcement to passengers via the mobile radio.

8.2.4 Vehicle location data is collected for all scheduled tram services. This data is then supplied to the Department of Infrastructure to verify service delivery



Warning

Fleet Operation Controllers know the location of all trams. Do NOT delay trams.

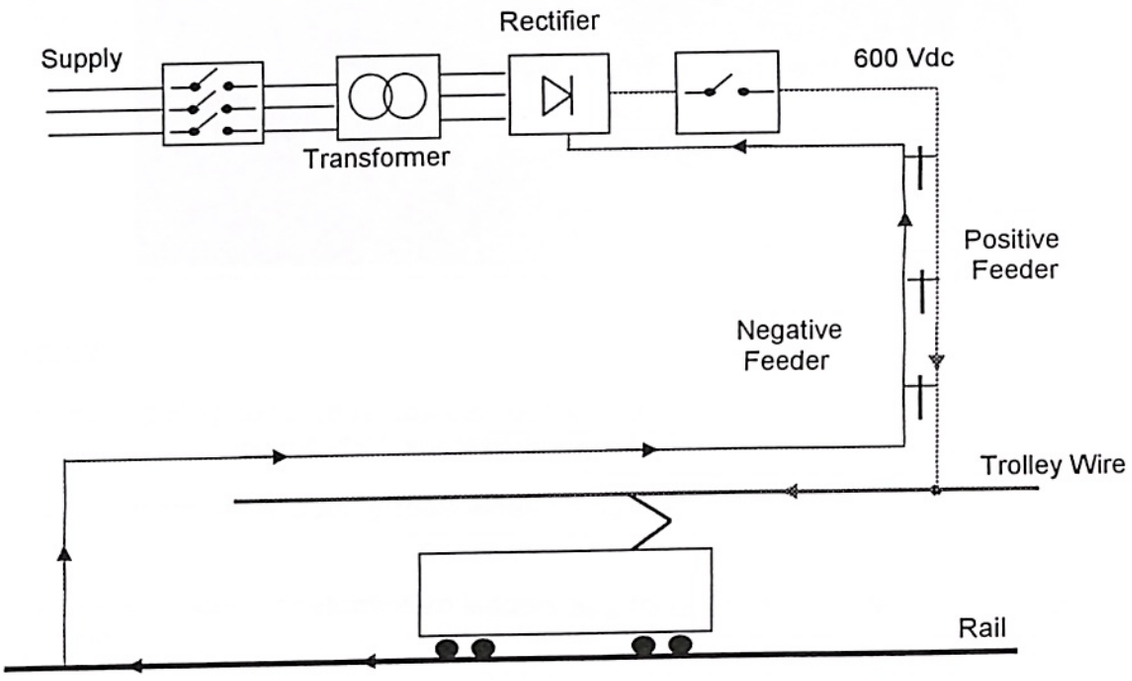
9.0 ELECTRICAL SYSTEM

The Tram Electrical Network consists of a number of elements:-

- Supply – electrical power is purchased from the Distribution Company at 22,000, 11,000 or 6,600 volts AC
- Transformer – reduces high voltage AC to low voltage AC
- Rectifier – converts low voltage AC into 600 volts DC
- Positive Feeder – copper cable that carries current from substation to trolley wire
- Trolley wire – hard drawn copper conductor that carried current to tram pantograph
- Tram – traction motors and control equipment to control speed of tram
- Rail – carries return current from tram wheels to negative feeder
- Negative Feeder – completes return circuit for current

The Electrical Network is controlled and operated by the Electrical Power Centre which is manned 24 hrs a day 7 days a week.

Tram Electrical System



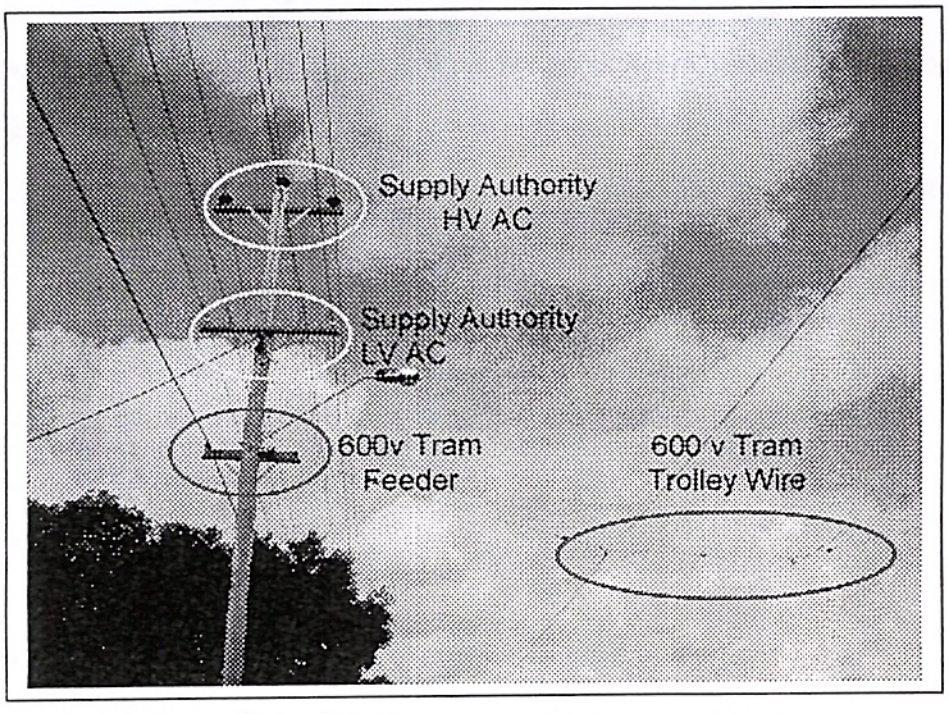
Warning:

In case of an accident or electrical incident contact the Power Centre immediately on 9610 3394 or 9610 3395

Dangerously high voltages may occur if all rails are cut or the negative bonding cable is broken or disconnected from the rail.

9.1 Precautions Before Starting Work Near Live Wiring

Ensure a site inspection or approval from the Power Centre Supervisor or his representative has been granted prior to commencement of any works. Familiarise the work party with any exposed live wiring and fittings in the work area. Make sure you can distinguish between those belonging to the 600v traction network such as the trolley wire and spans feeders and the high or low voltage assets belonging to the Supply Authority and that the Supply Authority has approved of the works.



Warning:

When moving long conductive objects such as pipes hold them horizontal and close to the ground and always position yourself to face towards the live wires or equipment.

Conductive materials including tools when being man handled are an extension of the body.

Never use wire bound or aluminium ladders and metal measuring tapes in a traction environment.

9.2 Limits of Approach to Live Electrical Apparatus.

- The Office of the Chief Electrical Inspector has issued Guidelines for Network Operators when Granting Permission for Work near Powerlines.
- The precautions vary depending on the type of work being undertaken and include:-
- Rules for Erecting Scaffolding Near Overhead Power Lines
- Rules for Operating Near Overhead Power Lines - Cranes, Concrete Placing Booms, Tipping Trucks, Load Shift and Excavating Equipment and
- Rules for Operating Elevating Work Platforms Near Overhead Power Lines

9.3 Electrical Permits

To allow work to proceed in a safe manner a number of electrical permits have been developed. For the purpose of this course, three electrical permits need to be considered.

9.3.1 Approval to Work Adjacent to Tramways Electrical Equipment and Wiring (also known as a Permit to Work [PTW] by OCEI).

- This permit is usually issued to groups wishing to carry out construction or maintenance tasks in proximity to overhead or underground tram electrical use plant or equipment on or near the tram track.
- This permit can be issued with the power isolated, but in certain cases be left on if Special Precautions have been put in place such as battens or hoardings to allow work to proceed safely.
- This permit does not require formal training or authorization.

9.3.2 Permit to Work in the Vicinity of Electrical Apparatus

- This permit is usually issued to groups wishing to use plant or equipment in close proximity to tram traction electric cables or equipment.
- The power is switched OFF and the wiring has been tested and short circuited before the "Vicinity Permit" is issued.
- This permit can only be issued to trained and authorized personnel.

9.3.3 Electrical Access Permit (EAP)

- This permit is normally only issued to electrical workers who are actually working on the electrical wiring. The power is switched OFF and the wiring has been tested and short circuited before the Electrical Access Permit is issued.

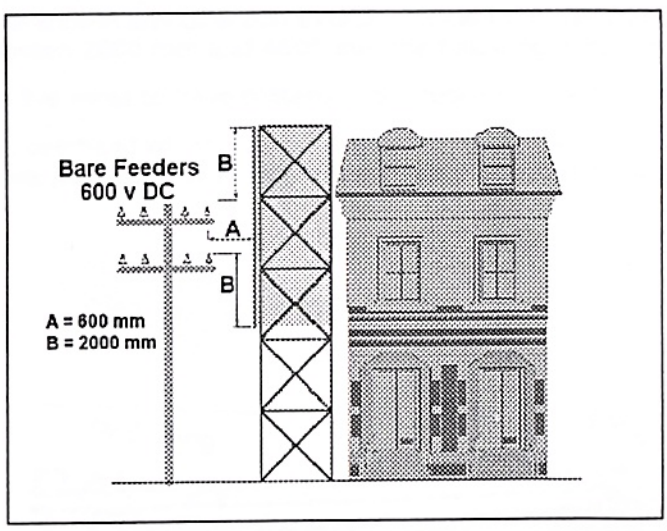
9.4 Rules for Erecting Scaffolding near Overhead Power Lines

Two conditions need to be considered, erecting the scaffolding and actually using the scaffolding. The construction phase is generally requires greater precautions as scaffolding pipes are being positioned and protection barriers may not be in place.

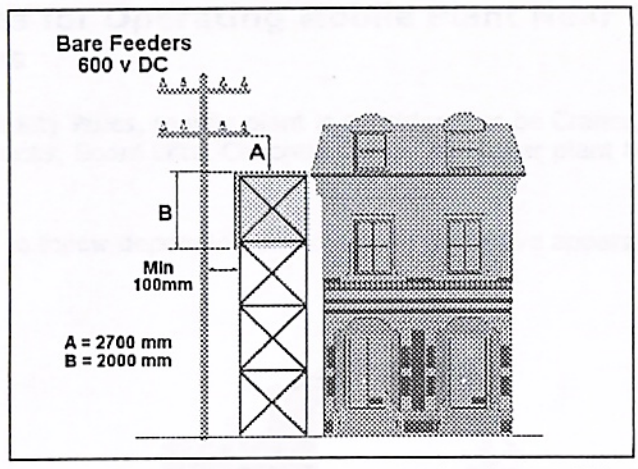
9.4.1 Once the scaffolding has been erected

- Clearance in any direction except vertical from the completed scaffold to the live feeders is greater than 4600 mm – No special precautions required.
- Clearance in any direction except vertical from the scaffold to the live feeders is between 600 mm and 4600 mm the following is required:
- the live wires to have battens (tiger tube) installed; and
- an approved insulating hoarding or barrier attached to the scaffolding; and
- An **"Approval to Work Adjacent to Tramway Electrical Equipment and Wiring"** to be issued.
- Clearance in any direction except vertical from the scaffold to the live feeders is less than 600 mm – Power Off - Permit to Work Adjacent or in the Vicinity of Electrical Apparatus.

For the purpose of electrical safety, standing on a shop veranda would be considered as scaffolding.



Minimum Horizontal Dimensions Between Erected Scaffold and Bare 600v DC Feeder and Insulated Hoarding



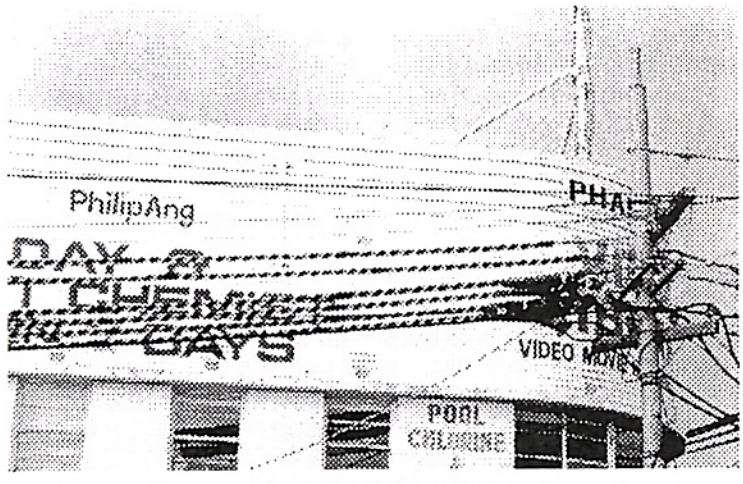
Minimum Vertical Dimensions Between Erected Scaffold and Bare 600v DC Feeder and Insulated Hoarding

Warning:

The minimum vertical clearance from the scaffold to the live feeders is 2700 mm

9.4.2 Erection of Scaffolding

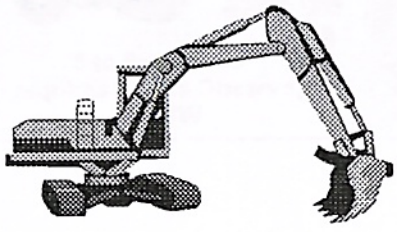
- Clearance in any direction except vertical from the scaffold to the live feeders is between 2000 mm and 4600 mm the following is required:
- the live wires to have battens (tiger tube) installed and
- The overhead wiring has been isolated, tested and short circuited and a **"Permit to Work Adjacent or in the Vicinity of Electrical Apparatus"** to be issued.



9.5 Rules for Operating Mobile Plant Near Overhead Power Lines

Under the Electrical Safety Rules, mobile plant is considered to be Cranes, Backhoes, Excavators, Piling Rigs, Tipping Trucks, Boom Lifts, Concrete Pumps and other plant fitted with lifting equipment.

There are procedures to follow depending on how close to the live apparatus the machinery is operating.



9.5.1 Horizontal Clearances

- Greater than 6.4 metres horizontally from exposed live overhead apparatus

  No Permit required and there is generally no need for a Spotter. If there is any doubt, or if the plant could come with in 6.4 metres of the overhead wiring then a spotter is required.

- Between 3 metres and 6.4 metres horizontally from exposed live overhead apparatus

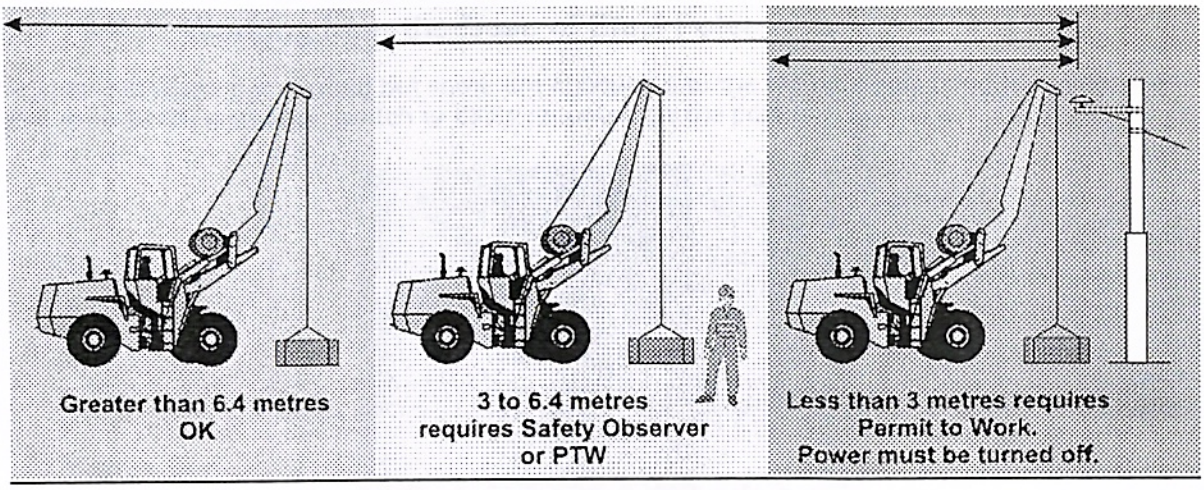
  When mechanical plant is operating between 3 metres and 6.4 metres from exposed live overhead apparatus a Spotter is required.

  The spotter's sole task is to observe the plant to ensure that it does not come with in 3 metres of the live overhead wiring. If there is a possibility that the plant may come with in 3 metres of the overhead wiring then the site must be inspected by Yarra Trams Power Centre Supervisor or his representative to determine what protective measures are required.

- Less than 3 metres horizontally from overhead apparatus

  The site must be inspected by Yarra Trams Power Centre Supervisor or his representative to determine what protective measures are required. It may be necessary to have the wiring covered by battens or have the power switched off, the wiring tested and short circuited and a "Permit to Work Adjacent or in the Vicinity of Electrical Apparatus" or both battens and a PTW.

No Contact with overhead wiring is permitted.



Warning:

- Loads must **NOT** be lifted over live apparatus.
- A Spotter's sole duty shall be to warn the plant operator of approach to overhead wiring.

9.5.2 Vertical Clearances

- Greater than 6.4 metres vertically below exposed live overhead apparatus

  No Permit required and there is generally no need for a Spotter. However, if there is any doubt, or if the plant could come within 3.0 metres of the overhead wiring then a spotter is required.

- Between 3.0 metres and 6.4 metres vertically below exposed live overhead apparatus

- When mechanical plant is operating between 3.0 metres and 6.4 metres vertically below live overhead apparatus a Spotter is required. If there is a possibility that the plant may come with in 3 metres of the overhead wiring then the site must be inspected by the Yarra Trams Power Centre Supervisor or his representative to determine what protective measures are required.

- Less than 3 metres vertically below overhead apparatus

  The site must be inspected by the Yarra Trams Power Centre Supervisor or his representative to determine what protective measures are required. It may be necessary to have the wiring covered by battens or have the power switched off, the wiring tested and short circuited and a "Permit to Work Adjacent or in the Vicinity of Electrical Apparatus" or both battens and a PTW.

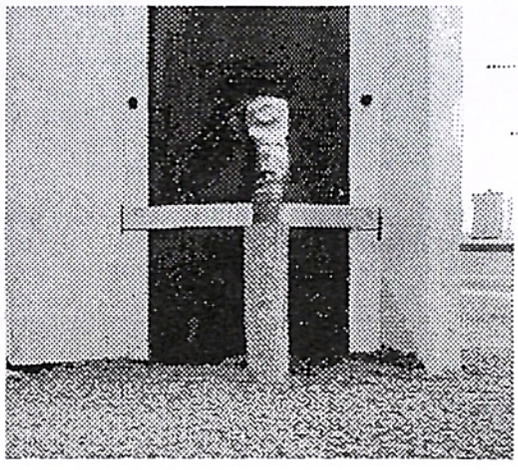
No Contact with overhead wiring is permitted

The overhead trolley wire height varies from approximately 4.0 metres to 5.64 metres above the top of the rail. Plant such as backhoes and excavators are prohibited from working under live trolley wiring unless fitted with devices approved by Yarra Trams Power Department, to physically prevent them from approaching less than 2 metres from the trolley wire.

Warning: Remember all Tram Overhead network must be treated as live not only the trolley wire.

9.6 Working Near the Base of Steel Poles

The steel poles are not earthed but some are connected to the rail by a pole bond particularly if there is an aerial contactor, switch or cable mounted on the pole.



Warning Look for a pole bond before digging around a pole. Always report damaged pole bonds.

9.7 Identifying the Safe Work Areas under a Permit to Work Adjacent or in the Vicinity of Electrical Apparatus

If a Permit to Work Adjacent or in the Vicinity of Electrical Apparatus has been issued on isolated wiring, the wiring that is to be approached will be short-circuited to the negative return at the most appropriate substation. In some instances an extra short circuit may be attached on one or both sides of the work area by a device called a 'trolley to rail short circuit'.

The locations and limits of the isolation will be clearly defined on the Permit to Work Adjacent or in the Vicinity of Electrical Apparatus.

Live equipment in proximity to the work site may also be defined on the permit.

Warning Never work outside the area that is covered by the Permit

9.8 Reporting of Irregularities

Irregularities or damaged components must be reported as soon as possible.

Irregularities include the following:

- Wires hanging loose or out of position;
- Excessive sparking or flashing;
- Bridge fittings or guards displaced;
- Broken insulators or brackets;
- Tree branches touching overhead wiring;
- Damaged or leaning poles; or
- Damaged pantograph or equipment on the roof of a tram.

10.0 SUMMARY

- Be alert at all times – cars and trucks as well as trams are major hazards when working on or near the tram system.
- Ensure that all controls are in place before starting work.
- Communicate. Warn others, report hazards and incidents.