Pit and Conduit Standard for Signalling and Communication Cables

Engineering Standard

Rail Commissioner

PTS-MS-10-SG-STD-00000094

Government of South Australia
Rail Commissioner

DOCUMENT CONTROL

Document Status

DOCUMENT OWNER: UNIT MANAGER, SIGNAL AND CONTROL SYSTEM ENGINEERING			
Action	**Name and Position**	**Signature**	**Date**
Prepared By:	Name: Kuldeep Zala Title: Technical Assurance Engineer Name: Phil Keany Title: Signals Inspector	 	5/3/18 05/03/2018
Reviewed By:	Name: Keith Charlton Title: Manager, Rail Technical and Operational Assurance Name: Nilesh Patel Title: Senior Signal Engineer	 	5/3/18 06/03/18
Approved By:	Name: Mayank Jain Title: Unit Manager, Signals and Control System Engineering		5/3/2018
Document Review Schedule:		This document is due for review as required	

Document Amendment Record

REVISION	CHANGE DESCRIPTION	DATE	PREPARED	REVIEWED	APPROVED
0	Initial Issue	July 2012	Kuldeep Zala	Keith Charlton	Brian Green
1	Depth of Conduit containment, conduit construction, GST information and additional Pit & cable information.	March 2018	Kuldeep Zala Phil Keany	Keith Charlton Nilesh Patel	Mayank Jain

TABLE OF CONTENTS

1. Introduction

The Department of Planning, Transport and Infrastructure (DPTI) owns, operates and maintains the Adelaide Metropolitan Passenger Rail Network (AMPRN) under the Rail Accreditation assigned to Rail Commissioner. This standard is intended to ensure that installation of pit and conduit for signalling and communications cables does not create any risks not deemed to meet the So Far As Is Reasonably Practicable (SFAIRP) principles under the Rail Safety National Law (RSNL).

2. Purpose

The purpose of this standard is to provide technical standards for pit and conduit systems that support signalling and communications infrastructure.

3. Scope

This standard applies only to pit and conduits systems for DPTI Rail Signalling and Communications cables.

In the context of signalling and communications power services it encompasses only Extra Low Voltage (ELV) and Low Voltage (LV) systems not High Voltage (HV) systems as defined in *AS3000 Electrical Installations (Known as the Australia/New Zealand Wiring Rules).*

This standard is NOT applicable to High Voltage (HV) systems.

This standard is NOT applicable to third party cables installed within the rail corridor.

4. Related Documents

DOCUMENT NAME	DOCUMENT NUMBER
691-A3-09-738 (KNet #8912509)	Signal and Power Services – Layout of cables in conduits in main cable trenches
691-A3-09-2463 (KNet #8912368)	Signal and Power Services – Layout of cables in conduits in under track main cable trenches
691-A2-92-227 (KNet #8913897)	Layout of cables in main cable trenches (direct buried main & tail cables)
691-A2-11-030 (KNet #8912385)	Signals and Power Services – Layout of direct buried cables in main cable trenches
SG1-DRG-100481 (KNet # 12412596)	Signals & Power Services Cable Joint & Non-Joint Plates
SG1-DRG-100482 (Knet # 12412885)	Signals & Power Services Cable Sign & Post Final Assembly

5. References

- *AS 7664:2012 Railway Signalling Cable Routes Cable Pit and Foundations*
- *AS 3000 Electrical Installations (Known as the Australian/New Zealand Wiring Rules)*
- *AS 4799 Installation of Underground Utility Services & Pipelines Within Railway Boundaries*
- *AS 2053.1 Conduits and Fittings for Electrical Installations. Part 1: General Requirements*
- *AS 2053.2 Conduits and Fittings for Electrical Installations. Part 2: Rigid Plain Conduits and Fittings of Insulation Material*
- *AS 1289 Method of Testing Soils for Engineering Purposes.*
- *AS/CA S009:2013 Installation requirements for Customer Cabling*
- *AS/CA S008:2000 Requirements for Customer Cabling Products*
- *AS HB 243 Communications Cabling Manual – Australian Regulatory Requirements*
- *AS HB 29 Communications Cabling Manual – Communications Cabling Handbook*
- *AS 2648.1 Underground Marking Tape Part 1: Non-detectable tape*

- *AS 4702-2000 (R2013) : Polymeric cable protection covers*
- *AS 7664 Railway Infrastructure Standard: Signalling Cable Routes and Foundations*
- *AS 1597 Precast Reinforced Concrete Box Culverts*
- *AS 3996 Access Covers and Grates*
- *AS 4586 Slip Resistance Classification of New Pedestrian Surface Materials*
- *AS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*
- *AS/NZS Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.*

6. Acronyms

ACRONYM	FULL NAME
AMPRN	Adelaide Metropolitan Passenger Rail Network
CBI	Computer Based Interlocking
DPTI	Department of Planning, Transport and Infrastructure
ELV	Extra Low Voltage
GLT	Ground Level Troughing
GRC	Glass Reinforced Cement
GRP	Glass Reinforced Plastic
GST	Galvanised Steel Troughing
HDPE	High Density Polyethylene
HV	High Voltage
LDPE	Low Density Polyethylene
LV	Low Voltage
MDPE	Medium Density Polyethylene
RFS	Remote Field Station
RISSB	Railway Industry Safety and Standards Board
UPVC	Un-plasticised Polyvinyl Chloride
URX	Under-Road Crossings
UTX	Under-Track Crossings

7. Conduit and Cable Route Design

7.1. General

1. The following types of cable routes are used within AMPRN:

   - Buried in conduit
   - Direct buried (not preferred)
   - Under Track (UTX) / Road (URX) bored
   - Under Track (UTX) / Road (URX) trenched
   - Above Ground Troughing (GLT)
   - Galvanised Steel Troughing (GST)
   - Conduits embedded in concrete structures

   Note:
   The term “Main cable routes” shall be taken to mean all above ground and buried line side routes associated with cables and conduits. It excludes Under-Track (UTX) and Under- Road (URX) crossings.

7.2. Cable Route Survey & Plan

1. Site survey drawings and a cable route plan shall be prepared in AutoCAD format on A3 size paper and if necessary be truncated at appropriate kilometre points on multiples of A3 size paper, showing all details required for the installation of the cable route including but not limited to the following:

   - Location of any existing cable routes and services.
   - Location of all proposed cables, conduits, pits and troughing, referenced to the nearest rail.
   - The type, size/diameter, depth, numbers and length of cables and conduits complete with a cross section of the cable and conduit arrangements.
   - The distance from any major structure that has a unique identification number, i.e. signal, points, location case etc.
   - Under-track (UTX) and Under-road (URX) crossings.
   - The arrangement of cables and conduits through creeks, culverts, waterways, embankments, railway bridges, subways, station platforms and tunnels.

2. The drawings shall be prepared prior to the commencement of work on site and be updated during the course of installation and amended on completion of work to reflect the as-built arrangements.

7.3. Conduit and Cable Route Location

1. Except as otherwise specified, main conduit and cable routes shall be installed on one side of the track and shall cross the track the least possible number of times for the shortest possible distance.

2. Where any new buried conduit and cable route is to be installed in the vicinity of an existing cable route, the new trench shall be installed in parallel with the existing cable route. The distance from the edge of the existing trench to the edge of the new trench shall be a minimum of 1000 mm. Where this is not possible the new trench shall be excavated using hand tools or approved vacuum excavation device i.e. Hydrovac truck

3. The minimum distance from the running face of the nearest rail to any buried main cable or conduit route shall not be less than three metres unless approved by Unit Manager, Signals and Control System Engineering.

4. Main conduit and cable routes shall, where possible, be on the side of the tracks not occupied by high voltage earthed locations such as sub-stations, power sectioning huts and transformer locations.

5. The main conduit and cable route shall be located as near as possible to the railway boundary. Care must be used to avoid the risk of damage due to fence installation or modifications.

6. New conduit cable routes require a minimum clearance of 1000mm between signalling trench and any existing or known future electrification structure.

7. New conduit cable routes require a minimum clearance of 1000mm between signalling trench and any new/existing high voltage third party cables. Parallel installations will require further separation to minimise induction into LV and ELV wiring systems to be determined by calculation of designer.

8. Trenched conduits shall be installed to ensure the alignment of the conduit does not cross over other conduits, the use of conduit spacers are required or other means of ensuring conduit alignment.

7.4. Cable Route Path

1. Main conduit and cable routes shall follow a constant grade and alignment and be parallel to the running lines wherever possible and shall have minimum changes in direction.

2. To connect individual equipment at remote ends, local conduit and cable routes shall be installed as required.

3. Main conduit, GST and GLT cable routes shall be located and installed so that they do not divert or interfere with any drainage (railway or natural) or underground services.

4. Special care shall be taken to ensure that the main conduit and cable route will not affect the stability of any embankment or cutting.

5. Unless otherwise agreed the treatment of the main conduit and cable route for occasional waterways or creeks, shall be to bore under the waterways or creeks. An environmental management plan shall be prepared and implemented to ensure such features are protected.

6. Where other services such as gas, water, telephone, sewerage, storm water, signal, communications and drainage could affect any proposed buried cable route then the conduit and cable route should be laid 500 mm below the obstacle.

7.5. Depth of Buried Conduit and Cable Route

1. The depth of any trenched main conduit and cable route shall ensure that the top of the shallowest conduit/cable is laid at a depth of <u>not less than 850 mm</u> below ground level. This dimension applies except in the circumstance where the trench passes under the track.

2. Where conduits are to be installed in Under Track Crossings (UTX) and Under Road Crossings (URX) the provisions of Section 10 shall apply.

3. The bottom of trenches shall be level and even, free of stones and sharp objects.

7.6. Bends and Radius of Bends

1. The smallest radius bend in any cable route shall not be less than the conduit/cable manufacturer's recommended minimum radius.

2. No more than two bends shall be installed between adjacent cable pits maximum of 180 degrees.

7.7. Cable Route Markers and Marking Tape

1. Markers shall be installed on buried cable or conduit routes:
   - at points of entering and leaving the rail corridor
   - at changes of direction
   - at distances between consecutive markers of the lesser of 50 m or line of sight
   - at all drains or other points of potential hazard
   - at the two ends of under track and under road crossings unless pits installed are in plain sight and the crossing can be visually detected.

2. Markers shall comply with the following requirements:
   - stand at least 1200 mm out of the ground, to the bottom of the marker plate
   - marker plates and poles shall be made of non-combustible material
   - wording on markers shall be legible, permanent, and formed in a non-combustible medium
   - descriptive wording and instructions that are shown on markers shall face away from the railway tracks
   - markers shall be placed away from any vehicle access tracks or pedestrian walkways
   - cable route markers attached to an Overhead Wiring (OHW) structure shall not cause deleterious effects to the structure or its protective coating

3. Wording on markers shall comply with DPTI rail signal's drawing number SG1-DRG-100481 and SG1-DRG-100482 which include the following:
   - "Government of South Australia"
   - "Department for Planning, Transport and Infrastructure"
   - a warning of the presence of a buried service
   - the nature of the buried service
   - contact number 72015035 in the event of an emergency
   - An offset' to the duct/pit if the marker is unable to be installed on the buried cable or conduit routes
   - Cable joint number

4. Underground marking tape shall:
   - conform to *AS 2648.1: Underground marking tape Part 1: Non-detectable tape*
   - be laid along the full length of all conduit trenches at 500 mm and 800 mm below ground level. The lower marking tape shall be 50 mm above the top most conduit in accordance with drawing number 691-A3-09-738
   - be orange coloured PVC and shall be labelled with black text "CAUTION SIGNAL CABLE"

7.8. Environmental Impacts

1. Main conduit and cable routes can have a visual impact on the surroundings and this can draw attention to the presence of copper cable and as such should be designed to be as unobtrusive as possible.

2. Cables, conduits and troughing should not be attached to or alter the appearance of any building or structure which is on a heritage list or is subject to a preservation order, without specific approval from the relevant heritage authorities.

3. Trees or shrubs should only be removed or lopped to the least extent necessary for construction of a main conduit and cable route. Damage to the root systems of mature or substantial trees should be avoided.

4. During construction silt runoff into any waterway should be prevented.

5. During construction blockage of any natural or track drainage should be prevented.

6. With the exception of under track crossings, during construction, the main cable route should not disturb the existing track formation.

7. The finished color of painted surfaces shall be compatible with the environment in which they are located.

8. Excavated spoil that is to be removed from the corridor shall be stockpiled within the corridor and tested for any contamination before removal. Disposal of contaminated spoil shall comply with all relevant environmental regulations.

9. Restoration work including ground stabilisation and cross drainage to reduce soil erosion should be carried out to restore the route to as near as reasonably possible to its original state.

7.9. High Voltage Areas

1. Existing high voltage earthing arrangements shall not be disturbed.

2. Signalling cables that are installed within 20 metres of any earth mat provided around high voltage locations as part of the earth protection arrangements for the high voltage installations shall be run in conduits.

3. The minimum separation between communications cables and HV power cables should be 450 mm or as specified in *AS/CA S009: Installation requirements for customer cabling.*

8. Buried Conduit

8.1. General

1. The requirements for buried conduit shall comply with Section 7 and this section.

2. All conduits shall be solid wall rigid and manufactured from heavy duty UPVC, HDPE, heavy duty Corflo may be used for short length connection to assets where flexibility is required. Steel conduits shall not be used.

3. Conduits shall be, as far as practicable, in a direct line between pits.

4. Prior to hauling cables through conduits, a suitable cleaning brush mandrel shall be used to clear the conduit of debris that may cause damage to the cables.

5. One spare orange and one spare white 100mm conduit shall be installed.

6. All spare conduits shall have installed a draw wire for installation of future cables, and be capped to prevent the ingress of vermin or dirt. The draw wire shall be preferably, 4 or 6 mm polypropylene rope or Telstra twisted rope.

7. All conduits shall comply with *AS/CA S008: Requirements for authorized cabling products* unless a conduit is to be installed as sub-ducting in a larger conduit that complies with *AS/CA S008*.

8. Conduit installed as sub-ducting in a larger conduit that complies with *AS/CA S008: Requirements for authorized cabling products* shall not have misleading markings or be of a prohibited color which may create a safety hazard.

9. All jointing of conduits shall be carried out in accordance with the conduit manufacturer's recommendations and guidelines.

10. Where communication cables are in the same trench as signalling or power cables then:

    - the communication cables shall be housed in a separate conduit
    - the communication conduits shall be above the signalling or power conduit for the total length of the trench

11. The minimum separation between communications conduits and signalling or other power conduits should be as specified in *AS/CA S009: Installation requirements for customer cabling*.

12. Fibre optic cable shall be in a separate conduit unless otherwise approved by Unit Manager, Signals and Control System Engineering and Unit Manager Communications and Electronic Systems.

13. Flexible or corrugated conduit shall not be used.

14. Conduit elbows and tees shall not be permitted in the installation, unless approved by Unit Manager, Signals and Control System Engineering.

15. Conduits shall be considered to be full when 50% occupied. If there are two bends up to 90 degrees in the conduit pull length then it shall be considered to be full when 40% occupied.

16. Conduit types shall comply with Table 8.4

8.2. Conduit Color

1. Conduit colors shall be as set out below:

   - White – Communications Cables
   - Orange – Power Cables and Signalling Control Cables

8.3. Conduit Dimension and Form

1. Dimensions and sizes associated with conduits, couplings, sockets and conduit entries shall comply with *AS 2053: Conduits and fittings for electrical installations*

8.4. Conduit Markings

1. Marking of the conduit and the location of the marking shall comply with *AS2053: Conduits and fittings for electrical installations*

ESSENTIAL			
ID	**SERVICE**	**CONDUIT TYPE**	**INTENDED USE**
1	Signalling Power LV (650 V A.C.)	1 x 100 mm Orange	Power
2	Signalling Power LV (110V A.C.)	1 x 100 mm Orange	Power
3	Signalling, SCADA & Passenger Information System	1 x 100 mm White	Optical Fibre Cable
4	ELV Communications	1 x 100 mm White	Copper or Optical Fibre Cable
	LV Communications (eg public address speaker cables)	1 x 63mm White	Copper cable
5	Signalling Control Cables(copper media)	3 x 100 mm Orange	Connectivity between RFS & Trackside Equipment where required
6	Signalling Power Spare	1 x 100 mm Orange	Future application
7	Communications Spare	1 x 100 mm White	Copper or Optical Fibre Cable
OPTIONAL			
ID	**SERVICE**	**CONDUIT TYPE**	**INTENDED USE**
8	CCTV & Ticketing & Future Services	100 mm White	Optical Fibre Cable for primary or redundant paths
9	ITS Communications	100 mm White	Optical Fibre Cable for primary or redundant paths
10	Commercial Use	100 mm White	Fibre Pairs/Optical Fibre Cable/Conduit for lease
11	Commercial Use	100 mm White	Fibre Pairs/Optical Fibre Cable/Conduit for lease

Table 8.4 Different Conduit Type

9. Direct Buried Cable (Not Preferred)

1. Application for this method of installation shall be made to the Unit Manager, Signals and Control System Engineering and Unit Manager Communications and Electronic Systems, this is not a preferred method of installation.

2. The requirements for direct buried cable shall comply with Section 7 and this section if approved by Unit Manager, Signals and Control System Engineering and Unit Manager Communications and Electronic Systems

3. The use of direct buried cable is not recommended within AMPRN.

4. The use of direct buried cable for under-track (UTX) and under-road (URX) crossings is not permitted.

5. Where direct buried signalling cables are installed in the same trench as communications or power cables, then the minimum separation between the cables shall be as specified in *AS/CA S009: Installation requirements for customer cabling.*

6. The top of the direct buried cable shall be a minimum depth of 1000 mm from ground level.

7. Cables shall be installed within a tolerance of ±50mm of the nominal depth subject to the minimum cover not being less than 1000 mm.

8. The cable installation method shall be approved by Unit Manager, Signals and Control System Engineering. Vacuum excavation using hydrovac truck or manual trenching methods are preferred to ploughing.

9. Where used, ploughing shall not be carried out:
   - Within 1000mm of any water, electrical or communications service, or
   - Within 1500mm of any gas service, or
   - Within 1500mm of any other service carrying dangerous or flammable materials.

10. Vibratory ploughing shall not be used.

11. Buried signalling cables are to be provided with mechanical protection, to prevent damage, by a cover strip of minimum width 150 mm placed on top of the cables and overlapping the cables by not less than 50mm on each side. The cover strip shall comply with *AS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules.*

10. Under-Track (UTX) and Under-Road (URX) Crossings

10.1. General

1. The requirements for UTX and URX shall comply with Section 8 and this section.

2. UTX and URX under existing tracks/road shall preferably be constructed by an approved directional boring method in accordance with Section 15.

3. Where it is not practical to install a UTX or URX by the boring process, the UTX or URX may be installed by trenching, backfilling and compaction in accordance with Section 14.

4. All UTX shall be installed at 90° (±5°) to the tracks.

5. For all UTX and URX cables shall be contained within conduit in accordance with table 8.4

6. Steel conduit shall not be used for UTX or URX.

7. Where power cables pass under tracks, they shall be enclosed in an appropriate 'Category A' system in accordance with *AS 3000: Electrical installations (known as the Australian/New Zealand Wiring Rules.*

10.2. Trenching of Under-Track (UTX) and Under-Road (URX) Crossings

1. The nearest edge of any UTX trench shall be located at least two sleeper spacing's from any rail joints.

2. Trenched UTX shall be a minimum of two metres clear of the movable parts of switches and of the V-crossing of any points and crossings.

3. UTX conduit shall extend not less than four metres beyond the outer rail on each side of the track except where the rail corridor ends within 4 metres or there is a physical obstruction that precludes this requirement therefore pits can be located in an available space, track Engineering must be consulted.

4. Cable pits, in accordance with the provisions of Section 13, shall be provided at each end of under-track crossings (UTX).

5. Trenched URX conduits shall extend under the nature strips and pathways on each side of the roadway sufficiently to provide a cable pit at each end of the URX that is wholly within DPTI property. If there is enough space within the DPTI property the cable pits shall be at least 3 metres clear of the roadway edge or in an available space.

10.3. Capacity

1. All UTX and URX cable routes shall include an additional 25% spare conduit with an absolute minimum of 3 spare conduits in main route UTX and URX and one spare conduit in local route UTX and URX cable route. Where a single large diameter conduit is installed by boring, spare capacity in this conduit, provided it is not less than 50% of the cross sectional area, shall be provided in lieu of additional conduits.

2. The area of spare capacity in a large conduit shall be sealed at each end of the conduit to safeguard against the ingress of moisture, vermin or other foreign material.

10.4. Depth

1. The top of the conduit shall be at a depth of not less than 1600 mm below the top of rail or 1000mm below ground level whichever is deeper. It shall be maintained at this depth for not less than 3 metres beyond the outer rails, when measured at right angles to the track.

11. Ground Level Troughing (GLT)

11.1. General

1. The requirements for GLT shall comply with Section 7 and this section.

2. Ground level troughing (GLT) is normally used for main cable routes where trenching is not feasible e.g. subways, tunnels, station platforms or narrow sections of the rail corridor. The troughing should be mounted in a suitable position without affecting the structural integrity of the tunnel and platform walls.

3. Ground level troughing (GLT) shall only be manufactured from reinforced concrete to *AS 1597: Precast Reinforced Concrete Box Culverts* or from moulded High, Medium or Low Density Polyethylene (HDPE, MDPE, LDPE), or glass reinforced plastic (GRP)

4. Concrete troughing shall be accurately manufactured to enable each segment to interlock securely with each other and concrete lids shall fit securely on the top of the troughing without rocking.

5. If GLT is to be used in an area where vehicle access (railway maintenance vehicles including tractors, front end loaders etc) is possible, the troughing and lid shall be capable of carrying a load of 4.5 tonne over a contact area of 100 mm x 300 mm applied to any part of the lid. The top of the GLT lid shall be at ground level.

6. In areas not accessible by vehicles, GLT shall be installed with the top of the lid a maximum of 75 mm above ground level.

7. Power cables are to be installed in conduit and marked at the beginning of the containment at 50 meter intervals and at the end of the containment. The marking shall be permanent and state either “650 volt” or “110 volt”.

8. Communications cables shall not be installed in the same compartment within the GLT as power or signalling cables.

9. Communication cables shall be installed in conduits within the communications compartment to separate LV from ELV cables.

10. High voltage cables shall not be installed in the GLT.

11. The transition arrangement between buried conduits and ground level troughing shall be through a pit. The entry from ground level troughing into the pit shall be in such a manner that it will not impact adversely on pulling of cables. The entry point shall be sealed between the GLT and the pit wall, to prevent the entry of water, rodents and vermin.

12. Where it is necessary to run troughing on bridges or viaducts it may be attached to the bridge/viaduct structures. However the bridge/viaduct structures shall not be drilled, cut, bent, welded or otherwise deformed to effect any attachment. Suitable clips shall be provided for securing brackets to bridge metalwork and all bolts shall have self-locking nuts.

13. Concrete bridge or viaduct troughing and/or support brackets shall be affixed using stainless steel chemical anchors of 12mm diameter and 75mm minimum anchoring depth. Expanding masonry anchors shall not be used.

14. GLT shall have the means to enable bottom entries or exits in approved cable management devices to ensure bend radius is not exceeded for any cables installed that require to transition.

15. Directional changes in GLT shall be avoided but where used and greater than 45°, the change shall be made using turning chambers.

16. Care shall be taken in the construction of a GLT route on banks and sloping sites to ensure that the supporting ground will not be eroded during periods of rain.

17. GLT shall be positioned such that it will not obstruct or be likely to be damaged by, the removal and replacement of railway sleepers.

11.2. Capacity of Ground Level Troughing

1. To provide for future requirements, 30% spare capacity shall be provided in each compartment of the troughing.

11.3. Drainage and Ground Level Troughing

1. Any GLT shall not affect the track or any other drainage system.

2. In areas where the GLT could act as a barrier to slow the dispersal of water during wet periods, drainage ducts shall be installed under the GLT at not greater than 20 metre intervals. These shall be located at vantage points to enable the quick dispersal of storm water.

3. Drainage ducts may be constructed from inverted GLT, pre-cast concrete box drains or PVC or HDPE pipes.

11.4. Ground Level Troughing Lids

1. Individual GLT lids shall not weigh more than 25kg to facilitate handling.

2. The GLT shall be thoroughly cleaned prior to installing lids.

3. After the cables are laid all cable entry points to GLT shall be sealed with an approved compound to prevent the entry of rodents and vermin.

4. Polyethylene GLT shall have the lids secured to the troughing by a minimum of 6 galvanised metal screws per lid (3 per side).

12. Galvanised Steel Troughing (GST)

12.1. General

1. The requirements for GST shall comply with Section 7 and this section.

2. GST troughing is normally used for main cable routes where trenching is not feasible e.g. subways, tunnels, station platforms or narrow sections of the rail corridor. The troughing should be mounted in a suitable position without affecting the structural integrity of the tunnel and platform walls.

3. GST troughing shall be constructed from steel, hot dip galvanised to *AS4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles* materials are to have a coating mass equal to Z600 on fabricated ferrous articles.

4. Standard GST support brackets, fixings and other fittings are of sufficient strength to support the troughing without permanent deflection when loaded to full capacity with cable plus incidental loads up to 100kg applied at any point on the trough.

5. A structural factor of safety of at least 3 shall be applied in the design and manufacture of brackets and their fitting and fixing.

6. Troughing is not screwed to the bracket it is merely placed onto the bracket. The bracket is held to the post with M12 x 30 hot dip galvanised nuts, bolts and washers.

7. Cut surfaces shall be protected in accordance with the repair requirements within *AS4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*.

8. GST wall thickness is to be 2.0mm.

9. The bottom and sides of the troughing shall be provided with a continuous 9mm thick lining of stable thermal insulating material such as fibre-reinforced cement for fire protection.

10. If GST is to be used in an area where vehicle access (railway maintenance vehicles including tractors, front end loaders etc) is possible then the GST must transition into pits before the access point and transition into a buried conduit route through the access point and into a pit past the access point, the containment may continue as a GST route or a buried services.

12.2. Design

1. GST shall be made continuous by the use of joining sleeves.

2. GST joining sleeves should be installed midpoint between the trunking support posts, or as otherwise determined by Signal Engineering.

3. GST height of installation in tunnels will depend on geographical features but the GST shall not be installed greater than 1800mm above ground level, installation in tunnels cannot prevent access to any personnel safety cutouts provide in the tunnel walls for safety refuges.

4. Standard installation in ground with 1500mm posts buried 600mm into the ground to provide stability. GST shall not be installed directly on to soil.

5. The minimum height from ground level to the bottom of the lowest trough on a post line shall be 400mm.

6. Standard post spacing is 2 metres, and if post spacing greater than 2 metres is proposed, proof of the trough strength to carry the loads at greater than 2 metres must be submitted to Signal Engineering.

7. Standard posts are designed to withstand vertically applied loads of 250kg with a simultaneous horizontal load of 150Kg.

8. Care should be taken to ensure that all posts are installed vertically in both planes and are equally spaced, and no further apart than 2 meters. Post spacing distances may be varied around change of direction, to support jointing bays, or for the end of a route. GST shall be installed at a generally constant level above ground.

9. Troughing attached to walls or rock faces shall have a minimum clearance between the trough and the wall or rock face of 25mm.

10. GST shall be designed and constructed to prevent the entry of vermin.

11. Troughs shall be installed to provide at least 20% spare capacity.

12. The minimum radius of all bends in the Steel Troughing route shall comply with the requirements of the bending radius of the largest cable to be installed on the route.

13. Power cables are to be installed in conduit and marked at the beginning of the containment at 50 meter intervals and at the end of the containment. The marking shall be permanent and state either “650 volt” or “110 volt”.

14. Communications cables shall not be installed in the same compartment within the GST as power or signalling cables.

15. Communication cables shall be installed in conduits within the communications compartment to separate LV from ELV cables.

16. High voltage cables shall not be installed in the GST.

17. Cable jointing bays ensure that the capacity of the troughing is not diminished due to the size of cable joints. Cable jointing bays should be provided; either above, below or beside the cable route. Consideration to the minimum ground clearances should be given when locating cable joints below the trough. The cable jointing bays are to be fabricated to ensure that;

    a) There is no net reduction in trough capacity where cable joints occur
    b) The bays shall be supported to prevent any deflection or twist of the jointing bay or cable route. The jointing bay shall be manufactured using the same material standards applying to galvanised Steel Troughing.

18. Lids shall be fitted onto Steel Troughing and secured with stainless steel strapping located 100mm from the end of each lid. Additional straps are required to ensure the interval between stainless steel straps does not exceed two (2) metres.

19. GST lids shall be positioned such that they overlap approximately two thirds of the troughing base.
20. GST lids shall be fitted in a manner that does not electrically short out insulating gaps.

21. On bridges, viaducts and over waterways, lids shall be fitted with galvanised chain (link size: 20mm, thickness 4mm-5mm, length 250mm-300mm) attached at both ends of the lid and in the centre section by welding or bolted connection; the free end of the chain shall be attached to the troughing in the same manner.

12.3. Joints and Insulated Sections

1. GST expansion joints shall be installed in the troughing runs at intervals of not greater than 50m.

2. GST expansion joints shall provide for change in length for a temperature range -5°C to 60°C, or as determined by Signal Engineering.

3. It is essential that the troughing is fixed to the troughing support brackets at the expansion joint only and arranged so that the troughing between expansion joints is free to expand and contract with temperature changes.

4. Insulated saddle joints should be used to minimise the effects of induced currents in GST.

5. Insulated saddle joints shall be installed in GST runs at intervals of not greater than 300m.

6. Insulated saddle joints shall be installed in GST runs at each end of steel bridges when the route is attached to or supported by the bridge.

7. Insulated joints shall be arranged to provide a gap of 30mm between the ends of adjacent lengths of GST.

8. When installing steel troughing near OHW structures no part of the route, including troughing or support brackets, can at any stage of the route be within 75mm of any OHW structure.

9. Additionally, where the steel troughing passes within 2 metres of any OHW structure it must be fitted with an insulated joint at least 2 meters from each side of the OHWS.

10. GST shall not be installed within 3m of 25kV overhead wiring, except where a tunnel profile precludes this clearance being achieved.

12.4. Bends within the Route

1. The minimum radius of all bends in the Steel Troughing route shall comply with the requirements of the bending radius of the largest cable to be installed on the route.

2. To construct a cable route bend, the bend can either be made in the factory by the manufacturer and then installed on site, or cut by site staff.

3. When cutting on site, installers should ensure that all bends are smooth, and filed to a rounded finish to prevent damage to any cables which may need to be pulled through the route.
4. To achieve an onsite bend of the correct radius, multiple cuts into the troughing are required, with each cut producing an incremental bend of no more than 22.5 degrees.

5. All cuts within the bend must be smooth and rounded to prevent damage to cables due to sharp corners or edges. Changes in direction either vertical or horizontal directions shall be at a maximum of 22.5 degrees. Where greater bends are

required, the bend shall be made up of multiple 22.5 degree bends, with careful consideration of the bending radius limitation of the cable. Note that under no circumstances can the minimum bend radius of any cable be exceeded.

6. The transitions shall be purpose built and manufactured using the same material standards applying to galvanised Steel Troughing.

12.5. Troughing on Bridges and Viaducts

1. Subject to approval, GST may be attached to the structures of bridges and viaducts. Note that per standard bridge engineering practices, the bridge or viaduct structural members should not be heated, drilled, cut, bent, welded or deformed in any way when fitting the route to the bridge.

2. Brackets should be designed with backing plates or clipping systems to allow fixing to the bridge without drilling. Engineering certification of the brackets must be provided to the asset owner. All bolts are to have self-locking nuts.

3. Concrete bridge and viaducts should not be drilled to fix brackets unless approval is granted by the bridge owner. If approval is given, any bracket attached to a concrete structure must be fixed using stainless steel anchors, set with chemical anchor. Anchors should be a minimum of 12mm and must be installed to a minimum depth of 75mm. Due to vibration caused by passing trains, expanding anchors must not be used.

12.6. Route Transitions

1. The transition between GST and Under Track Crossings (UTX) and Under Road Crossings (URX), shall be made with a purpose built adaptor manufactured to the same material standards applying to galvanised steel troughing, the route shall enter pits before the UTX or URX.

2. The adaptor shall be of sufficient size to accommodate all pipes, including spares, from the buried cable route, ULX or URX.

3. At the transition, sufficient cable slack should be provided to assist in future maintenance repairs.

13. Cable Pits

13.1. General

1. Communication cables shall not occupy pits with signalling or power cables unless the separations within the pit as specified in *AS/CA S009: Installation requirements for customer cabling* are met. Note that LV Communications and ELV Communications must be segregated at all times.

2. Signalling cables, communication cables and low voltage power cables shall not be installed in pits with high voltage power cables. **Cables are to be permanently identified in cable pits so the function of the cable can be determined**.

3. Cable pits are to be located at changes in the cable route direction and at the location of cable joints.

4. The maximum distance between pits shall be governed by the gradient of the route, changes in route direction, maximum allowable cable pulling tension and the drum length of cable. Maximum length between pits to be 300 meters.

5. All internal surfaces of cable pits shall be smooth.

6. Pits should be located so as not to undermine or deteriorate an embankment during periods of heavy rain.

13.2. Cable Pit Construction

1. Cable pits may be made from precast concrete, concrete cast in situ, brick, concrete block, glass reinforced plastic (GRP), glass reinforced cement (GRC), High Density Polyethylene (HDPE) or other materials approved by Unit Manager, Signals and Control System Engineering. The type of material depends on the size, location and the loading to which the pit cover will be subjected.

2. Concrete, concrete block and brick pits shall have a concrete floor of not less than 75 mm thickness.

3. Cast in situ concrete pits less than or equal to 1500 mm deep shall be constructed with a minimum wall thickness of 100 mm with a layer of F82 galvanised mesh reinforcement. The reinforcement shall be located to provide a minimum cover of 50 mm from the outside of the wall.

4. Cast in situ concrete pits deeper than 1500 mm shall be constructed with a minimum wall thickness of 150 mm with two layers of F62 galvanised mesh reinforcement. The reinforcement shall be located to provide a minimum cover of 50 mm from the outside of the wall.

5. Pits constructed from brick or concrete block shall include appropriate steel reinforcement.

6. GRP and GRC shall be bedded on stabilised sand not less than 75 mm thick.

7. Where pits are installed in roadways and maintenance access roads and will be subject to heavy road vehicle and pedestrian traffic, a concrete pit with Gatic or similar steel plate cover shall be installed. A suitable steel protecting edge which fits onto the top of the pit shall be required to protect the pit edge.

8. The top of each pit shall be 100-200 mm above the surrounding ground level except on platforms, paved areas, pathways or roadways, sealed or unsealed,

where the top of the lids shall be flush with the surrounding ground level and the pit and lid shall be load rated to the vehicular or pedestrian load applying to the location.

13.3. Cable Pit Dimensions

1. The internal size of all pits shall provide for the minimum bending radius of the largest cable to be installed within the pit.

2. The minimum internal diameter of round pits in main cable routes shall be 1000 mm for a pit depth of 1500 mm and 1200 mm if the pit depth is over 1500 mm.

3. The minimum internal size of square or rectangular pits in main cable routes shall be 1000 mm x 1000 mm for a pit depth of 1500 mm and 1200 mm x 1200 mm if the pit depth is over 1500mm.

4. The size of the pit shall give consideration for present and future requirements for:

    - safe access by maintenance persons requiring access to the pit as part of their job function
    - the number of cables
    - changes in direction of cable routes
    - jointing requirements
    - provisions for racking and jointing

5. The size of the pit shall provide for a minimum cover of 1000 mm from the top most conduit to ground level for UTX pits and 850mm cover for main cable routes.

6. The depth of pits shall suit the depth of conduit as applicable, so that the bottom of the lowest cable conduit is 200 mm above the base of the pit.

7. Pits shall have a galvanised steel ladder fixed securely to the wall at the top and the bottom of the ladder. For pits up to 1200 mm depth rungs as an alternative to a ladder may be used. The rungs should be constructed from 20 mm galvanised steel rod, be 300 mm wide and cast into the wall at a maximum of 300 mm centers.

8. Pits shall be installed with the longest wall parallel to the rail or cable route.

9. Pits shall be of sufficient size to provide a safe work environment under the Occupational Health and Safety and Welfare Act (1986) and associated regulations for the activities to be performed in the pit. Pits more than 600 mm deep shall be large enough to provide for a person to stand in the pit clear of cables.

13.4. Cable Pit Location

1. Except where the width of the rail corridor precludes, the closest edge of the pit shall not be located within four metre's from the nearest rail of any track, Unit Manager Track and Civil must be consulted for permission within 4 metre rule.

2. Pits shall not be installed in low lying areas which may experience silt build up due to drainage issues.

3. Pits shall be placed to minimise the risk of being covered by ballast or other debris.

4. Cable pits for each of the conduits shall be located at intervals to allow for hauling of the cable and connections to terminal equipment.

5. Cable pits shall be provided at the following specific locations:

   - at each end of a station
   - at each Remote Field Station (RFS) as applicable
   - at each Relay Room
   - at each Signalling location case
   - at changes in direction of conduit alignment of more than ten degrees
   - at interfaces between different types of cable routes e.g. buried conduit to above ground conduit/troughing
   - at every 300 metres or less as dictated by the cable used and the requirement to 'draw' that cable through the conduit
   - either side of a road or rail crossing
   - at signal mast, gantry locations, AWS & Balise
   - at point machine locations, unless there is insufficient room and a pit cannot be fitted.
   - at level crossing locations cases and all level crossing masts
   - at all ends and major entry points to UTX, URX, through platforms and crossings

13.5. Conduit and Cable Pit Interface

1. Where the conduits enter the cable pits, a clearance hole (-0 +5 mm) to suit the conduit size shall be cut in the pit using an approved hole cutter or similar tool. Holes knocked in with a hammer or similar tool are not permitted.

2. Only one hole for each conduit entering the box shall be cut.

3. The conduit shall be sealed to the pit with an appropriate approved sealant to prevent ingress of water and rodents.

4. Cable entries for conduits entering the pit shall be in the form of a bell mouth, smooth and free of sharp edges to prevent damage to the cable during installation and subsequent operation of the cable.

5. Cable entries for conduits entering the pit should be identified using an appropriate labeling system within the pit and approved by Unit Manager, Signals and Control System Engineering and Unit Manager Communications and Electronic Systems.

6. The pit shall be able to accommodate multiple conduit entry points without compromising the pit structural integrity. Cable entries into pits shall be through the sides only, not through the bottom of any pit.

7. Where conduits or GLT enter pits or cable turning chambers the conduit ends or GLT shall be encased in concrete for a distance of not less than 300 mm to hold them securely in position. Protrusion of conduits or GLT into pits not less than 50mm.

8. Conduits shall be sealed once all cables have been run, a mortar mix applied as a plug not exceeding 30mm used to prevent ingress of water and rodents.

13.6. Cable Joints in Pits

1. Cable cleats or suitable racking shall support cables and joints within the pit to ensure that no damage is caused to the cable or joint by normal operation or future maintenance and installation activities.

2. Joints in cables shall be arranged and supported in the pit in a manner which will provide for easy access to all joints within the pit for future maintenance purposes.

3. Ends of cables to be jointed shall have sufficient overlap to allow for future re-jointing as applicable.

4. Where cables are required to be jointed inside pits, this shall be carried out using resin filled cable jointing kits or enclosures approved by Unit Manager, Signals and Control System Engineering.

13.7. Cable Jointing Pits

1. Cable jointing pits shall be provided wherever optical fibre cable is to be jointed or spliced and a suitable communications cable termination cabinet does not exist.

2. To accommodate the need to have vehicular access for the splicing of optical fibre cables, cable jointing pits shall, where possible, be positioned where road access is available.

13.8. Cable Pit Access Covers

1. Cable pit access covers shall:

   - comply with *AS 3996 : Access Covers and Grates*
   - be an approved Gatic or similar steel plate
   - be lockable, or require the use of a specialised tool to gain access to the cable pit
   - be removable without the need for lifting appliances such as cranes
   - shall have a lifting tool hole at each end of the cover (or at each end of each split - cover part) capable of being used with an approved lifting tool
   - have lifting holes designed to prevent the insertion of materials including needle sharps
   - in platforms, other paved areas, sealed or unsealed roads and pathways, be of an appropriate trafficable design
   - in other areas, be capable of carrying incidental live loads of 1.5KPa
   - weigh no more than 30 kg each, and where the weight exceeds this, the weight shall be clearly shall be labelled on the cover
   - when installed in a pedestrian access way, have a surface that prevents water gathering or pooling and have a slip resistance rating for wet conditions surface compliant with AS 4586: Slip Resistance classification of new pedestrian materials
   - be designed to resist the ingress of water
   - be vermin proof

13.9. Cable Pit Identification

1. All pits shall be identified with a permanent label as shown in the example detailed below.

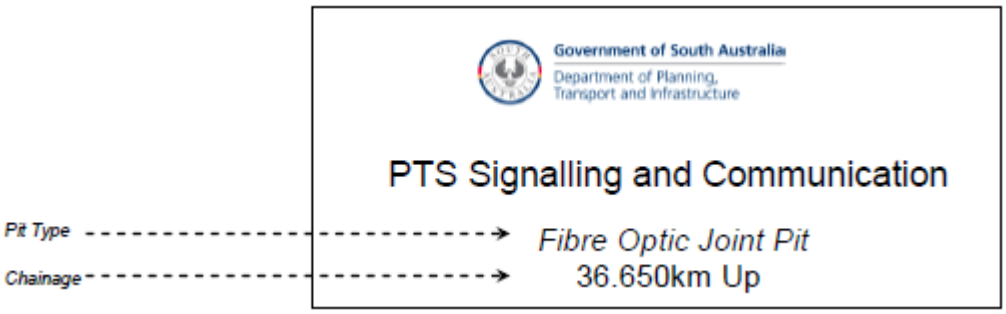

Figure 13.9 Pit Identification Label

Pit labels shall be fixed to the pit body and pit lid.

13.10. Cable Pit Drainage

1. Conduit and pit design shall consider the potential for ingress of water into the pit.

2. To minimise the amount of standing water in the pit a drainage hole of, typically, 40 mm diameter shall be installed in the base of the pit and, where applicable, connected through a pipe to a suitable approved drainage outlet such as a railway drain, public storm water drain, or natural drainage course.

3. If no suitable drainage outlet is available a gravel drainage sump shall be installed as close to the pit as possible. Gravel drainage sumps shall consist of 20 mm aggregate with a minimum depth of 300 mm.

4. Where ground water level is frequently above the bottom of the pit, the pit shall be sealed.

14. Excavation, Backfilling and Compaction

14.1. Excavation

14.1.1. Location of Existing Services

1. Before excavation or boring operations commence all existing signalling and communications cables, railway drains and all other buried services in the area to be excavated including water, storm water, sewerage, gas, power and telephone cables shall be located and marked on site.

2. The use of mechanical digging or boring machines for excavation within 2 metres of high voltage cables or within 1 metre of other existing buried services is not permitted.

3. Any excavation within 2 metres of high voltage cables or within 1 metre of other existing buried services shall only be performed using hand tools or an approved vacuum excavation device i.e. hydrovac truck.

14.1.2. Preparation of Cable Routes

1. The selected main cable route shall be cleared and levelled only to the extent necessary to permit trenching and access for plant/vehicles.

2. Levelling work shall not adversely affect railway or natural drainage, or pedestrian or vehicular access routes.

3. All service trenching and main cable routes shall be pegged by the contractor or projects team and the route approved by Unit Manager, Signals and Control System Engineering prior to the commencement of any trenching work.

4. Excavations shall be to the minimum width and depth necessary to successfully carry out the work.

14.1.3. Excavation Stability

1. Excavations in or near tracks, platforms ,access roads or other railway infrastructure shall be securely shored to prevent the sides of the excavation from collapsing.

14.1.4. Excavated Spoil

1. Excavated spoil shall not be placed in the track area such that it will foul the ballast. If the spoil has to be temporarily placed on the track with the approval of Unit Manager, Track & Civil Engineering, tarpaulins, plywood or other suitable material shall be used to provide a barrier between the ballast and the spoil.

2. Spoil shall not be placed in a position where it could obstruct track drainage or be washed into track drains or onto the ballast during periods of heavy rain.

14.2. Backfilling and Compaction

14.2.1. General

1. Conduits and buried cables shall be encased in sand, friable soil or clean fill free of sharp stone to 50 mm above the uppermost conduit or cable.

2. Surface drains shall be reinstated during the backfilling operation.

3. Trenches and other excavations should not be backfilled until the trench has been inspected.

14.2.2. Main Cable Routes

1. Where the buried conduit or cable is located in areas other than track formation, platforms, access roads or pathways, the trench above the sand/friable soil may be filled utilising the excavated soil from the trench or alternatively clean fill shall be used. In both cases the material shall be free of:
   - broken concrete, brick, rubble, wood, glass, rubbish, steel or other metallic objects which could damage the conduit or cable
   - other metallic objects that could affect the operation of electronic cable locators

2. The backfilling of the excavation will normally take up the majority of the excavated spoil. However, any surplus spoil or unsuitable fill shall be stockpiled at an appropriate location within the corridor for testing and disposal.

3. Trenches and excavations in areas other than the track formation, platforms, access roads or pathways, should be compacted in 150 mm layers by a whacker packer (vibratory plate compactor) and should be finished with a slight mound, to a height equal to approximately 20% of trench width.

4. The first 150mm of fill over cover strips or conduits shall be carefully compacted to ensure that the cover strips / conduits are not disturbed.

5. Trenches and other excavations shall be inspected after backfilling is completed to identify and correct any depressions caused by subsidence or erosion.

6. For main cable route trenches in the track formation, along earth filled platforms, access roads, pathways, through shunting yards or at the base of embankments it is preferred that backfilling is carried out using ‘controlled low-strength material’ (CLSM) or 4% cement-stabilized material. This is subject to DPTI rail engineering approval and the submission of the relevant mix design and on-site testing procedures. Bedding sand is not required around the conduits in this instance.

7. If CLSM is not used then main cable route trenches in the track formation, along earth filled platforms, access roads, pathways, through shunting yards or at the base of embankments shall be:

   - compacted by mechanical means to achieve 95% Standard Compaction in accordance with *AS 1289 Method of Testing Soils for Engineering Purposes*
   - filled and compacted in layers of 150mm maximum thickness to achieve the specified density
   - independently tested and a Certificate of Compaction provided

8. Where the backfill does not achieve the required density specified in clause 7 above, it shall be re-excavated to within 200mm of the cover strips and/or conduits, re-filled, re-compacted and re-tested.

9. Where the access road or pathway over the trench is sealed, the trench shall be capped with the same material to the same thickness as the original seal.

10. For trenches in sealed, earth filled platforms the trench shall be resealed immediately following backfilling, with material of the same thickness and density as the original seal to ensure public safety.

14.2.3. Under-Track (UTX) and Under-Road (URX) Crossings (Trenched)

1. It is preferred that backfilling is carried out using 'controlled low-strength material' (CLSM) or 4% cement-stabilized material. This is subject to DPTI rail engineering approval and the submission of the relevant mix design and on-site testing procedures. Bedding sand is not required around the conduits in this instance.

2. Where CLSM is not used, backfilling shall be carried out using a suitable material compacted in 150 mm layers up to the underside of ballast level / top of capping layer. This material must comply with DPTI Rail Code of Practice, Volume 2, Part 9: Formation and Earthworks (Document CP-TS-959).

3. Where CLSM is not used and material specified in clause 2 is used, trenches for UTX and URX shall be:

    - compacted by mechanical means to achieve 95% Standard Compaction in accordance with *AS1289 : Method of testing soils for engineering purposes*
    - filled and compacted in layers of 150 mm maximum thickness to achieve the specified density

4. Where CLSM is not used each trench must be independently tested and a Certificate of Compaction provided prior to the placement of ballast.

5. Where the backfill does not achieve the required density, it shall be re-excavated to within 200 mm of the cover strips and/or conduits, re-filled, re-compacted and re-tested.

6. Finished work shall be inspected prior to the passage of the first train.

15. Boring

15.1. General

1. A trenchless installation method is preferred for under-track (UTX) and under-road (URX) crossings. The preferred installation method is by guided directional drilling, using one of the proprietary directional drilling systems operated by appropriately trained and qualified personnel.

2. The boring process must not disturb or damage any pavement, railway infrastructure or other structure in any way.

3. Where multiple bores are used, there shall be a minimum spacing of 10D (where D is the diameter of the largest bore) between individual bores to ensure the combined surrounding cavities of multiple bores do not undermine any pavement, railway tracks and formation or structure.

4. Boring by water jetting is not permitted.

5. The diameter of the bored hole should not exceed the outside diameter of the conduit by more than 50 mm.

6. Where the diameter of the bored hole exceeds the outside diameter of the conduit by more than 50 mm or it is necessary to abandon a bored hole, prompt remedial measures shall be taken to provide support for the railway and the hole shall be backfilled with approved material such as grout.

7. Bores greater than 100 mm diameter shall not be carried out while trains are operating.