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1. SCOPE

This Standard covers the minimum requirements for the design and installation of underground process and services piping and includes corrosion protection, trenching, pipe laying, jointing, inspection, testing, backfilling and route marking.

2. DEFINITION OF TERMS

2.1 CONTRACTOR/VENDOR

The company which provides the equipment and services needed.

2.2 SUB-CONTRACTOR

A third party to be employed by the Contractor/Vendor and who has been approved by the Superintendent in writing.

2.3 SUPERINTENDENT

CSBP Limited, or authorised representative.

2.4 CSBP

CSBP Limited.

2.5 WORKS

The scope of works that a Contractor is or may be required to execute under an agreement including variations and remedial work.

3. STANDARDS

All materials, equipment and work covered by this Standard shall conform with the requirements of all Statutory Authorities having jurisdiction over the work site.

The Contractor shall perform the Works in accordance with this Standard and the latest issue of referenced standards. Should there be a conflict between the Works, Statutory Authority requirements and the Standards, the Contractor shall notify the Superintendent in writing for resolution. In general, the most stringent requirement will prevail.

3.1 STANDARDS ASSOCIATION OF AUSTRALIA

- AS 1289 Methods of Testing Soils for Engineering Purposes
- AS 1319 Safety Signs for the Occupational Environment
- AS 1518 Extruded High Density Polyethylene Protective Coating for Pipes
- AS 1627 Metal Finishing Preparation and Pre-treatment of Surfaces

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AS 1646	Elastomeric Seals for Waterworks Purposes
AS 1697	SAA Gas Pipeline Code
AS 1768	Lightning Protection
AS 2032	Installation of UPVC Pipe Systems
AS 2033	Installation of Polyethylene Pipe Systems
AS 2187.2	Use of Explosives
AS 2430	Classification of Hazardous Areas
AS 2634	Chemical Plant Equipment made from Glass Fibre Reinforced Plastic(GRP) based on Thermosetting Resins
AS 2648.1	Underground Marking Tape - Non-detectable Tape
AS 2832.1	Cathodic Protection - Pipes, Cables and Ducts
AS 2885	Pipelines - Gas and Liquid Petroleum
AS 3000	SAA Wiring Rules
AS 3690	Installation of ABS Pipe Systems
AS 3894	Site Testing of Protective Coatings

3.2 AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

- B31.3 Chemical Plant and Petroleum Refinery Piping
- B31.8 Gas Transmission and Distribution Piping Systems

3.3 RAILWAYS OF AUSTRALIA CODE

For the Installation of Other Parties' Services and Pipelines within Railway Boundaries

3.4 CSBP ENGINEERING STANDARDS

- ES-14-101-02 Drawing Management
- ES-14-101-03 Drawing Preparation
- ES-14-101-04 Drawing Numbering
- ES-14-101-06 Equipment Numbering System
- ES-14-102-09 Labels and Signs: Plant and Equipment
- ES-14-102-12 Protective Coatings
- ES-14-103-19 Fibre Reinforced Plastics
- ES-14-601-01 Basis for Design Piping
- ES-14-602-01 Fabrication and Installation of Piping
- ES-14-602-02 Inspection and Testing of Piping Systems
- ES-14-603-01 Piping Material Specifications



ES-14-603-02 Valve Specifications for Process Isolation

ES-14-902-01 Materials and Workmanship for Electrical Installations

3.5 CSBP GUIDES

GM-11-036-04 Excavations

3.6 CSBP STANDARD DRAWINGS

9900-2-0600/001	Normal Security Fencing Details.
9900-2-0600/002	Medium Security Fencing Details.
9900-2-0600/003	High Security Fencing Details.
9900-2-1300/001	Bollards
9900-6-5103/000	Concrete Thrust Blocks for Pressure Pipelines with Rubber Ring Joints

4. SYSTEM DESIGN

Design and selection of pipeline material and components, and corrosion protection for use in Underground Piping Systems, shall be in accordance with applicable standards referenced in Section 3 of this Standard and based on technical, environmental and economic considerations for each application.

5. STEEL PIPING - PROTECTIVE COATING

All buried steel pipes and components, including stainless steel, shall have a protective coating applied to maximise the life of the piping system by preventing serious and irrecoverable damage by surface corrosion attack.

The coating system shall be either of the following systems as determined by the Superintendent or as specified in the Works.

The Coating Manufacturer shall verify that the protection system specified in this standard is suitable for the specific application.

Where environmental conditions dictate, the Coating Manufacturer shall recommend alternate systems. Any alternative shall only be used after the Superintendent has given written approval.

5.1 TAPE WRAPPING SYSTEM

5.1.1 Fittings, Flanges and Valve Wrapping

'Denso Petrolatum System', or approved equivalent alternate applied in accordance with manufacturer's instructions shall be used.

The following requirements shall apply:



a. Surface Preparation

Wire brush to remove dirt and loose rust.

b. Primer

Apply primer in accordance with the manufacturer's specification.

c. Filler

Where necessary, contour all sharp and irregular profiles with filler to improve contours for subsequent tape wrapping and elimination of voids or risk of perforating tape.

d. Inner and Outer Tape

Without stretching, spirally apply tape with a 55% overlap to achieve consistent full double thickness of tape protection.

5.1.2 Bends, Joints and Continual Line Pipe Wrapping

'Denso Ultraflex System', or approved equivalent alternate applied in accordance with manufacturer's instructions shall be used.

The following requirements shall apply:

- a. Surface Preparation
 - 1. Carbon steel with hardened mill scale shall be abrasive blast cleaned to AS1627.4 class 2.5.
 - 2. Carbon steel with loose rust shall be power cleaned to AS1627.2 class 2.
 - 3. Galvanised pipe which may be flaking shall be locally wire brushed. Any oil or grease on the surface shall be removed before proceeding with primer application.
 - 4. Stainless steel. Solvent clean to remove any grease or other surface containments. Ensure applied solvent does not leave a residue.
- b. Primer

Apply primer in accordance with the manufacturer's specification.

c. Mastic Strip

Where necessary, contour irregular profiles such as weld beads with mastic strip, to improve contours for subsequent tape wrapping.

d. Tape

Without stretching, spirally apply tape with adhesive mastic face to primed substrate with a 55% overlap.

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5.1.3 Field Joint Protection

'Denso Ultraflex System', or approved equivalent alternate shall be applied to clean pipe (refer Section 19.0) in accordance with manufacturer's instructions.

The System shall commence a minimum 100mm onto the line pipe coating, extend over the bare steel with a 55% overlap and finish a minimum 100mm onto the other line pipe coating.

Note: Field joints shall be left exposed until all pipe testing is complete.

5.1.4 Below/Above Ground Pipe Interface

'Denso Ultraflex System', or approved equivalent alternate shall be applied in accordance with manufacturer's instructions.

System to be applied a minimum of 700mm below ground surface and extend upwards with a 55% overlap and finish 500mm above ground level.

An ultra violet resistant 'Denso Sirex Tape', or approved equivalent alternate shall be applied over the top of the 'Ultraflex' tape, with a 55% overlap. It shall commence at ground level and finish at same height as the 'Ultraflex' tape.

5.2 EXTRUDED HIGH DENSITY POLYETHYLENE SYSTEM

5.2.1 Coating Application

Supply, application and testing shall be in accordance with Australian Standard AS 1518.

The following requirements shall apply:

a. Surface Preparation

Clean substrate to minimum

- 1. Class 2 AS 1627.4 shop preparation/coating
- 2. Class 2 AS 1627.2 field or repair purposes
- b. Sealant

Bituminous unvulcanised rubber blend, or material with similar properties, heat treated and applied to clean, dry pipe surface in accordance with manufacturer's instructions.

c. Polyethylene Extrusion Compound

Immediately following application of sealant to the pipe, the polyethylene compound shall be extruded to the required thickness in a controlled manner. Coating shall be continuous resulting in a smooth outer sheath of uniform thickness and free from pinholes, cracks, voids etc. The cooling process shall be controlled.



5.2.2 Coating Thickness

Minimum thickness of polyethylene compound shall be as specified in AS 1518. Where additional protection is required a thicker single coat shall be applied. Double coating shall only be used to obtain the required thickness when recommended by the coating manufacturer or when specified by the Superintendent.

5.2.3 Coating Colour

If requested by the Superintendent, the pipe coating shall be colour coded to identify the service group. Refer to CSBP Engineering *Standard Labels and Signs: Plant and Equipment* (ES-14-102-09) for details of pipeline service identification colours.

5.2.4 Pipe Ends

Prior to installation, a nominal 150mm at each end of the pipe, or as specified by the Superintendent, shall be kept free of coating and thoroughly cleansed of any sealant or contaminant.

5.2.5 Inspection

Coating shall be visually inspected and subject to an electric flaw detection test. Any fault detected during the electric flaw test, or any area that is wrinkled, cracked or has any other suspect locations shall be repaired and re-examined.

5.2.6 Coating Repairs

Where a minor fault occurs in the coating and the band width of removed coating does not exceed 250mm, sealant-lined heat shrink sleeves may be used. Minimum overlap of the sleeve over undamaged coating shall be 100mm.

A maximum of three sleeves shall be applied to any single pipe, in accordance with manufacturer's instructions.

Where major faults occur in the coating or more than three sleeves are required to repair minor damage/faults, the pipe shall be stripped back to the bare metal and re-coated to the manufacturer's specification and re-examined.

5.2.7 Recorded Coating Details

All pipes shall be indelibly marked on the polyethylene coating, by a Superintendent approved method such that the coating surface is not broken or scored.

As a minimum, the information specified in AS 1518 shall be marked on the coating surface. Additional information shall be included when specified by the Superintendent.

5.2.8 Field Joints

Field joints of a buried pipeline with extruded polyethylene coating, shall be protected from corrosion with the application of 'Denso Ultraflex System', or approved alternate.



Tape shall be applied to clean pipe in accordance with manufacturer's instructions. Refer to Sections 5.1.3 and 19.0 for details.

Note: Field joints shall be left exposed until all pipe testing is complete.

6. EARTHING SYSTEM

Where required, the pipeline system shall be connected to the earth grid of the area.

Design, installation, testing and commissioning of earthing system shall be installed in accordance with AS1768 and AS3000.

6.1 BONDING

Underground services comprising metallic pipes shall be bonded to the earth termination network in accordance with AS1768 Clause 4.14.2.2, to prevent side flashing.

Metallic piping systems shall be equipotential bonded to the main electrical earthing conductor in accordance with AS3000 Clause 5.8.1.

Underground services that enter areas with explosive or highly flammable contents shall be bonded in accordance with AS1768 Clause 7.3.

7. CATHODIC PROTECTION SYSTEM

Cathodic protection systems shall only be used where it can be demonstrated to be required by the specifics of the design and it is compatible with the pipeline coating system.

Cathodic protection systems shall be designed, manufactured, installed, tested and commissioned in accordance with AS 2832.1 Guide to the Cathodic Protection of Metals - Pipe, Cables and Ducts, and any other relevant standards and regulations.

Note: With reference to AS2430, cathodic protection systems shall not be used in Class 1 Zone 0 hazardous areas, and only in Class 1 Zone 1 areas where the system can be bonded to the earth grid of the area.

7.1 INSULATION JOINTS

Insulating joints shall be installed where specified in design documentation and in accordance with manufacturer's requirements. Typically they will be used to limit current flow along the pipeline system, to isolate dissimilar cathodic protection systems and elsewhere where there is a need to electrically isolate and prevent the effect of the cathodic protection being dissipated to other services.

A 'Prochind' or equivalent insulating joint, or an insulating flange kit shall be installed at the below/above ground pipe interface.



7.2 ANODE MATERIAL

Selection of anode material shall be based on the classification of their end use, as impressed current anodes or galvanic (sacrificial) anodes. This will be determined on a project by project basis.

7.3 ANODE INSTALLATION

Anodes shall be installed in accordance with design documentation, in locations that will achieve the desired spread of protection along the pipeline, for the type of anodes used.

Procedures for the handling and installation of anodes and congestion leads, shall be submitted by the Contractor to the Superintendent for review and approval prior to commencement.

The anode congestion leads shall follow the shortest practical route to the test congestion box. For details of underground cable installation, refer to CSBP Engineering Standard *Materials and Workmanship for Electrical Installations (ES-14-902-01).*

7.4 TEST POINTS

Test points shall be installed at the following locations:

- a. Adjacent to insulating joints and pipeline terminations
- b. Close to other services
- c. At rail and road crossings
- d. At maximum 500m spacing along pipeline
- e. Elsewhere specified in design documentation, to ensure cathodic protection effectiveness is monitored for the whole of the underground piping system.

Labelling shall identify all test points. The test point stand, as detailed in Figure 1, shall be located where it is unlikely to be damaged by vehicles.





Figure 1 Test Point Stand

7.5 INSPECTION AND TESTING

Installation of each test point shall be subject to inspection and acceptance testing by the Superintendent.

A complete commissioning survey shall be carried out with potentials recorded at all test points after the cathodic protection system is energised to ensure that the pipeline is cathodically protected in accordance with design criteria.

8. NON-METALLIC PIPING SYSTEM

For general requirements for each type of non-metallic piping system, CSBP Engineering Standard *Basis for Design-Piping* (ES-14-601-01) shall apply. Any special requirements of the manufacturer or the relevant Australian Standard for the design, selection, fabrication, installation and testing of buried non-metallic piping shall be complied with.

Note: Metallic components of buried non-metallic piping systems shall be protected using an approved coating method. Refer to Section 5.0 for details.



9. INSPECTION PITS

Inspection pits shall be provided for any valve or pipe fitting needing periodic access for isolation or maintenance and where required by piping design.

Construction of pits including pit drainage, covers and marking shall be in accordance with design details.

Trafficable pits are to be provided at roadways and hardstand areas. All non-trafficable pits shall have bollards at each end of the pit as detailed in CSBP standard drawing 9900-2-1300/001.

Note: Care shall be taken to ensure that construction of the pit does not cause any damage to the pipe coating.

10. THRUST BLOCKS

Concrete thrust blocks shall be provided where specified at change of direction, branches and pipe ends to prevent joint movement during testing and operating conditions.

Refer to CSBP Standard Drawing 9900-6-5103/000 for dimensional details of thrust blocks for use with pressure pipelines with rubber ring joints.

11. THERMAL MOVEMENT

Where required, anchors or guides to control thermal movement at the under/above ground interface shall be installed in accordance with design details.

12. PIPELINE ROUTE SETTING OUT SURVEY

Prior to any excavation work, a licensed surveyor shall locate and peg out the pipeline route based on the pipeline alignment sheets. The existence of services, structures and any other obstructions on route shall be checked, identified and recorded.

Where the pipeline route crosses existing services, the surveyor shall clearly mark on the ground the areas that shall be hand dug. The extent of hand excavation shall be:

a. Two (2) metres either side of existing services where the precise location is known.

b. Five (5) metres either side of an estimated service location.

Refer to Figure 2 for details.

Note: Transverse exploratory hand dug trenches may be required to expose the service.

Once the precise location of existing services within the ten-metre band has been established, hand excavation can be reduced to two (2) metres either side of the existing service.







The recorded survey shall be updated after installation to reflect as built configuration and to record the precise location of existing services that are crossed. Refer to Section 23.0 for details.

13. TRENCHING

Excavation work shall not commence until detailed pipeline route pegging survey has been completed (refer to Section 12.0) and Excavation Permit(s) have been issued.

The trench shall be excavated according to surveyed line and design drawings. It shall be deep enough to maintain the minimum pipeline coverage and specified grade, and to allow for 150mm of pipeline bedding material. Soil removal shall be by a method approved by the Superintendent.

Note: If the Contractor excavates deeper than necessary, any costs associated with backfilling and compaction to correct trench floor level are the responsibility of the Contractor.

The completed trench shall have a flat base and give continuous support to the entire length of the pipeline. The bottom width should be as narrow as practicable, but of sufficient width to allow pipeline to be installed in position without being damaged and to permit full consolidation of bedding and backfill material. In general the bed width should be 300mm minimum larger than the pipe diameter.



The bottom and walls of the trench shall be free from stones, roots or any other debris that could cause damage to the pipe coating during lowering operation and bedding in of pipe.

Localised pockets are to be dug to accommodate pipe couplings, joint flanges, valves etc. so they do not rest on the excavated trench floor. The trench floor shall be covered with clean compacted sand or other approved granular material, free from stones, debris etc. for bedding in of pipe and achieving continuous support of pipeline.

Refer to Figure 3 for typical trench cross section and Table 1 for minimum depth of cover for pipelines.

Note: No blasting shall be carried out unless written approval is given by the Superintendent. Any blasting will be in accordance with statutory requirements, local authority by-laws and Australian Standard AS 2187.2 - Use of Explosives. The most stringent requirements will prevail.



Figure 3 Typical Trench Cross Section



	MINIMUM DEPTH (mm)			
PIPELINE CONTENTS	NORMAL EXCAVATION	UNDER A ROAD	UNDER A RAILWAY	
Non-Hazardous Category D ASME B31.3	600	Within CSBP-600 Outside CSBP-1200	1200	
Other than HVPL or Category D ASME B31.3	900	1200	2000	
High Vapour Pressure Liquid (HVPL) eg: LP Gas	1200	1200	2000	

Table 1 Minimum Depth of Cover for Pipeline

Note: Refer to Figure 4 and Figure 5 for coverage details with pipeline crossing a road or railway. Refer to Figure 6 for existing pipeline services crossover.

14. CROSSINGS

14.1 ROAD AND RAIL CROSSINGS

Within CSBP reserves, all road and rail crossings shall normally be crossed by boring and sleeving methods. Sleeves shall be made from steel pipe, either hot dipped galvanised or coated as per Section 5.0, except where the pipeline passing through the sleeve is cathodically protected in which case the sleeve shall be hot dipped galvanised. The sleeve shall be a minimum 250mm nominal bore to allow for future installation of other 'small' lines without the need to dig up or bore under the road or rail line again. If the road or rail reserve has to be dug up to install a pipe then at least one spare pipe sleeve shall be installed, if there are no existing spare sleeves.

Sleeved pipes, covering slabs, box culverts and tunnels shall be used where excessive loading conditions dictate, and as required by the specifics of the design.

The minimum depth of cover when crossing under a road or railway shall be as specified in Table 1.

Where a steel pipe passes through a sleeve, insulators or other Superintendent approved method, shall be used to prevent scuffing or damage to pipe coating during installation. Installation procedures and equipment details shall be submitted by the Contractor to the Superintendent for review and approval prior to commencement.

Where required due to the specifics of the design, a venting system shall be installed in the sleeve. Each end of sleeved section shall be sealed to prevent entrance of ground moisture and backfill material.

Refer to Figure 4 and Figure 5 for further details.



Note: Any proposed change to the engineering design by the Contractor requires the written consent of the Superintendent before implementation.



TYPICAL COVER OVER A PIPELINE CROSSING UNDER A RAILWAY



TYPICAL COVER OVER A PIPELINE CROSSING UNDER A ROAD



Figure 4 Sleeved Pipeline Crossing Under Road and Railway





Figure 5 Culvert Type Road and Railway Crossing

14.2 EXISTING SERVICES

In areas where a trench crosses existing underground services the Contractor shall use extreme caution. Existing services shall be located by hand excavation before mechanical excavation is used. Refer to Section 12 for details.

The minimum specified soil coverage and crossover clearance shall be maintained by crossing under existing services if necessary.

The minimum crossing clearance to existing services shall be:

- a. 300mm pipeline to pipeline
- b. 100mm pipeline to electrical cable or conduit

The Contractor shall notify the owners of all underground services to be crossed and verify that nominated crossover clearances are acceptable. Where required, work to be carried out shall be in accordance with owner's procedures of the services to be crossed.

Temporary construction supports for existing services shall be provided where necessary. Details to be approved by the Superintendent and the owner of the existing service before commencement of work.

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Refer to Figure 6 for details and Table 1 for minimum soil coverage.

Note: Any costs associated with the attendance of representatives of existing services during the excavation and installation of pipeline are the responsibility of the Contractor.



Figure 6 Existing Pipeline Services Crossover

15. SHORING

The Contractor shall provide temporary 'shoring' to sides of trench to ensure that there is no likelihood of wall slippage/collapse during pipeline installation.

Alternatively, where sufficient space exists, the Contractor can eliminate the need for shoring if preferred and at no additional cost to CSBP, by widening the trench top to give a side slope equal to or greater than the angle of repose of the excavated material.



Shoring methods shall be designed having regard to soil conditions, depth of trench, ground water, statutory requirements and all other aspects that need to be considered. Procedures and equipment details shall be submitted by the Contractor to the Superintendent for review and approval prior to commencement.

16. DE-WATERING

The Contractor shall provide de-watering equipment to maintain dry excavations where there are wet ground conditions. No pipe shall be laid in water and trenches are to be kept dry until sufficient backfill has been placed to prevent flotation of the pipeline.

17. PIPELINE FABRICATION, INSTALLATION, INSPECTION & TESTING

Fabrication, installation, inspection and testing of underground piping system shall be in accordance with the following CSBP Engineering Standards where relevant:

- a. ES-14-601-01 Basis for Design Piping
- b. ES-14-602-01 Fabrication and Installation of Piping

Note: Field joints shall be left exposed until completion of pressure testing, field joint coating and full coating integrity testing has been carried out and accepted by the Superintendent.

18. TRANSPORTATION AND HANDLING OF PIPE AND FITTINGS

Pipe and fittings shall be handled with care at all times to avoid damage to pipe and protective coating where applied.

Before installation, open ends of pipe shall be kept covered by approved methods, to keep inside clean and free from sand, water and other debris.

The pipe shall be carefully lowered into trench using wide canvas straps or other approved method, to prevent scuffing or other damage to coating. Use of wire rope slings or chains is prohibited.

19. INSPECTION AND TESTING OF PIPE COATING

Prior to lowering into trench, pipes and fittings shall be visually examined. Any defective or damaged coating shall be repaired or replaced. Repairs shall be carried out in accordance with coating manufacturer's recommendations.

19.1 COATING OF FIELD JOINTS

The Contractor shall provide equipment, facilities and materials for the handling, cleaning, coating and inspection of pipeline field joints in accordance with this Standard.



After the field welds have successfully passed non-destructive examination (NDE) and hydrotesting, field joints shall be cleaned in accordance with Superintendent approved Contractor's procedures. Field joints are to be free of grease, moisture, dirt, rust, weld spatter or other foreign matter that may affect the bonding of the coating. Coating shall be applied to clean pipe in accordance with coating manufacturer's instructions.

On completion of field joint coating, the entire system shall be subject to a continuous electric holiday detector test to ensure 100% coating integrity is achieved. Any defective areas located shall be repaired and submitted for further testing.

Tests shall be witnessed by the Superintendent and approval given when no faults are detected.

20. BACKFILLING

Backfilling shall not commence until all pipework, anchors, etc., have been installed in the trench and have been inspected and approved by the Superintendent.

Backfilling shall be carried out in two phases:

- a. Phase 1 Partial backfill to prevent joint movement prior to and during pressure testing. Field joints shall be left exposed.
- b. Phase 2 Completion of backfilling after pressure testing, field joint coating and full coating integrity testing has been carried out and accepted by the Superintendent.

20.1 PHASE 1 - PARTIAL BACKFILLING

The Superintendent shall approve the material used for partial backfilling. Excavated soil, other than topsoil, that is free from clay, stones and lumps remaining on a 25mm sieve, vegetable matter and any building debris may be used. The exception is under pavement areas which shall use coarse sand.

The Superintendent shall approve location of partial backfill. Material shall be placed uniformly over the width of the trench in 150mm compacted layers and be a minimum two layers (300mm) above top of pipe.

Layers, including the first 150mm above the top of pipe, shall be carefully compacted by hand ramming, to provide good bedding-in free from cavities and to ensure that no damage occurs to pipe coating. The second 150mm above top of pipe need not be compacted until after pressure testing is complete.

Refer to Figure 3 for typical trench cross section.

20.2 PHASE 2 - BACKFILLING COMPLETION

After all testing has been satisfactorily completed and approval by the Superintendent has been given, trench backfilling can be completed.



Joints left exposed for testing and other sections of pipe not originally subject to partial backfilling, shall be backfilled in accordance with partial backfilling Section 20.2, prior to completing backfilling.

Backfilling of the remaining trench may be by mechanical means. Excavated material except that which contains large rocks or vegetable matter, which could cause damage to the pipeline or produce subsequent uneven settlement of the soil may be used. The top 150mm layer shall be original topsoil compacted and finished flush with natural ground level. Excess material shall be removed. The exception is under paved areas that shall use coarse sand or fine crushed rock. Refer Section 20.4 for further details.

All backfilling shall be compacted in 300mm layers, or larger if the Contractor can demonstrate to the satisfaction of the Superintendent, that the required standard of compaction can be achieved using Contractor equipment and methods, without damage to the underground piping system.

Compacted layers shall not be less than 90% of the modified maximum dry density obtained in compaction tests defined in AS 1289.5.2.1, or to a density at least equal to that of the surrounding ground, whichever is the greater.

Refer to Figure 3 for typical cross section.

20.3 BACKFILL UNDER PAVED AREAS

Backfill under paved areas shall be coarse sand or fine crushed rock, free from clay, vegetable matter or any other debris. Compaction in 150mm layers to achieve a 95% modified maximum dry density from compaction tests defined in AS1289.5.2.1.

21. ROUTE IDENTIFICATION

The route of all underground piping systems shall be identified as follows:

- a. Buried Warning Tape All piping systems, to warn during excavation of the presence of an existing pipe buried further below the ground, refer to Section 21.1.
- b. Wire Trace All non-metallic piping systems.
- c. Aboveground Sign Posts and Marker Slabs All Hazardous fluids

21.1 BURIED WARNING TAPE

Underground warning tape shall be buried 300mm below the surface of the trench, directly over the centre-line of the entire pipe route.

Tape shall be colour coded, nominally 150mm wide heavy gauge polyethylene film or other approved material. Wording to identify the nature of the buried pipe shall be repeated at 1m maximum intervals, in accordance with Australian Standard AS 2648.1. Inscriptions to be as per the following examples (or similar acceptable text).



a.	Green Tape	
	CAUTION	BORE WATER PIPE
b.	Red Tape	
	CAUTION	FIRE SERVICES PIPE
c.	Blue Tape	
	CAUTION	WATER PIPE
d.	Yellow Tape	
	DANGER	NATURAL GAS PIPE
	DANGER	SULPHURIC ACID PIPE
	DANGER	LPG PIPE

Refer to Figure 3 for location of warning tape in a trench.

21.2 WIRE TRACE

In conjunction with the buried warning tape, a 2.5mm insulated earth wire trace line shall be installed on all non-metallic underground piping systems. It shall be laid directly over the centreline of the pipe for the entire pipe route and secured with tape at one (1) metre intervals, to ensure the trace wire remains in place while the trench is backfilled.

On pipelines greater than 500 metres, the trace wire shall terminate at the below/above ground pipe interface enabling a stronger signal to be obtained.

Where necessary, splices shall be soldered or crimp joints.

21.3 ABOVE GROUND ROUTE MARKERS

21.3.1 Outside CSBP

Route of import/export underground pipelines, external to CSBP land reserves, containing fluids which are toxic, corrosive, flammable or a pollutant in ground water shall be sign posted at each change of direction, at each side of road, rail or pedestrian crossing and at 100m maximum spacing on straight runs.

Typically the sign shall specify the following as a minimum:

- a. DANGER or WARNING as applicable
- b. Pipeline contents
- c. Emergency contact company name and number
- d. Size and colour of emblem, wording and sign background to be in accordance with AS 1319.

Refer to Figure 7 for typical layout.









21.3.2 Within CSBP

Underground piping carrying hazardous fluids shall have markers to identify the pipe route.

Above ground marker posts shall be used where there is traffic free open ground and marker slabs installed flush with ground level in vehicle or pedestrian access areas.

Route markers shall be installed at each change of direction, at each side of road, rail or pedestrian crossing and at maximum 50m spacing on straight runs.

21.3.2.1 Marker Posts

Above ground posts shall be labelled and coloured as follows:

POST COLOUR & BASIC IDENTIFICATION	LABEL WORDING
Yellow – Hazardous Fluids	DANGER
	(Notes 1 & 2) PIPING IN THIS VICINITY

Note 1. Name of service to be specified

AMMONIA	
NATURAL GAS	
LPG	
NITROGEN	
HYDROGEN	
SULPHURIC ACID	
CAUSTIC SODA	

Note 2. Where pipes share a common trench service, names can be listed on one post.

The marker post may be driven into place provided the trench is new and there are no direct buried pipes within 850mm of the finished ground level. If there are, holes shall be hand dug to the required 600mm depth.

Where marker posts are to be used to identify existing pipe trenches, the pipe shall be located and the hole for the post hand dug to the required 600mm depth.





21.3.2.2 Marker Slabs

Pipe marker slabs shall indicate direction arrow and be embossed with wording to indicate the nature of the fluid, as per the following examples:

GAS PIPING ACID PIPING

Refer to Figure 9 for details.





STRAIGHT RUN MARKER SLAB



CHANGE OF DIRECTION MARKER SLAB

Figure 9 Typical Marker Slab

22. REINSTATEMENT

Existing surfaces removed or disturbed by trench excavations shall be reinstated by the Contractor to match existing and adjacent ground, to the satisfaction of the Superintendent.

Fences that were removed or damaged during the Works shall be reinstated in accordance with CSBP standard drawing 9900-2-0600.

23. AS-BUILT SURVEY

The Contractor shall complete an as-built survey of the pipeline. The Superintendent shall approve results of the survey.

Drawings, recording the as-built details, shall be prepared, numbered, approved and handed over in accordance with CSBP Engineering Standards:

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- a. ES-14-101-02 Drawing Management
- b. ES-14-101-03 Drawing Preparation
- c. ES-14-101-04 Drawing Numbering

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