CABLING, RACKING, TRENCHING & EARTHING INSTALLATION CODES OF PRACTICE

PL 727

REV. 011

APPROVAL

RESPONSIBILITY	DESIGNATION	SIGNATURE	DATE
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AMENDMENT RECORD

REV	REV DATE	CHG REQ NO.	CHANGE SUMMARY	PAGES AFFECTED
003	30/10/95	n/a	Document approved for distribution	All
004	07/05/99	n/a	Document revised to incorporate Project Tele (PYP233) Standards	All
005	06/10/99	n/a	Document revised to incorporate Pipeline Crossing/Instr Install/Cable Strap specs	All
006	21/09/00	n/a	Document revised to incorporate Core Identing and Cable Tagging specs	All
007	12/04/01	n/a	Document revised to incorporate additional Core Identing and Cable Tagging specs	All
008	01/09/02	n/a	Document revised to incorporate additional clarification, Field JB wiring and Plant Earthing specifications	All
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011	25/01/10	n/a	Rev 10 has been rev'ed up to Rev 11 to resolve NMPP Alliance documentation handling issues.	All

TABLE OF CONTENTS

1. INTRODUCTION

The objective of this Cabling, Racking, Trenching & Earthing Installation Standard is to establish codes of practice that shall be required to be adhered to by both Contractor and Client in the supply and installation of Electrical and Instrument Cabling, Racking, Trenching and Earthing Reticulation on all Transnet Pipelines Sites.

2. SCOPE

2.1 General

This document defines as a minimum, the general responsibilities for the provision of all Electrical and Instrument Cabling, Racking, Trenching and Earthing Reticulation on all Transnet Pipelines sites, whether by the Client or Contractor, for and on behalf of Transnet Pipelines. In this regard, contractors are required to familiarise themselves with all applicable Standards and Codes of Practice listed herein, and to ensure compliance in the execution of any work in terms of this document. Failure to comply may render the contractor liable for corrections at his own cost.

These Standards and Codes of Practice should be read in conjunction with all other Specifications and drawings as issued for a particular contract. Where discrepancies occur, these must be brought to the attention of Transnet Pipelines in writing before commencement of work. In the event of any conflict between the contents of any documents forming part of a contract (as listed in the Schedule of Contract Documents) and this document, the former shall prevail.

2.2 Application to Work Activities

The Standards and Codes of Practice contained herein apply to all installations requiring Electrical and Instrument Cabling, Racking, Trenching and Earthing Reticulation and includes amongst others the following standards:

- Supply of electrical and instrument cable trenches
- Supply, installation of electrical and instrument ladder racking reticulation
- Supply, installation of electrical and instrument dropper reticulation
- Supply, installation and termination of electrical and instrument cabling
- Cable Tagging and Core Identing standards for electrical and instrument cabling
- Supply, installation of instrument and electrical earthing

3. REFERENCE DOCUMENTATION

3.1 The requirements of the materials, design, layout, fabrication, assembly, erection, examination, inspection and testing of equipment and facilities on site shall be in accordance with the relevant sections of codes: -

a) ASME/ANSI.B31.3 - Chemical Plant and Petroleum Refinery Piping

b) ASME/ANSI.B31.4 - Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia and Alcohols

c) SANS 10089-2:2002 - The Petroleum Industry Part II: Electrical Code

d) SANS 10142 - Code of Practice for Wiring of Premises

e) SANS 10198:2004 - The Selection, Handling and Installation of Electric Power Cables of rating not exceeding 33 kV

f) API RP 2003 - Protection against ignitions arising out of static, lightning and stray currents

g) SANS 10313 - The Protection of structures against lightning.

h) SANS 10086 - The Installation and Maintenance of Electrical Equipment used in explosive atmospheres. Refer to Section 2 for hazardous area classifications.

i) SANS 97:2001 - Electric Cables: Impregnated Paper-Insulated Metal Sheathed cables for rated voltage 3.3kV:3.3kV to 19kV/37kV.

j) SANS 1507:2007 - Electrical Cables with extruded solid dielectric insulation for fixed installations (300/500V to 1900/3300V)
Part 1: General
Part 3: PVC Distribution Cables
Part 4: XLPE Distribution Cables

k) SANS 1274 - Coatings applied by the Powder Coating Process

l) DIN 41494 - Specification for Panel Mounting Racks

m) DIN 24185 - Specification for Air Filters used in General Ventilation

n) Government, local authorities or other statutory bodies' regulations, laws, requirements or customs which are more stringent than those specified in this project specification.

3.2 The following standard specifications are to be used for reference purposes and need to be noted by Contractors in order to signify familiarity and compliance with the requirements. It is expected of Contractors that they be familiar with the applicable clauses

and that these will be adhered to in the execution of any work in terms of this specification. Contractors will be required to confirm that they are able to meet these requirements.

a) SANS 10108: 2005 The Classification of hazardous locations and the selection of electrical apparatus for use in such locations

b) The Occupational Health & Safety (OHS) Act No. 85 of 1993

c) SANS 60079-1 Flameproof Enclosures for Electrical Apparatus

d) SANS 60079-25 Intrinsically Safe Systems

e) API Manual of Petroleum Measurement Standards Chapters 4 to 12
IP Chapter 10 and Papers 2 and 3

f) SANS 60529 Degrees of protection provided by enclosures (IP Code)

g) Safety Regulations for Contractors

h) Technical Instruction No. 16 - Contractors Work Permit Procedures.

3.3 Where no specific rules, regulations, codes or requirements are contained in this specification nor covered by the above mentioned codes, the contractor shall, in consultation with Transnet Pipelines, adhere to internationally accepted modern design and engineering practices in the Petroleum Industry.

4. SPECIFICATIONS

4.1 The following standard specifications are to be read in conjunction with this document and require separate statements of compliance, which should be included in the tender documents.

Specification for Equipment Cabinets to house Electronic Equipment	PL711
Specification for Low Voltage Switchgear and Distribution Boards	PL631
Specification for Medium Voltage Switchgear	PL632
Safety Regulations for Contractors	

5. ABBREVIATIONS & DEFINITIONS

5.1 For the purpose of understanding these Standards, the following abbreviations apply.

ANSI	American National Standards Institute
C & I	Control and Instrumentation
IEC	International Electrotechnical Commission
ISA	Instrument Society of America
SABS	South African Bureau of Standards

5.2 The following Definitions are consistent with the Transnet E5 Agreement and General Conditions of Contract and apply to this specification in its entirety.

CHIEF EXECUTIVE (Transnet Pipelines) means the officer appointed as Chief Executive (Transnet Pipelines) of Transnet Limited or any person lawfully acting in that capacity.

ENGINEER means any officer in the office of the Chief Executive (Transnet Pipelines) deputed by the Chief Executive (Transnet Pipelines) to supervise and take charge of the contract.

PLANT means any machine, excluding a tool, and any vehicle, excluding a passenger vehicle, used on site for the carrying out of the Works.

EQUIPMENT means any device not forming a permanent part of the Works, used on site for the carrying out of the Works, and also any temporary building which is required for the carrying out of the Works and which is erected on site.

TOOL means any instrument, powered or otherwise, which is accepted as a hand tool by the industry concerned and which is normally used in a manual operation by an individual labourer, artisan or workman.

MATERIAL means any constructional substance or ingredient which shall form part of the permanent Works and the substances in excavations and earthworks.

DRAWINGS means the drawings referred to in any specifications, schedule of quantities and prices and any alterations of such drawings made or approved in writing by the Engineer and such other drawings as may from time to time be furnished or approved in writing by the Engineer.

SITE means the land and any other place on, under, over, in or through which the Works are to be executed or carried out and any other land or place made available by Transnet in connection with the Works.

WORKS means the works to be executed in accordance with the Contract.

6. TRENCHING RETICULATION CODES OF PRACTICE

This specification details standards and codes of practice to be adhered to in the supply of Electrical and Instrument Cable Trenching Reticulation at all Transnet Pipelines Sites.

The requirements of the materials, design, layout, fabrication, assembly and erection shall, where relevant, be in accordance with the following approved Installation Typicals forming part of this Specification: -

Cable Marker Specification 727/001/cblmarker

6.1 General

6.1.1 The Contractor must familiarise himself with the requirements for conducting excavations in hazardous areas.

6.1.2 The Contractor will be required to submit proposed Trench Route Reticulation Diagrams to Transnet Pipelines for approval, prior to commencement of work. In this regard, contractors will be required to have studied all relevant Site Layout drawings and familiarised themselves as to the nature and location of all existing services, both buried and visible. Contractors are to note that approval of trench routing by the client in no way absolves the contractor of his responsibilities regarding damage to and rectification of existing services. **All damages to existing services, inclusive of cabling and piping shall be required to be rectified at the Contractor's cost.**

6.1.3 The Contractor must advise the client of any uncharted services encountered during excavations.

6.1.4 During trenching operations the Contractor must ensure that all precautions are taken to prevent damage to underground services.

6.1.5 The Contractor shall advise the client immediately if any damage is caused to underground services; inclusive of cabling, water mains etc.

6.1.6 Approval must be given by the client for the removal of obstructions.

6.1.7 Excavations across oil pipelines shall not be done without the authorised personnel present on site. The client must be advised 14 days in advance when such excavations will take place.

6.1.8 Cable crossings of oil pipelines shall only be at right angles.

6.1.9 Contractors are to note that where cable sleeves are not installed, all cable trenches are required to remain open until the end of the Commissioning Phase of the project, unless instructed otherwise. Provision for the possible erosion of the backfill / collapsing of trenches shall be made by Tenderer's in their Offers. Contractors are to note that where requested by Transnet Pipelines Operational Staff, platforms/bridges shall be required to be provided by the Contractor for the crossing of open trenches and provision shall be made in the Tenderer's Offer accordingly. Trenches across road, access ways or foot-paths shall not be left open for a period longer than eight hours.

6.1.10 **Power driven mechanical excavators shall not be used for excavations, without prior permission from the client.**

6.1.11 Trenches shall be as straight as possible with the bottom of the trench firm and smooth without sharp dips or rises, which may cause tensile forces in the cable during backfilling.

6.1.12 Trenches shall have no sharp objects, which may cause damage to the cable during laying or backfilling.

6.1.13 The width of the trench at any bend or place where cable slack is required shall be such as to allow the bending radius of the cable not to be less than is specified in SABS 97 and SABS 1339 for that particular cable.

6.1.14 The Contractor shall remove any accumulated water or liquid from the trenches and dispose of it without creating a nuisance or hazard.

6.1.15 The client reserves the right to alter any cable route or portion thereof prior to the laying of cables.

6.1.16 The Contractor shall supply and install cable markers at all locations that mark either a change in direction of a cable trench, the location of a cable joint or the location of a draw box. Cable Markers shall comply fully with all provisions detailed in Drawing 727/001/Cblmrk (latest revision), attached to this Specification.

6.2 Trench Specifications

Separate Trenches shall be supplied to cater for the following cable types:

6.2.1 ELECTRICAL HV/MV TRENCHES

Trench Dimensions	: 1000 mm deep by 500 mm wide (two cables), add 300mm width for additional cables
River Sand Bedding	: PVC Piping – 75 mm above pipe, 50mm under pipe : Direct Burial – 100 mm
Identification	: PVC or Concrete Interlocking Tiles at a depth of 350mm
Cable Markers	: Concrete with engraved anodised aluminium ID plates Cable Marker Colour – Brilliant Green
Cabling	: Medium and High Voltage Power Cabling > 400 VAC
Separation	: 500 mm (LV cabling), 1000mm (Instrument cabling)

6.2.2 ELECTRICAL LV TRENCHES

Trench Dimensions	: 750 mm deep by 300 mm wide
River Sand Bedding	: PVC Piping – 75 mm above pipe, 50mm under pipe : Direct Burial – 100 mm
Identification	: Polythene Marker Tape (150mm wide, yellow and marked with the words “Electric Cable/Elektriese Kabel”) at a depth of 350mm
Cable Markers	: Concrete with engraved anodised aluminium ID plates. Cable Marker Colour – Black
Cabling	: Low Voltage Power Cabling 400 VAC/230 VAC (e.g. Actuators, Aux Motors, DB circuits)

	: Control Cabling (e.g. MV Breaker Inter-tripping cables, Actuator control signals, Aux Motor local stop/start panels etc.)
Separation	: 500 mm (HV/MV cabling), 1000mm (Instrument cabling)

6.2.3 INSTRUMENT TRENCHES

Trench Dimensions	: 500 mm deep by 300 mm wide
River Sand Bedding	: PVC Piping – 75 mm above pipe, 50mm under pipe : Direct Burial – 100 mm
Identification	: PVC Tiles / Polythene Marker Tape (150mm wide, yellow and marked with the words "Electric Cable/Elektriese Kabel") at a depth of 350mm
Cable Markers	: Concrete with engraved anodised aluminium ID plates Cable Marker Colour – Light Blue
Cabling	: Instrument Multi-core & Single Pair Cabling (IS and non IS)
Separation	: 1000mm (HV/MV/LV Electrical cabling)

6.2.4 CABLE SLEEVING

6.2.4.1 Electrical LV and Instrument Cables shall where possible, be run in buried Cable Sleeves on the following routes (to facilitate pulling of new cables in the future):

- From the Switchgear Room to the manifold
- From the Control Room to the manifold
- From the Switchgear Room to the Control Room (where the buildings are located apart from each other)

6.2.4.2 Electrical LV and Instrument Cables may dependant on distances, be direct buried or run in buried Cable Sleeves on the following routes:

- From the Switchgear Room to Station Block Valve Chambers, Guard Huts
- From the Control Room to Station Block Valve Chambers, Guard Huts

6.2.4.3 All areas subject to vehicle traffic, rail crossings and paved areas shall be sleeved.

6.2.4.4 Sleeves shall be designed so as to ensure 25 % spare capacity.

6.2.4.5 Sleeve Specifications

Material	: PVC or PHD Polyethylene
Dimensions	: 100 mm OD min
Standards	: DIN EN50086-2, BS EN50086-2-4:1994

6.2.5 DRAW BOXES

Where cable sleeves are utilised and to facilitate the hauling of cables, brick draw boxes shall be provided at all trench junctions, complete with concrete slab, as detailed below:

Draw Box Dimensions (min)	: Internal 450 mm square, 3 courses of stock brick deep
Base & Top	: Concrete 50mm thick

6.3 Excavation & Backfill Specifications.

6.3.1 Areas subject to Vehicle Traffic utilising sleeved access (PVC piping).

The bottom of the trench shall be levelled, compacted and a 50mm depth of bedding material placed and compacted. The bedding material shall have a PI of less than 8 and a compatibility factor within the range 0 to 0,4. The bedding material shall have a grading as follows;

a) No particles retained on the 19mm sieve.
b) No more than 55 by mass shall be retained on the 13,2mm sieve.
c) More than 40% by mass shall be retained on the 0,6mm sieve.

Following the laying of the pipe a further 75mm of suitable bedding material shall then be placed around and above the pipes and compacted.

Backfilling shall then proceed in layers of not greater than 150mm and compacted to 90% Mod AASHTO density up to a level of finished road surface minus 450mm.

From –450mm to –300mm the backfill shall consist of selected quality material and compacted to 93% Mod AASHTO density.

From –300mm to –150mm the backfill shall consist of a stabilised sub base compacted to 95% Mod AASHTO density, stabilised with 2 pockets of OP cement per m^3.

In the case of concrete surface roads, from –150mm to –75mm, backfill shall consist of crushed stone compacted to 98% Mod AASHTO density. The final 75mm shall consist of in situ concrete of 30 MPa, vibrated and floated at the finished road surface. No vehicle traffic shall be permitted to cross the new concrete for a period of 7 days.

In the case of tarmac surface roads, from –150mm to –55mm, backfill shall consist of crushed stone compacted to 98% Mod AASHTO density. The final 50mm shall consist of TPA medium cold mix tarmac laid on a CAT 60 prime coat.

A DCP test result of not more than 5mm per blow, when averaged out of 150mm will be considered acceptable. This result shall be obtained over the top two layers of 150mm.

A CBR reading of 50 or greater shall be required to be obtained with the above DCP results.

All backfilling shall be completed using a mechanical trench rammer. A water cart shall be available on site to wet the backfill materials. Scales, sieves and DCP equipment shall be made available on site for use by Transnet Pipelines staff in the conducting of any of the above-mentioned tests.

6.3.2 Rail Crossings utilising sleeved access (PVC piping).

The excavation, backfilling and pipe laying across rail tracks shall be in accordance with Transnet specification CSE-516/1 (January 1985).

The bottom of the trench shall be levelled, compacted and a 50mm depth of bedding material placed and compacted. The bedding material will have a PI of less than 8 and a compatibility factor within the range 0 to 0,4. The bedding material shall have a grading as follows;

a) No particles retained on the 19mm sieve.
b) No more than 55 by mass shall be retained on the 13,2mm sieve.
c) More than 40% by mass shall be retained on the 0,6mm sieve.

Following the laying of the pipe a further 75mm of suitable bedding material shall be placed around and above the pipes and compacted.

Backfilling shall then proceed in layers of not greater than 150mm and compacted to 95% Mod AASHTO density up to a level of finished formation level. The backfill shall consist of excavated material mixed with OP cement in the ration of 2 pockets of cement per 1 cubic meter of backfill.

The DCP test result of not more than 5mm per blow, when averaged out of 150mm will be considered to be acceptable. This result shall be obtained over the top two layers of 150mm.

A CBR reading of 50 or greater shall be required to be obtained with the above DCP results.

All backfilling shall be completed using a mechanical trench rammer. A water cart shall be available on site to wet the backfill materials. Scales, sieves and DCP equipment shall be made available on site for use by Transnet Pipelines staff in the conducting of any of the above-mentioned tests.

6.3.3 Paved Areas not subject to Vehicle Traffic utilising sleeved access (PVC piping).

The bottom of the trench shall be levelled, compacted and a 50mm depth of bedding material placed and compacted. The bedding material shall have a PI of less than 8 and a compatibility factor within the range 0 to 0,4. The bedding material shall have a grading as follows;

a) No particles retained on the 19mm sieve.
b) No more than 55 by mass shall be retained on the 13,2mm sieve.
c) More than 40% by mass shall be retained on the 0,6mm sieve.

Following the laying of the pipe a further 75mm of suitable bedding material shall be placed around and above the pipes and compacted.

Backfilling shall then proceed in layers of not greater than 150mm and compacted to 90% Mod AASHTO density up to a level of finished road surface minus 300mm.

From –300mm to –150mm, the backfill shall consist of selected excavated material compacted to 93% Mod AASHTO density while the last 150mm shall be compacted to 95% Mod AASHTO density.

A DCP test shall be required to give an average of not more than 11mm per blow averaged over the last 150mm of backfill, thus approximating a CBR value of over 20, which is considered acceptable for backfilling in trenches subject to pedestrian traffic.

All backfilling shall be completed using a mechanical trench rammer. A water cart shall be available on site to wet the backfill materials. Scales, sieves and DCP equipment shall be made available on site for use by Transnet Pipelines staff in the conducting of any of the above-mentioned tests.

6.3.4 Common Areas not subject to Vehicle Traffic utilising sleeved access (PVC piping).

The bottom of the trench shall be levelled, compacted and a 50mm depth of bedding material placed and compacted. The bedding material would have a PI of less than 8 and a compatibility factor within the range 0 to 0,4. The bedding material shall have a grading as follows;

a) No particles retained on the 19mm sieve.
b) No more than 55 by mass shall be retained on the 13,2mm sieve.
c) More than 40% by mass shall be retained on the 0,6mm sieve.

Following the laying of the pipe a further 75mm of suitable bedding material shall be placed around and above the pipes and compacted.

Backfilling shall then proceed in layers of not greater than 300mm and compacted to 90% Mod AASHTO density up to a level of finished road surface minus 300mm.

From –300mm to finished ground level; backfill shall consist of selected excavated material and compacted to 93% Mod AASHTO density.

A DCP test shall be required to give an average of not more than 15mm per blow averaged over the last 150mm of backfill, thus approximating to a CBR value of over 15 which is considered acceptable for backfilling in trenches subject to pedestrian traffic

All backfilling shall be completed using a mechanical trench rammer. A water cart shall be available on site to wet the backfill materials. Scales, sieves and DCP equipment shall be made available on site for use by Transnet Pipelines staff in the conducting of any of the above-mentioned tests.

6.3.5 Common Areas not subject to Vehicle Traffic utilising direct burial.

The bottom of the trench shall be levelled, compacted and a 50mm depth of bedding material placed and compacted. The bedding material would have a PI of less than 12. The bedding material shall have a grading as follows:

a) No particles retained on the 10mm sieve.

Following the laying of the cable a further 50mm of suitable bedding material shall be placed around and above the cable.

Backfilling shall then proceed in layers of not greater than 300mm and compacted to 90% Mod AASHTO density up to a level of finished road surface minus 300mm.

From –300mm to finished ground level; backfill shall consist of selected excavated material and compacted to 93% Mod AASHTO density.

A DCP test shall be required to give an average of not more than 15mm per blow averaged over the last 150mm of backfill, thus approximating to a CBR value of over 15, which is considered acceptable for backfilling in trenches subject to pedestrian traffic

All backfilling shall be completed using a mechanical trench rammer. A water cart shall be available on site to wet the backfill materials. Scales, sieves and DCP equipment shall be made available on site for use by Transnet Pipelines staff in the conducting of any of the above-mentioned tests.

6.4 Pipeline Crossings.

6.4.1 All work performed outside of Transnet Pipelines Pump Station perimeters and within Transnet Pipelines pipeline servitudes shall conform to all requirements as laid down by the Transnet Pipelines Pipeline Crossings Manual (as amended), inclusive of the following:

6.4.2 Excavations across oil pipelines shall not be done without the authorised Transnet Pipelines personnel present on site. The client must be advised 14 days in advance when such excavations will take place.

6.4.3 All Cable Trenches (inclusive of both Instrument and Electrical Trenches) are to be trenched to a depth of 1.0 metre.

6.4.4 Crossing of pipelines shall be kept to an absolute minimum and shall require prior approval by Transnet Pipelines. Crossings shall be at right angles to the pipeline. All cabling shall be taken underneath the pipeline at a depth of 500 mm below the pipe surface. All damage to existing services, inclusive of piping and wrapping, shall be required to be rectified at the cost of the Contractor.

6.4.5 Power driven mechanical excavators shall not be used for excavations, without prior permission from Transnet Pipelines. Trenching in or near to pipeline servitudes shall be performed by hand, unless prior permission is otherwise granted by Transnet Pipelines.

6.4.6 When trenching in Transnet Pipelines servitudes and prior to commencement of trenching, actual position of the pipeline within the servitude is required to be located and clearly marked. The use of existing pipeline markers will not be considered as sufficient indication of the route of a pipeline.

6.4.7 All pipeline crossings will be performed in accordance with the Transnet Pipelines Pipeline Crossings Policy, Excavations Policy and Crossing Instructions (Instructions 1 through 5).

7. RACKING RETICULATION CODES OF PRACTICE

This specification details standards and codes of practice to be adhered to in the supply of Electrical and Instrument Cable Racking Reticulation at all Transnet Pipelines Sites.

The requirements of the materials, design, layout, fabrication, assembly and erection shall, where relevant, be in accordance with the following approved Installation Typicals forming part of this Specification: -

Typical for Instrument Stands - double	727/002/Instand
Typical for Instrument Stands - single	727/003/Instand
Typical for Angle Iron Droppers	727/007/Rack_Droppers
Typical for Racking Layouts incl. over Bund Walls	727/009/Rack_Typical
Typical for Junction Box stands	727/010/Junction Box Stand

7.1 General

7.1.1 The Contractor shall allow for the supply and installation of all cable racking and droppers where specified, including all supporting steelwork, accessories, clamps, fixing materials, deviations, bends, angles, tees, reducers and all other components required, to make cable racking and droppers complete and ready for the laying of cables.

7.1.2 All racking (inclusive of ladder racks and droppers) will be cut, fabricated, formed and then hot-dip galvanised (mild steel) prior to installation. Material of manufacture shall be mild steel unless specified otherwise in the Scope of Works attached to an Order.

7.1.3 All clamps, fixing materials and accessories, including nuts, bolts, washers etc. shall be manufactured from 316 Stainless Steel or chrome plated, to prevent corrosion. Fixing screws shall comprise of Pan head screws and nuts.

7.1.4 All welding must comply with SABS 044 Code of Practice for Welding and BS 1856 General Requirements for the Welding of mild steel. Tack or point welding of joints/seams is not considered acceptable practise.

7.1.5 In cases where galvanised cable racks or other steelwork are cut or drilled, all such cuts or holes shall be treated with an approved cold galvanising paint within 12 hours after cutting or drilling.

7.1.6 Holes larger than 7mm in diameter shall not be drilled in the structural steelwork without prior consent of the Consulting Engineer.

7.1.7 Separation of a minimum of 1000mm will be maintained between all instrumentation cable racking and parallel running electrical cable racking reticulation. Instrument cable racking having to cross electrical cables will do so at 90 degrees to minimise noise and interference.

7.1.8 All cable racking will be installed in a neat and straight manner and will be adequately supported with brackets attached to joists, walls or floors by the Installation Contractor following agreement with the Engineer. Horizontal racking runs will be level, vertical racking runs will be upright (90 deg), and shall be determined by use of spirit level. All ends will be free of jagged edges and will be neatly rounded.

7.1.9 All cable racking reticulation shall be **continuous and mounted in the vertical plane** and shall be positioned so as to avoid obstruction to walkways and access routes. All cable racking shall be installed in such a way so as to provide no obstruction to mechanical fitting

or maintenance procedures (associated with vessels, flanges, valves, actuators etc). Where access to walkways and equipment has been obstructed, it shall be the Contractor's responsibility to provide the necessary access via catwalks or stairs. Pricing for the aforesaid shall be deemed to have been included in the Tenderer's Offer.

7.1.10 Bonding straps, comprising of 10mm insulated (green/yellow) cable and lugged at both ends, shall be installed across all fish plates joining ladder racks together, in compliance with SABS 0142. All cable racks and supports (including angle iron where used in place of cable racks) shall be earthed to the station earth at two designated earth test points within the manifold. Note that angle iron droppers may be excluded from this provision.

7.2 Supports

7.2.1 Adequately sized Concrete Plinths shall be required to be provided by the contractor and incorporated into Tenderer's Offers under the following circumstances:

- All Cable Racking and Droppers supported at any height off of floor level, outside of concreted bund areas.
- All Cable Racking and Droppers supported at a height of greater than 1 000 mm off of floor level, within concreted bund areas.
- All Field Junction Box supports, whether within or outside of concreted bund areas.
- All Instrument Stands, installed outside of concreted bund areas

Plinths shall be sized and racking supports provided to ensure no lateral movement ie. no noticeable deflection of the rack/dropper between support points when fully loaded. Allowance shall be made for additional loading where cable racks are not fully occupied. The Contractor will be required to submit proposed Plinth and Support Bracket Diagrams to Transnet Pipelines for approval, prior to commencement of work. Provision for the supply and installation of concrete plinths and adequate supports shall be included in all Tenderer's Offers. The use of gussets of height less than 300mm shall be permitted to provide lateral support for Racking stands. Note however that the use of stays to provide support shall not be permitted. Racking stands shall be mounted vertically and grouting used to level with the bund floor, where required. **All support brackets shall be fastened to the concrete plinths by means of chemical anchors.**

7.2.2 Cable Racking and Droppers supported at a height of less than 1 000 mm off of floor level within concreted bund areas, and Instrument support brackets installed within concreted bund areas shall be fastened to the bund floor via means of adequately sized support brackets to ensure no lateral movement ie. no noticeable deflection of the rack/dropper between support points when fully loaded. Allowance shall be made for additional loading where cable racks are not fully occupied. The Contractor will be required to submit proposed Racking Support Diagrams to Transnet Pipelines for approval, prior to commencement of work. Provision for the supply and installation of adequate supports shall be included in all Tenderer's Offers. The use of gussets of height less than 300mm shall be permitted to provide lateral support for Racking stands. Note however that the use of stays to provide support shall not be permitted. Racking stands shall be mounted vertically and grouting used to level with the bund floor, where required. **Support brackets shall be fastened to the bund floor by means of chemical anchors.**

7.2.3 All supports, inclusive of racking reticulation and field junction box supports shall be installed in such a way so as to be both easily accessible and yet unobtrusive.

7.3 Dropper Reticulation (Electrical & Instrument)

7.3.1 Angle Iron Droppers shall be supplied and installed as cable supports to all instrumentation and valves, for all unsupported cable runs exceeding 1 000 mm in length.

7.3.2 Fabricated angle iron runs, with associated brackets and supports, will be supplied and installed for all individual instruments/electrical equipment, by the Installation Contractor, as required.

7.3.3 All bends and tees will be formed with a minimum inner radius capable of accommodating the minimum bend radius of the associated cable specifications. All bends shall be formed/swept – angled bends are not permissible.

7.3.4 All individual Instrument/Electrical Cable Droppers will be manufactured from angle iron with the following dimensions:

25x25x3mm or 40x40x5mm as required.

7.3.5 Angle Iron Droppers shall be sized to support an appropriate number of cables. In this regard, no more than three cables shall be supported on any one dropper.

7.4 Ladder Racking Reticulation (Electrical & Instrument)

7.4.1 **Pre-fabricated, heavy duty, hot dip galvanised ladder** racking reticulation, equivalent to the “O Line” support system, with all associated brackets and supports, will be supplied and installed for all instrument/electrical cabling requirements, by the Installation Contractor, as required.

7.4.2 In this regard O Line OL76 Type (Medium Duty) or equivalent racking may be utilized under the following circumstances:

- Racking to be installed at a height of less than 1 m from bund floor level
- Racking supports be spaced at a maximum width of 1.5 m apart, to lend additional support.

All racking installed at heights of greater than 1m from bund floor level must comply with O Line PS75 Power Span (or similar). The above concession in no way alleviates the Contractor of the responsibility to ensure that racking installed is not subject to lateral movement or sagging when fully loaded. In such cases, the Contractor will be required to rectify the fault at no additional cost to Transnet Pipelines.

7.4.3 All ladder racking shall be supported by adequate brackets and supports, a maximum width of 3m apart. In addition, all racks shall be supported at every change of direction of cable rack route. The cross stays of the ladder racking shall be installed with a maximum width of 500mm apart. All bends and tees will be formed with a minimum inner radius capable of accommodating the minimum bend radius of the associated cable specifications.

7.4.4 All bends and tees shall be formed/swept, with a minimum inner radius capable of accommodating the minimum bend radius of the associated cable specifications. Reducers shall be used when converting from one racking size to another, including right angle joints.

8. CABLING RETICULATION CODES OF PRACTICE

This specification details standards and codes of practice to be adhered to in the supply, installation, termination, cable tagging and core identing of Electrical and Instrument Cable and Wiring Reticulation at all Transnet Pipelines Sites. The Installation Contractor will supply, install and terminate all instrumentation and electrical cabling to be run from the central Control System, via field marshalling cabinets up to and including connection to field instrumentation as well as from the Switchgear/PLC Room up to including electrical equipment, as specified in the Scope of Works attached to an Order.

The requirements of the materials, design, layout, fabrication, assembly and erection shall, where relevant, be in accordance with the following approved Installation Typicals forming part of this Specification: -

Typical Instrument Loop Drawing	727/005/InstrLoop
Typical Valve Loop Drawing	727/006/VlvLoop

8.1 General

8.1.1 Cable Supply

8.1.1.1 All Electrical and Instrument cabling shall be in compliance with the specifications as stated in the Scope of Work attached to an Order. Contractors are to note that the provisions of SANS 10198 (“The Selection, Handling and Installation of Electric Power Cables of rating not exceeding 33 kV”) must be strictly adhered to in regard to the supply, installation and termination of all electrical and instrument cabling.

8.1.1.2 Sizing of multiple twisted pair cabling will accommodate the grouping of instrumentation terminations in each individual marshalling cabinet.

8.1.1.3 All Control and Instrument multi-core cables will include 25% spare capacity, unless otherwise specified in the Scope of Work attached to an Order.

8.1.1.4 The Installation Contractor shall be responsible for undertaking whatever preliminary engineering is required to verify cable core and quantity requirements. Contractors are to note that Transnet Pipelines will accept no liability for the accuracy of quantities specified in Contract Bills of Quantity. All excess material and off cuts not installed shall remain the property of the Contractor on completion of the contract i.e. payment shall be based on the quantity of material installed.

8.1.2 Cable Installation

8.1.2.1 Strapping

All instrument and electrical cables shall be installed on cable racking (whether in the vertical or horizontal orientation) and held to the racking at maximum intervals of 2 metres using approved cable ties/straps. Strapping intervals shall be determined by taking into account the mass of the cabling, length of the run and number of cables to be strapped together. Note that the maximum interval permitted between strapping is 2 metres. No more than 3 cables will be permitted per individual Cable Tie/Strap. All cable ties/straps shall comply with the following specification, unless otherwise specified in the Scope of Work attached to an Order:

- 316 Stainless Steel Bandit or Runlock (4 mm, 6 mm, 8mm width)

All Cabling shall be fastened securely and tightly to the Cable Racking Reticulation using the specified Cable Ties/Straps, in order to prevent cable sagging from occurring. In this regard and where necessary, Cable Droppers shall be drilled or slotted in order to ensure secure contact between Cable Tie and Cables installed. **No packing shall be allowed.**

8.1.2.2 Joints

No cable joints shall be permitted without the prior permission of Transnet Pipelines.

8.1.2.3 Cable Laying

Cable drums shall be supported on jacks and shall be rolled in the indicated direction to prevent twisting, tension or mechanical damage to the cable. Cable shall be drawn into position using sufficient rollers and labour to avoid damage by excessive bending and dragging. Particular care must be exercised when drawing cables through pipes and ducts to avoid abrasion, elongation and distortion of any kind.

Where cables come out of a trench or pass through a floor, they shall be protected by suitable mechanical protection, extending from 50mm to 1000mm above ground/floor level.

Where cables are cut and not immediately made off, the ends are to adequately sealed to the satisfaction of the Engineer and without delay, to prevent the ingress of moisture.

8.1.2.4 Cable Duct Preparation

All cable ducts, including those entering bundwall areas, buildings and panels shall be sealed against the ingress of water, fire and vermin (rodents). The use of Intumastic Sealant (or similar) is recommended for fire proofing of all cable duct entries.

8.1.3 Cable Termination

8.1.3.1 Glanding

All instrument and electrical cables will be glanded at both ends using the appropriate sized gland and will include associated adaptors, washers, ferrules, bands, etc. Provision for all glands, adaptors, washers, ferrules, bands etc. shall be included in the Tenderer's offers. All cable glands shall comply with the following specification, unless otherwise specified in the Scope of Work attached to an Order:

Dekabon Armoured and unarmoured Cabling (Instrumentation)
Increased Safety Ex"e" rated compression gland (CCG Posi Grip EExe or similar), IP68 rated, in accordance with SABS 1031. All adaptor/reducers and blanking plugs are to be FLP.

PVC SWA Cabling (Instrument Multicore, Ex"e" rated motors)
Increased Safety Ex"e" rated non-compression gland, IP68 rated, complete with SWA protection (CCG Ex Armortex EExde IIC or similar), in accordance with SABS 1031. All adaptor/reducers and blanking plugs are to be FLP.

PVC SWA Cabling (Ex"d" rated motors, actuators)
Flameproof Ex"d" rated non-compression gland, IP68 rated, complete with SWA protection (CCG Armortex Exde I/IIC or similar), in accordance with SABS 808. All adaptor/reducers and blanking plugs are to be FLP.

PVC SWA Cabling (Electrical and PLC Panels located within buildings rated as Safe Areas in terms of Hazardous Area Classifications SANS 10108)
Non-Flameproof rated, non-compression gland, IP68 rated, complete with UV resistant (black) shroud where required (CCG BW with shroud for SWA cables, CCG A2 Compression with shroud for non-SWA cables, or similar).

All glands will be waterproof and in the case of Hazardous Areas, correctly rated in terms of the Explosion Proof Classification of the equipment housings to which they are installed.

It shall be the responsibility of the Installation Contractor to ensure that all excess gland entries into both panels and equipment (e.g. valve actuators, instruments) are plugged by means of suitably rated gland plugs. In hazardous areas, this will require the use of EEx d/e rated plugs. The use of "push-out" blanking inserts to plug cable entries shall not be permitted.

8.1.3.2 Termination

All cables will be terminated at field instrumentation, electrical equipment, field junction boxes, switchgear panels and control room marshalling cabinets according to manufacturers specifications, instrument hook-up diagrams and control system specifications as provided/approved by Transnet Pipelines.

Instrument Dekabon Cabling

- Outer Dekabon armouring shall be stripped back to the entry point into the associated termination/junction box. Protrusion of cable sheath/armouring into the termination/junction box (through the compression gland) shall be a minimum of 15mm and a maximum of 50mm.

- Cable pair inner aluminium foil shall be stripped back to the point at which the individual cores leave the PVC Trunking to be terminated onto the respective terminal rails. Ends of the inner foil shall be neatly taped/heat shrunk so as to prevent unravelling.

- Individual cable ends shall be sealed with the use of heat shrink tubing applied over the cable sheath/armouring at the point of entry into the termination/junction box/panel, in order to protect the cable and prevent the ingress of moisture.

- Both cable overall (drain wire) and individual screens shall be insulated with the use of appropriately sized green coloured sleeving, to prevent inadvertent contact with metallic surfaces.

- All individual cable cores (including spares) will be left long enough to accommodate 200mm slack, i.e. taking into account the routing via the trunking.

- Excess lengths of individual cable cores will be neatly folded and tied within the trunking provided. All spare cores shall be terminated into terminals so provided.

- Termination of individual cable cores in the termination strips will be such that all Control System related cabling will be terminated to one side of termination strips, whilst all field instrumentation/equipment cabling will be connected to the other side of termination strips.

In the case of Field Junction Boxes with dual terminal strips, multi-core cabling will be glanded in the centre of the gland plate and terminated into terminal rails provided, running from the centre PVC Trunking outwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the outermost PVC Trunking inwards. In the case of dual terminal rails, discrete signals will be terminated on the LHS terminal rail, and analogue signals on the RHS terminal rail. Where PLC and Metering signals are terminated into the same Field Junction Box, PLC signals will be terminated on the LHS terminal rail, and Metering signals on the RHS terminal rail.

In the case of Field Junction Boxes with single terminal strips, multi-core cabling will be glanded on the right side of the gland plate and terminated into terminal rails provided, running from the right hand side of the panel inwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the left hand side of the panel inwards.

- All cables connected to individual instruments/equipment will be provided with a single loop of minimum diameter of 150mm. All loops will be neatly strapped.

- All cores (including spares) will be terminated into allocated termination strips/rails in the respective Instrumentation, Termination and Field Junction Boxes

Instrument PVC SWA Multi-core Cabling

- Cable SWA armouring shall be stripped back to the entry point into the associated marshalling cabinet/junction box and shall be glanded in such a manner so as to ensure electrical continuity with the gland. When terminated in hazardous areas, cable armouring shall be bonded to the panel equi-potential bonding system via means of earthing rings provided as an integral part of the gland. Contact between the gland and the gland plate shall not be considered as sufficient for bonding purposes.

- Protrusion of cable inner PVC sheaths into the marshalling cabinet will be a minimum of 25mm and a maximum of 50mm.

- Cable inner aluminium foil shall be stripped back to the point at which the individual cores leave the PVC Trunking to be terminated onto the respective terminal rails. Ends of the inner foil shall be neatly taped/heat shrunk so as to prevent unravelling.

- Cable ends shall be sealed with the use of heat shrink tubing applied over the cable inner sheath at the point of entry into the termination/junction box/panel, in order to protect the cable and prevent the ingress of moisture.

- Both cable overall and individual screens shall be insulated with the use of appropriately sized green coloured sleeving, to prevent inadvertent contact.

- All individual cable cores (including spares) will be left long enough to accommodate 200mm slack, i.e. taking into account the routing via the trunking.

- Excess lengths of individual cable cores will be neatly folded and tied within the trunking provided. All spare cores shall be terminated into terminals so provided.

- Termination of individual cable cores in the termination strips will be such that all Control System related cabling will be terminated to one side of termination strips, whilst all field instrumentation/equipment cabling will be connected to the other side of termination strips.

  In the case of Field Junction Boxes with dual terminal strips, multi-core cabling will be glanded in the centre of the gland plate and terminated into terminal rails provided, running from the centre PVC Trunking outwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the outermost PVC Trunking inwards. In the case of dual terminal rails, discrete signals will be terminated on the LHS terminal rail, and analogue signals on the RHS terminal rail. Where PLC and Metering signals are terminated into the same Field Junction Box, PLC signals will be terminated on the LHS terminal rail, and Metering signals on the RHS terminal rail.

  In the case of Field Junction Boxes with single terminal strips, multi-core cabling will be glanded on the right side of the gland plate and terminated into terminal rails provided, running from the right hand side of the panel inwards. Individual Instrument cables will then be terminated into the terminal rails provided, running from the left hand side of the panel inwards.

- All cores (including spares) will be terminated into allocated termination strips/rails in the respective Instrumentation, Termination and Field Junction Boxes

Electrical Power and Control Cabling (Low Voltage)

- Cable SWA armouring shall be stripped back to the entry point into the associated equipment housing/termination box/panel and shall be glanded in such a manner so as to ensure electrical continuity with the gland. When terminated in hazardous areas, cable armouring shall be bonded to the panel equi-potential bonding system via means of earthing rings provided as an integral part of the gland. Contact between the gland and the gland plate shall not be considered as sufficient for bonding purposes.

- (Option 1) Cable inner PVC sheath shall be cut back at the point of entry into the equipment housing/termination box/panel, protrusion of the inner sheath into the associated switchgear cabinet/equipment housings shall be a minimum of 25mm and a maximum of 50mm. Heat shrink tubing shall be applied at the point of entry into the equipment housing/termination box/panel, in order to protect the cable and prevent the ingress of moisture.

  (Option 2) Where cables are glanded into panels, cable inner PVC sheaths may be taken directly into trunking/marshalling arrangements, with the inner PVC sheaths cut back at point of termination. Note that in this instance, heat shrink need not be applied at the point of entry into the cabinet.

- All individual cable cores (including spares) will be left long enough to accommodate 200mm slack, i.e. taking into account the routing via the trunking.

- Excess lengths of individual cable cores will be neatly folded and tied within the trunking provided.

- Termination of individual cable cores in the termination strips will be such that all Starter related cabling will be terminated to one side of termination strips, whilst all field cabling will be connected to the other side of termination strips.

- All cables connected to individual instruments/equipment will be provided with a single loop of minimum diameter of 150mm. All loops will be neatly strapped.

8.1.3.3 Cable Identification

All instrument and electrical cables will be marked with an identification number /cable tag at both ends. Identification numbers will be approximately 10 characters and will comprise of the following specification:

All Field Cabling:
Grafoplast Targa Metal TGT System (Carrier Rail length: 58mm for 7 characters, 82mm for 11 characters, 106mm for 15 characters) 316 Stainless Steel Markers, with punched text 6 mm height minimum, fastened onto the cable at both ends via means of Stainless Steel cable ties or
Laser engraved 316 Stainless Steel Markers, of length 90mm, height 10mm and text height 6mm. Note that the marker should have slots cut at the ends for attaching cable ties. Tags shall be fastened onto the cable at both ends via means of Stainless Steel cable ties.

Note that selection as to which cable-tagging system to use shall be made on a site basis i.e. a mix of both systems on one site will not be accepted.

Cable Tags associated with instrument and electrical cabling entering or leaving termination/junction boxes in the field will be attached to the cable outside of the marshalling cabinet i.e. below the gland plate and within 150mm of the entry point to the cabinet.

Cabling installed within buildings:

1. Where Cable Tags are fixed to the cable within Electrical / PLC Panels:

   Grafoplast Trasp Series 130 Gull-wing transparent PVC sleeves (30mm in length), with printed text black on white background, fastened onto the cable via means of Stainless Steel cable ties. Text height to be 3mm minimum.

2. Where Cable Tags are fixed to the cable outside of Electrical / PLC Panels:

Grafoplast Targa Metal TGT System (Carrier Rail length: 58mm for 7 characters, 82mm for 11 characters, 106mm for 15 characters) 316 Stainless Steel Markers, with punched text 6 mm height minimum, fastened onto the cable via means of Stainless Steel cable ties or

Laser engraved 316 Stainless Steel Markers, of length 90mm, height 10mm and text height 6mm. Note that the marker should have slots cut at the ends for attaching cable

ties. Tags shall be fastened onto the cable at both ends via means of Stainless Steel cable ties.

Note that selection as to which cable-tagging system to use shall be made on a site basis i.e. a mix of both systems on one site will not be accepted.

For details on Cable Identification Standards, refer to Section 8.5 of this Specification.

8.1.3.4 Cable Core Identification

All individual instrument and control cable cores (including spares) will be marked with an identification number at both ends. Identification numbers will be approximately 10 characters in length and will comprise of the following specification:

- Instrumentation - Grafoplast Printed (Black lettering on white background)
- Electrical - Power - Crutchley
- Electrical - Control - Crutchley

Identification characters will be sized to correspond to the overall diameter of the individual cores, i.e. ID tag sheaths will be sized and provided with a good fit (not loose) over the core ends.

Identification tags will be so located as to leave cable core/pair lettering/numbering visible. Individual core labelling will, in this respect, be approximately 11 characters per label. Text on core idents shall be black on white or yellow background, except for Trip "T" idents which shall be black on red background.

For details on Cable Core Identification Standards, refer to Section 8.6 of this Specification.

8.1.3.5 Cable Core Lugging

All individual cable cores will be neatly terminated. Appropriately sized lugs will be attached to all core ends, using the appropriate crimping tool (not side cutters or ordinary pliers). The colouring of crimps will match the size of the associated cable core. All cable lugs utilised shall comply with the following specification, unless otherwise specified in the Scope of Work attached to an Order:

- Instrument Cables - bootlace ferrules
- Electrical Power Cables - spade lugs for compression terminals, ring lugs for screw terminals (pin lugs are not acceptable)
- Electrical Control Cables - spade lugs for compression terminals, ring lugs for screw terminals (pin lugs are not acceptable)

8.1.3.6 Cable Screening – Instrument Cabling

Individual Screens

All Individual Instrument Cable Pair Screens shall be terminated into terminals provided within the Instrument Termination Boxes as well as the Field Junction Boxes, and shall be grounded to a common insulated earth rail to be provided in each of the Control System Marshalling Cabinets, alongside the Termination Rails provided. Individual Screens shall be terminated in such a manner so as to be continuous from the Instrument/Instrument Termination Box to the Control System Marshalling Cabinets i.e. individual instrument cables as well as multi-pair cables.

Individual screen terminals shall be insulated in the Termination Boxes and Field Junction Boxes provided, thus ensuring that the individual cable pair screens are not grounded at instrument/equipment ends, i.e. to prevent common mode noise. Where Instrument Cables terminate directly into Instrument housings, individual screens shall be cut back and insulated within the Instrument housing using heat shrink sleeving, to prevent inadvertent contact with any conducting surfaces.

All individual screen earth rails in the Control System Marshalling Cabinets will be connected to the existing panel Instrument Earth bar via means of a 25mm insulated earth cable, which shall in turn be connected at two points via means of PVC Cu 70mm2 insulated earth cables (Yellow/Green in colour), to the Instrument Earth bar located within the control room.

Overall Screens

All Instrument Cable Overall Screens/Drain wires shall be terminated to insulated earth bars provided within the Field Junction Boxes, and shall be earthed to a common electrical earth bar to be provided in each of the Control System Marshalling Cabinets. Overall Screens /Drain Wires shall be cut back and insulated within the Instrument Termination Boxes and Instrument housings (where applicable) to prevent inadvertent contact with the Termination Box housing, utilising heat shrink sleeving. Overall Screens shall be terminated in such a manner so as to be continuous from the Instrument Junction Box to the Control System Marshalling Cabinets.

The electrical earth bar shall be earthed to the Cabinet Frame, and connected at two points via means of PVC Cu 70mm2 insulated earth cables (Yellow/Green in colour), to the Electrical Earth bar located within the control room.

8.1.3.7 Cable Screening – Electrical Cabling (Power & Control)

All electrical cable screens/drain wires (where applicable) will be grounded to a common electrical earth bar to be provided in each of the Control System Marshalling Cabinets/Switchgear Cubicles. The electrical earth bar shall be earthed to the Cabinet Frame, and connected at two points via means of PVC Cu 70mm2 insulated earth cables (Yellow/Green in colour), to the Electrical Earth bar located within the control and switchgear rooms.

8.1.3.8 Cable Testing – Low Voltage Cables (< 1 kV)

Each individual core of all cables (including spares) will be checked for continuity and insulation breakdown, in accordance with SANS 1507:2007 (PVC):

- Insulation Resistance shall be measured with a 1000V Megger and the readings tabulated and certified.
- Similarly, earth continuity resistance shall be measured and recorded.
- All cables will be checked for correct termination.

8.1.3.9 Cable Testing – Medium Voltage Cables (< 22 kV)

Each section of laid and jointed cable shall be tested, in accordance with SANS 97:2001 (PILC/SWA):

- Insulation Resistance shall be measured with a 1000V Megger, followed by the relevant pressure test. Readings shall be tabulated and certified.

- AC test voltage must be applied to each phase in turn for one minute, or alternatively the DC test voltage for fifteen minutes. Leakage current shall be measured and recorded for each test.
- All cables will be checked for correct termination.

8.2 Instrumentation Cabling

Instrument Cabling as defined within this and other Transnet Pipelines Specifications includes the following types of cabling:

1. PVC SWA Multicore instrument cables running between Instrument Junction Boxes in the field and PLC Cabinets (IS and non-IS rated)
2. PVC SWA Multicore instrument cables running between instruments in the field and PLC Cabinets (IS and non-IS rated)
3. Dekabon armoured instrument cables running between Junction Boxes in the field and the instruments themselves (IS and non-IS rated)

8.2.1 All Instrumentation Cabling will comply in all respects to the specifications as contained in the Scope of Work attached to an Order. In the absence of cable specifications being detailed in the Scope of Work attached to an Order, the following cable specifications will apply.

8.2.2 Instrument cabling will be marshalled on Instrument racking and trenching as defined elsewhere within this specification.

8.2.3 Instrument multi-core cabling running between the Field Junction Boxes and the Control System Marshalling Cabinets will comprise of steel wire armoured, PVC Insulated, individual and overall screened multi-core cable. Note that Transnet Pipelines has standardised on 1 pair, 2 pair, 8 pair and 16 pair cable – prior approval from Transnet Pipelines will be required to deviate from these specifications.

Conductors:

Core Size : 1.0 mm2
Stranded untinned copper, 7 strands minimum
PVC Insulated, Insulation Breakdown Voltage between conductor-earth, conductor-screen and screen-earth to withstand 500V 50Hz RMS for a 1 min
Insulation Colours : Black and White
Multipair cores to be numbered (numeric on both conductors of the pairs)
Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Shield/Screen

Individual & overall screened – plasticised aluminium foil (100%) coverage
Stranded tinned copper drain wire 0.5 mm2

Inner Jacket

Extruded fire retardant black PVC with rip cord for jacket removal.
Minimum thickness 1.2mm up to 8 pair, 1.5 mm for 16 to 36 pair

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – UV resistant (Carbon Black added)

Jacket thickness 1.5mm up to 8 pair, 2.0 mm for 16 to 36 pair.
Jacket to be totally bonded to a steel wire armoured sleeve.

IS Circuits: Jacket color light blue Non IS Circuits: Jacket color black.

8.2.4 Individual Instrument cabling running between the Field Junction Boxes and the individual field mounted Instruments will comprise of Dekabon armoured, PVC Insulated, individual and overall screened multi-core cable. Note that Transnet Pipelines has standardised on 1, 2, 4 and Triad cable – prior approval from Transnet Pipelines will be required to deviate from these specifications.
(Note that this specification only applies to cabling running on racks above the ground, all Instrument cables running in trenches will need to comply with the Instrument Multi-core Cable Specifications detailed above).

Conductors.

Core Size : 1.5 mm2
Stranded untinned copper, 7 strands minimum
PVC Insulated, Insulation Breakdown Voltage between conductor-earth, conductor-screen and screen-earth to withstand 500V 50Hz RMS for a 1 min
Insulation Colours : Black and White
Multipair cores to be numbered (alphanumeric on both conductors of the pairs)
Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Shield/Screen

Individual & overall screened – plasticised aluminium foil (100%) coverage
Stranded tinned copper drain wire 0.5 mm2

Inner Jacket

Extruded fire retardant black PVC with ripcord for jacket removal.
Minimum thickness 1.2mm

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – UV resistant (Carbon Black added)
Jacket thickness 1.5mm.
Jacket to be totally bonded to an inner waterproof aluminium sleeve.

IS Circuits: Jacket color light blue Non IS Circuits: Jacket color black.

8.3 Electrical Cabling

Electrical Cabling as defined within this and other Transnet Pipelines Specifications includes the following types of cabling:

1. HV Power Cabling (88 kV to 11 kV) running between points of supply, MV Substations and associated transformers.
2. MV Power Cabling (6.6 kV to 3.3 kV) running between points of supply, MV Substations and associated transformers.
3. LV Power cabling (230/400 VAC) running between electrical equipment in the field and LV Panels, Valve Panels and Distribution Boards

4. LV Control Cabling running between field equipment, and between field equipment and LV Panels, Valve Panels and Distribution Boards. This will include valve actuator control signals, motor start/stop panels, supply breaker inter-tripping signals etc.

8.3.1 All HV & MV Power cabling shall be in compliance with the specifications as stated in the Scope of Work attached to an Order.

8.3.2 Unless otherwise specified, MV Power Cabling (6.6/3.3 kV) shall conform to the following specifications:

- PVC Insulated, PVC Bedded, SWA PVC Sheathed, 6.6/3.3 kV, 3 core cable manufactured to SANS 1507:2007. Fire retardant, UV resistant, low-toxic fume emitting plastics to be used for outer jacket.

8.3.3 All LV Power & Control cabling will be marshalled on LV Electrical racking and trenching as defined elsewhere within this specification.

8.3.4 All LV Power Cabling (230/400 VAC) will comply in all respects to the specifications as contained in the Scope of Work attached to an Order. In this regard, Contractors are to note that the responsibility for correct cable core sizing shall remain at all times with the contractor.

In the absence of cable specifications being detailed in the Scope of Work attached to an Order, the following cable specifications will apply to all cabling of voltage 600 V/1000 V or less: (In full compliance with SABS 1507).

8.3.4.1 Electrical LV Power cabling running between Equipment located in the field, LV Panels or Motor Control Centre Panels, Valve Panels and Distribution Boards will comprise of steel wire armoured, PVC Insulated, four core cable, as follows:

Conductors.

Core Size : 4 core - Rated as per application (SABS 10142-1)
Stranded untinned copper, 7 strands minimum
PVC Insulated, Insulation Breakdown Voltage to withstand 2 kV 50Hz RMS for a 1 min period
Insulation Colours : Colored RD-BL-YE/WT-BK (not numbered)
Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Inner Jacket

Extruded fire retardant black PVC with rip cord for jacket removal.
Minimum thickness 1.2mm

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – fire retardant and UV resistant.
Jacket thickness 1.5mm.
Jacket to be totally bonded to a steel wire armoured sleeve.

Fire retardant, low halogen (20% Halogen, Blue Stripe) plastics to be used in non-ventilated areas. Fire retardant, high halogen (100% Halogen, Red Stripe) plastics may be used in ventilated areas. Fire retardant, no halogen (0% Halogen, White Stripe) plastics not required to be used.

8.3.4.2 Electrical Control cabling running between the Equipment located in the field, Control System Marshalling Cabinets, LV Panels and Incomer Breaker panels will comprise of steel wire armoured, PVC Insulated, multi-core cable, as follows :

Conductors.

Core Size : 7 core – 1.5 mm2 (Valve Actuators)
12 core – 1.5 mm2, 19 core – 1.5 mm2 (Switchgear)
Stranded untinned copper, 7 strands minimum
PVC Insulated, Insulation Breakdown Voltage to withstand 2 kV 50Hz RMS for a 1 min
Insulation Colours : 7 core and less – colored BL-YE/WT-RD-GR-BK-BR-PR/OR (Not numbered)
12 core and more – black, conductors to be numbered
Lay Twist to be 40 – 60 mm (i.e. 16-25 twist per metre)

Inner Jacket

Extruded fire retardant black PVC with ripcord for jacket removal.
Minimum thickness 1.2mm up to 7 core, 1.5mm for 12 and 19 core

Outer Jacket

Overall weatherproof thermoplastic PVC jacket – fire retardant and UV resistant.
Jacket thickness 1.5mm up to 7 core, 2.0mm for 12 and 19 core
Jacket to be totally bonded to a steel wire armoured sleeve.

Fire retardant, low halogen (20% Halogen, Blue Stripe) plastics to be used in non-ventilated areas. Fire retardant, high halogen (100% Halogen, Red Stripe) plastics may be used in ventilated areas. Fire retardant, no halogen (0% Halogen, White Stripe) plastics are not required to be used.

8.4 Additional Requirements for Ex ia/ib Installations

8.4.1 All I.S. (Ex ia/ib Intrinsically Safe) Installations shall be in strict compliance with IEC 79-14 Electrical Installations in Hazardous Areas, and in particular Chp 12 "Additional Requirements for type protection Instrinsic Safety", inclusive of the under mentioned items.

8.4.2 **Clause 12.2.**
In installations with Zone 1 and 2 classifications, IS apparatus and the intrinsically safe parts of associated apparatus shall comply to at least category "ib". Note that Transnet Pipelines has standardised on category "ia" protection, and permission will need to be sought in writing for relaxation to "ib".

8.4.3 **Cables - General**
Where multi stranded cables are used in a hazardous area, the ends of the conductor shall be protected against separation of individual strands, by means of cable lugs.

Where cable screens are required, these shall be connected to earth at one point only, normally in the non-hazardous area. (Refer to Transnet Pipelines Specification PL727 Section 8.1.3.6 and 8.1.3.7).

Cable armouring shall normally be bonded to the equi-potential bonding system via the cable entry devices (glands), at the end of each cable run. Where interposing Junction Boxes exist or other apparatus, the armouring shall be similarly bonded to the equi-potential bonding system at these points. In this regard and where earthing rings are

provided as an integral part of the gland, use of these is recommended in serving this function. Contact between the gland and the gland plate shall not be considered as sufficient for bonding purposes.

Conductors of intrinsically safe circuits and non-intrinsically safe circuits shall not be carried in the same cable.

Conductors of intrinsically safe circuits and non-intrinsically safe circuits in the same bundle or duct shall be separated by an intermediate layer of insulated material or by an earthed metal partition. No segregation is required if metal sheaths or screens are used for intrinsically safe or non-intrinsically safe circuits. Note that Transnet Pipelines has standardised on physical separation regardless of whether the cabling is screened or not, and permission will need to be sought in writing for relaxation.

8.4.4 **Cables - Marking**

Un-armoured Cables containing intrinsically safe circuits shall be marked. If outer sheaths are marked by color, the color used shall be light blue. Note that whilst armoured cabling is not required to be marked in terms of IEC79-14, Transnet Pipelines has standardised on the principle of marking all cable outer sheaths carrying intrinsically safe circuits by color (light blue), whether armoured or not, and that this will need to be complied with in all instances.

8.4.5 **Cable Insulation Tests**

All cables carrying intrinsically safe circuits shall be proven to be capable of withstanding an RMS AC test voltage of twice the normal voltage of the intrinsically safe circuit with a minimum of 500 V between the armouring and screens joined together and the individual conductors. Tests shall be conducted in accordance with manufacturers specifications. Where no such method is available, tests shall be carried out as follows:

- Voltage shall be an ac voltage of sinusoidal waveform at a frequency of between 48 and 62 Hertz
- Voltage shall be derived from a transformer of at least 500 VA output
- Voltage shall be increased steadily to the specified value in a period of not less than 10 seconds and maintained for a period of not less than 60 seconds.

8.4.6 **Cable Termination**

All terminals shall be reliably separated from non-intrinsically safe circuits (for example by a separating panel or gap of at least 50mm). Terminals of intrinsically safe circuits shall be marked as such. Transnet Pipelines has standardised on marking by color - the specified color being light blue. All terminals, plugs and sockets shall satisfy the requirements of IEC79-11 Sections 6.3.1 and 6.3.2 respectively (6mm creepage and clearance rules 4mm to earth).

8.4.7 **Zone 1 Installations - Surge Protection**

All equipment installed in Zone 0 areas and exposed to hazardous potential differences (e.g. lightning surges), shall have a surge protection device installed between each non-earth bonded conductor/core and the local earthed structure as near as is practically possible. The surge protection device shall be capable of diverting a minimum peak discharge current of 10kA (8/20 microsecond impulse according to IEC60-1, 10 operations). The bonding connection between the protection device and the structure shall have a minimum cross sectional area equivalent to 4 mm2 copper.

Note that Transnet Pipelines has extended these requirements to include all analogue transmitters installed in the field, whether in hazardous areas or not, and will need to be complied with in all instances.

8.5 Electrical & Instrument Cable Identification Standards

These standards have been based on the Transnet Pipelines Identification Standard as defined in the Document G52001 – L4017-U101 Sheets 1-4, which is largely based on the DIN 40 719 Standard. Refer to Transnet Pipelines Specification PL 101 Plant & Equipment Tag Numbering Standards.

8.5.1 DEFINITION.

All Cabling (inclusive of Instrument, Electrical Power and Control Cables) are to be tagged as follows:

A – NN XXXX YYY – nn

Where: **A** represents Cable Usage as follows: P = Power C = Control, Instrument

NN XXXX YYY represents the Functional Descriptor of the equipment to which the cable is terminated – either source or destination. (As defined in Transnet Pipelines Standard Dwg G52001-L4017-U101)

nn may be optionally used to provide additional information regarding Cable Function. (e.g. A = Analogue, D = Digital, H = Heater, ES = Emergency Stop). Where two cables of the same functionality are terminated to the same device/equipment, then this identifier may be used in the form of a unique cable number in order to uniquely identify the cables.

8.5.2 RULES OF ASSIGNMENT

8.5.2.1 Cable Usage will be indicated on all cables by utilising the Cable Usage Identifier (P for power and C for Control and Instrument cabling).

8.5.2.2 Cables will be identified using the Functional Descriptor of the device/equipment to which the cable has been terminated. Either source or destination device Functional Descriptors may be used; selection shall be based on the Descriptor that will convey the most information about the cable.

Examples:
In the case of a power cable feeding an auxiliary pump from a LV Panel, the Functional Descriptor of the auxiliary pump shall be used
In the case of a power cable feeding lights and plugs from a DB Board, the Functional Descriptor of the DB Board Feeder shall be used

8.5.2.3 An additional Identifier may be allocated to the Cable Tag to indicate additional information regarding Cable Function. **Note that use of this Identifier is optional and is normally used in the following circumstances:**

Instrument Multi-cores to indicate Signal Type : A = Analogue, D = Digital
Electrical cables to indicate Function : ES = Emerg Stop, H = Heater Supply

8.5.3 EXAMPLES / INTERPRETATION

8.5.3.1 INSTRUMENT CABLES

Instrument cables may be divided into two types, namely individual Instrument cabling running from the instrument itself to a Junction Box, and Instrument Multi-core cabling running from the Junction Box to the Marshalling Cabinet located in the Control Room.

In the case of individual Instrument cables, the Functional Identifier used in the Cable Tag always relates to the Instrument to which the cable has been terminated. In the case of Instrument Multi-core Cables, the Functional Identifier used in the Cable Tag always relates to the Junction Box to which the cable has been terminated.

(Examples listed below describe cables located at the Coalbrook Pump Station - hence use of the Pump Station Identifier No. 17).

C – 17JB01 – A	Instrument Multi-core Cable carrying analog signals and running from the Field Junction Box 17JB01 to the PLC Panel 17PLCnn
C – 17JB01 – A/D	Instrument Multi-core Cable carrying both digital and analog signals and running from the Field Junction Box 17JB01 to the PLC Panel 17PLCnn
C – 17TT011	Instrument Cable running from the Instrument TT011 to Junction Box 17JBnn in the field
C – 17VE011	Instrument Cable running from the Vibration Sensor VE011 to Junction Box 17JBnn in the field

8.5.3.2 VALVE ACTUATOR CABLES

Valve Actuator cables may be divided into two types, namely actuator power cabling running from the actuator to the Valve Distribution Panel, and actuator control cabling running from the Junction Box to the PLC Marshalling Cabinet located in the Control Room.

In the case of both actuator power and control cabling, the Functional Identifier used in the Cable Tag always relates to the actuator to which the cable has been terminated.

(Examples listed below describe cables located at the Coalbrook Pump Station - hence use of the Pump Station Identifier No. 17).

P - 17XVR1A	Supply to Valve Actuator R1A, fed from Valve Distribution Panel 17LVnn.
C – 17XVR1A – D	Cable running from Valve Actuator R1A to PLC Panel 17PLCnn in Control Room, carrying digital signals.
C – 17CVP0J – A	Cable running from Valve Actuator P0J to PLC Panel 17PLCnn in Control Room, carrying analogue signals

8.5.3.3 INCOMER BREAKER/ TRANSFORMER / MOTOR STARTER CABLES

Incomer Breaker/ Transformer/ Motor Starter cables may be divided into two types; namely power cabling (e.g. running from the motor to the Starter Panel) and control cabling (e.g. running from E/Stops located in the field to the Starter Panel or running from the Starter Panel to the PLC Marshalling Cabinet located in the Control Room).

In cases where the cable runs directly to the device (or field mounted local operator panels mounted alongside the device e.g. E/Stop pushbutton station), the Functional Identifier used in the Cable Tag always relates to the device to which the cable is terminated. In cases where the cable runs between two Starter/Incomer Panels, the Functional Identifier used in the Cable Tag usually relates to the destination Starter Panel.

(Examples listed below describe cables located at the Coalbrook Pump Station - hence use of the Pump Station Identifier No. 17).

C – 17MVF11	Control cable carrying electrical signals and running to the rear of the Incomer Panel 17MVF11 (associated with Incomer OCB F11)
C – 17MVF11-1	One of two control cables carrying electrical signals and running to the rear of the Incomer Panel 17MVF11 (associated with Incomer OCB F11)
C – 17A1	Control cable running from Aux Transformer A1 to Incomer Panel 17MV nn. **Note:** The cable carries both PLC feedback signals and electrical tripping signals – if the cable carried only digital PLC Feedback signals, the cable would be tagged C-17A1-D.
C – 17MVF11 - ES1	Control Cable running to Incomer Panel 17MVF11 (associated with OCB F11) from Station E/Stop Breakglass No. 1. located in the field.
C – 17MVF11 - ES2	Control Cable running to Incomer Panel 17MVF11 (associated with OCB F11) from Station E/Stop Breakglass No. 2. located in the field.
P – 17LV21-1	Supply to Constant Voltage Transformer from LV Panel 17LV21
P – 17LV21-2	Supply from Constant Voltage Transformer to LV Panel 17LV21
P - 17X01	Supply to Auxiliary Pump X01, sourced from LV Panel 17LV nn.
C - 17X01 - ES	E/Stop associated with Aux Pump X01 and wired to the Starter LVX01 located in LV Panel 17LVnn.
P - 17P01 - H	Heater Supply for Motor P01, sourced from LV Panel 17LV nn.
P – 17MV01 - H	Heater Supply for Incomer Panel 17 MV01 sourced from LV Panel 17LVnn.
C – 17MVP01 - H	Control Cable running between Motor Starter Panel 17MVP01 and LV Panel 17LVnn – used to control the switching of the Heater Supply based on P01 Starter status.
P – 17 E06	Supply cable running from Standby Generator E06 to LV Panel 17LVnn.
C – 17GEN01 – D	Cable running from the Standby Generator Control Panel 17GEN01 to the LV Panel – ET200 PLC, carrying PLC digital feedback signals associated with the Standby Generator.

8.5.3.4 **POWER DISTRIBUTION CABLES**

Power Distribution Rail identification.
Where multiple Power Distribution Rails are located within panels (e.g. MV, LV, PLC Panels), these are uniquely identified by use of a Distribution Rail Identifier appended to the Panel Identifier, as follows:

NN XXXXYYY B nnn

Where NN XXXXYYY represents the Panel Identifier (As defined in Transnet Pipelines Standard Dwg G52001-L4017-U101)

G nn:	24 VDC	
J nnn:	220 VAC	where nnn is a unique number used to identify
E nnn:	380 VAC	the different power rails within the same panel

Primary Distribution Rail Identification numbers are numbered consecutively from 1 – 99, with sub distribution feeders related to the primary feeder by the addition of a suffix (comprising of a unique consecutive number), in this way identifying the primary feed.

For example, a 24 VDC Distribution Rail located in LV Panel 17ETL01 will have a Distribution Rail ID of 17ETL01.G50. The Distribution Rail in 17ETM01 will have an ID of 17ETM01.G501, thus identifying it as a sub feed of rail G50.

Power Distribution Circuit Breaker identification.
Power Distribution Circuit Breakers are uniquely identified by use of a Distribution Circuit Breaker Identifier appended to the Panel Identifier, as follows:

NN XXXXYYY Q nnn

Where NN XXXXYYY represents the Panel Identifier (As defined in Transnet Pipelines Standard Dwg G52001-L4017-U101)

Q nnn:	where nnn is a unique number used to identify the different circuit breakers within the same panel

Primary Circuit Breaker Identification numbers are numbered consecutively from 1 – 99, with sub distribution feeders related to the primary feeder by the addition of a suffix (comprising of a unique consecutive number), in this way identifying the primary feed. For example, if the incomer MCB for a DB Board is labelled Q01, then all MCB's fed from Q01 will be labelled Q10, Q11, Q12 etc. If a MCB is labelled Q21, then all MCB's fed from Q21 will be labelled Q210, Q211, Q212 etc.

Note that MCB's fed from normal supply will be labelled consecutively from Q01 onwards, whereas MCB's fed from Emergency Supply will be labelled consecutively from Q60 onwards.

Where multiple distribution rails exist within a panel, the Distribution Circuit Breaker Identifier will include the Distribution Rail Identifier as a prefix i.e. B nnn.Q nnn.

For example, MCB Q20 fed from DB Board 17DB10, will have an Identifier of 17DB10 .Q20; MCB Q55 fed from LV Panel 17ETL01 Distribution Rail G50, will have an Identifier of 17ETL01.G50-Q55.

Power Distribution Cable identification.

Distribution Feeder Cable Identifiers comprise of two components; namely, the Panel Identifier from which they are fed, and the unique Circuit Breaker ID number allocated to each Feeder.

NN XXXXYYY Qnnn

Where NN XXXXYYY represents the Panel Identifier (As defined in Transnet Pipelines Standard Dwg G52001-L4017-U101)

Qnnn represents the Protection/Circuit Breaker Identifier, numbered from 1 – 999.

(Examples listed below describe cables located at the Coalbrook Pump Station - hence use of the Pump Station Identifier No. 17).

P–17DB01	Cable Tag for a power cable fed from LV Panel 17LVnn and used to feed 380/400 V AC mains to 17DB01. **(Feeder Cable)**
P–17DB01.Q10	Cable Tag for a power distribution cable fed from DB Board 17DB01 MCB Q10. **(Distribution Cable)**
P–17LV31.Q60	Cable Tag for a power distribution cable fed from DB Board 17LV31 (UPS Distribution) MCB Q60 feeding for example PLC Panel 17PLC01. **(Distribution Cable)**
P–17PLC01.J20-Q20	Cable Tag for a power cable fed from PLC Panel 17PLC01, 220 VAC Distribution Rail J20, MCB Q20
P–17PLC01.G55-Q50	Cable Tag for a power cable fed from PLC Panel 17PLC01, 24 VDC Distribution Rail G55, MCB Q50
P–17ETL01.G55-Q50	Cable Tag for a power cable fed from ET Panel 17ETL01, 24 VDC Distribution Rail G55, MCB Q50
P – 17BATT01.Q80	Battery Supply Distribution to field, fed from Battery Charger Panel 17BATT01 MCB Q80 (eg. 110V DC Supply to 3.3 kV Starter Panel).

8.6 Cable Core Identification Standards (Core Identing)

8.6.1 ELECTRICAL CONTROL CIRCUIT WIRING

8.6.1.1 Core Ident Standards as detailed below are required to be adhered to with regards to identification of **control wiring** used in electrical circuits in HV, MV and LV Electrical Panels.

8.6.1.2 All conductors shall be identified by means of a core identification number, in conformity with the approved circuit and connection diagrams. All core ident numbers shall be unique and shall be placed on either end of the conductor. Core Ident numbers shall comprise of solid heavy-duty interlocking ferrules bearing clear permanent engraved black characters on white background. Crutchley core ident markers shall be utilized.

8.6.1.3 All circuit diagrams shall clearly identify all termination/connection points with the appropriate terminal identification numbers.

8.6.1.4 Core Ident numbers shall comply with the following specification:

Y XXX (T)

where

Y--- (T) represents an alphanumeric character to indicate signal type

- "M" denotes AC feed to primary of Voltage Transformer (Primary Supply)
- "H" denotes AC feed (un-rectified) from secondary of Voltage Transformer
- "J" denotes DC feed (rectified) from secondary of Voltage Transformer
- "C" denotes phase wiring from Current Transformers
- "E" denotes phase wiring to panel mounted voltmeters
- "D" denotes phase wiring to panel mounted ammeters
- "S" denotes wiring from Current Transducers (4-20 mA)
- "K" denotes control wiring fed from a DC Control Voltage Supply (e.g 50 VDC, 110 VDC)
- "Kxxx(T)" denotes control wiring with trip functionality. Note that the "T" marker shall comply with white on red background coloring.
- " " denotes control wiring fed from an AC Control Voltage Supply (e.g. 220 VAC)
- "X" denotes status feedback wiring to Control Systems (usually voltage free contacts)
- "U" denotes unused/spare auxiliary contact wiring (usually voltage free contacts)

XXX represents a unique numeric identifier, up to a maximum of three digits

Examples:

K1(T)	Tripping circuit fed from DC Control Voltage Supply (50 VDC/110 VDC)
K10	Control Circuit fed from DC Control Voltage Supply (50 VDC/110 VDC)
501	Control Circuit fed from AC Control Voltage Supply (220 VAC)
U101	Auxillary Switch circuit
X101	Status Feedback to Control System (e.g PLC)
E10, E20, E30	Three phase wiring fed to panel mounted Voltmeter

8.6.2 POWER DISTRIBUTION WIRING

8.6.2.1 Core Ident Standards as detailed below are required to be adhered to with regards to identification of power distribution wiring as follows:

- Power Distribution in PLC and Equipment Panels (24 VDC, 220 VAC)
- Power Distribution in ET200 Panels (24 VDC, 220 VAC). Note this includes ET200 PLC Interface Cubicles located in HV, MV and LV Panels.

8.6.2.2 All Distribution Feeder Wiring shall be core idented using the Functional Descriptor of the feeder/circuit breaker to which the cable has been terminated, as well as the terminal into which the core has been terminated.

AAA . Bnnn - Qnnn - xx

Where - AAA represents Power Type and Distribution Feeder (where applicable) as follows:

0V	: 0V
24V	: 24V positive
110V	: 110V positive
220V	: 220V live
N	: 220V neutral

- Bnnn represents the Distribution Rail ID where assigned (only assigned in panels with multiple power distribution rails)

- Qnnn represents the Protection/Circuit Breaker Identifier

- xx represents the terminal into which the core is terminated

(Refer to PL 727 Section 8.5.3.4 for details on the derivation of Distribution Feeder Functional Identifiers).

Examples:

24V.G55 - Q20 – 10	Core Ident for wiring feeding 24 VDC from Distribution Rail G55 MCB Q20 and terminated into terminal 10.
0V.G55 - 30 – 2-A1	Core Ident for wiring feeding 0 VDC from Distr Rail G55 (associated with MCB Q30) and terminated into terminal 2-A1 (Relay A1)
220V.J20 - Q15 – 5	Core Ident for wiring feeding 220 VAC Live from Distribution Rail J20 MCB Q15 and terminated into equipment terminal 5
N.J20 - 30 – 6	Core Ident for wiring feeding 220 VAC Neutral from Neutral Rail J20 (associated with MCB Q30) and terminated into equipment terminal 6
220V.Q15 – 5	Core Ident for wiring feeding 220 VAC Live from MCB Q15 and terminated into equipment terminal 5 (Distribution Rail Identifier is not required where multiple distribution rails are not in existence)
N. 30 – 6	Core Ident for wiring feeding 220 VAC Neutral from Neutral Rail (associated with MCB Q30) and terminated into equipment terminal 6 (Distribution Rail Identifier is not required where multiple distribution rails are not in existence)

8.6.2.3 Core Ident numbers will be approximately 10 characters in length and will comprise of Grafoplast printed (black lettering on white background) core ident markers. Identification characters will be sized to correspond to the overall diameter of the individual cores, i.e. ID tag sheaths will be sized and provided with a good fit (not loose) over the core ends. Identification tags will be so located as to leave cable core/pair lettering/numbering visible and shall be placed on both ends of the conductor. A sheath length of 30mm has been standardised upon by Transnet Pipelines.

8.6.3 INSTRUMENTATION AND EQUIPMENT PLC INTERFACE WIRING.

8.6.3.1 Core Ident Standards as detailed below are required to be adhered to with regards to identification of all Instrumentation and Equipment PLC Interface wiring (derived from electrical circuits in HV, MV and LV Electrical Panels).

8.6.3.2 Core Ident Standards have been detailed in the following Typical Loop Diagrams attached to this Specification:

- Typical Loop Diagram – Instrumentation 727-005/InstrLoop Rev 0.1
- Typical Loop Diagram – Actuated Valves 727-006/VlvLoop Rev 0.1

8.6.3.3 All individual instrument and control cable cores (including spares) will be marked with an identification number at both ends. Identification numbers will be approximately 10 characters in length and will comprise of printed (black lettering on white background) Grafoplast Ident Markers. A sheath length of 30mm has been standardised upon by Transnet Pipelines.

8.6.3.4 Identification characters will be sized to correspond to the overall diameter of the individual cores, i.e. ID tag sheaths will be sized and provided with a good fit (not loose) over the core ends.

8.6.3.5 Identification tags will be so located as to leave cable core/pair lettering/numbering visible.

9. COMMUNICATION INFRASTRUCTURE IDENTIFICATION STANDARDS

This specification details standards and codes of practice to be adhered to in the identification of Communication Equipment and associated communication cabling Infrastructure. These standards should be adhered to on all Transnet Pipelines Sites.

Diagrammatic Examples of the under mentioned detail may be found in Appendix B of this document.

9.1 Communication Equipment Identification Standards

All Communications Equipment will be identified using the following Functional Descriptors:

=XX YYY nn

Where - XX represents the Station Identifier
- YYY represents the Equipment Type (refer below for details)
- nn is a unique consecutive number

For example: A Comms Panel located at PS1, will have an identifier of =51 COM 01

EQUIPMENT TYPE: (YYY)

Communications Panel = COM

Terminal Bus Scalance Units = SJT
System Bus A Scalance Units = SJA
System Bus B Scalance Units = SJB
CAS Network Scalance Units = SJC
ST7 Network Scalance Units = SJS
Electrical Network Scalance Units = SJE

Cisco Network Routers =	SJR
OTN Network Routers =	SJO
Patch Panels =	X
HUB / Switch =	HB

Sever Panel = SVR

PCS7 Server A =	SVRA
PCS7 Server B =	SVRB
PCS7 Client (Operational) =	OSC
Replay Server =	RPY
Engineering Server =	ENG
KVM Switch =	KVM

OLM FO Convertors: - A xyz e.g. -A 21A

Where A = component designation
x = PLC No
y = OLM Set No
z = channel (A or B)

9.2 Communication Cable Identification

9.2.1 PLC Network Cabling

Cable Ident to be placed on either side of the cable as follows:

Equip A - In/Out e.g. PLC01A-IN, ET21A-OUT

Where Equip = Equipment designation PLCnr, ETnr, Hxy
A = channel (A or B)
In/Out = function (IN or OUT).

9.2.2 Comms Network Cabling

Cable Ident to be placed on either side of the cable as follows:

EquipSource - EquipDest - Channel e.g. OMS-HB1-10

Where EquipSource = Source equipment (eg. SUN, OMS, MUX, PTR)
EquipDest = Destination Equip (eg. HB1)
Channel = Channel No.

10. FIBRE OPTIC INFRASTRUCTURE IDENTIFICATION STANDARDS

This specification details standards and codes of practice to be adhered to in the identification of Fibre Optic Cabling Infrastructure, including cable, manhole and splice identifications. These standards should be adhered to on all Transnet Pipelines Sites.

Diagrammatic Examples of the under mentioned detail may be found in Appendix B of this document.

10.1 Splicing Manhole Identification

10.1.1 Label Text

Format = NL-SSS-DDD-XXY

Where:

N = Network (i.e. E for the enterprise network – 48 fibre 655.D or P for the process control network – 24 fibre 652.D)
L = Network link number (i.e. 1=Primary link, 2=Secondary link, etc)
SSS = Source end of network link per Transnet Pipelines standard abbreviations (see below)
DDD = Destination end of network link per Transnet Pipelines standard abbreviations (see below)
XX = Sequential number starting from 01 at source end
Y = Suffix to permit additional unplanned splices if required - Sequential letter starting from A

The source and destination are aligned with the dominant direction of product flow in the pipeline.

Examples of the above are:

P1-KDL-WAO-01 = 1st Process Control Network Primary Link splicing manhole along the Kendal-Waltloo route
P1-KDL-WAO-03 = 3rd Process Control Network Primary Link splicing manhole along the Kendal-Waltloo route
P1-KDL-WAO-24A = 1st unplanned splice between splice 23 and splice 24

10.1.2 Splicing Manhole Label Text

50mm high text etched in black stenciled on the manhole cover

10.2 Cable Ident Identification

Grafoplast Targa Metal TGT System (Carrier Rail length: 106mm for 15 characters) 316 Stainless Steel Markers, with punched text 6 mm height minimum, fastened onto the cable at both ends via means of Stainless Steel cable ties or
Laser engraved 316 Stainless Steel Markers, of length 90mm, height 10mm and text height 6mm. Note that the marker should have slots cut at the ends for attaching cable ties.

Tags shall be fastened onto the cable at both ends via means of Stainless Steel cable ties. Cable Tags are attached to the cable outside of the express joint or ODF cabinet and within 150mm of the entry point to the cabinet or express joint housing.

10.2.1 Cable Ident Text

Format = NL-SSS-DDD-XXYZ

Where:

N = Network (i.e. E for the enterprise network – 48 fibre 655.D or P for the process control network – 24 fibre 652.D)

L = Network link number (i.e. 1=Primary link, 2=Secondary link, etc)
SSS = Source end of network link per Transnet Pipelines standard abbreviations (see below)
DDD = Destination end of network link per Transnet Pipelines standard abbreviations (see below)
XX = Sequential cable number starting from 01 at source end
Y = Suffix to permit additional unplanned splices if required - Sequential letter starting from A (i.e. 24A for a unplanned splice between splice 23 and splice 24)
Z = Suffix X is added for numbering express joint cables (i.e. cable leaving/returning to the main cable)

The express joint cable to the MOBV ODF carries the number of the cable it is spliced to but with an X suffix (e.g. P1-KDL-WAO-03X)

The express joint cable from the MOBV ODF carries the number of the cable it is spliced to but with an X suffix (e.g. P1-KDL-WAO-04X)

A cable runs from a termination or splice point to the next splice or termination point, i.e. if a 4km cable is spliced at any point along its length, the cable sections either side of the splice are numbered as separate cables.

Examples of the above are:
P1-KDL-WAO-01 = 1st Process Control Network Primary Link cable along the Kendal-Waltloo route (i.e. running between the ODF at Kendal and the first splice point outside Kendal)
P1-KDL-WAO-03 = 3rd Process Control Network Primary Link cable along the Kendal-Waltloo route (i.e. running between the 2nd and 3rd splice point manholes)
P1-KDL-WAO-34X = Process Control Network Primary Link express joint cable running from express joint P1-KDL-WAO-34 (spliced to cable P1-KDL-WAO-34) to a motorised block valve along the Kendal-Waltloo route
P1-KDL-WAO-35X = Process Control Network Primary Link express joint cable running to express joint P1-KDL-WAO-34 (spliced to cable P1-KDL-WAO-35) from a motorised block valve along the Kendal-Waltloo route

10.3 Express / Splice Joint Identification

Grafoplast Targa Metal TGT System (Carrier Rail length: 106mm for 15 characters) 316 Stainless Steel Markers, with punched text 6 mm height minimum or
Laser engraved 316 Stainless Steel Markers, of length 90mm, height 10mm and text height 6mm. Note that the marker should have slots cut at the ends for attaching cable ties.

Cable Tags are fastened onto the express joint housing via means of Stainless Steel cable ties.

10.3.1 Express / Splice Joint Text

Format = NL-SSS-DDD-XXY

Where:
N = Network (i.e. E for the enterprise network – 48 fibre 655.D or P for the process control network – 24 fibre 652.D)
L = Network link number (i.e. 1=Primary link, 2=Secondary link, etc)
SSS = Source end of network link per Transnet Pipelines standard abbreviations (see below)

DDD = Destination end of network link per Transnet Pipelines standard abbreviations (see below)
XX = Cable number feeding the express joint
Y = Suffix X is added for numbering express joint cables (i.e. cable leaving/returning to the main cable)

11. EARTHING CODES OF PRACTICE

This specification details standards and codes of practice to be adhered to in the supply, installation and termination of earthing systems on all Transnet Pipelines Sites.

11.1 National Standards

11.1.1 The requirements of the materials, design, layout, fabrication, assembly, erection, examination, inspection and testing of an earthing system on site shall be in accordance with the relevant sections of codes: -

• SABS 089 Part 2	1965	Electrical Code for Petroleum Industry
• SABS 0121	1977	Cathodic Protection of Buried and Submerged Structures
• SABS 0123	1976	The Control of Undesirable Static Electricity
• SABS 0198 Part 12	1988	Installation of Earthing System
• SABS 0199	1985	The Design and Installation of and Earth Electrode
• SABS 0200	1985	Neutral Earthing in Medium Voltage Industrial Power Systems
• SABS 0292	1999	Earthing of Low Voltage (LV) distribution systems
• SABS 0313	1999	Protection of Structures against Lightning
• SABS 1063	1998	Earth Rods and Couplers
• SABS IEC 61000-5-2	1997	Electromagnetic Compatibility (EMC) Part 5: Installation and mitigation guidelines Section 2: Earthing and Cabling
• SABS IEC TS 61312-2	1999	Protection against Lightning Electromagnetic Impulse (LEMP) Part 2: Shielding of structures, bonding inside structures and earthing
• SABS IEC 61024-1	1990	Protection of Structures against Lightning Part 1: General principles
• SABS IEC 61024-1-1	1993	Protection of Structures against Lightning Part 1: General principles

		Section 1: Guide A – Selection of protection levels for lightning protection systems
• SABS IEC 61024-1-2	1998	Protection of Structures against Lightning Part 1-2: General Principles Guide B – Design, Installation, maintenance and inspection of lightning protection systems
• SABS IEC 61312-1	1995	Protection against Lightning Electromagnetic Impulse Part 1: General principles
• SABS IEC 61312-4	1998	Protection against Lightning Electromagnetic Impulse Part 4: Protection of Equipment in existing structures
• SABS IEC 61643-1	1998	Surge Protective Devices Connected to Low Voltage Power Distribution Systems Part 1: Performance requirements and testing methods
• SABS IEC TS 61312-2	1999	Protection against Lightning Electromagnetic Impulse (LEMP) Part 2: Shielding of structures, bonding inside structures and earthing

11.1.2 Statutory Requirements

a) The Contractor shall ensure that the installation satisfies the requirements of all relevant South African Statutory Regulations

b) Where applicable, equipment items shall carry the SABS mark to demonstrate compliance with the regulations.

11.1.3 The requirements of the materials, design, layout, fabrication, assembly and erection shall, where relevant, be in accordance with the following approved Installation Typicals forming part of this Specification: -

Instrument Earthing Schematic	727/004/Instr_Earth
Earthing Concept Drawing	727/008/Earth_Concept

11.2 Technical Requirements

11.2.1 General

a) A common integrated station earthing system shall be provided for electronic and electrical systems equipment, static and lightning protection in accordance with the requirements of this document.

b) A soil resistively survey shall be carried out by a specialist earthing consultant/contractor. The consultant/contractor shall prepare a detailed report on the conditions identified and provide the survey data recordings together with proposals, for a basis of the earthing system design.

c) Major electrical equipment such as switchgear, transformers, lighting boards, floodlight towers on poles, control panels etc. and associated metallic support

frameworks, shall be connected to the station safety earth via Electrical Earth bars located nearby.

Use of embedded conductors within a power cable (spare core earth) may be utilised as the primary equipotential bonding system provided the following conditions are met: (SABS 086-1:2001)

- The embedded conductor has a cross-sectional area equal to those of the live and neutral conductors or equal to the values in Table 1 of SABS 0142)

In addition, a second visual earth connection shall be provided to each item of electrical equipment, to prevent the potential to earth of such equipment rising above spark potential. (SABS 089-2:2000)

d) The neutrals of generators and transformers shall be connected to the main earth grid either directly or via an earthing resistor, as required. Where neutrals of transformers are connected directly to earth, this shall be done via means of connections to both an individual earth rod located nearby as well as to the station earth mat by means of Electrical Earth bar located within the Switchgear Room.

e) Frames of motors shall be connected to the earthing system in accordance with the following table:

Motors kW Rating	Minimum Earth Conductor Size
Up to 30	16 mm^2
37 – 132	50 mm^2
150 – 175	70mm^2

Note:
In order to minimize the number of different sizes of earth conductor, the above three sizes only shall be used throughout, unless specifically stated otherwise.

f) Cables supplying lighting fixtures shall be 3 core for single-phase supplies and 5 core for 3 phase supplies, of which one core shall be used as the earth conductor.

g) Plant Infrastructure such as manifold piping, tanks and metallic support frameworks, shall be connected to the station safety earth, either directly or by means of Electrical earth bars located nearby.

h) Flanged joints in metallic pipelines shall be considered inherently continuous provided the surfaces of one of the bolts are cleaned and identified for earthing. Flanges of metallic pipelines that have insulated linings for purposes other than cathodic protection shall be bonded to ensure electrical continuity.

Pipelines shall only be connected to the earthing system where they enter and leave the battery limits.

i) Storage tanks that are not cathodically protected shall be earthed through at least two separate connections to the tank. Tanks shall be earthed in accordance with the relevant SABS code.

Electrically continuous structural steel columns may be used as down conductors by means of which elevated tanks, vessels, etc. shall be deemed to be connected to the earthing system.

All tank covers, gauge floats and stirrers etc. as well as all pipes entering the tanks shall be earthed.

The steel roof shall be in a direct electrical contact with, or bonded to the tank shell.

Earthed grids, gauges, gratings and the like placed in or across the inlets of tanks are not to be used as a means of static discharge. Individual bonding shall be made to the earthing system.

j) Cable trays and cable racks (including angle iron where used for this purpose) shall have continuous earth continuity. This shall be ensured by installing 10mm^2 earth straps across the racking fishplates (joints). Cable Trays shall be connected to the earthing system in two places - where they enter and leave the battery limits.

k) Earthing connections to all equipment and process plant shall comprise of welded earth bosses in compliance with SABS 089 Part II:1965 regulation 5.1.4K with properly provided terminations i.e. 10mm diameter earth studs. Anchor bolts shall not be used.

Earth connections to all equipment shall be effectively bolted, using crimped lugs. All cable connections shall be fitted with a “star” or serrated washer in addition to the backnut, to ensure good earth contact.

l) All earthing connections between the station earth system and respective earth bars/lightning protection systems shall where possible be made above ground, by means of bolts, crimped lugs and PVC taped.

All cable connections shall be fitted with a “star” or serrated washer in addition to the backnut, to ensure good earth contact.

Earth connection points shall be clearly labelled.

In cases where earth connection points are required to be made underground (e.g. to earth rods), inspection wells shall be provided comprising of pre-cast concrete/PVC surrounds complete with covers, to facilitate periodic inspection.

m) Earthing conductors rising through paving or other concrete work shall be run in suitable protective sleeves which shall project above finished level.

n) Earthing and bonding conductors shall be sized and installed in compliance with regulations detailed in the current SAIEE Standard Regulations for the Wiring of Premises and in SABS 03 as applicable.

o) Extendable earthing rods shall be manufactured from stainless / copper clad / galvanized steel (dependant on soil acidity and chlorides and existence of cathodic protection systems) 16mm diameter, 1200 mm long sections, and shall have molecular bond between the two metals to prevent moisture ingress. Where it is necessary to join earth rods together, a non-ferrous corrosion resistant coupling device shall be used which shall prevent the ingress of moisture into the joint.

p) Lightning and static earthing protection shall be provided for all tall steel, masonry and concrete structures, towers, vessels, tanks etc, as well as all buildings used to house sensitive electrical/electronic equipment. Lightning protection systems shall be connected both to individual earth rods as well as bonded to the station earth mat. Where possible, the mesh method (as defined in SABS 0313: 1999 Section

5.2.4) should be utilised in the protection of buildings against lightning strikes i.e. the use of masts and catenary conductors are to be avoided.

Tall steel structures such as towers or structure columns, provided they are electrical continuous, shall be considered inherently protected against lightning by their connection to the earth.

q) **The resistance of the common earthing system to the general mass of earth shall not exceed 1 Ohm.**

r) Where a separate system is installed for other than electrical equipment in remote locations, e.g. storage tanks; its resistance to the general mass of earth shall not exceed 7 Ohms. (Note: This applies only for Lightning Protection and remote valve chambers that are not connected to the Station Earth).

11.2.2 Station Safety Earth

In cases where a new Station Safety Earth Mat is required to be provided, the following specifications shall apply:

The **Earth Mat** shall consist of a completely buried, lattice network of 40x3mm, bare copper tape. All the crossover points of the lattice shall be braised or cadwelded and protected with PVC insulation tape. Buried joints or splices shall not be clamped or bolted. The earth mat shall be buried, 1000mm minimum, below finished grade.

The interconnecting conductors shall be radially interconnected to form a common earthing system, for all electrical equipment, lightning protection and static earthing in accordance with relevant SABS requirements.

If required, additional earth electrodes may be installed to achieve the specified resistance, of the common earthing system to the general mass of earth. Where earth rods are paralleled in a group to reduce the earth resistance to the permissible value, they shall be spaced apart for a distance at least equal to their buried depth length.

11.3 Switchgear Room Building and Equipment

11.3.1 A Main Safety/Electrical Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Switchgear Room. Where possible, this Earth Bar shall be designated as the Primary Test Point for the station earthing system with the following equipment directly connected:

- **Station Earth Mat**. Where possible, a minimum of four separate connections shall be taken into the Switchgear Room via separate routes from the Earth Mat, by means of 40mm x 3mm Cu Earth tape. Connection to the Main Safety Earth bar shall be made in two places by means of 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductor, to facilitate testing of the Earth System.
- **Transformers**. By means of 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductor
- **MV/LV Panels**. By means of dual 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductors
- **Generator**. By means of 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductor

- **Instrument Earth**. By means of dual 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductors
- **Manifold Earth**. By means of dual 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductors

Note that on existing sites, the earth mat has been connected to the station earthing system in multiple places (namely; the Switchgear Room, Control Room and Manifold), and thus designation of a single Primary Test point is not possible. Multiple test points have thus been defined as follows: Switchgear Room, Control Room and Manifold Mainline Pumps 1 & 4 (where possible).

11.3.2 All secondary earthing within the substation shall be attached to this station earth bar at appropriate demarcated points.

11.4 Control Room Building and Equipment

11.4.1 A secondary Safety/Electrical Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Equipment/Control Room in an easily accessible position. Where possible, this Earth Bar shall be directly connected to the Main Safety/Electrical Earth bar located in the Switchgear Room, by means of dual 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that all marshalling and equipment panels shall have an electrical earth bar, separate from an insulated instrument earth bar, installed and to which all electrical equipment earths shall be connected.

11.4.2 An Instrument Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Equipment/Control Room in an easily accessible position. Where possible, this Earth Bar shall be directly connected to the Main Safety Earth bar located in the Switchgear Room, by means of dual 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that all marshalling and equipment panels shall have an insulated instrument earth bar, separate from the electrical earth bar, installed and to which all clean/instrument earths shall be connected.

11.4.3 Instrument and Electrical Earth systems shall be clearly labelled.

11.5 Manifold Area and Equipment

11.5.1 All manifolds shall have an insulated manifold earthing system installed, comprising of the following specifications:

- 40mm x 3mm min flat copper tape, to run the entire length of the main electrical racking reticulation and supported off of insulators at distances of no more than 2m apart. Use of existing electrical racking reticulation supports shall be permitted. All joints will require to be braised. Earthing reticulation shall be installed in such a manner so as to be unobtrusive and yet accessible and shall be positioned so as to avoid obstruction to walkways and access routes.
- The Manifold Earth bar shall be connected to the main safety/electrical earth located in the Switchgear Room, by means of dual 70mm^2, 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that on existing sites, the earth mat has been connected to the earthing system in multiple places (namely; the Switchgear Room, Control Room and Manifold), and thus designation of a single Primary Test point is not possible. Secondary test points have thus been defined where possible as follows: Switchgear Room, Control Room and Manifold Mainline Pumps 1 & 4.

11.5.2 All process plant and equipment located within the manifold area shall be attached to this manifold earth bar at appropriate demarcated points, via appropriately sized insulated PVC copper cable (green/yellow colored insulation), as follows:

- All electrical equipment shall be earthed via two separate earths, namely via the power cable earth core back to the respective Starter Panel electrical earth bar, and secondly via a separate visual earth from the motor frame to the manifold earth bar. Use of cable armouring as an earth conductor is not acceptable.

- All instrument stands and field junction boxes shall be separately earthed via means of an insulated 16mm2 min PVC copper cabling.

- All process vessels (tanks, vessels and piping) and racking reticulation shall be earthed via insulated 70mm2 min PVC copper cabling in two separate places.

All earth conductors utilized shall comprise of stranded, PVC insulated copper conductors with crimped cable lugs. All connections shall be fitted with a “star” or serrated washer in addition to the backnut, to ensure good earth contact.

11.6 Earth System Identification Standards

11.6.1 Earth Bar Labels

Earth bars shall be clearly labelled according to their functionality (e.g. “EB xx” to denote an electrical earth bar, “IB xx” to denote an instrument earth bar, where xx denotes a unique consecutive number). The Functional Identifier “EB 00” shall always denote the Station Earth Mat.

In addition, earth bars designated as Test Points shall be labelled accordingly.

Labels shall comprise of the Traffolyte engraved type, and fixed by means of stainless steel screws. Finish shall comprise of black letters against a white background, with text 40mm height.

Labels shall be readable/visible after the wiring has been done.

11.6.2 Earth cable Identification

Earth cables may be divided into two types, namely primary earth cabling running from subsystem earth bars directly or indirectly to the main station earth (and used for testing purposes), and secondary earth cabling running between the subsystem earth bars and equipment or infrastructure.

Only Primary earth cabling (i.e. those used for testing purposes) is required to be identified, by means of a Functional Identifier denoting both source and destination earth bars.

Identification numbers will comprise of the following specification:

- Grafoplast Targa Metal TGT System (Carrier Rail 58mm in length) 316 Stainless Steel Markers, with punched text 6 mm height minimum, fastened onto the cable at both ends via means of Stainless Steel cable ties

Examples:

EB01 – EB00	Cable Identifier for Earth cable running between Electrical Earth bar EB01 and the Station Earth Mat
IB01 – EB00	Cable Identifier for Earth cable running between Instrument Earth bar IB01 and the Station Earth Mat

11.7 Testing

11.7.1 Earth Resistivity and Electrode Testing

It will be the Contractors responsibility to carry out all necessary earth resistivity tests on site, where applicable. Tests will be in accordance with the requirements of BS 1013 as amended.

After all earth electrodes/trench earth's have been installed, an earth megger shall be used to test the earth resistance at the earth bar or connection point to the main station earth and the results recorded. Note that all ECC connections, and any other bonding material shall be disconnected from the earth connection point whilst the earth is being tested.

Earth Continuity Testing.

Earth continuity readings shall be measured and recorded from the earth bar to each item of equipment and process plant, and shall include all piping, vessels, transformers, motors, actuators, switchgear cabinets, marshalling enclosures and instrumentation.

11.7.2 The following are the maximum acceptable earth electrode resistances:

Electrical Earth
a) Main substation - 1 ohm
b) Miniature substations and kiosks - 2 ohms
c) Highmasts - 5 ohms.

Instrument Earth
a) Instrument Earth - < 1 ohm

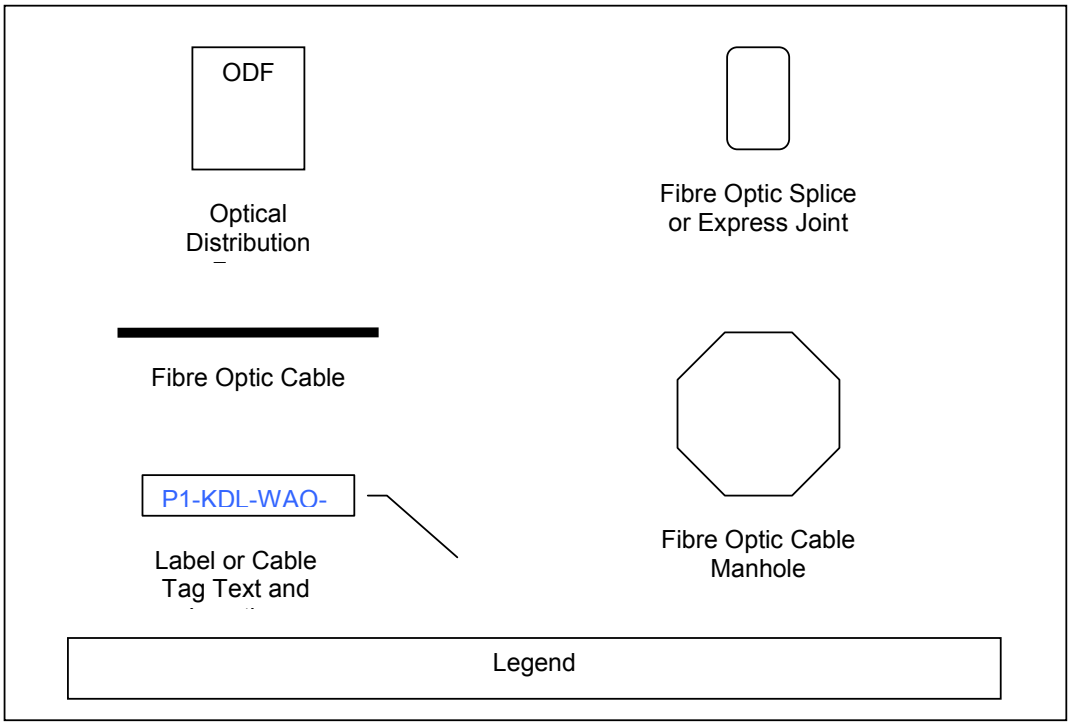
---------- End of Document ----------

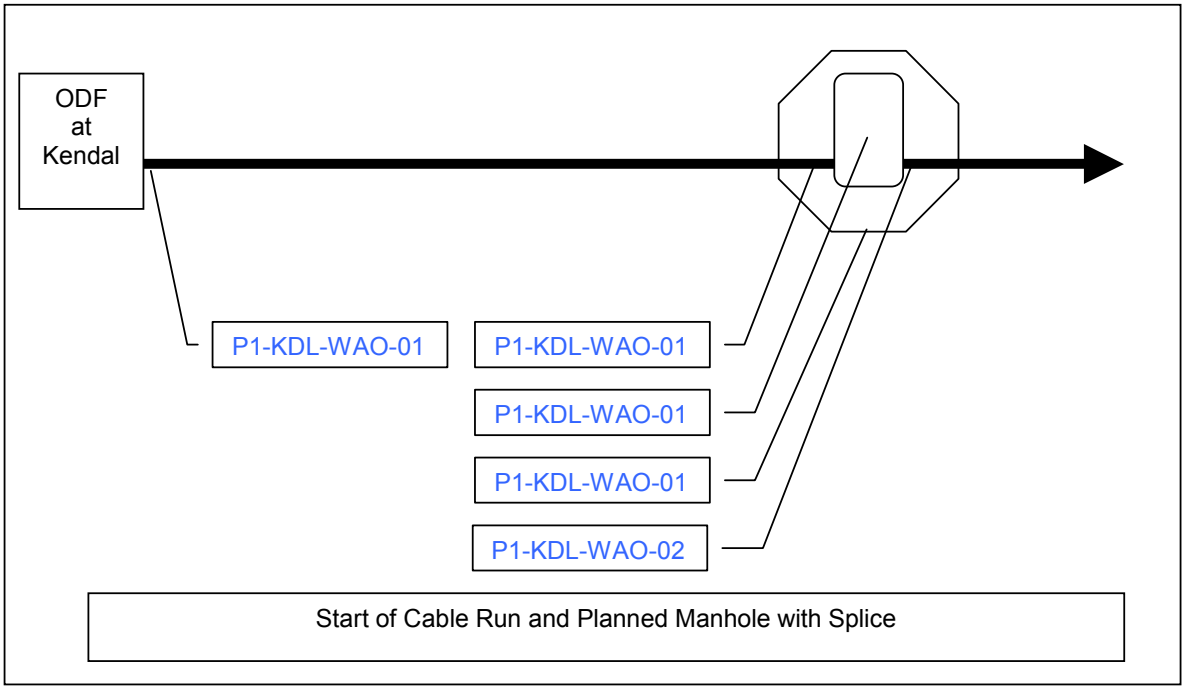
APPENDICES

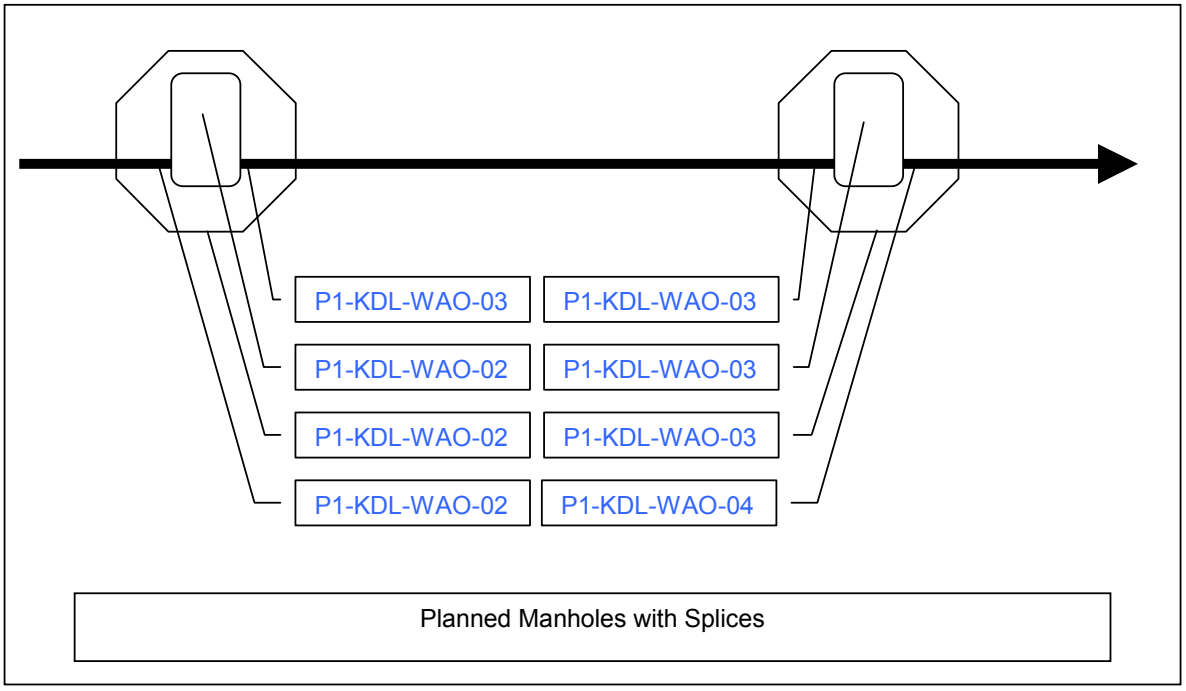
A1. Drawings.

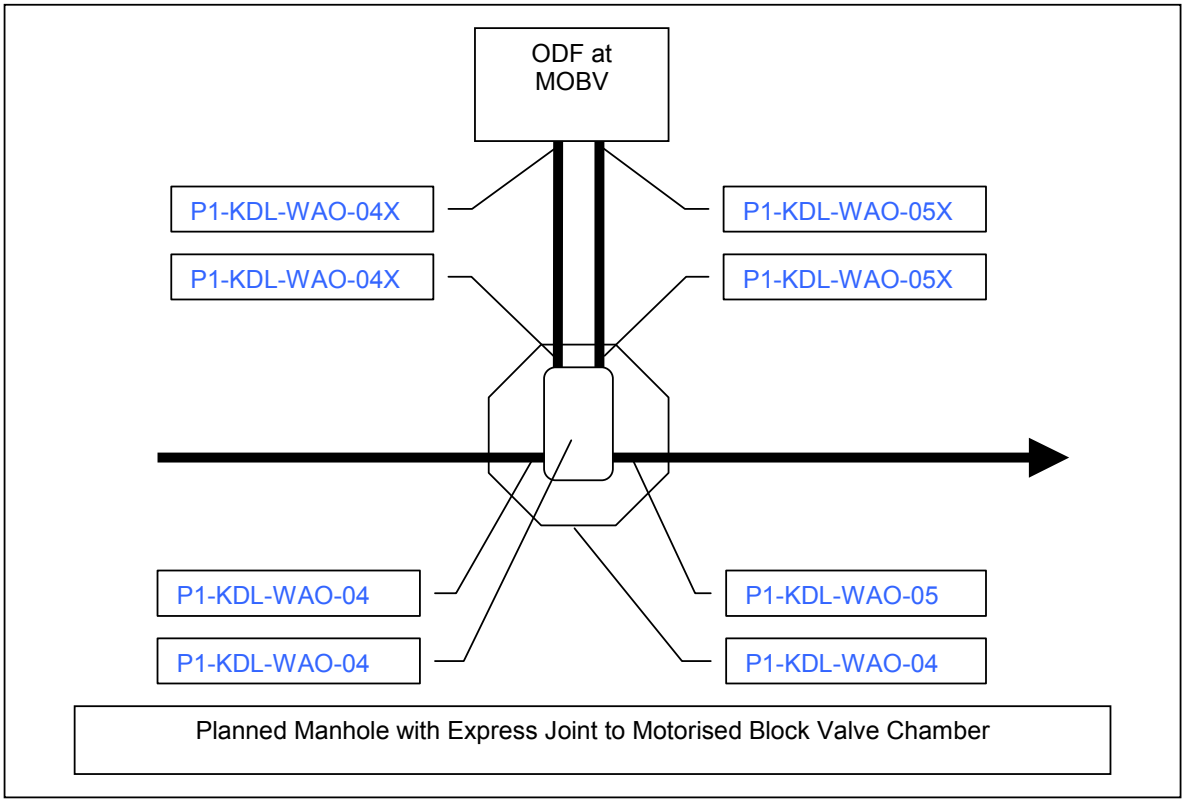
Cable Marker Specification	727/001/cblmrk
Typical for Instrument Stands - double	727/002/Instand
Typical for Instrument Stands - single	727/003/Instand
Instrument Earthing Schematic	727/004/Earth_Instr
Typical Instrument Loop Drawing	727/005/InstrLoop
Typical Valve Loop Drawing	727/006/VlvLoop
Typical for Angle Iron Droppers	727/007/Rack_Droppers
Earthing Concept Drawing	727/008/Earth_Concept
Typical for Racking Layouts incl. over Bund Walls	727/009/Rack_Typical
Typical for Junction Box stands	727/010/Junction Box Stand

A2. FIBRE OPTIC INFRASTRUCTURE IDENTIFICATION STANDARDS – TYPICAL DRAWINGS

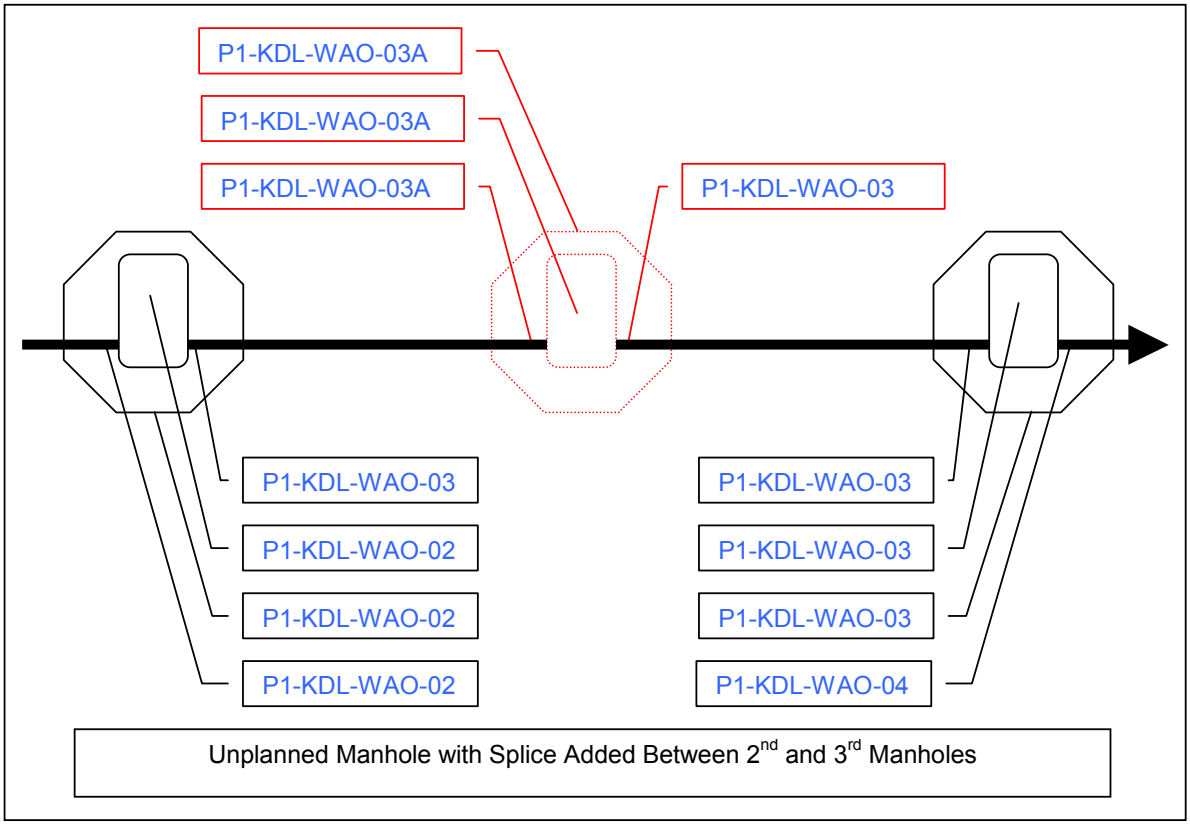








Planned Manhole with Express Joint to Motorised Block Valve Chamber



Unplanned Manhole with Splice Added Between 2nd and 3rd Manholes