ITS specification

Duct Supply and Installation (ITS-02-01)

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More information …

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Document management plan

1) Purpose

The purpose of this document is to specify the requirements for ITS power and communications ducting design, supply and installation.

2) Document information

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3) Key words

ITS Duct Supply and Installation Requirements

Record of amendments

Amendment number	Section amended	Description of change	Updated by	Effective date
0	All	ITS Draft Specifications Issue	TLH	20/9/2010
Draft R1	All	AMA Specifications Review	JF & TLH	25/1/2011
Final R2	2.2.1 2.3.1 2.4.1 3.2.1	Removal of NZTA imprint on Ducting, Addition of TDM section, change of dimension for protruding ducts. Trench Depth Detail	JF	26/06/11
Final R3	All	Updated following consultation comments	PTA	09/01/2012
Final R4	All	Final	BW & JS	14/02/2012
Final R5	All	Addition of DAS median duct, air-blown fibre and clarification of previously identified issues.	KF & TLH	2/12/2014
Final R6	All	Provisional	KF & TLH	11/02/2015

Contents

1.0 General

1.1 Scope

This specification sets out the requirements for the design and construction of the ITS Communications Infrastructure main ducts and the local power, fibre optic and control cable and feeder cable ducts.

1.2 Drawings

The attached standard drawings are provided for information to provide a basis for design:

- 000-0000-0-7104-01-R2 Jointing Chamber and Pulling Pit
- 000-0000-0-7104-02-R2 Detail of Duct Installation Highways and Motorways

Site specific detailed design drawings for all duct routes and details shall be provided for review prior to commencement of installation.

2.0 Cable Duct Requirements

2.1 General

Duct routes shall be kept as straight as possible.

Where curves are required, the natural flexibility of the duct shall be used to form the curve. The radii of the curves for 100mm diameter ducts shall not be less than 35 metres.

Where bends are required in the duct, a pull-pit or chamber shall be installed.

Ducts shall be extra high impact uPVC or flexible High Density Polyethylene (HDPE) duct complying with AS/NZS 2053.

In general, all duct installation shall be in open cut trench. Where crossings of existing roads or the like is required, directional drilling or thrusting of duct shall be used as the preferred means to install ducts.

Cover to ducts shall be as required for the duct situation as detailed on drawing 000-0000-0-7104-02-R2.

Marker tape shall be laid within the trench excavation not more than 300mm above the ducts.

2.2 ITS Backbone Ducts

2.2.1 Ducts

In general, the ITS Backbone ducts shall be in the highway berm parallel to the edge of the carriageway and ramp shoulders and outside any side protection barriers.

2.2.1.1 Urban Ducting

ITS backbone ducts shall be installed along the highway connecting to existing jointing chambers at each end. The ITS Backbone shall have:

a. Two 100mm nominal bore (NB) ducts coloured Salmon

b. One 100mm N.B. duct coloured Orange.

c. Chamber locations shall be as specified in NZTA ITS specification ITS-02-02: Jointing Chambers and Pull Pits section 2.1.1 Chamber Locations.

2.2.1.2 Rural Ducting

When ducts are installed for regional rural highways, depending on future need, the ITS backbone duct shall reflect the asset density required, proposed or projected along the highway.

If power for roadside assets is sourced locally and there is a low density of loop detectors the backbone ducting may consist of two ducts, or one duct.

A one-duct backbone shall comprise one 100mm N.B. orange duct containing four (4) 32mm internal diameter HDPE sub-ducts arranged as follows:

a. Three sub-ducts coloured salmon for fibre optic cable; and

b. One sub-duct coloured orange for low-voltage power cable.

c. Chamber locations shall be as specified in NZTA ITS specification ITS-02-02: Jointing Chambers and Pull Pits section 2.1.1 Chamber Locations.

2.2.2 Sub-ducts

Four 32mm N.B. sub-ducts shall be installed in one of the backbone fibre optic cable ducts.

Sub-ducts shall be PE duct, installed in one continuous length from jointing chamber to jointing chamber or from jointing chamber to pull-pit.

Sub-ducts shall protrude into Jointing Chambers and pull-pits by 400-600mm to allow for connection of hauling equipment.

2.2.3 Air-blown Fibre Multi-ducting

If air-blown fibre ducting is specified a suitable multi-duct shall be used. The multi-duct installation shall be appropriate to the requirements of the ducting network.

Where the ducting is installed either as part of a motorway or expressway backbone duct network, or alongside a rural Highway, it may either:

a. Replace one or more of the 32mm sub-ducts in the fibre duct. It shall run from joint-to-joint and the backbone micro-duct shall not be broken-out in pull-pits.

b. Be provided alongside the ATMS 100mm ducting.

Where only fibre is required and there is no foreseeable future requirement for non-fibre ducting, a suitably designed direct-buried multi-duct may be provided on non-motorway/expressway roads.

HDPE direct-buried multi-ducting shall be installed along the highway connecting to existing joint chambers at each end, for the backbone cable.

The main features of multi-ducting shall be:

- Four 12mm OD/10mm ID + five 5mm OD/3.5mm ID HDPE micro-ducts with ribbed surface inside tubes to reduce friction
- Low friction internal coating for maximum fibre blowing distance
- Ripcord
- Tracer wire or sheath
- Anti-rodent protective layer
- Nylon Layer
- Polymer Filler
- HDPE Outer Jacket (UV resistant) coloured “Salmon”
- 2km continuous lengths – minimise connectivity

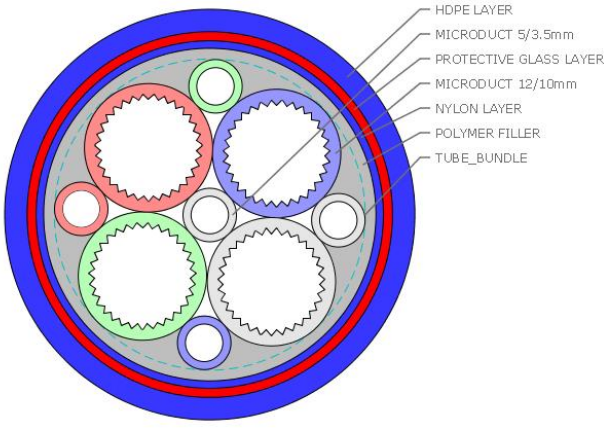


Figure 1. Example of a typical backbone multi-duct.

Chamber locations shall be as specified in the NZTA ITS specification ITS-02-02: Joining Chambers and Pull Pits section 2.1.1 Chamber Locations. Pull pits are not required for this type of ducting.

If the micro-ducting of one manufacturer is joined to the micro-ducting of a different manufacturer, the connector must be compatible to both ducting types. The installer must satisfy himself that the adjacent ducting types can be connected to manufacturer's tolerances for water tightness and continuity.

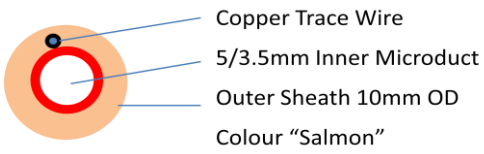
Blowing a fibre of one manufacturer through the micro-duct of another manufacturer may limit the distance the fibre can be blown due to differences in texture and coating compatibility between the outer surface of the fibre and the inner surface of the micro-duct. In this situation, the installer must first satisfy himself that the fibre can be blown the required distance.

2.2.4 Air-blown Fibre Micro-ducting

If the system in use for the ITS backbone is air-blown fibre, one of the 5mm OD/3.5 mm ID micro-ducts may be used where a spur cable runs on the backbone route. If the backbone route is not followed by the spur cable, the spur cable shall be in its own separate duct of equal ID.

A spur duct separate from the backbone duct shall be a one way direct-buried 5mm OD/3.5 mm ID micro-duct

Construction of the micro-duct shall be as shown below. Note: a trace wire is shown, but a sheath may also be used:



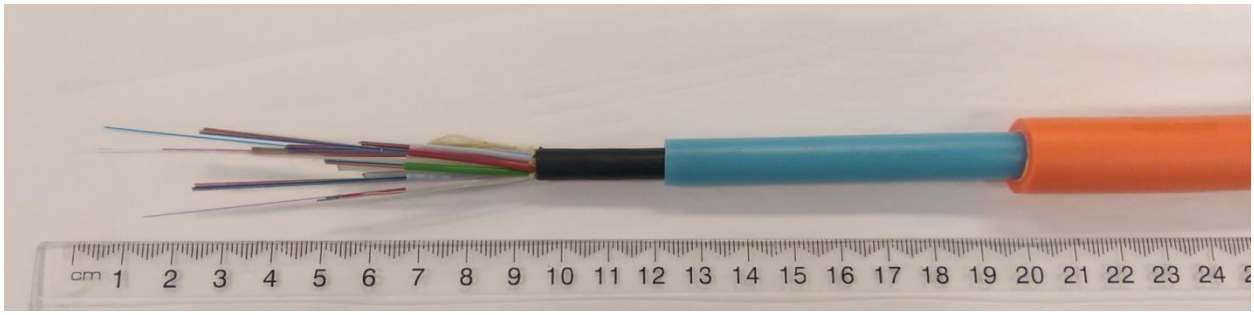


Figure 2. Example of a 96f micro-fibre in a single direct-bury micro-duct. The blue inner duct can be jointed using the appropriate connectors to a compatible micro-duct. The orange protective outer covering can be seen on the right.

2.3 ITS Roadside Cabinet Connection Ducts

2.3.1 Jointing Chamber Connection Ducts

Local duct connections from the ITS Backbone jointing chambers to roadside control cabinets shall have:

a. One 100mm N.B, duct coloured Salmon.

b. One 100mm N.B. duct coloured Orange.

c. Separate ducts for local power and control cable ducts as required for connections to the ITS systems equipment.

d. Any telephone cable ducts shall be 50mm N.B. duct coloured Green.

Duct connections into jointing chambers shall be made with straight ducts aligned directly to the roadside control cabinet.

2.4 Local Equipment Connection Ducts

2.4.1 ITS Equipment Connection Ducts

Local duct connections from the roadside control cabinets shall have separate ducts for power and data/control cables.

Duct connections into the roadside control cabinets and into ITS equipment supports or foundations shall be made with long radius bends, a minimum bending radius of 600mm is required for one 100mm duct (a factor of 6).

Local equipment connection ducting shall be installed along on-ramps and the urban roads for connection of assets associated with Ramp Signals to the ramp signal controller cabinet. The TDM ducts shall have:

a. One 100mm N.B, duct coloured “Salmon” running the entire length of the On-Ramp for local fibre and inductive loop feeder cable.
b. One 100mm N.B. duct coloured “Orange” running the entire length of the On-Ramp for power cable.

Chamber locations shall be as specified in ITS 02-02 Section 2.1.3 Chamber Locations and ITS 05-01 Ramp Meter Site Layout.

2.4.2 Cable Pits and Jointing (Toby) Boxes

The supply and installation of cable pits and the connection of ducts into the pits shall comply with NZTA ITS specification ITS-02-02: Jointing Chambers and Pull Pits.

2.4.3 Distributed Acoustic Sensing Ducts

The purpose of providing a fibre specifically for a distributed acoustic sensing role is to

a. Locate the fibre in a position where it will receive the best possible signal from passing traffic and,
b. Provide close coupling between the ground and the fibre in order that the fibre can detect as much traffic noise as possible.

There are two locations where the duct can be laid

a. Alongside the carriageway and as close to it as possible to the edge of the carriageway. This method is best used where there is a backbone fibre close to the opposite carriageway.
b. Along the central median. This method is best used where the backbone fibre is not close to the side of the carriageway and provides equal signatures from both carriageways.

For motorways and expressways with two lanes in each direction, a fibre located in the median provides the best signature frim both carriageways. The quality of this signature deteriorates as the road gets wider and busier, so for larger motorways, a fibre placed alongside each side would be the better solution.

The duct can be installed by any means, including thrusting, trenching, micro-trenching, chain-digging, mole ploughing or casting within the foundation of a concrete barrier. Slot-cutting may be used if an air-blown fibre micro-duct is used.

For loose tube fibre, the duct shall be a 25mm diameter duct containing a fibre of minimum 6 cores.

Where air-blown fibre is used, a 6mm internal bore will be optimal for a 2-core fibre to be blown for a distance of 3-4km. The duct shall be laid at a depth of 100mm to 130mm

A suitably robust duct shall be used that will not become damaged by the passage of maintenance vehicles if it not laid into a barrier foundation.

If a duct is laid in the foundation of a concrete barrier, chambers shall be provided adjacent to the barrier and connected to the duct under the barrier by using the natural curve of the duct itself.

The median duct shall be connected to the roadside backbone fibre with the use of cross-road structures (under or over) or by thrusting a duct beneath the carriageway.

Chambers may be provided at intervals up to 2km.

2.5 Draw-wires

Draw tape shall be installed in all ducts and within one sub-duct to facilitate the hauling-in of cable after the completion of the ducting.

Alternatively, each duct may be fitted with a pigmented, stranded polypropylene or equivalent rot-proof material draw cord of 5kN breaking load and having a design life of not less than 20 years, the ends of which shall be made fast within the chambers to which the duct is terminated. Draw cords shall be secured to the duct plugs. Draw cords shall not be knotted within ducts; where a joint is required it shall be a spliced joint.

All ducts and conduits used or unused shall be left with a draw-wire in place.

Draw-wires are not required for air-blown fibre systems

2.6 Trace Wire

A trace wire shall be installed either separately or integrated into one of the backbone fibre optic cable ducts in the space between the sub-ducts and the main duct

A trace wire shall be installed in all local fibre optic cable ducts.

The trace wire shall be a copper-based wire with at least two conductors of 1.5mm^2, individually insulated, overall insulated. This is not applicable to pre-installed co-extruded trace wire.

If an air-blown micro-duct contains a built-in trace wire or sheath, a separate trace wire will not be required.

2.7 Plugging Ducts

Cable ducts entering chambers shall be trimmed such that they protrude no more than 40mm from the chamber wall and sealed with Telecrete or similar to avoid water seepage.

After installation of cables, all duct (but not sub-duct or micro-duct) entrances shall be filled with a watertight, non-hardening sealant that can be removed as necessary in future to install more cabling.

All unused ducts, sub-ducts and micro-ducts shall be plugged with removable plugs or tight-fitting caps to prevent ingress of water and soil.

2.8 Above Ground Ducts

2.8.1 Concrete Encased Ducts

Where it is impractical to install ducts in trenches with the minimum cover requirements the ducts shall be encased in concrete.

Where the duct is above ground the concrete cover to the ducts shall be a minimum of 50mm of concrete below and on each side of the ducts and a minimum of 100mm on top of the ducts.

Concrete for encasing the ducts shall be minimum 17.5 MPa compressive strength concrete.

Mark all such lengths of encased duct at intervals of approximately 25m with the legend “ITS Cables” clearly imprinted a depth of 5mm in the concrete during finishing.

The concrete surface shall be trowel or float finished to provide a smooth surface.

2.8.2 Galvanised Steel Conduit

Where ducts are exposed above ground and not encased in concrete. Galvanised steel pipe conduit securely fixed in place with non-corroding, vibration resistant and UV stable fixings shall be used. The design of above ground ducting shall consider the ability to pull cables around bends and deviations in the duct (for example, at bridges). Access plates for cable pulling or jointing boxes shall be provided where necessary.

The size and numbers of galvanised steel conduits shall be sufficient to match the size and numbers of ducts provided for underground ducting connected.

All bends in the galvanised steel conduit shall be sweep bends with a minimum radius, which will be a function of the diameter of the tube and elongation required.

Bending radius = 0.5x diameter of tube / % elongation required. The % elongation =

- 42% for AKDQ steel
- 60% for annealed 304 stainless steel
- 33% for annealed 409 stainless steel

Screw joints shall be fitted at 90 degree bends so the bend section can be removed for cable installation.

The galvanised steel conduit shall be fixed with galvanised steel saddles at regular intervals of not more than 2.0m to the adjacent supporting structure.

All galvanised steel conduit shall be proved and have trace wire and draw tape installed.

Figure 3. Typical galvanised steel ducting on the side of a bridge.

Galvanised steel conduit shall not be attached to safety rails or rail posts or interfere with their performance in the event of a crash.

Duct installation

2.9 Handling

Duct shall be given adequate support at all times when being handled. Care shall be taken at all times when transporting it, loading and unloading to avoid sharp shocks, damage to ends of duct, or damage from sharp objects to the walls of the duct. Any duct damaged must be rejected.

When stacking uPVC duct, the duct socket ends shall to be placed alternately with the sockets protruding to avoid distortion of the duct. For long term stacking, each layer shall be separated with wooden packers, each at least 50mm wide, at 1000mm centres. No more than six layers shall be stacked.

2.10 Trenching

2.10.1 Excavation

All excavations for trenches shall be to the lines shown on the drawings and to such directions as may be given by the Engineer.

The excavations shall be open trenches unless the written permission of the Engineer is obtained for other construction methodology.

Not more than 100 metres of trench shall remain open at one time unless otherwise approved by the Engineer.

In excavating trenches any surfacing materials shall be salvaged and stockpiled as far as possible so as to be replaced after the trench has been backfilled. Any surfacing materials lost shall be reinstated by the Contractor at his own expense.

All spoil from the trench shall be kept away from the edge of the trench at the top to avoid overloading the trench sides and to comply with the HSE Regulations.

2.10.2 Surface Cutting

The edge boundaries of trenches and excavations shall be marked on the surface in a line type or coloured that is different from markings for existing services.

In sealed areas the sealed surface shall be neatly saw cut set back from the edge of the excavation. The setback shall be 150mm for a trench width of 30mm or less, and 300mm elsewhere. In unsealed areas the edge of the surface opening shall be kept as neat as possible.

Where the surface consists of cobblestones or pavers, these shall be carefully removed and stored for reinstatement. Any damaged paver units shall be replaced by the Contractor.

Should the sides of the excavation slump, or the surface surrounding the edge of the excavation become depressed, then the cut shall be opened wider until a stable sub-surface is found. This additional excavation shall be at the Contractor’s cost.

2.10.3 Dewatering Trenches

The Contractor shall maintain all trench bottoms free from flowing or accumulated water, so that all ducts can be bedded, laid and jointed in dry working conditions.

The Contractor shall provide sufficient labour and plant, and maintain all drains, pipes, pumps and sumps to keep the works clear of water to the satisfaction of the Engineer.

All water shall be disposed of to the approval of the Engineer and any damage caused shall be made good by the Contractor at its own expense.

2.10.4 Support of Trenches

All work involving excavations must comply with the requirements in the HSE Act and the HSE Regulations and OSH Best Practices.

Excavations shallower than 1.5 metres

Excavations shallower than 1.5m shall not necessarily be regarded as safe from the risk of collapse. The Contractor shall consider such excavations on a case by case basis and determine if special precautions or work methods are necessary.

Excavations 1.5 metres or deeper

Excavations greater than or equal to 1.5 m deep are particularly hazardous and must be supported or benched back to a safe slope, as determined by the Contractor, in accordance with the HSE Regulations.

2.10.5 Duct Installation in Trenches

The floor of the trench shall be clear of any obstacles and shall be as flat as possible. It shall be de-watered prior to installation of bedding material. If the bottom of the trench is naturally occurring rock, or has stones, gravel or other sharp material in occurrence, a 50mm granular layer shall be laid and compacted before the bedding layer is laid.

Bedding material shall be laid to 50mm minimum thickness (compacted) over the bottom of the trench. Bedding material shall be clean imported sand free of larger sharp particles conforming to GAP 7.

Ducts shall be jointed before laying at the side of the trench or immediately above it on timber supports. Prior to making the joint the duct checked for any internal damage or defects in the duct. Any damaged or defective duct shall be discarded.

The duct shall be carefully lowered, not dropped, onto the bedding material. Open ends of ducts shall be kept plugged to ensure material cannot enter ducts.

Ducts shall be laid with at least 50mm clearance to the trench walls, and shall be held in place with packers as required. The packers shall be removed progressively as the bedding material is laid over the ducts. Bedding material shall be laid over the ducts to a compacted thickness of 100mm.

Where more than two ducts are laid, they shall be laid with purpose made spacers and strapping which shall bind the ducts tightly in the formation during installation, backfilling and for the whole life of the duct. The spacing of the strapping shall be such that the ducts shall not separate by more than 50mm. This spacing would typically be 1m. Spacers shall not cause damage to the ducts during installation or in service. The spacer shall ensure that there is sufficient room for jointing collars.

2.10.6 Jointing Ducts

uPVC ducts shall be jointed with solvent cement of a type recommended by the duct manufacturer so as to form a “solvent weld” joint. HDPE ducts shall be joined using the best method recommended by the duct manufacturer to give a watertight seal. Prior to making the joint the duct shall be prepared by cutting the spigot end square and de-burring the inside and outside edges and the joint surfaces and components cleaned. Measures shall be taken to prevent soil or other material from entering ducts.

The ducts to be jointed shall then be dry fitted to ensure the inserted duct fits in at least two-thirds of the way into the socket. Each duct shall be anchored to prevent movement before the work is completed. Ducts shall not be jointed in adverse weather that may affect the quality of the joint.

The duct surfaces to be jointed together shall then be cleaned and degreased immediately before laying with a fluid recommended by the manufacturer. The solvent cement shall then be uniformly applied over

the surfaces to be jointed. The ducts shall then be connected and fully inserted without twisting the ducts, and any surplus cement wiped off. The joint shall be left for at least 10 minutes undisturbed to allow the joint to cure.

Solvent cements shall be kept in sealed containers at all times when not in use. Should the cement become contaminated with foreign material (dirt etc.), then it shall be discarded. Solvent cement is a volatile compound and shall be treated with care. Keep naked flames well clear of the cement, and ensure adequate ventilation at all times when applying it.

Ducts will expand and contract with temperature changes. To minimise the chance of joints pulling apart, when laying ducts in ground, the backing-filling shall be kept as close to the work face as possible. By doing this, the ducts will have normalised to ground temperature.

Where air-blown ducting is directly buried, direct-buried connectors sourced from the supplier of the ducting shall be used.

For 1-way direct buried 5mm OD/3.5mm ID micro-duct, remove adequate amount of outer sheath to ensure that the inner micro-duct is pushed past the O-ring in the connector, when joining or connecting to the air-blown fibre backbone duct.

Figure 4. Example of a direct-buried ducting connector being installed. These connectors allow a spur to be broken out of the duct line. The spur itself is broken out from the backbone fibre at an upstream joint. The spur fibre is thus blown from joint to asset through this connector. This enclosure is direct-buried into the trench (visible on the right). These are green ultra-fast broadband ducts.

2.10.7 Backfilling of Trenches

Ducts in trench shall be backfilled over as soon as is practicable after they have been laid, bedded and jointed as specified.

Excavated materials shall only be used for backfilling where the excavation to be backfilled is in a grassed or planted berm.

In sealed or unsealed roadways, driveways or footpaths hardfill shall be used and the surplus excavated material disposed of off the site.

Hardfill shall be GAP 65 laid in layers not exceeding 200mm and each layer compacted to a density of 90% of the optimum dry density as defined by test 4.1 in NZS 4402.

Full use shall be made of hand operated compaction tools on each side of the ducts and within a height of 0.6m above the crown of the ducts. Heavy construction equipment and heavy compaction plant shall not be operated over or near the ducts until backfilling is completed.

Compaction requirements for fill material and the specification for the types of allowable fill material shall be as per NZS/AS 3725.

2.11 Directional Drilling or Thrusting Ducts

Ducts for cables under trafficked carriageways shall be installed by directional drilling or thrust boring.

The directional drilling or thrust shall be made to provide a minimum cover of 2.0m at any point under a carriageway along the length of the duct installed.

Before the design is complete, the designer must satisfy himself that sufficient space is available to set-up the drilling rig in order to reach the required depth before the drill passes beneath the carriageway. Additional permission may be required from adjacent landowners outside the highway designation for temporary access.

The duct routes installed by directional drilling or thrusting shall be kept as straight as possible.

All pits required for directional drilling or thrusting shall comply with the requirements for excavation and shall be kept as small as possible.

The ground surface at these pits shall be reinstated to the same condition as the adjacent surface.

Open ends of thrust ducts shall be kept plugged to ensure that material cannot enter the ducts.

Spoil from the drilling machinery and excavations shall be contained within the site, and shall not be permitted to enter storm-water drains, natural drains, streams etc. The Contractor shall remove all spoil from site at completion of drilling/thrusting at that site.

The minimum duct size for cross-carriageway thrusts is 100mm.

2.12 Jointing Chambers and Pull Pits

The supply and installation of jointing chambers and pull pits and the connection of ducts into the chambers and pits shall comply with NZTA ITS specification ITS-02-02: Jointing Chambers and Pull Pits.

2.13 Proving Ducts

All ducts installed shall be proven as intact and free of obstacles by drawing a suitably sized mandrill through the length of the duct, once installation of the duct is complete. Any damaged areas shall be excavated, removed or repaired and re-tested until a satisfactory test is achieved.

Air-blown fibre ducting shall be tested for continuity using an approved method (such as the ball chain test method) and pressure tested as per manufacturer's recommendation.

3.0 Appendix A: Drawings

Jointing Chamber and Pulling Pit	000-0000-0-7104-01-R2
Detail of Duct Installation Highways and Motorways	000-0000-0-7104-02-R2

Jointing Chamber and Pulling Pit

Detail of Duct Installation in Highways and Motorways